

# The Scholar

Issue 7 + 8  
December 2017  
[thebrilliantclub.org](http://thebrilliantclub.org)

SPECIAL  
EDITION  
**Bumper  
Pack!**

***If I was given the  
opportunity, would  
I go to space?***

+

***43 new academic  
essays from Brilliant  
Club young scholars  
in this special edition***



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# The Brilliant Club

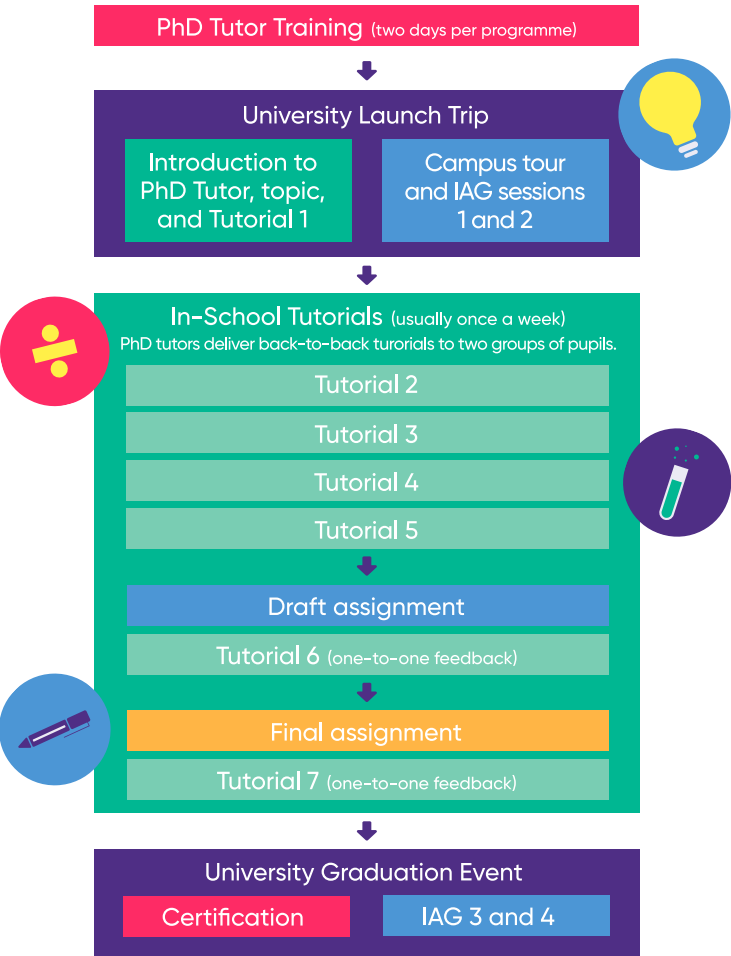
## What is The Brilliant Club?

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 10,000 pupils from over 550 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 a very special edition of The Scholar!

This edition is a bumper pack, containing 44 fantastic articles authored by Brilliant Club pupils. For the first time, it includes work by pupils who completed Uni Pathways, the university access course led by our Researchers in Schools participants. Researchers in Schools is the UK's only teacher training programme exclusively designed for PhD graduates.

The map to the right shows the locations of all our pupils featured in this edition of The Scholar, including one pupil in Glasgow, Scotland! The Brilliant Club aims to make its programmes available to any school that wants to take part and we are committed to serving rural and coastal areas, as well as inner cities.

In November, the State of the Nation report was released by Government and featured a case study of The Brilliant Club's work in rural and coastal areas. Of the 10, 500 pupils we work with, one fifth are in rural schools. We are very proud of our work in these communities and will continue to work with our partner universities and fantastic tutors to deliver excellent programmes to rural and coastal schools in 2017/18!

Across are some brief updates from The Brilliant Club on our forthcoming podcast, Uni Talks; The Scholars Programme and Researchers in Schools.

We hope you enjoy this edition of The Scholar, The Brilliant Club's academic journal dedicated to the work of state school pupils. If you would like more information on The Brilliant Club and how you can get involved, please visit our website at [www.thebrilliantclub.org](http://www.thebrilliantclub.org) or send an email to [hello@thebrilliantclub.org](mailto:hello@thebrilliantclub.org). Thank you!



The map above shows the locations of all pupils featured.

Updates

# News from The Brilliant Club

## Scholars Programme pupils now benefit from an extra feedback tutorial

Pupils on The Scholars Programme are now able to attend an additional one-to-one feedback session with their PhD Tutor! Research and evaluation conducted by the Research and Impact Department at The Brilliant Club has demonstrated that the additional feedback session supports pupils to attain the most value from their university-style learning experience.

The Scholars Programme team are busy working with schools and tutors to make sure that as many pupils as possible get to take part in the programme in the spring and summer terms. We are now almost fully subscribed for 2017/18 so if you are a teacher interested in running The Scholars Programme in your school, do get in touch as soon as possible with the relevant contact below:

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## 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).

## The Brilliant Club announces its new podcast, UniTalks

The Brilliant Club is preparing to release its new podcast UniTalks in January 2018! Created in collaboration with the Institute of Arts and Ideas, UniTalks aims to answer many of the questions that pupils may have about applying to and studying at university. Aimed at Key Stage 4 and 5 pupils thinking about applying to university, the podcast will see Brilliant Club pupils interrogate leading thinkers from the UK's best universities about their subjects and academic experience.

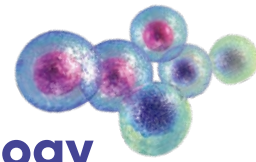
UniTalks will also feature a university agony aunt section, where the admissions team at King's College London will answer questions submitted by pupils from across the country, covering topics like university finances, choosing a course and moving out of home.

We believe the podcast will be an exciting resource for pupils and teachers so do look out for UniTalks in 2018!



## Research Highlights

## nature research



## Climate Change

## Lasting heavy rains to come

The volume of rain produced by individual storms is projected to rise in the coming years thanks to global warming.

Rainfall is expected to become more intense in a warming world, but how the duration of discrete events might change has not been clear. David Neelin at the University of California, Los Angeles, and his colleagues used a global climate model and statistical theory to analyse how the upper limit of water accumulated in individual rainfall events might change in a warming climate. They found that if temperatures rise by 3 °C above preindustrial temperatures, the probability of the largest regional precipitation events observed in the past increases as much as tenfold in most regions. By the end of the century, unprecedented accumulation of rain water could pose a challenge to societies' capacity to adapt to a shifting climate, the authors say.

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

## Developmental Biology

## Human–pig embryo made

Human stem cells can integrate into developing pig embryos, a finding that could lead to new ways of growing human organs and studying early human development.

Previous attempts to engraft human stem cells into developing mice have met with limited success. Juan Carlos Izpisua Belmonte at the Salk Institute for Biological Studies in La Jolla, California, and his colleagues instead worked with embryos of pigs, which are biologically more similar to humans. They injected various types of human pluripotent stem cell – which can develop into any cell type – into balls of cells called blastocysts that become embryos. Early-stage human pluripotent stem cells integrated into the blastocysts, but only stem cells injected at an intermediate stage of maturity went on to form later-stage embryonic chimaeras, which contained appreciable numbers of cells from both species. The researchers also grew rat stem cells into organs in mouse embryos by eliminating the development of certain mouse organs – a technique that could be applied to human–pig chimaeras to generate human organs in the future.

Cell 168, 473–486 (2017)

© 2017 Macmillan Publishers Limited, part of Springer Nature. All rights reserved. 3D rendering of a T cell. Credit: CC BY 3.0. Blausen.com staff. "Blausen gallery 2014." Wikiversity Journal of Medicine. DOI10.15347/jvrm/2014.010. ISSN 20169623. Read more at: <https://phys.org/news/2017-12-cells-infections-decades.html#p>

## Astronomy

## A leisurely way to visit the stars

Plans to explore the nearest star system rely on light sails – reflective panels that are propelled by light. These craft travel so fast that they will have little time to explore their destination, but altering the way the sails are used could help. An Earth-sized planet orbits Proxima Centauri, the Sun's nearest neighbour, which is 1.3 parsecs (4.2 light years) from Earth. Astronomers hope to send a fleet of miniature probes to explore it and the neighbouring twinned stars of Alpha Centauri. Under current proposals, these laser-propelled craft would take 20 years to reach the stars and zip past them in just a few hours (see Nature 542, 20–22; 2017). But René Heller of the Max Planck Institute for Solar System Research in Göttingen, Germany, and Michael Hippke of Neukirchen-Vluyn, Germany, say starlight could be used to slow down a sail-carrying probe, allowing more data about the planet to be collected. In their proposal, the sail would shift direction as it passed Alpha Centauri so that starlight and the stars' gravitational pull could slow it down.

The probe would then swing into orbit around Proxima Centauri, allowing multiple fly-bys of Proxima's planet. Using this set-up, a probe would take roughly a century to get from Earth to Alpha Centauri, and another half-century to reach Proxima.

Astrophys. J. 835, L32 (2017)

## Infection

## How malaria boosts its spread

The malaria parasite produces a molecule that affects red blood cells, luring mosquitoes to bite infected people, and may enhance the parasite's spread. Ingrid Faye at Stockholm University and her colleagues found that the parasite Plasmodium falciparum produces a metabolite called HMBPP. This stimulates red blood cells to release carbon dioxide and other gases that together attract the Anopheles gambiae mosquito, a major malaria vector. The mosquitoes preferred human blood containing HMBPP, ingesting larger amounts of this than HMBPP-free blood. Mosquitoes consuming malaria-infected blood laced with extra HMBPP also had more parasites in their salivary glands than did those ingesting just infected blood, suggesting that the molecule boosts the insects' susceptibility to infection. HMBPP altered the expression of certain neural and immune genes in mosquitoes, supporting the idea that the molecule changes mosquito feeding behaviour and immune function to support malaria transmission.

Science <http://doi.org/bzkw> (2017)

## Guest Article

## Aim High and Apply

Professor Tim Leuning

Associate Professor of Economic History, LSE  
and Former Chief Scientific Advisor, Department for Education



Twenty-nine years ago I applied to Oxford. That decision changed my life. For many young people, applying to Oxford is what you do. Your friends do it. Your parents did it, your grandfather did it, and so you do it.

But top universities are for everyone, not just – or even particularly – for people who expect to go to one.

I was the first person in my family to go to Oxford. In fact, I was the first person from my family to go to University. I came from a single parent family, and my mum worked as a cleaner and in retail and wholesale. I was on free school meals. It didn't matter: I enjoyed (almost) every minute at university, and an Oxford degree opened doors that would not otherwise have been open.

My advice, based on my experience, is simple: aim high, and apply. You have nothing to lose. What is the worst that can happen? You get rejected. The honest truth is that, given the number of applicants, most will be rejected. But even if that happens, you are not worse off than if you had never applied in the first place. That is why I say that you have literally nothing to lose.

I have been a tutor for admissions at three universities. I know that I never let in a weak candidate. I also know that I rejected some outstanding people. If you have 50 places, and 500 candidates, many who are rejected will be outstanding. So if you are rejected, hold your head up high and remember, there is a lot of luck in these things. No selection process is perfect.

And some of you will get in, and if you get in, the chances are that you will be successful. Top universities reject good people all the time. We (virtually) never let in weak candidates. So if you get the offer, be confident that you are good enough.

People talk a lot about tips to get in. My advice is simple: be yourself. No university has a "perfect student" against which they judge all candidates. We know that applicants come in all shapes and sizes, literally and metaphorically.

There is no evidence that playing the cello, or captaining the rugby team, or doing six weeks saving the rainforest in Borneo increase your chances of getting an offer. Universities want clever people – good grades, in sensible subjects, who are interested in the course. There really isn't much more to it than that.

Universities understand that your school may not have been perfect. I once had a student at LSE who had an A\* in maths GCSE, and an E in physics. Indeed, his grades were all over the place. But he had enough A\*s that we could tell he was bright and hard working. We judged that his school taught physics badly, and that was why he got that grade. (We were right: his school went into special measures shortly afterwards, and has since improved). So don't worry if you don't have a perfect set of grades. Some good ones are necessary, but perfection is not.

Broadly speaking, straight Bs at GCSE (or a mix that averages to straight Bs) means that you should be looking at a selective, recruiting university. Your school, and others, can give you more detailed advice on what is plausible, given who you are. If you have those grades, don't just follow your friends, or go to the local university. Rightly or wrongly, employers really care about which university you go to. A degree from a more prestigious university is worth having. Aim high – and good luck!

Professor Tim Leuning



# STEM

## The climate has always been changing, so humans cannot possibly be responsible for the current climate change. Discuss.

Year 8, Key Stage 3

D. Hutchinson, Helston Community College, Cornwall  
Supervised by K. Unglert, University of Exeter

Climate change is when the average weather pattern in a certain region (or, in this case, on a global scale) alters. An example of climate change is the strong increase in Earth's temperature since 1950, which is known as the Great Acceleration [1]. There has been debate ever since the idea of human-induced climate change was introduced: could humans really have caused Earth's climate to change? Earth's climate has been fluctuating between glacial and interglacial periods for millennia before humans existed. Therefore, one can ask, if our planet's climate can change so significantly due to natural phenomena, are we even impacting the climate at all? However, there is plenty of evidence to suggest that human-induced climate change is having a substantial effect on our climate.

Earth's climate has constantly changed and evolved alongside our planet. Major changes to the planet have impacted and altered the climate. There are many natural processes that encourage climate change. Volcanic eruptions prevent solar radiation from reaching Earth's surface due to the ash and sulphur dioxide which is released. The sulphur dioxide released during eruptions collects in the atmosphere and forms clouds of sulphate aerosol particles, which will remain in the atmosphere for around two years [2]. The Sun is one of the main natural climate drivers and goes through cycles of giving off different levels of solar radiation due to the number of sunspots that are present on its surface. The movement of the continents and tectonic plates can alter the climate by either creating or blocking ocean currents. Orbital changes of our planet change how close we are to the Sun and therefore the amount of solar radiation that we receive. Alterations in ocean currents (such as the Gulf Stream) can change how heat is distributed around Earth. Those are just a few natural factors that can greatly impact the climate.

An example of how our planet's climate has significantly changed, due to natural factors, is the Karoo Ice Age. The Karoo Ice Age (or the Permo-Carboniferous glaciation) occurred on Earth from 360-260 Ma (million years ago). This was during the Palaeozoic Era. The climate was extremely cold and a large proportion of the Southern hemisphere was covered in continental glaciers. The majority of the land on Earth was positioned in the Antarctic region; the continents were not situated where they are currently. This meant that there were not expanses of ocean between the land masses. Therefore, the albedo (and consequently the climate) would have varied from what it is today. The albedo is how much

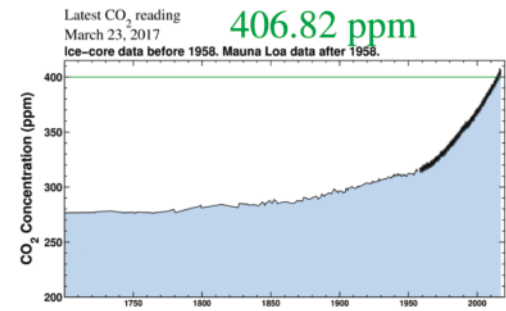
solar radiation is reflected by a surface. For example, ice has a very high albedo because the majority of incoming solar radiation is reflected, whereas the ocean has a very low albedo because it absorbs, rather than reflects, the majority of incoming solar radiation. [3]

The main factor that caused the Karoo Ice Age was the fact that the initial land plants were emerging. The number of plants continued to rise because plants produce oxygen during photosynthesis and also use carbon dioxide in respiration. The increase in the level of oxygen in the atmosphere, meant that further plants grew and the cycle continued. This is an example of the positive feedback effect. The introduction of plants to Earth, meant that CO2 levels were decreasing. This is because plants take in carbon dioxide and they also absorb and store it. Carbon dioxide is one of the major greenhouse gases, the more greenhouse gases there are, the more solar radiation is retained and the hotter the climate gets. Consequently, the reduction of CO2, resulted in an increasingly cold climate across Earth. Due to the fact that the snow and ice (from previous winters) couldn't melt, the surface frost, snow and ice started to gather and, over time, formed vast glaciers. These glaciers had a very high albedo, which reflected the majority of solar radiation back into space. The combination of low atmospheric levels of CO2 and the high albedo of the ice, meant that temperatures dropped further still and Earth was plunged into an ice age.

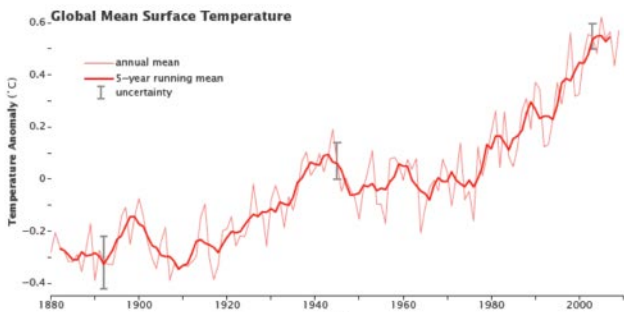
However, plants cannot survive in extremely cold temperatures and the majority of water was stored as ice. This meant that plants stopped photosynthesising and growing. As the number of plants decreased, the levels of CO2 increased and the Karoo Ice Age was reversed. Overall, the main cause of the Permo-Carboniferous glaciation was the introduction of the first land plants. These altered CO2 levels within the atmosphere, which therefore drastically changed the climate over time. To put this major alteration into perspective, this dramatic cooling happened 360 - 260 million years ago and yet humans only began to appear on Earth between 5 million and 7 million years ago [4]. This proves that our planet is capable of altering its climate without our contribution.

Even though the climate can vary due to natural phenomena, human activities can enhance natural processes and exacerbate climate change. One of the main ways in which humans are contributing to climate change, is by increasing the levels of greenhouse gases in our atmosphere. This enhances the greenhouse effect. The natural greenhouse effect is when a layer of greenhouse gases in the atmosphere (which include methane, carbon dioxide and water vapour) trap solar radiation and heat up Earth. Without the greenhouse effect, the majority of solar radiation, and therefore the Sun's heat, would be reflected back into space. Human activity gives off these gases in many industries: cattle ranching, cement making, manufacturing, vehicle emissions and the generation of electricity to power electrical appliances are just a few examples of the sources of these man-made greenhouse gases. As the demand for electricity increases, the volume of fossil fuels being burnt to generate this electricity will rise and the amount of greenhouse gases given off when these fuels are burnt will escalate. How can we be certain that the rise in greenhouse gases and specifically CO2 in the atmosphere is a consequence of human activity?

There was a strong escalation in global temperature at around 1950 (see graph below). This coincides with the vast increase in the number of automobiles and factories and power stations across the globe.



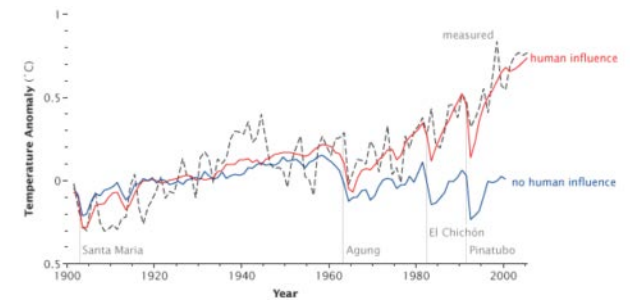
This graph shows the strong escalation in CO<sub>2</sub> levels at around 1950. [5]



This graph shows how the global temperatures also escalated at approximately the same time as CO<sub>2</sub> levels rose. [6]

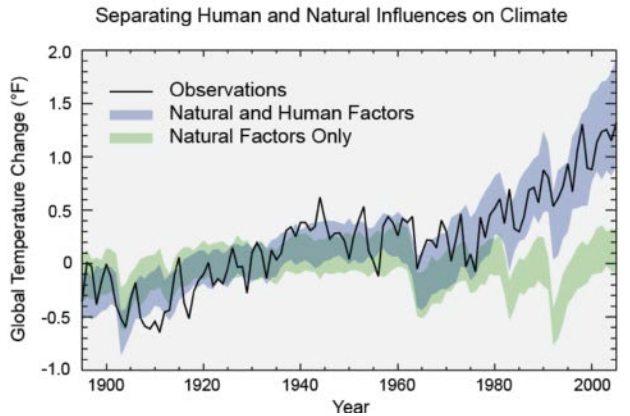
These graphs give evidence to support the suggestion that there is a strong correlation between the increase in atmospheric CO2 levels and the rising global temperatures. Due to evidence such as this, the name Anthropocene was suggested by Paul Crutzen (2000) for a new epoch. In 2011 he said: "This name change stresses the enormity of humanity's responsibility as stewards of the Earth." The name Anthropocene describes how humans are now the prime drivers of our climate and how natural processes only contribute (rather than control) the climate. Many geologists believe that the significance of humans driving our climate should be made known and a new epoch (the Anthropocene) should be adopted as a formality. To officially declare a new epoch on Earth, a signal has to be found which will be present in the layers of rock that are currently forming. This will then be distinguishable for future generations to identify the transition into the Anthropocene. Just a few of the signals that the scientists are considering to signify the transition into the proposed Anthropocene are: plastic or aluminium molecules in the rock, increased carbon dioxide levels within the rock or the radioactive particles from nuclear bomb testing. All of these particles would be evident in the rock formations/deposits. These particles are all from the mid-1900s and the early 21st century, which is when the proposed new epoch will be listed as commencing. A location also has to be determined which will define the commencement of the new epoch (despite the fact that the signal has to be found globally.)

When the current climate change is compared to how previous trends would have predicted it to have altered, it is clear to see that human interference is most definitely driving our climate:



This graph shows the impact of human activity on the climate compared to what the climate would be without human interference. [7]

"The climate has always been changing, so humans cannot possibly be responsible for the current climate change." This is a common misconception and there is plenty of evidence to counter this belief. Whilst the blame cannot wholly be placed on human activity, the Great Acceleration would not have occurred purely because of natural contributors [1]. Even though natural factors, such as orbital changes and sunspots, have affected the climate previously and will continue to do so, they no longer drive the climate. Instead, natural factors have been overtaken by human activity, such as mass manufacturing and transport which rely heavily on burning fossil fuels.



This graph shows how the combination of both human and natural contributors have led to an increase in global temperature. It also shows that without human interference, there would only be a very slight increase in global temperatures rather than the 0.8°C increase that has occurred since 1880. [8][9]

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### PhD Tutor's note

It was a pleasure to work with the students at Helston Community College. They were enthusiastic about the opportunity to participate in the course, and excited to learn about new topics. D's essay was particularly impressive in the way she combined her thorough understanding of human-induced climate change with her excellent writing style. She was able to put some newly acquired referencing skills into practice, and even included and discussed some graphics to illustrate her points - just like a trained scientist would!



# Are Bacteriophages a Feasible Alternative to Antibiotics?

Year 9, Key Stage 3

F. Harris, Countesthorpe Leysland Community College, Countesthorpe. Supervised by A. Ramachandran, University of Leicester

At present, there are increasing cases of bacteria becoming resistant to antibiotics. This could either be a result of bacteria becoming immune to multiple strains of antibiotic (Alanis 2005) all at once (named “superbugs”) or sometimes, if more than one course of antibiotics is taken due to a return of the infection, the resistant ones that remain from the previous infection will replicate. Their daughter cells will have the same resistance and will likely not be killed by the antibiotic. Due to the urgency of this situation, scientists have begun to research new methods of clearing infection. Unfortunately, as a result of the takeover of antibiotics during the 1930s and onward, following their accidental discovery by Fleming in 1928 (Davies 2010), little time and research has been put into any alternatives – including phage therapy.

Phage therapy was originally used predominatly in the global East, for example in Russia and it’s surrounding countries. However it was mainly used to prevent the infection of wounds, cuts and injuries, not medicinal or therapeutic uses like it is being researched for today.

Bacteria phages are an alternative to antibiotic treatment. These are bacterial viruses that enter the host cell and kill it. Their name literally translates to “Bacterium eater” and there are three types of phage: Siphoviridae, which have the longest tail, Myoviridae, which have a shorter tail than the Siphoviridae, and Podoviridae, which are considerably smaller than the other two. These phages vary due to their nucleic acid properties, which is their DNA that has two strands. Phages have two different life cycles that they occasionally switch between: the lytic cycle and the lysogenic cycle.

The lytic cycle will produce more phages and lyse (break open and kill) the host bacteria cell. The cycle consists of three phases. When the lytic cycle is induced, the proteins and DNA are synthesised and put together within the host cell into multiple new phages. In turn, the cell lyses and these new phages are released causing these new phages to find a new host cell. The phage then injects its DNA into a new host cell and the cycle repeats. However, sometimes the phage can slip into the lysogenic cycle as a result of different factors acting upon it. Firstly, the phage’s DNA fuses with the chromosomes in the bacterial cell becoming a “prophage”. Then, the bacteria will reproduce normally, except each daughter cell will contain the prophage also. Sometimes, the prophage will come out of the chromosome and will trigger the lytic cycle.

Phages are very specific, in fact, they are host specific and will only lyse a certain kind of bacteria for example the bacteria, *Bacillus anthracis* can only be lysed by phage lysin PlyG and *Staphylococcus aureus* can be lysed by bacteriophage MR11 (Strauch, 2006).

A positive of phage therapy is that patients will only need a single dose as they are self-replicating (Kutateladze, 2010)

and can also be combined with antibiotics in treatment and cause no adverse effects on those it is administered to. This will reduce the amount of antibiotics used, creating less chance for bacteria to become resistant. It would also be cheaper as viruses are the most abundant life form on Earth and they are very fast-acting.

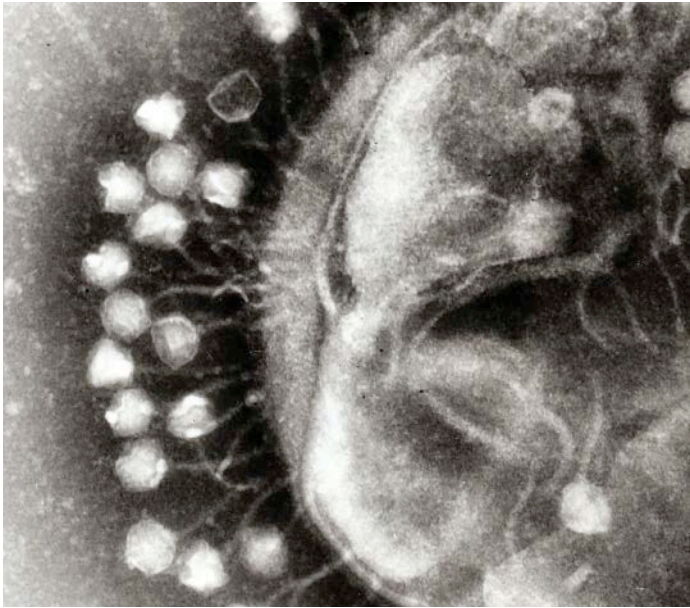
On the other hand, the phages could get stuck in the lysogenic cycle and there is uncertainty of when the phages will re-emerge and enter the lytic cycle which would mean that the illness would be getting worse as the bacteria replicate within that time. Bacteriophages would not be good in this way as the patient could get a lot more ill before any recovery occurs and would be more effective in combination with antibiotics. Another negative would be that if the phage cannot mutate with the bacteria as it changes, it won’t keep up and it could take a very long time to clear the infection. Although, there is proof that phages have been co-evolving with the bacteria for more than three and a half billion years (Sulakvelidze, 2005) and so if phages were to be used in a phage “cocktail” comprised of multiple phages, it would be able to deal with most, if not all, strains and mutations of that bacteria species.

It has been proven that bacteriophages do lyse bacterial cells in the stomach as, a group of scientists carried out an experiment on *E.coli* in the gut of mice (Skumik and Strauch, 2006) . The results showed that all the cells were lysed by at least one of the phages within the cocktail and they have also been shown to not be toxic or have any adverse reactions with the human body itself (Housby, 2009). This was proven by studies by Ochs *et al* and the phage had no adverse effects when administered on the people. This could be contradicted by the fact that occasionally, the body has had reactions to the phage therapy in a way similar to allergic reactions. For example, the body’s antibody response to some of the phage proteins has sometimes been known to kill the phages before they can do their job (Summers, 2012) or sometimes they reacted with the substances within the gastric passage ways or with the bacteria’s natural resistance to the phages.

Also in vitro (in laboratory conditions) phages have seemed to work well but when tested in vivo, or in living organisms, they haven’t been so effective and there is a lack of knowledge as to why this might be. It is this lack of knowledge that makes the public unsure of phage therapy (Summers, 2012). Many people that don’t understand phage therapy think of it as putting a virus inside of you and, to many, this is an uneasy or somewhat scary concept to grasp without the knowledge of what it actually is. If the public aren’t going to warm to the idea of phage therapy, there needs to be more research carried out to prove that they genuinely work on humans, in real life.

Even though there is much evidence that bacteriophages are non-toxic to humans, there is also evidence that there is a slight chance of the opposite. It is said that a rapid induction of phages by the spleen or contamination of the phages before treatment (Inal, 2003) could lead to toxic genes being taken in by the body, therefore it is essential to know which type of phages to use as a wrong decision could lead to toxic genes implanted in the body. These genes were discovered in phages in 2002 by Boyd and Davis. The genes that were found were CTX genes or Cholera toxins (Inal, 2003) which are extremely harmful to the body. Saying that, there is only a miniscule chance of this actually occurring. Bacteriophage therapy is extremely flexible and can

be modified to the newly mutating or resistant bacteria (Sulakvelidze, 2001). This means that they are quicker to isolate or produce than creating a whole new antibiotic medicine for a newly resistant bacteria as antibiotics take a lot longer to chemically put together than to find a new phage or for an old one to mutate. There is likely to be phage resistance in the future though (Sulakvelidze, 2005) and as there wasn’t much understanding of phages when they were first discovered, or any need for understanding due to antibiotics, there still isn’t much knowledge today and so phage therapy isn’t as advanced as it could be (Sulakvelidze, 2005). As well as this, it is suggested that the original founders of phage therapy were not very thorough and “sloppy” (Summers 2012), they did not research it properly and “convinced” themselves that it worked because they desperately wanted their idea to work. This shows “wishful thinking” not the scientific evidence which is still being sought for to this day (Summers 2012).



In this electron micrograph of bacteriophages attached to a bacterial cell, the viruses are the size and shape of coliphage T1.

Also, there is a possibility of phage resistant mutants (Kutateladze 2010) which would not be lysed by the phage therapy. This, however would be a perfect opportunity to combine the phage therapy with the antibiotic treatment as there are no adverse effects of combining them and using them as a joint treatment. Although phages are host specific and this is a good thing as it doesn’t wipe out the natural microflora in the gut or any other part of the body you are treating, it does mean that it is very easy for the bacteria to mutate and not be able to be killed by the host specific phages. Luckily, scientists have developed CRISPR technology which is a gene changing enzyme which can speed up the mutation of the phages to match the mutation of the bacteria making it so the bacteria cannot mutate fast enough to get far enough away from the phages so they cannot be lysed by them. Having said this, sometimes this CRISPR technology can work against the phage therapy (Barrangou, 2007), not with it. This is because it could either have the same effect on the bacteria, making them mutate too far ahead, or make the phages mutate to fast, so, being host specific, they could no longer lyse their specific bacteria. CRISPR technology is a work in progress and could help or hinder phage therapy. Also, at the time of the first discovery of phage therapy, it wasn’t as effective as there was a lack

of understanding in that time period and that could have affected our opinion of its usefulness today.

I think that bacteriophages are a feasible alternative to antibiotics because they are host specific and can prevent immune system weakening which is an effect that broad spectrum antibiotics can have due to the loss of digestive bacteria. Also, I think that they need to be used more frequently as then there will already be an alternative when antibiotics are no longer effective at all or at least in combination to reduce the amount of antibiotics used. On one hand, I think that a more reliable method than phage therapy would be more useful as the phages could get stuck in the lysogenic cycle, but they could potentially be used alongside antibiotics and so would have more of a positive and efficient result than just on their own. I believe that they are a very useful alternative and if there were a way to make sure they were more reliable, they would definitely be a treatment that would help many people and stop the pathogenic bacteria becoming increasingly resistant to antibiotics.

However, due to the lack of knowledge and evidence proving that they work, I think that they would need to be researched more and scientifically proven (like the scientists at the Royal Society who said “a new era in science based only on observation and direct experience”) to show that they would be more effective than antibiotics. One thing that almost makes me disagree with them is their specificity which is good for natural microflora but is tricky and takes a long time to isolate and match the correct phage with the bacteria. Getting it wrong could be costly and it will take a while to make phage therapy as advanced as antibiotics are nowadays.

Overall, the positives outweigh the negatives as many of the bad things about them only have a slight chance of occurring, just like intolerances and side effects we already have with regular antibiotics. I believe they are a useful alternative and should definitely be used in collaboration with antibiotics.

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## PhD Tutor’s note

F. Harris from Countesthorpe Leysland Community College produced an outstanding final assignment on bacteriophages and their potential to replace antibiotics. She clearly understood some complex ideas, which she wrote about in a very well-structured manner. F. went out of her way to do extra reading and research which shone through in her excellent essay, allowing her to achieve a 1st meaning that in Year 9 she was already performing to an excellent standard at A Levels.



# Privacy Enhancing Technologies

Year 9, Key Stage 3

L. Ho, Haberdasher's Aske's School, London  
Supervised by C. Bradley, UCL

Privacy enhancing technologies are services which can boost your security when you are on the internet. This can range from encrypting your messages, finding your personal information or keeping all the data you have secure. One example of privacy enhancing technologies is a mix network. I will be explaining how Tor (a type of mix network) provides security for people who use it, how efficient mix networks are and evaluating whether Tor should be illegal or not.

Tor (short for The Onion Router [1]) is a server, which enables users to go on the internet anonymously. They are used by individuals who want to visit websites without worrying if anyone is tracking them and some people use Tor to have access to the dark web. People who use Tor can browse the internet anonymously by hiding their IP address as they use the mix network. The service takes their IP address and then gives them a random IP address granting them anonymity on the web. Whenever you want to go to a website, there's never any direct interaction between your computer and that website. As you go to that website, the request is passed through two middle relays (the computer where they pass on the information/request) before reaching the exit relay (the computer, which passes on the information to the website [2]). When it reaches the exit relay, that request is given to the website and the information the website provides is passed through the chain to the computer wanting to go on it. Mix networks heavily rely on the people using their server; the more people using the server the harder it is to track the different relays. For example, if there were 1 million users currently on Tor it would be incredibly difficult to track where one path is going because there are numerous other paths intercepting it. Since they have a random IP address they can browse the internet without having others tracking them down. Furthermore, when you utilize the mix network you can go to websites that normal search engines, such as google, can't access. Because they can go to different websites (than normal search engines), their URL are '.onion'.

One weakness of Tor is that they don't encrypt any of the user's messages. This means if Alice (the sender) sends a message to Bob (the receiver) and someone intercepts it they can read those messages and share it with the whole world. An example of this occurring was on the 9th of October 2007, when a security researcher intercepted thousands of emails and leaked their messages, usernames, and passwords. The security researcher intercepted all those messages by hosting five exit relays [4]. Because he has done that every time someone sends messages and it goes to the exit relay, he can take that message making sure he can read it and not the receiver (Bob). This news shows that the weak spot in Tor is their exit relay as that's the one place where the information there is exposed to the whole Tor network and those hosting that exit relay [4]. The fact that Tor doesn't encrypt their messages lead to thousands of user's emails being leaked and shows how that network has failed to provide good security for their customers.

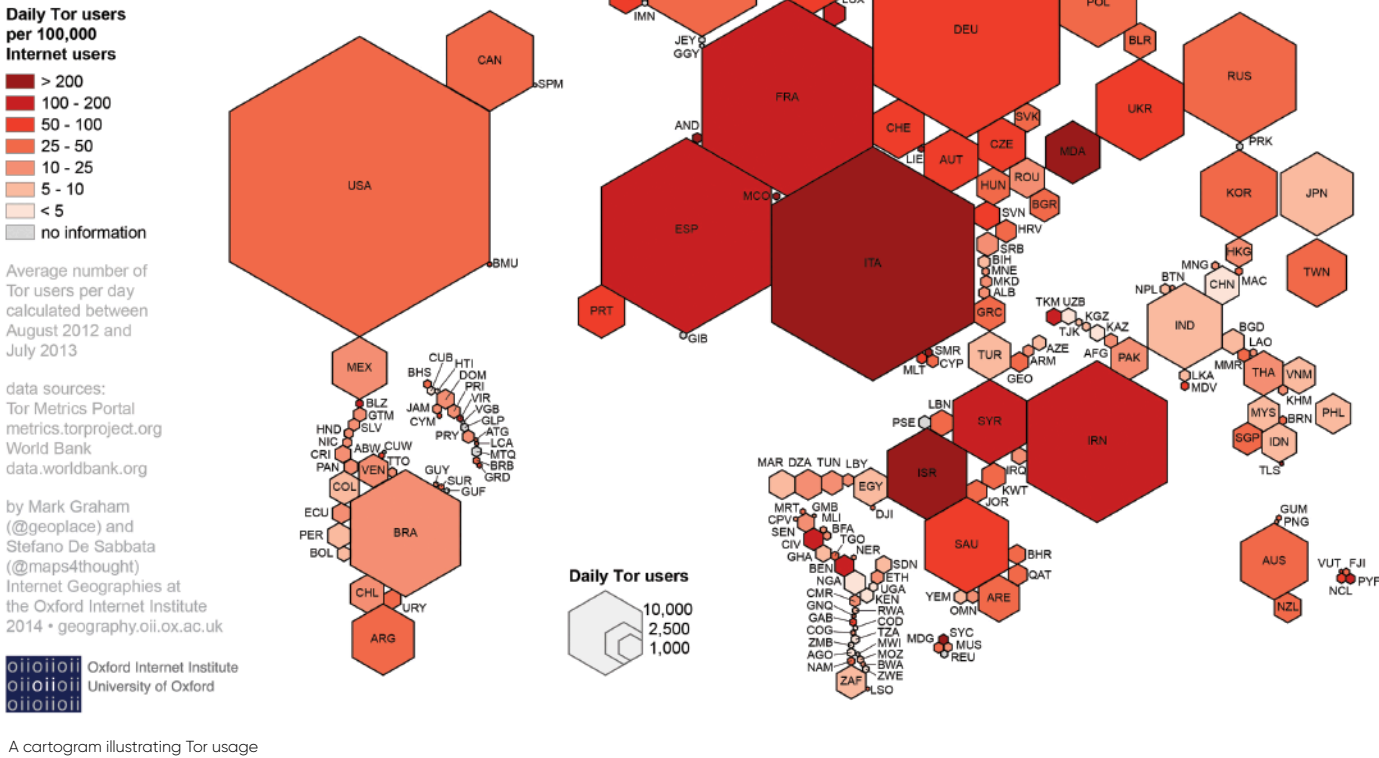
To improve the security of the Tor network, they should have all the information being transferred encrypted until Bob is authenticated (verifying that it's the person they are sending it to). Doing this will make the exit relay less weak in terms of security and it could prevent crimes (such as what the security researcher did) from occurring again. For example, with the message being encrypted throughout the different relays, if someone was to intercept the exit relays then they won't be able to understand the encrypted messages.

When people use normal search engines such as Google, they are on the public network. This makes it easy for people to do a traffic analysis on you (they can see your search history and understand your patterns) when you are on the web. [3] However, when you use Tor, all this traffic analysis is stopped. The moment someone sets up Tor, Tor disables all traffic analysis making them able to go on the internet anonymously. Additionally, companies such as Google can sell your data and your pattern on the internet to different companies and third parties [4]. All this information demonstrates how normal search engines have a lot of flaws compared to Tor. With Tor, people's data won't be sold off to different companies and they can be safe on the internet. Also, Tor can provide more anonymity in comparison to a PET (Privacy Enhancing Technology) like end to end encryption. End to end encryption encrypts all the messages you send however it has some flaws. For example, end to end encryption can reveal who you are and who you are talking to. With Tor, they can make you (Alice and Bob) anonymous so no one can track you down.

A lot of people use Tor so they can go to the dark web and go onto websites such as silk road. Silk road is a website made in February 2011 and people who went on the website could buy anything from guns to drugs. After a few years, Silk road made a total of \$1.2billion but then it got shut down by the FBI [5]. This website that Ross Ulbricht made is an example of how individuals can take advantage of Tor. Originally, Tor was "developed with the U.S. Navy in mind, for the primary purpose of protecting government communications" [6]. However, criminals are using it for their personal gain, using Tor to do illegal things on the internet and not get caught. If technologies are used primarily to benefit the US services, then it shouldn't be easily accessed by others. Tor is a technology that can grant anonymity to others and so if the wrong people had it then it would result in them doing lots of crimes. Furthermore, Tor is easily downloaded by the public and the government would find it harder to track down the criminals because they have done the bad acts anonymously. This means if Tor was made illegal then the government can track down people doing illegal activities on the dark web more easily and websites like Silk road are less likely to exist.

On the other hand, criminals aren't the only people that utilize Tor, normal citizens do too. For example, some people would feel better if they could browse the internet anonymously so they would install Tor. The Tor project says that Tor could protect children online [6]. Children are the ones who should be the most protected from the internet as they don't know how it fully works and dangers of going to certain places on the web. So, if they used Tor, they can go on the internet safely and parents won't have to worry so much about them. However, if Tor was made illegal then so much information about them can be exposed (such as IP address and hostname [7]).

# The anonymous Internet



A cartogram illustrating Tor usage

As well as children, ordinary people can look on sensitive websites, ones that the country may not want people to look at [6]. When they are using Tor, they can go to websites that normal search engines can't go to, meaning that they can go to those sensitive websites. People can now have a wider knowledge of the world and can explore more things on the internet. In my opinion, people should have the freedom to read whatever they want so they can have a wider understanding of the world. Therefore, privacy enhancing technologies (such as Tor) can help people to learn more and be safer online.

In conclusion, I think that privacy enhancing technologies such as Tor should be illegal for the public to utilize. This is because Tor is very effective in terms of preventing traffic analysis when the users browse the internet with Tor on. Tor changes your IP address to a random one and when you go to a website the request to go to that website is gone through those exit relays making sure there's no direct interaction between you and the website. Even if Tor doesn't encrypt any of your messages, many people won't be needing to communicate to others to do crimes on the web. Meaning, if they went on the dark web and go to websites like Silk road and bought some illegal products then the government will find it difficult to track them down. Tor being easy to download on the internet makes crime rates increase and forces the government to spend more time developing technologies to track those cyber criminals down. Even if making Tor illegal restricts the amount of information people can see, considering about the safety and the law is more important as it affects everyone.

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**PhD Tutor's note**  
I was very proud of all of my students who engaged with the material in thoughtful and thought-provoking ways, but L.'s essay stood out in reflection of her hard work both in and outside the classroom. In addition, the case studies she used demonstrated independent and imaginative research which made her essay interesting to read as well as a first-class piece of work.

# What we have learned from mammoth fossils and DNA? Could we and should we clone a mammoth?

Year 9, Key Stage 3

J. Stephenson, Parkside Academy, Durham  
Supervised by R. Barnett, University of Durham

In 1996 the world was awakened to cloning when Dolly the sheep was made famous. Since then the world of science has evolved, and today's scientists are researching how to bring back the woolly mammoth. This has become more possible since the find of a young woolly Mammoth completely frozen in time. This paper will discuss cloning as a procedure, ethics and opinions and to answer the question "Could we or should we clone a Woolly Mammoth".

### 1.Introduction

#### 1.1 What Information have we learned from cloning?

In 1996, Dolly a cloned sheep was created. Dolly was the first mammal created by somatic cell nuclear transfer. In this experiment Ian Wilmut and Keith Campbell and colleagues at the Roslin Institute, part of the University of Edinburgh, created a lamb from an adult sheep's cells and placed it into an enucleated egg. After 277 attempts they produced one embryo that was carried to term in a surrogate mother. The famous lamb, Dolly, was brought into fame as soon as she was born on the 5th July 1996. She died from progressive lung cancer five months before her seventh birthday. She was created using the technique of somatic cell nuclear transfer, where the cell nucleus from an adult cell is transferred into an unfertilised oocyte that has had its cell nucleus removed. The hybrid cell is then stimulated to divide by electric shock and once developed into a blastocyst is implanted into a surrogate mother.

#### 1.2 Legacy

After cloning was successfully demonstrated through the creation of Dolly, many more large mammals were cloned, including pigs, deer, horses and bulls. The attempt to clone an argali, a type of mountain sheep, did not however produce viable embryo. The attempt to clone a banteng bull was more successful, as were the attempts to clone a mouflon, both resulting in viable offspring. The reprogramming process that cells need to go through during cloning is not perfect and embryos produced by nuclear transfer often show abnormal development. Making cloned mammals was highly inefficient – in 1996 Dolly was the only lamb that survived to adult hood from 277 attempts. By 2014 Chinese scientists were reported to have 70%-80% success rates cloning pigs.

Wilmut, who led the team that created Dolly, announced in 2007 that the nuclear transfer technique may never be sufficiently efficient for use in humans. However, cloning may have uses in preserving endangered species and may become a viable tool for reviving extinct species. In January 2009, scientists from the Centre of Food Technology and Research in Aragon, northern Spain, announced the cloning of the Pyrenean ibex, a form of wild mountain goat, which was officially declared extinct in 2001. Although the new-born ibex died shortly after birth due to physical defects

in its lungs, it is the first time an extinct animal has been cloned, and may open doors for saving endangered and newly extinct species by resurrecting them from frozen tissue. In July 2016, four identical clones of Dolly were alive and healthy at nine years old. Scientific Americans concluded in 2016 that the main legacy of Dolly the sheep has not been the cloning of animals but advances into stem cell research. During my research, I found that in 2013, Shoukhrat Mitalipov took a skin cell from a patient and fused it with a donated egg cell and after a series of electric shocks the egg began to divide. The key to success in this experiment was the changes he made to the culture liquid. Between 1963 and 2005 there has been 20 clones of animals created and now scientists are hoping to get hold of a living cell from the mammoth so that the process of cloning can begin.

Ian Wilmut, the scientist who cloned Dolly the sheep has announced that he will apply for a licence to clone human embryos, stating that he is "still opposed reproductive cloning but that the research could provide new treatments for diseases such as motor neurone disease that may involve the use of stem cells or small molecule drugs". (Koralage, 2004)

### 2. Method

#### 2.1 How is DNA recovered?

DNA is recovered through these steps:

1. A PCR vial containing all the identical DNA molecules is placed in a PCR machine that lowers and raises the temperature, reacting the mixtures together and controlling the stages of the reaction.
2. The mixture is heated to 90 – 95°C for around 30 seconds and at this stage the DNA strands are separate.
3. The reactants are cooled down to 50 – 60°C for 20 seconds allowing the primers to bind to a single DNA strand.
4. The mixture is heated to 75°C for a minute. This is the optimum temperature for the DNA enzyme. They then make multiple strands, identical to the original one.
5. After this you simply repeat steps 2 and 4 around 30 times to get 1 billion copies of the original DNA. This may take up to six hours.

#### 2.2 Cloning procedure

To perform the process of cloning, a scientist will copy a DNA structure multiple times. The DNA must be isolated then introduced into a DNA vector that can replicate itself:

1. The chosen piece of DNA is 'cut' from the source organism using restriction enzymes.
2. The piece of DNA is 'pasted' into a vector and the ends of the DNA are joined with the vector DNA by ligation.
3. The vector is introduced into a host cell, often a bacterium or yeast, by a process called transformation. The host cells copy the vector DNA along with their own DNA, creating multiple copies of the inserted DNA.

4. The vector DNA is isolated (or separated) from the host cells' DNA and purified.

### 3. Ethics of cloning

Savulescu states that he "believes that the medical and scientific benefits of research into therapeutic cloning are so great that this research is morally required. There is an overwhelming argument against reproductive cloning at present – it is unacceptably risky. However, when cloning becomes as safe as other reproductive methods, the arguments against it are weak". (Savulescu, 2005)

In an article dated 8 July 1999, Alison Abbot wrote that "The European Society for Human Reproduction and Embryology (ESHRE) last week confirmed its view that human cloning should not be used at present for reproductive purposes, but that the development of cloning techniques for therapeutics should not be banned". (Abbott, 1999)

#### 3.1 Recent views on cloning

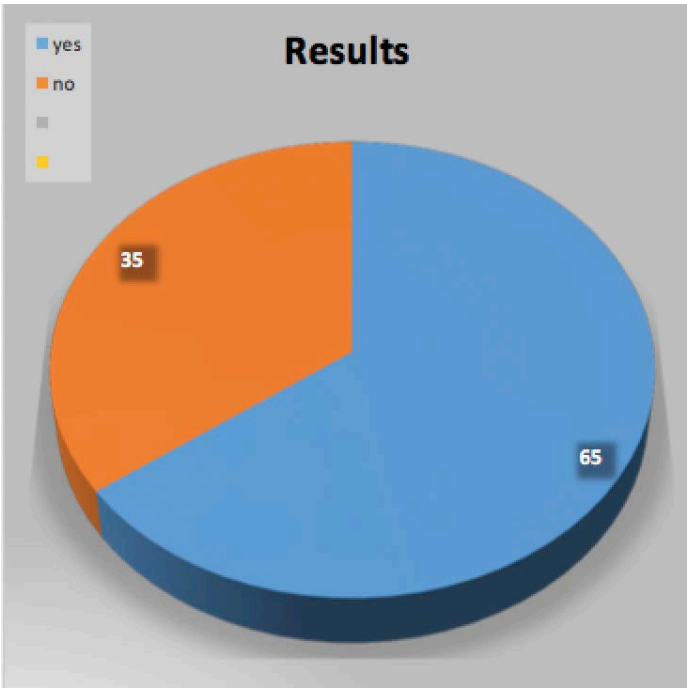
There has been an article published that discusses scientists claiming they are on the verge of resurrecting the woolly mammoth within two years. Mammoths became extinct around 4,000 years ago. Speaking ahead of the American Association for the Advancement of Science (AAAS) annual meeting in Boston, the scientist leading the "de-extinction" effort said "the Harvard team is just two years away from creating a hybrid embryo, in which mammoth traits would be programmed into an Asian elephant. Our aim is to produce a hybrid elephant-mammoth embryo," said Prof George Church. "Actually, it would be more like an elephant with a number of mammoth traits. We're not there yet, but it could happen in a couple of years." (Devlin, 2017). There are a variety of ethical positions regarding cloning from reading literature I have researched. Cloning of animals has been opposed by animal groups due to the number of cloned animals that suffer from malformation before they die, and while food from cloned animals has been approved by the US FDA, its use is opposed by groups concerned about food safety.

#### 4. Could we or should clone a mammoth?

"Recently there has been growing interest in applying the most advanced embryological tools, particularly cloning, to bring extinct species back to life, with a particular focus on the woolly mammoth (*mammuthus primigenius*)" (Fulka, Jr. et al., 2009). On a May morning in 2007, on the Yamal Peninsula in north western Siberia, a reindeer herder named Yuri Khudi discovered a perfectly preserved baby mammoth. The one-month old female is helping scientists to unravel how the extinct ice age giants once lived. The contents of her stomach have provided scientists with valuable clues about what she and her fellow mammoths ate. Alexei Tikhonov, from the Russian Academy of Science who also helped to study the baby mammoth, added: "Lyuba is a creature straight out of a fairy tale. When you look at her, it's hard to understand how she could have stayed in such good condition for nearly 40,000 years." (Richard Gray, 2017).

I think it would be possible to clone a mammoth if we discovered a living cell from their bones or their mummied bodies. But one problem I have thought over is how they would survive in today's climate. The earth's climate is much warmer than it was when mammoths roamed the planet freely. Attention would be needed to locate them in a climate in which they thrive, in Russia for instance or

the Artic where conditions would be more suited. But how do we feed them and get them to act like mammoths, will they already know how to do this? The woolly mammoth went extinct around ten thousand years ago but as they tended to live in the Artic their bones and potentially some mummies have been preserved in permafrost. If any have a living cell in them we can clone the mammoth, but unfortunately we can't yet as we have no living cell. But once scientists discover this, would it be suitable to let an elephant rear it or would the elephant reject it for looking different to the other herd of elephants? There are a variety of ethical positions when it comes to cloning, those against cloning have concerns that today's technology is not yet progressed enough to be safe. Reading scientific articles and credited web sources, I discovered there is a lot of different opinions on the whole cloning procedure and I decided to carry out my own research into what my family and friends think of cloning. They were asked one simple question with a yes or no answer "Do you think scientists should clone a woolly mammoth"?.



#### 4.1 Discussion of my survey results

The survey carried out shows mixed results about people's perceptions of cloning a woolly mammoth. Out of 100 people, 65 were in favour of cloning a woolly mammoth, whereas 35 were against the procedure. Further studies would need to be carried out to ascertain the reasons for their answers. A similar survey carried out by May showed that "Most participants condemned cloning as immoral and said it should be illegal. The most commonly reported positive sentiment was by far interest/curiosity. Negative emotions were much more varied, but anxiety was the most common. Only about a third of participants selected disgust or repugnance as something they felt, and an even smaller portion had this emotion come to mind prior to seeing a list of options". It is very exciting to think that woolly mammoths could be roaming our planet once again in my lifetime.





Image 4. Harvard geneticist George Church

Some people suggest that since humans likely contributed to the extinction of mammoths, we may have a moral obligation to bring them back. George Church, a Harvard University geneticist working on the de-extinction of mammoths, suggests that “reintroducing the mammoth to tundra regions could help bring back the ancient dry, grassy “mammoth steppe” ecosystem shaped by their grazing”.

Harvard geneticist George Church says his lab has already made 15 genetic changes in elephant cells to make them more mammoth-like. They hope to conduct tests in lab-grown organs and embryos as soon as possible. (CBC News, 2017)

## 5. Conclusion

Cloning is a minefield of laws, issues and an ethical approach to the topic is needed. There is a vast amount of reports and news articles on the internet that cover the story of cloning a woolly mammoth. Mixed feelings and concerns over this have been raised all around the world. The world of science and major science companies are very excited about the future of cloning. Cloning will always be supported and opposed by organisations and groups around the world. Do we need woolly mammoths back in today's modern world, what will be their purpose, what could we learn from them, how will they impact the environment in which they are located? Question after question will need to be answered if it were to happen. Would the woolly mammoth become a tourist attraction, would it be allowed to exist like it did thousands of years ago? If for example scientists were able to clone a perfect specimen what would this lead to, would mankind want to explore more and bring dinosaurs back from extinction? Could we really have a Jurassic Park on our planet? *“I laughed when Steven Spielberg said that cloning extinct animals was inevitable. But I'm not laughing anymore, at least about mammoths. This is going to happen, it's just a matter of working out the detail.”* ~Hendrik Poinar.

### PhD Tutor's note

J. was a quiet and serious contributor to the tutorials. I was seriously impressed throughout by the high standard of his work and have no hesitation in saying that his essay is as good or better than many I have marked from undergraduates five or six years his senior. He has a brilliant academic mind and excellent work ethic and I wish him all the best for his future, which I am sure will be bright.

# How Does Behaviour and the Brain Change During Adolescence?

Year 9, Key Stage 3

M. Scholand, Finchley Catholic School, London  
Supervised by L. Magis Weinberg, UCL

Adolescence is the period between childhood and becoming an adult. It is obvious to most people that the body changes a lot during this time, and that behaviour does too. Advances in science and technology in recent times have meant that it is now possible to study the brain and to see how it changes during adolescence as well. This has enabled scientists to see how changes in thinking and behaviour might be linked to brain changes.

In order to discuss how behaviour and the brain both change through adolescence, we need to look at both in more detail. Behaviour is the way that people act. Studies of adolescent behaviour have shown a number of aspects of behaviour that tend to change during the period between age 12 to the mid 20s.

Firstly, adolescents tend to be much more influenced by the behaviour of their peers. Often peer relationships become more important in adolescent years. Teens often respond to peer group pressure. Many teenagers may change their actions, the way they dress or even their views because of what their friends and peers think. This is sometimes good, for instance in a group of friends where good grades are respected, everyone in that group may push themselves to get good grades so they look impressive to their friends. This can help everyone in the group to achieve better grades. However, peer influence can also be bad. If someone has a group of friends who are obsessed by things such as drugs or crime, then the person may feel pushed into taking part. Similarly, if someone hangs out with friends who take a lot of risks, then the people in that group may take lots of risks just to impress their friends. In fact, an American study done by the National Institute of Drug Abuse showed that in a driving game adolescents were more likely to take risks if a friend was watching them play than if they were playing the game all on their own. This shows how even one friend can influence behaviour.<sup>[1]</sup>

Another change in behaviour during this time is that adolescents can experience a lot of mood swings, and can move quickly from being happy to being depressed. They can also get very angry during this period, as they feel more frustrated, and have stronger views on things such as their appearance, and their pastimes.

Adolescents can also become more interested in taking risks. They want to try doing different things, this means they can be easily influenced by their peers. As they grow older they want to be viewed as more responsible and usually to develop their own views on things and take less risks. However while they are adolescents they still try to impress their peers.

Laurence Steinberg who is a researcher at Temple University (in Philadelphia America) said “There are two main features

that seem to distinguish teenagers from adults in their decision making. During early adolescence in particular, teenagers are drawn to the immediate rewards of a potential choice and are less attentive to the possible risks. Second, teenagers in general are still learning to control their impulses, to think ahead, and to resist pressure from others.”

His research found that teens tend to act before thinking about the results of their actions. This behaviour changes as the adolescent gets older and becomes better at controlling their behaviour.<sup>[2]</sup>

Having an interest in being more independent is another characteristic that tends to develop in teenagers. They become interested in making decisions for themselves and want to do things their own way. This can lead to arguments, especially with parents, which are usually made worse by the fact that teenagers are usually more self-centred at this age.

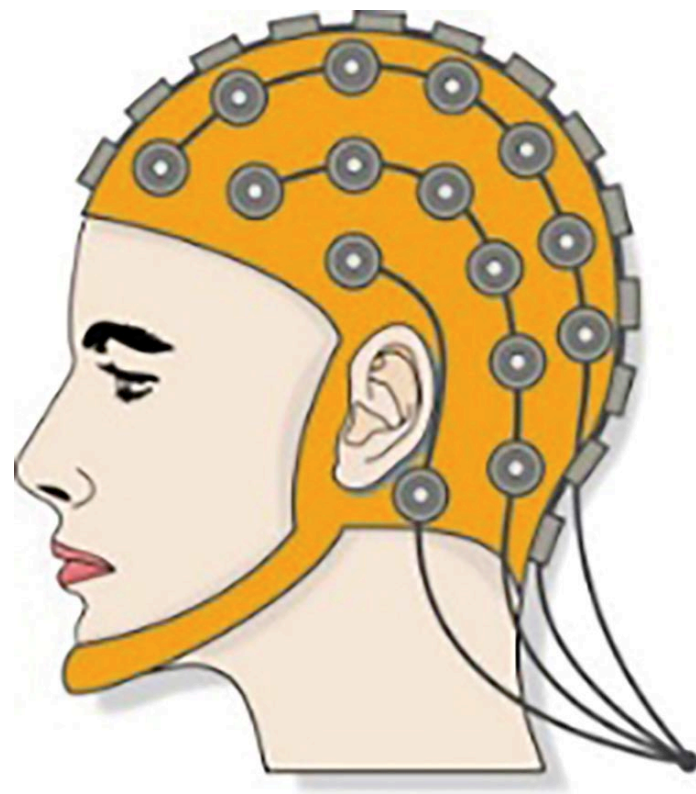
Adolescents start to develop their own opinions and challenge the views of their parents, they do not necessarily want to do something just because their parents tell them to, they try to work out what is important to them, and begin to test the boundaries of what their parents will and will not let them do. Also during this period, adolescents’ brains change and they develop higher levels of reasoning. As they grow up they begin to think more about what is right or wrong, because they begin to think more deeply about their actions. They tend to begin to draw on their individual experiences and knowledge in order to make decisions, which is something they did not do as children.

Some of the key characteristics of adolescents are: mood swings, exploring, risk taking, developing personal identity, peer influence, independence, self-centred attitudes, testing rules and boundaries and lastly increased cognitive development.

Scientists were not able to demonstrate the link between changes in behaviour during adolescence and changes in the brain until fairly recently. However, scientific advances and technology have meant that it is now possible to map brain changes.

Most information on changes in the adolescent brain have come from the use of Magnetic Resonance imaging (MRI). This method uses very strong magnets (about 1000 times stronger than the average fridge magnet) to align all the protons in water. Normally the protons are all spinning randomly, when the magnet is turned off they all try to return to the position they were once in. However in some tissues it is easier for the protons to return to normal compared to others <sup>[3]</sup>. This allows the doctors to see the structure of parts of the body such as the brain that they would not see previously unless they examined a brain specimen. Doctors can do structural MRI tests even while people are asleep, this means it can be done on young children and animals. During the test, the patient must remove all metal objects as otherwise it will be pulled towards the magnets which could injure them. The test-subject must also be very still otherwise the images the doctors receive will be blurry and difficult to read. Using structural MRI, scientists can work out when an area of an adolescent’s brain is fully grown by comparing it to adults’ brains.

Functional Magnetic Resonance Imaging (fMRI) is another way to examine behaviour changes during development and for finding links between brain structure and brain function. It measures brain activity by detecting which areas of the brain are using up the most oxygen. Since the 1990s, fMRI has been used to carry out brain mapping research because it does not require people to have injections, surgery, to swallow substances, or be exposed to ionising radiation, like some other procedures do. Areas of brain activity can be presented on a computer in a graphic form by colour-coding the strength of signals across the brain or in a specific region. Both these techniques in particular have helped scientists to learn about the development of teenage brains and how they change during adolescence.



Electroencephalography (EEG) uses the small electrical pulses generated by the neurons that make up the brain. The neurons cannot be measured by themselves because the amount of electricity is far too small to be measured. However if there are a lot of neurons working at the same time, the electricity can be measured. These impulses made from thousands of neurons working at the same time can be detected on the skin by little electrodes. However, if the person has hair, then a cap can be put over their heads (see image i). It allows you to figure out what areas of the brain are responsible for what activity. However it does not give you an image of the brain but instead a graph which can be difficult to read unless you are an expert. The EEG method has also enabled scientists to study teenage brains but it has not been as useful as MRI or fMRI.

Scientists used Magnetic Resonance Imaging (MRI) to carry out brain scans of children as they grew from early childhood to age 20. The scans surprised many people because they gave unexpected results. Studies show that adolescence is a time when the brain grows and develops a great deal. People used to think



that the brain was fully developed by the end of teenage years however the scans showed that although the brain reaches its full size between the ages of 12 and 14, parts of the brain still continue to develop until the early twenties. The prefrontal cortex (found near the front of the head) is one of the last areas of the brain to change and develop. This part of the brain is responsible for decision-making, planning ahead and controlling impulses, because this part is not yet fully developed, teenagers might use another part of their brain called the amygdala to make decisions (this section of the brain is part of the limbic system (which is associated with emotions) <sup>[4]</sup>). This explains why adolescents might take more risks and be more impulsive. The studies also showed that over the course of childhood the volume of grey matter (brain tissue) increased and then decreased. They noticed that some of the connections or synapses which were not used over time were 'pruned' or cut, and others were strengthened by having the connections surrounded by a chemical called myelin. This helps the brain to become more efficient over time and more specialised because it keeps the connections that are used often and removes the unused connections. The pruning of synapses begins at the back of the brain and finishes at the front, this is why the prefrontal cortex is one of the last parts to develop.

The brain tests also discovered that during adolescence, some of the many changes in the brain effect sleep. These changes might explain why teenagers often stay up later at night. Sleep is important for teenagers, and not getting enough sleep can cause attention problems and lead to sadness and anger. Studies of children and adolescents have found that lack of sleep can increase impulsive behaviour. The proper amount of sleep is crucial to adolescents' health. It is recommended by the American National Institute of Health that American teenagers get at least 9 hours of sleep per night <sup>[6]</sup>, a US study published in the Journal of Youth and Adolescence, found that only 9% of adolescences actually get this amount of sleep <sup>[7]</sup>. It was also found that 20% of teenagers were only sleeping for less than 5 hours a night. This is often due to many distractions such as TV or the computer. The TV and computer trick the brain to think that it is day-time with the light that they emit, this can delay the production of a hormone called melatonin that causes you to sleep. According to a BBC article <sup>[8]</sup> it was discovered in a sleep study that teenagers start producing melatonin 3 hours later than adults (at 1 am). This could be another reason why teenagers get less sleep, not just because of their actions but because of their bodies as well.

Sleeping is incredibly important for adolescents as it produces crucial hormones needed for growth spurts, the less sleep the teenager gets, the less that they grow, this can have a bad effect later in life. Sleep is when the brain looks over what happened that day and stores it. It can be much harder for adolescents to remember things if they don't sleep enough. Sleep is also when the brain carries out lots of important processes that help emotions and learning. Without sleep teenagers can become angrier, and more depressed and are less likely to do well in school.

In conclusion, we can say that adolescence is a period when young people tend to change their behaviour drastically. Some characteristics of adolescent behaviour are: mood swings, exploring, risk taking, developing personal identity, peer influence, independence, self-centred attitudes, testing

boundaries and lastly increased cognitive development. Although scientists thought that changes in the brain might be partly responsible for these changing behaviour patterns, it is only recently that they have been able to study how the brain changes from childhood to adulthood.

Advances in science led to the development of Magnetic Resonance Imaging, and functional Magnetic Resonance Imaging techniques. These methods have changed brain studies greatly, and have enabled scientists to understand about the changes to the structure and connections in the brain that occur during adolescence. We now know that as the brain develops it becomes more efficient. One of the last parts of the brain to develop is the prefrontal cortex. This part of the brain is responsible for decision-making, planning, and for controlling impulses. While this part is not yet developed, teenagers might use another section of their brain called the amygdala to make decisions. This explains why adolescents might take more risks and be more impulsive. As the brain continues to develop during adolescence and to form and lose different connections, it is important what teenagers choose to do during this period, as their behaviour and what they study can influence the development of their own brain. Sleep is also important during these years as the part of the brain that effects sleep patterns was also found to develop during adolescence. Lack of sleep can influence emotional and intellectual development. Many of the problems that teenagers experience such as those associated with risk taking and being influenced by peers could be helped by encouraging teens to adopt positive behaviour and healthy practices, such as getting more sleep. Finally I think it is very interesting to learn that although changes in the brain during adolescence influence behaviour (eg. risky decisions), the opposite is also true, as behaviour can also influence the development of the brain (eg. synaptic pruning).

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**PhD Tutor's note**

I thoroughly enjoyed my placement at Finchely Catholic School, where the students and staff were very committed and enthusiastic about the programme. M's essay reflects his capacity to integrate a variety of very complex topics on the psychology and neuroscience of adolescence with his own experience in an engaging manner. I was very impressed by this piece of work, and I am very happy that it will be shared with a broader audience of readers!

# Will we Win the War on Cancer?

Year 9, Key Stage 3

Pakefield School, Lowerstoft

D. Pointon, supervised by K. Makin, University of Anglia

Cancer is "a term for diseases in which abnormal cells divide without control and can invade nearby tissues" by the National Cancer Institute. Cancer is in fact, much more complicated than the definition suggests. Cancer cells are the only cells which are immortal, and can even disguise themselves as healthy cells, making it nearly impossible for the immune system to target them. This causes various problems, as some treatments have unfortunate side effects due to the lack of an effective way to discern between healthy and cancerous cells.

There are various causes of cancer, including alcohol, smoking, HPV and UV exposure. Smoking causes cancer because of carcinogens inside tobacco that are released when it is burned. Carcinogens are chemicals that cause cancer. Normally mutations caused by smoking in, for example, the lung would be repaired, and this would not cause cancer. If the smoking is regular, however, it reaches the point where the mutations become cancerous, as they aren't repaired or the cell doesn't die as usual by apoptosis. UV exposure can cause cancer as well, but can be combated using sun cream. UV causes cancer because it is a form of radiation which can result in 'double-strand breaks' in DNA. If one 'strand' of DNA is broken by radiation or mutation it can usually be repaired. Double strand breaks are so dangerous because the DNA may find it difficult to repair if this occurs. Radiation breaks multiple strands of DNA at once, making it difficult to repair.

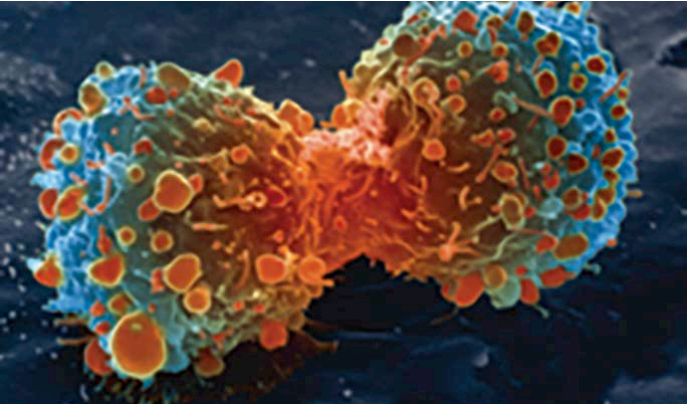
Cancer occurs on a cellular level because of mutations in the genetic material inside the cell. The mutated cells are able to evade being killed or having the mutations corrected. The mutations in a cell can cause uncontrolled cell growth, causing tumours. Tumours can be either benign or malignant. Benign tumours do not spread around the body or to other parts of the affected region, whereas malignant tumours do, making them incredibly dangerous.

The three most common types of treatment in clinical use today are chemotherapy, radiotherapy, and surgery. Chemotherapy uses a chemotherapeutic agent to stop rapidly dividing cells from dividing and thus can stop tumours from growing. Chemotherapy is however, one of the treatments that has the drawback of not being able to discern healthy cells from cancerous cells. If chemotherapy is unable to tell which cells to prevent from dividing, all cells which divide rapidly will be prevented from dividing. The side-effects of this are catastrophic and can even result in death. Hair loss, suppressed immune function, nausea, dry mouth and fatigue are all caused by chemotherapy affecting healthy cells. Albeit, the method the immune system uses can be bypassed by cancer cells, the side effects of having no method are still catastrophic. A suppressed immune system can be potentially fatal in the event of an opportunistic infection or even a simple virus like the common cold.

Radiotherapy is an alternative treatment that is sometimes used alongside chemotherapy and surgery and uses radiation

to kill cells. It does this in two ways, either by damaging the cell's DNA using double strand breaks, or by creating 'free radicals', which damage cells further. Double strand breaks damage DNA by breaking strands of DNA. If a single strand of DNA is damaged, the DNA can easily be repaired. This however, does not apply to double strand breaks, as they are harder to repair because strands have been separated, not just one strand being destroyed. Double strand breaks can cause mutations, which can lead to cancer. This is one of the primary consequences of radiotherapy. Free radicals are atoms which are highly reactive and unstable, because of the amount of electrons in the outer shell. This is dangerous to DNA and cells because they are unstable. The secondary consequence of radiotherapy is that, like chemotherapy, it can't differentiate between healthy and cancerous cells. This means that sometimes healthy cells inside crucial areas of the body are prevented from duplicating. These cause different side effects depending on the part of the body affected, including localised burning of the skin, nausea, fatigue, stiff muscles and hair loss (NHS direct).

A more sophisticated alternative to radiotherapy is proton beam therapy. A beam of high energy protons are fired at the cancer cells, which kill the cancer cells. Protons kill cancer cells using double strand breaks, in exactly the same way as radiotherapy. The difference is that once the target has been destroyed, the protons stop killing cells. The proton beam is generated using a particle accelerator, similar to the CERN supercollider. The major downside of this treatment is that, like radiotherapy, it poses a risk for future cancers developing, but the risk is reduced.



Lung cancer cell during cell division.

Surgery is a rather self-explanatory form of treatment, in which a tumour is physically removed. This is a very good form of treatment when it can be used because it doesn't do damage to healthy rapidly dividing cells or provide any further risk of cancer. However in many cases, it can't go ahead, either because the tumour is inoperable or the survival rate for the surgery is too low. Surgery isn't always a permanent solution if a cancer is metastatic. Metastatic means a cancer has spread from the location of the primary tumour. This means while a tumour can be removed in one place, it can come back in another, so surgery could be life-prolonging as opposed to life-saving.

The most revolutionary recent treatments are immunotherapy and targeted treatments. Cancer cells use protein chains in their life processes, such as cell duplication. Targeted treatments disrupt the chains in order to prevent the action from going ahead, or to kill the cell. This treatment is



life-saving, but has one catastrophic downside. A cancer cell can adapt and use a different chain of proteins. As the drug attempts to disrupt the same chain, the cancer cell becomes resistant to the targeted treatment drug, and the treatment as a whole becomes futile. Immunotherapy is designed to fix the problems the immune system has with dealing with cancer cells. Cancer cells are able to use markers such as PDL1 in order to prevent the immune system's antibodies and antitoxins from taking action against the cancerous cells. In order to solve this, anti-PDL1 drugs, or PDL1-inhibitors can be used. This means the antibody, such as a T-cell, is able to discern between healthy and cancerous cells, which I think is imperative in the war against cancer.

A cell can resist cancer drugs in various ways. One of these is alteration of the target site or the drug itself, if the target site in which an interaction between a drug and the cancer cell would take place is manipulated, the interaction cannot take place. The efflux can also be increased, resulting in a higher amount of the drug being expelled from the cell. If this takes place, the likelihood of an interaction taking place is severely decreased. Another way in which the likelihood of an interaction taking place can be decreased is by reducing influx. If less of the drug is coming in, the likelihood of an interaction is obviously going to be reduced, much the same as if efflux is increased. For this reason cancer treatments don't work for everyone, as every cancer is different in different patients and not every drug will work.

I believe that current cancer treatments are not effective enough to beat cancer, and if science is truly to find a solution new treatments must be found or current treatments must be improved. Some of the potential treatments which are being looked at may seem reminiscent of something in a science fiction film, but are in fact closer than it seems to being achieved. One example of seemingly futuristic technology being used to treat cancer is nanotechnology. Nanotechnology is science, technology and engineering conducted between 1 and 100 nanometres according to nano.gov. For contrast, a cervical cancer cell is 450 nanometres (phys.org). Nanotechnology could potentially already have one advantage over chemotherapy, the ability to discern between healthy and cancerous cells. In a recent study scientists were able to use neural networks and by showing photos of cancerous and non-cancerous cells to the neural networks, the neural networks adopted the skill of distinguishing between cancerous and non-cancerous cells. This could have potentially a significant impact when combined with new technology developed by Stanford University, a nano-laser capable of destroying cancerous cells. A solution to cancer could be found therefore, by combining the two. The only problem is that miniaturisation technology has not yet advanced to catch up with nanotechnology. The world's smallest transistors are only 7 nanometres small, but a processor capable of sending photos off to a server to be analysed and then acting on the result with a nano-laser or alternative method of killing cells would require millions of transistors. Combined with the external hardware (camera, laser, etc) the resulting solution would be far too big to be used in practise at this point.

Besides nanotechnology, technology most probably will play a significant role in the war against cancer in a different way. A common example of this are organoids. Organoids are 3D models of organs, sometimes 3D printed. designed in order

to test and develop treatments for individual people. This means that multiple treatments can be tried before actually being used on a subject. This is somewhat reminiscent of honeypots, a cybersecurity mechanism in which virus' are sent into a fake computer system, so a solution can be found. The model of cancer as a computer virus is actually remarkably accurate. A virus, like cancer, is specialised to avoid detection, multiplies rapidly (in the case of some viruses), and every virus, just like every example of cancer, is different. The body, like a computer, has systems, namely the immune system and apoptosis, to deal with cancer. A lot of advances have been made in computer security, it is possible these solutions could be adapted to be applied on a biological level.

The perhaps most promising advancement technology has to offer is genome sequencing. Your DNA can be uploaded to a computer and analysed for cancer. Cancer Research is currently investing a significant amount of money into this solution, and it is promising. Because the root to cancer lies primarily in DNA, the potential of this information is huge. Genome sequencing has already been used to find genes that cause cancer such as the BRCA1 gene that can cause breast cancer. It could also be used to develop personalised medicine, which solves the problem that no two cases of cancer are the same. If the genetics of cells and even how they will react could be predicted, the impact on the war on cancer would be massive.

To conclude, I believe the war on cancer can't be won through the current treatments available unless they are radically improved. Radiotherapy, for example, needs a solution which only kills cancer cells, so the risk of contracting cancer in future as a direct result of radiotherapy is annihilated. Various new technologies could play a crucial role in gaining an advantage, such as organoids or nanotechnology, but the innovation is not yet there to make them practical. Cancer cells can also be adapted to avoid drugs damaging them or halting duplication, and a way to bypass this could be found as genetic science improves, but once again, the innovation is just not there. As the average life expectancy continues to grow, the number of people getting cancer will do also, as age is a crucial factor in contracting cancer. Approximately 1 in 2 people will have cancer in their lifetimes, so it's imperative that a solution is found, and fast.

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**PhD Tutor's note**

I really enjoyed the time spent with all of my pupils at Pakefield School, they had many interesting ideas and spent time researching around the topic which indicated their level of enthusiasm. D's essay really was at an exceptionally high level, he grasped all of the key concepts and developed an excellent writing style that made for an essay that was a pleasure to read, well done D!

**Real Lightsabers Made From Lasers**

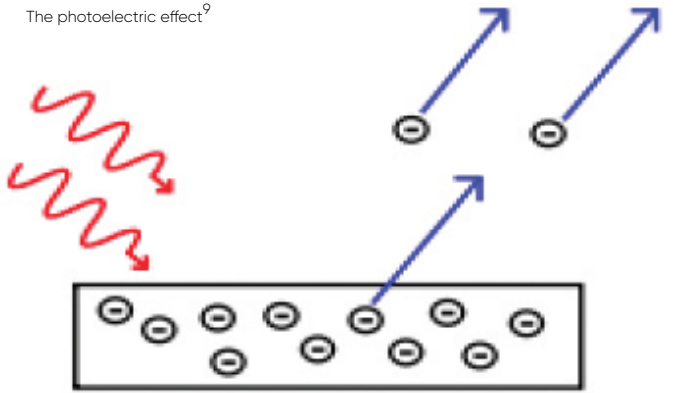
**S2, Key Stage 3**

**M. Naeem, Holyrood Secondary School, Glasgow**  
**Supervised by H. Parker, University of Edinburgh**

**Part 1, Question 1**

Lightsabers are science-fictional energy swords originating from the movie Star Wars.<sup>1</sup> They were first created by George Lucas and are considered as the staple weapon of the Jedi order. The sword has many functions in Star Wars for example: fencing, fighting, melting, cutting, stabbing and many more.<sup>2</sup>

When people hear the word lightsaber, they often think about the science fiction movie of Star Wars however lightsabers may not stay fictional forever. Different physicists, scientists, engineers and extreme Star Wars fans have started to come up with ways of creating real life lightsaber swords. The obvious way of developing lightsabers is by using laser technology, although this may not be possible. I'm going to continue by first considering all the possibilities and impossibilities of real lightsabers then I will go on to my conclusion. There are some possibilities for creating laser lightsabers and YouTube has a lot of tutorials to show how to make them. However, there are only a few Internet posts on the facts and possibilities related to them.



According to Harvard University, 'photons of light behave like solid molecules' which can help with quantum computing and lightsabers.<sup>3</sup> Scientists say that they have learnt 'how to make photons bind together to form solid light' and then hopefully with that they can have a technology quite similar to the one required for lightsabers in the movie Star Wars. However, due to the photons being massless and not being able to interact, this might be difficult.<sup>4</sup> Nevertheless, Harvard said that 'the molecules can potentially be shaped to form solid structure', which may include lightsabers. I now move on to the impossibilities of real life laser lightsabers. I'd have to say that the number one problem of real life laser lightsabers is that the beam from the lightsaber would have to come to a stop whereas lasers go on forever. You would also need lots of energy and power. As well as this, there are some visual and audio effect problems. According to Physics.org, 'a light beam cannot be seen on its side' and the lightsaber would appear to be invisible.<sup>5</sup> To conclude, I agree with those who say we won't be able to make the lightsabers just yet because apart from all the elements holding back the production of lightsabers,

they can also lead to a big health and safety hazard for example with just a little bit of distraction, you can severely harm the people around you.<sup>5</sup> Perhaps lightsabers can become a weapon in the future as we advance in our technological theories of lasers and light or if scientists come up with something more advanced than lasers.

**Part 1, Question 2**

*Photons are the packets of energy that make up light. They are completely massless.*

*Imagine for the purpose of this thought experiment that a photon had the same mass as an electron,  $9.1 \times 10^{-31}$  kg. The sun is Earth's primary light source, the sun has a mass of  $1.99 \times 10^{30}$  kg.*

*If the number of photons emitted from the sun was  $4.2 \times 10^{44}$  per second, how long would the sun burn before it disappeared to nothing?*

Answer  
Sun mass=  $1.99 \times 10^{30}$  kg  
Photon mass=  $9.1 \times 10^{-31}$  kg  
Photons emitted per second=  $4.2 \times 10^{44}$  per second  
Time =  $\frac{1.99 \times 10^{30}}{9.1 \times 10^{-31}}$   
=  $2.186813187 \times 10^{60}$   
=  $2.186813187 \times 10^{60}$   
 $\frac{4.2 \times 10^{44}}{2.186813187 \times 10^{60}}$   
=  $5.206698064 \times 10^{15}$  seconds

**Part 2**

I would like to draw your attention to an important area of physics and I will also in detail, describe the usage of laser treatments to cure many kinds of diseases. In this report, I will be explaining contributions of scientists towards the physics of light and the concept of lasers in medicine. I have summed this report up into four different headings. The first subject I will be talking about is The Theory of Light, followed by The Double Slit experiment by Thomas Young and later on discuss whether light is a wave or particle. Before I end with my conclusion, I will go into detail about lasers and their uses.

**The Theory of Light**

In history, there has been quite a confusion regarding the theory of light and many different scientists and mathematicians have put forward very interesting debates on the subject.

Sir Isaac Newton claimed that light particles were made up of lots tiny particles. He gave lots of points to support his claim. One of them was the fact that just as light travels in straight lines so do particles. He also said that waves can't travel through space as they need a medium through which to travel, yet somehow we get light from distant stars. Due to black holes, space is described as a vacuum. Since waves aren't able to travel through a vacuum whereas particles are, he claimed that light can only be a particle. Due to Newton's popularity, people automatically thought he was right.<sup>6</sup> On the other hand, Christiaan Huygens thought of light as a wave. His main proof to back up his theory was the fact that light diffracts, and particles don't.<sup>6</sup> He also said that due to the presence of a substance called 'ether', when light travels in waves, it vibrates the air around it.<sup>7</sup> Unlike Sir Isaac Newton, Christiaan Huygens



had trouble persuading other scientists and the public to believe that light is a wave. This was mainly due to the fact that most people listened to Newton's theory.<sup>6</sup>

Unfortunately, both Newton and Huygens went to their graves without knowing which one of them was right. Then, Thomas Young discovered the double slit experiment and the wave duality of light. With his discovery of an interference pattern between light and waves, he proved that light is a wave.Later, Albert Einstein described the photoelectric effect, which is the emission of electrons from metal stimulated with light.<sup>8</sup>The electrons are emitted when the light is shone onto the metal. Due to his discovery, he concluded that light is both a wave and a particle. Max Planck also contributed to the Theory of light. He won a Nobel Prize in 1918 due to his work on the Quantum theory.<sup>10</sup>

### The Double Slit Experiment

Thomas Young discovered the Double Slit experiment in 1801. The experiment starts off with one slit and a large board directly behind it. Matter that is considered as particles, is shot through the slit. It then forms a line parallel to the slit on the board. The same applies with two slits but the matter forms two lines parallel to the two slits. The single slit experiment with waves has the same result as with particles. However, when waves go through two slits, they form an interference pattern which gives a result of multiple lines. When light is shone through the slits, it gives the exact same results as the waves did: when shone through one slit it formed one line on the board and when it was shone through two slits it formed multiple lines.<sup>11</sup>

### Light: Wave or Particle

Judging by the results of the double slit experiment, light is considered a wave. However, scientists decided to revisit the double slit experiment. When they did the experiment again the results were the same, light is a wave. Afterwards, they decided to observe it very closely. They put a detector beside the slit and to their surprise light didn't act as a wave, it acted as a particle. It was as if the atom knew it was being observed which then forced it to act as a particle and not a wave. To conclude, light mostly acts as a wave but when observed up close, it acts as a particle. This is a phenomenon called 'the wave-particle duality of light'.<sup>13</sup>

Although all the above mentioned physicists have contributed to the theory of light, I would have to say that Thomas Young's contribution to the physics of light is the most important because at first people weren't really sure if it was either a particle or a wave. If it weren't for his experiment, scientists wouldn't have assumed light was a wave and they wouldn't have been able to revisit the double slit experiment and therefore wouldn't have gotten the final answer we have today.

### Lasers and Their Uses

Laser, is an acronym that stands for 'light amplification by stimulated emission of radiation'.<sup>14</sup> Stimulated emission is when a photon with a particular frequency interacts with an excited atomic electron.<sup>15</sup> There are five main components of a laser: the mirror, pump, partially reflecting mirror, collimated beam and medium. The pump provides the medium with energy and photons, the medium stores all the atoms, the partially reflected mirror allows the laser light to be emitted and the purpose of the mirror is to confine the photons.<sup>16</sup> The collimated beam is the light which directly shines out of the laser. When the laser is on, the beam of light will always stay the same width from the start of the light to

the spot where it's pointed to.<sup>17</sup> This is called collimation. Lasers in medicine are very thin lights that heat up the tissue they are aimed at. Due to having the ability to focus accurately on small areas, lasers can be used to cure diseases like cancer. Types of cancer that can be treated with lasers are: skin cancer, cervical cancer, non-small cell lung cancer, penile cancer and many more. The treatments treat cells that could develop into cancer, destroy different tumours and can treat cancer symptoms like bleeding or blockage.<sup>18</sup> Lasers can also be used to improve eyesight, short and long sightedness so that people won't need to wear glasses or contact lenses. Laser treatments can also treat larynx cancer (tumours in the voice box).<sup>19</sup> Lasers can also be used to remove hair.<sup>20</sup> The advantages of laser treatments are that treatments with lasers are more precise and damage less normal tissues. They are also less painful to the patient and have less bleeding, scarring and swelling.<sup>21</sup> The disadvantages of laser treatments are that they cost a huge amount of money, the surgeons must have special training in order to perform the surgery and in some cases the patient's recovery may not last long so they might need to repeat the surgery.<sup>21</sup>The three types of lasers that are used to treat cancer are: carbon dioxide lasers, argon lasers and neodymium: yttrium-aluminium (Nd: YAG) lasers.<sup>21</sup> During laser therapy, an endoscope with fitted 'optical fibres' is inserted into an open part of the body such as the mouth, nose, anus or vagina. In 2014, 86,500 males and 76,900 females died of cancer in the UK. According to the lung cancer statistics of 2014, there have 46,403 cases of lung cancer of which 5% of them survived and 35,895 died. Furthermore, there have been 55,222 cases of breast cancer. 78% of them have survived and 11,433 have not. There have also been 15,419 cases of skin cancer and 90% of them have been treated.<sup>22</sup> These are just a few of the cases of cancer, there are still many more. Cancer research says, 'every four minutes someone in the UK dies from cancer'.<sup>23</sup>

To sum up, I think laser technology in medicine is very important due to the fact that it can possibly cure these life-threatening diseases and with that perhaps we won't have this many deaths because of cancer. Without understanding light and lasers we wouldn't be able to cure these major killing diseases and it is very important for scientists to understand and discover more on the theory of light and to understand how it is both a particle and a wave.

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### PhD Tutor's note

M. is a gifted and hardworking student. She produced an exceptionally well written piece of work following on from our course on the use of lasers in medicine. M. tackled the breadth and complexity of the course content with a quiet and calm maturity, working through concepts far beyond what would normally be expected from someone her age. Although M. had expressed uncertainty in her future, I can see her following in the footsteps of the scientists she wrote about so brilliantly in her report.

## Which Protein is the Key Player in Alzheimer's Disease?

### Year 9, Key Stage 3

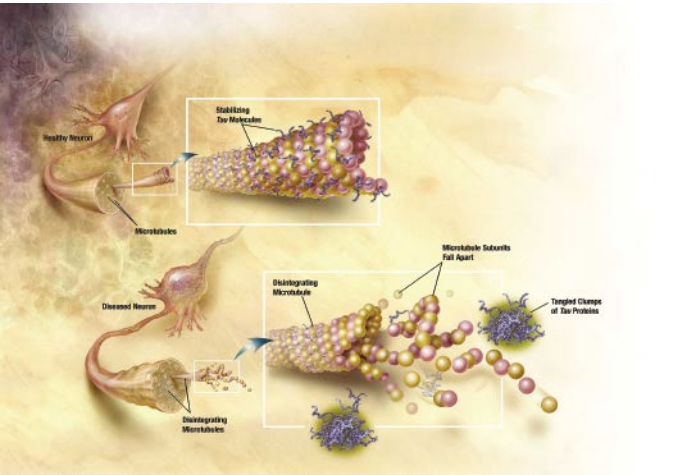
**T. Bryant, Cornelius Vermuyden School, Essex**  
**Supervised by C. Murray, UCL**

Alzheimer's disease is widely known as the most common type of dementia, affecting an estimated 850,000 people in the UK, and in the larger picture, approximately 35.6 million people worldwide, and this is increasing with the aging population. It is a neurodegenerative disease, and the symptoms progressively become more severe as time goes on; ultimately leading to the death of neurons in the brain. The disease typically effects one in six people over the age of 80; however, in some circumstances it can affect people younger than 65, accounting for 4% of cases. These are very high and alarming figures and therefore continuing to research the possible causes and finding treatments for Alzheimer's is vital for everyone. The most widely known effects of the disease are memory loss (beginning in the hippocampus, which is associated with long-term memory), language difficulties, personality or behavioural differences, and visual/spatial complications. Scientists have come to a general agreement that Beta amyloid (A $\beta$ ) plaques and neurofibrillary tangles are the two abnormalities of the disease; which may lead to the ultimate neurodegeneration that is associated with Alzheimer's. However, the debate around which is the main culprit is ongoing and can be approached in many ways, with extensive studies and scientific evidence.

Beta amyloid (A $\beta$ ) is believed to be one of the main possible culprits for the neurodegeneration of the brain in Alzheimer's disease and this can be demonstrated through many experiments and studies. Amyloids is a general term for protein fragments that the body produces normally; whereas A $\beta$  is a protein fragment which has been snipped by an amyloid precursor protein (APP), which usually plays a vital role in neural growth and repair in the brain. However the corrupted form associated with Alzheimer's leads onto the destruction of nerve cells. In unaffected brains, the A $\beta$  protein fragments are eliminated from the brain; however; in a diseased brain these fragments assemble and form the insoluble plaques which are known as Amyloid plaques. As APP is being embedded into the membrane of the cell, specific enzymes 'snip' or 'cleave' it into distinct fragments. These enzymes are called alpha-secretase, beta-secretase and gamma-secretase. This leads to two possible outcomes with different consequences for the cell. Firstly, the beneficial pathway is named the benign pathway, where the aftermath is positive and APP does not form the harmful plaques. On the other hand is the negative result, where plaques are ultimately formed when beta amyloid peptide is released into the space outside the neuron and begins to attach itself to other beta-amyloid peptides, called oligomers. Leading theories present the idea that plaques containing A $\beta$  are toxic to neurons; which contributes to their destruction and therefore neurodegeneration.

Continuing on from A $\beta$ , Tau, like amyloid, is a normal protein found in the brain but when negatively affected, leads to problematic outcomes. Tau is proteins which stabilise microtubules and are abundant in nerve cells and exist at low levels in oligodendrocytes and astrocytes. If they

become ineffective at stabilising the microtubules, this can lead to the development of diseases including Alzheimer's. Phosphorylation of Tau can be regulated by normal, unaffected Tau, however the hyper-phosphorylation of the protein leads them to aggregate, leading filaments to become tangles (known as 'neurofibrillary tangles') associated with Alzheimer's, contributing to the pathology of the disease. Once Tau has formed tangles, it can no longer carry out the transportation of materials that the neuron needs for its survival. This cuts off communication between neurons and, like a circuit, the whole neuron will be disconnected completely once it has degenerated.



In Alzheimer's disease, changes in tau protein lead to the disintegration of microtubules in brain cells.

This poses the question that numerous scientists and studies are attempting to answer: Which one - Tau or Beta amyloid - has the most significant impact on the brain? The first thing to consider is that A $\beta$  may be the main origin of the neurodegeneration and cognitive decline. Beta amyloid begins as a solitary molecule, and then bunches up to form the familiar amyloid plaques, one of the hallmarks of Alzheimer's. A study has shown the protein can create a strong bond with receptors of nerve cells, which are necessary for the connections between cells, eroding their synapses with other nerve cells. Synapses are vital to storing memories, the process of thoughts & emotions, and other important duties they perform in the brain. A lack of healthy synapses in the brain leads to the neurodegeneration and memory loss that is associated with Alzheimer's.

A study conducted by Harvard University using a mouse strain which was highly receptive to the effects of Alzheimer's disease, gave the result that a lack of surface-protein positioned close to the synapses would lead to an impairment of memory breakdown, and the loss of synapses, associated with the disease. The results of this study are important, supporting the idea that A $\beta$  has the potential to destroy the receptors, leading to cognitive decline in humans affected by Alzheimer's.

Mice models can also be used to detect the cognitive effects of Alzheimer's. Due to the complexity of the disease, transgenic mice have been created to be able to exhibit the major hallmarks of the disease. Research by scientists in South Korea has led to a potentially important discovery of how the removal of amyloid plaques can temporarily improve the symptoms of Alzheimer's, shining a light on how A $\beta$  impacts the brain when untreated. This study was executed by providing Alzheimer's affected mice with 4-(2-hydroxyethyl)-1-piperazinepropanesulphonic



acid (EPPS), which binds to amyloid-beta aggregations, making them form into the normal single unit proteins they formally were. The research presented the findings that mice who were treated with the EPPS could navigate around a maze more efficiently than the mice that were not, opening the door to a potential short-term therapy for the neurodegenerative disease. Although this study by the scientists may sound reliable and considerable; critics such as Professor Tom Dening say that it is too early to jump to conclusions that the removal of plaques in humans would match the beneficial properties that it provided to the mice. However, this case may still be appealing to other researchers and clinicians.

Research on other neurodegenerative diseases have shown that neurofibrillary tangles are not specific to Alzheimer's and are typically found in a spread of dementias. This creates an interesting argument that since tau is not specific to Alzheimer's but Aβ depositories are almost singularly associated with Alzheimer's, it might be Aβ the has the most significant effect on the disease process. However, this is counteracted by some scientists who claim more focus should be placed on malfunctioned tau because it is involved in many other diseases. When amyloid is derived from the normal APP processing, it is cleaved in a normal cell to release a fragment molecular biologists have explored the differences between the normal cleavage and the cleavage that produces the fragment of Aβ. The relationship shows that, because the amyloid is divided in this process, when it is intact it cannot be a product of normal APP processing. This shows that the presence of Aβ fragments in Alzheimer's disease affected patients may be the outcome of pathological processing of the protein and processing that happens with Aβ in the brain is not in relation to the normal APP process.

On the other hand, there are studies which favour the point that Aβ is not the major hallmark of Alzheimer's - but Tau and neurofibrillary tangles, are more significant in the pathology of the disease. A large portion of Alzheimer's research has focused on amyloids and plaques but new studies have shown that the entire spotlight should not be on one hallmark only, but should explore further into the depths of the pathology of the disease. Lead researcher and neuroscientist Melissa Murray claims that the 'Alzheimer's field became myopic'. A study was produced of 3,618 post-mortem brains, with 1,375 belonging to past patients with various stages of dementia. Timelines were created to discover and quantify the progression of negative amyloid and tau build up in the brain. The analyses and comparison of amyloid protein clusters belonging to a live brain from patients before death, and the post-mortem results, showed that the severity of problematic tau, not Aβ, gave a better prediction of age-related cognitive decline and other mental defects. The journal *Brain* also published an article on how researchers found a strong relationship between Aβ and cognitive decline however the severity of tau destroyed this link as some brains found to contain Aβ did not show signs of cognitive decline where there was an absence of tau. This study shows how the effects of Alzheimer's may not be limited to only one section of pathology, if there is proof that tau could be the shadow behind dementia-related symptoms.

The association between tau and cognitive decline has been explored in more depth by researchers who have developed PET images, which harmlessly bind tau in the

live brain. A tau binding version was used alongside an amyloid binding version; to analyse deposits of the proteins in 10 people with mild Alzheimer's and 36 people who were healthy. The results showed that the more tau deposits in the temporal lobe (part of the brain associated with memory) the lower the results in memory and attention tests. The Aβ results proved differential to tau led to the conclusion that tau is a better predictor of the disease as it progresses.

However, this is counteracted by Pedro Rosa-Neto, a clinical neurologist, who claims that the results cannot be reliable due to how the study only took a snapshot of the person's brain at one time, and claims this means that there cannot be any association. Yet this study still shows a good comparison of how tau and Aβ have a different effect on cognitive decline.

My personal opinion of the dominant hallmark of Alzheimer's had been more focused on Aβ in the beginning because Aβ is specific to Alzheimer's, whereas tau is present in many dementias. However, after reviewing different studies about tau and the cognitive effects of it, I am now unsure what to conclude. The study by Melissa Murray and the article in *Brain* changed my view on the singular importance of Aβ. Personally, my current conclusion is that together, malfunctioned tau and Aβ both effect the brain significantly. More research will need to be conducted and should not be 'myopic' but focus on each protein more to discover possible treatments for the future.

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Emily Underwood May. 11, 2016, 2:00 PM

### PhD Tutor's note

The quality of T.'s work is outstanding for her age. Dementia has become the leading cause of death in the UK and is a global issue. Lots of research is taking place but as T. shows, the brain is very complex and understanding what causes the disease is a difficult task. T. has used independent research skills to provide a very balanced argument about competing theories for this complex disease. She writes in a manner that is entirely appropriate for any scientific article, using technical language that was only recently introduced to her. She is a highly able student with high potential going forward.

# Machine Learning and Big Data: How smart are computers?

Year 10, Key Stage 3

J. Tegegne St Bonaventure's, London

Supervised by D. Birrenkott, University of Oxford

The aim is to create a k-means clustering algorithm on Python, utilising unsupervised machine learning to classify 50 coins from all over the world into nine homogeneous sets of coins. Over time, especially in the past century, devices and machines have claimed to sort coins with accuracy. K-means clustering involves calculating the Euclidian distance between coins and centroids, assigning coins to a centroid, then updating the location of a centroid by working out the mean position of the coins in its cluster but iterating the process until the centroids no longer move. The solution was programmed on Python and had an error rate of 0.94.

### 1. Introduction

The objective is to sort a random collection of coins from all over the world with a machine learning algorithm. This is when a program develops artificial intelligence by being given past experience data to solve a problem.<sup>9</sup> With the right technique, we could find a way for it to sort coins more efficiently than a human.

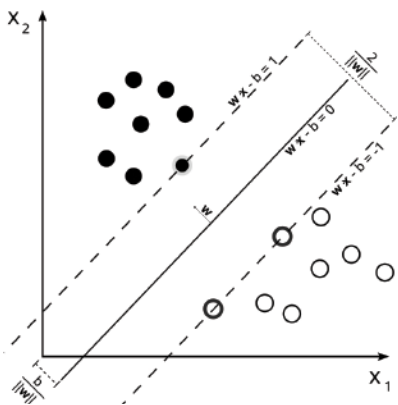
In 1911, people proposed ideas that claimed to sort coins quicker than money-handlers. Made by Charles Batdorf, the coin-separator consisted of trays, and according to the size of the coin, would be graded in diameter but also thickness. It would ensure that the coins were distributed into different compartments where coins of the same denomination are each stored.<sup>1</sup> In 1937, a rather complex coin sorting machine was invented that had many rotating discs.<sup>2</sup> A downside was that it needed a relatively large power supply to work, making it less favourable than cheaper coin sorters. A decade later, a device quite similar had many features, like a side drum with a set of peripheral grooves spaced so that each one passed through the approximate centre of a coin.<sup>3</sup> In addition, it counted the coins too, as they fell into their separate compartments. A few years later, coin sorting machines used features such as area, thickness and weight in order to classify coins, while ignoring visual features in the coins.<sup>4</sup> Gravity would feed the coins into stacking tubes that would each end up storing coins of the same denomination. It is clear that many coin sorting devices use diameter to separate coins because it is easiest to create a device that can use this factor. Money-handlers, with no physical assistance, will always use visual features to classify coins.

Although, coin-counters were experts at their jobs<sup>6</sup>, fake coins could deceive them, as they could simply be lower-denomination made to look like more valuable coins. Simple, adaptable devices nowadays are sold so that people can sort coins themselves. For instance, the Nadex Coin Sorter sends coins through a single path, that eventually splits into different paths, one by one, but each inclined plane has a different diameter.

The new paths widen the more the coins travel down the primary path, otherwise any coins smaller than the diameter would also fall into the same tube. Overflowing coins, coins

that stack on top of each other, are picked up by the first slot at the very start, therefore they must be re-placed, but it can take 300 coins per minute.

It is hypothesized that a collection of heterogeneous coins can be assorted more effectively than a human using a k-means clustering algorithm, based on the coin's diameter and weight, as they show the most variation, hence making it easier to differentiate clusters from each other. In addition, it is believed it can reduce the error rate and time taken, thus increasing efficiency, while the best money handlers are prone to make mistakes.



A support vector machine is a classifier that divides its input space into two regions, separated by a linear boundary. Here, it has learned to distinguish black and white circles.

### 2. Method

Unsupervised machine learning can be used to classify coins into their subset. This is the opposite of supervised machine learning, where the objects are labelled and you know the groups. Hierarchical clustering could have been used – it can be deemed as consistent because you would definitely get the same clustering results.

K-means clustering starts with a random choice of clusters, although it is simpler and easier to work with. Each coin is plotted onto a graph with multiple factors, for instance, diameter and weight. To collect a data set for the random assortment of coins, a micro meter was used to measure diameter and a digital scale for weight as these tools have small increments, millimeters and milligrams respectively (although the weight is then converted to a small number of grams). This provides accurate and precise measures as the objects are small. At first, diameter and circumference was considered. However, diameter is directly proportional to circumference – which is a product of diameter and π, so instead one factor was used and the other, replaced. By placing the same number of centroids, they will each represent a cluster, a group of similar coins.

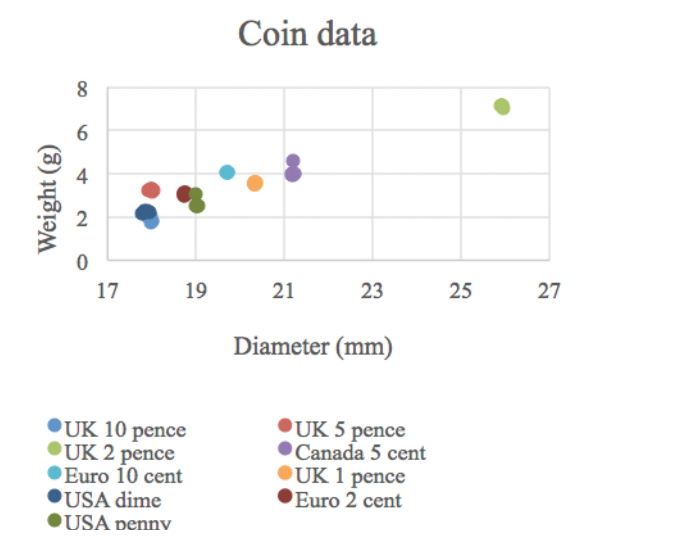
Pythagoras' Theorem is used to calculate the Euclidian distance, or the hypotenuse in this context. This is the distance between two points in Euclidian space; conveyed always by a straight line: it is equal to,  $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$  where  $(x_1 - x_2)$  is the x or horizontal difference and  $(y_1 - y_2)$  is the y or vertical difference between the two points. The smallest Euclidian distance to a centroid for each coin would mean that it is in the centroid's cluster, as it is of a greater proximity.

With each centroid representing a cluster of coins, the mean x and y value would be calculated, creating a new position where the respective centroid is moved to. The general formula is:  $\frac{1}{n} \sum_{i=1}^n x_i$ , but the specific expression is:  $\frac{1}{n} \sum_{i=1}^n x_i$ . The x position is the sum of the x values of the

coins in the centroid's cluster, and the same is done for the y position, but with the y values. The process is repeated until the centroids move no more so the coins would remain assigned to the same centroid. The centroid's continuously changing position would keep it representative of its cluster. In our case it is applied to coin denomination, it would be very difficult for currencies or large groups as they are less specific and show great difference. K-means clustering is completed with a programming software so it can easily be done with more variables or coins.

3. Results

50 coins from all over the world were sorted, and their diameter and weight were measured. There were nine different types of coins from four different countries and currencies. The coins were: UK 10 pence, five pence, two pence, one pence, Canada five cent, Euro 10 cent, two cent, USA penny and dime. Three coins out of 50 were assigned to the wrong centroid, therefore the error rate is 0.94 and 94 percent of coins were classified correctly. Cluster 1 had the lowest F1 score, of 3/8, proving that it seemed to qualitatively perform the worst. Below is a scatter graph representing the coin data, where the colour denotes the type of coin, and the two factors are weight and diameter.



4. Discussion

The results support the hypothesis, because the coins were effectively sorted as there was a low error rate. Error is bound to happen due to some abnormalities or when the dimensions of a coin are similar to that of a coin of a different type, it may be classed into that cluster. For instance, two 10 pence pieces were classed into the wrong cluster – cluster 7 for the USA dime. Although those two coins had normal diameter, their weight was above two grams whereas the other 10 pence coins had weights less than 1.8. Similarly, all USA dimes had weights in the range of 2.15 and 2.25 grams.

Coin sorting on a much larger scale could take a great amount of time for a human, whereas this algorithm could complete the process much faster. On the other hand, it may be argued that the hypothesis is partially contradicted, because all the coins, except the two pence UK coin, had similar weight and diameter, so there were coins assigned to the wrong cluster. Perhaps, other features such as thickness, could have been used to reduce the error. If thickness was used, as opposed to weight, there may have been less error

because the USA dime has a thickness of 1.35 mm, unlike the 10 pence coin which is significantly larger – 1.85 mm.

Other types of machine learning could be used. Heirarchical clustering could have been used – working from the bottom, all the data would be split into smaller subsets of clusters, and eventually a point is reached where each cluster holds data for one type of coin and there are a hierarchy of clusters. In addition, it does not need to know how many clusters there are which could be useful when there are a great amount of coins and the different types present are unknown. Furthermore, the process is much simpler as there are far less mathmetical calculations which can make it easier to carry out.<sup>7</sup>

Supervised learning could have been used, where the program is highly reliant on information already given.<sup>8</sup> The program can be given artificial intelligence by providing the features of a few coins per coin type, and from there, the program should be able to classify any given coin. The more data given, the more effective and successful this will be over time – and would perhaps reduce the need for an algorithm.

5. Conclusions

The hypothesis was to assort coins more effectively than a human using a k-means clustering algorithm; the low error rate of 0.94 of the code supported the hypothesis, therefore the code could be applied on a greater scale, with many more coins and variables. In the future, given more time, different approaches could be taken to improve the quality, time taken and most importantly the error rate.

Coding

```
#!/usr/bin/perl
use strict;
use warnings;

my $centroid_x = [18.00, 9.99, 30.93, 21.22, 19.71, 20.31, 20.31, 17.84, 4.32];
my $centroid_y = [1.78, 9.29, 7.14, 4.03, 4.04, 3.8, 3.8, 2.7, 3.02];

my $coin_x = [0.9, 1.1, 2.9, 3.1, 5.9, 4.1, 7.9, 8.1, 9.9, 10.1, 11.9, 12.1, 13.9, 14.1, 15.9, 16.1, 17.9, 18.1];
my $coin_y = [0.09, 1.01, 2.09, 3.01, 5.09, 4.01, 7.09, 8.01, 9.09, 10.01, 11.09, 12.01, 13.09, 14.01, 15.09, 16.01, 17.09, 18.01];

my $coin = [];
my $a = 0;
my $b = 0;
my $c = 0;

while ($a > 0) {
    $calc = round(meth_sqrt((($coin_x[$a]-$centroid_x[0])**2) - ($coin_y[$a]-$centroid_y[0])**2));
    $coin->append($calc);
    $b = $a + 1;
    $a = $a - 1;
}

print "Coin 1 is in cluster", $coin->index(min($coin))+1;

$coin = [];
$a = 1;
$b = 0;
$c = 0;

while ($a > 0) {
    $calc = round(meth_sqrt((($coin_x[$a]-$centroid_x[1])**2) - ($coin_y[$a]-$centroid_y[1])**2));
    $coin->append($calc);
    $b = $a + 1;
    $a = $a - 1;
}

print "Coin 2 is in cluster", $coin->index(min($coin))+1;

#Calculate euclidean distance of a coin to each centroid then states what
#cluster the coin is in after 1 iteration
```

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PhD Tutor's note

I have taught 'Machine Learning and Big Data: How Smart are Computers?' many times and am always amazed at the assignments the students submit. J's assignment is one of the best I've seen. The assignment is quite a challenging one, as it requires students to conduct an experiment, research why they might want to conduct that experiment, and write an academic-style report on their results. J. did an absolutely fantastic job at all three of these aspects and is certainly well-poised to be very successful at the uni of his choosing!

The Simplex Algorithm for the House-cleaning-cookie-baking problem: the case, of three siblings



Year 10, Key Stage 4

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"It is four years later and Emma and Tom now have a younger sister Laura and they moved into a larger house. Again, the parents return home in three hours and they can make them happy by either cleaning the house or baking cookies. Both Tom and Laura need supervision by Emma while baking. Like last time, Tom gets annoyed if he cleans more than twice the time as Emma does or an hour more than her. Laura gets upset if she cleans longer than both Tom and Emma together. They have to clean an area of at most 150 m<sup>2</sup>. Emma, Tom and Laura now clean at rates 0.6 m<sup>2</sup>/min, 0.4 m<sup>2</sup>/min and 0.2m<sup>2</sup>/min respectively and they bake 0.45 cookies/min, 0.25 cookies/min and 0.1 cookies/min. Every clean square meter makes a happiness contribution of 5.5, every baked cookie of 4. What is the optimal time for the siblings to spend on cleaning and baking?"

To start off with, from the information above, we can derive the restrictions of this problem. Let Emma's time spent cleaning in minutes to be *tE*, Tom's time spent cleaning in minutes to be *tT* and Laura's time spent cleaning in minutes to be *tL*.

It is stated that "the parents return home in three hours". From that fact we can derive that all the variables must have a value smaller than 180, since any value higher would imply that the children would be cleaning after the parents had come home. Therefore, the resulting inequalities are:

- 1.  $t_E \leq 180$
- 2.  $t_T \leq 180$
- 3.  $t_L \leq 180$

It is stated that the children can only clean "an area of at most 150 m<sup>2</sup>", so from this, we can derive that the sum of each child's cleaning rate multiplied by the minutes they spend cleaning must be equal to or less than 150. Let Emma's cleaning rate be defined as *CE*, Tom's cleaning rate to be defined as *CT* and Laura's cleaning rate as *CL*. When rewritten as a formula, this becomes:

$(c_E \times t_E) + (c_T \times t_T) + (c_L \times t_L) \leq 150$

When we substitute the values of *CE*, *CT* and *CL*, the resulting constraint is:

$0.6t_E + 0.4t_T + 0.2t_L \leq 150$

It is stated that Emma needs to supervise both Tom and Laura when they are baking cookies. This means that the time spent by Tom or Laura baking must not exceed the time spent by Emma baking (otherwise she would not be able to supervise her younger siblings). The times spent baking by Emma, Tom and Laura are 180 – *tE*, 180 – *tT* and 180 – *tL*, respectively. Therefore, the constraints are:

- 1.  $180 - t_T \leq 180 - t_E$
- 2.  $180 - t_L \leq 180 - t_E$

Which are equivalent to:

- 1.  $t_T \geq t_E$
- 2.  $t_L \geq t_E$

It is stated that Tom, "gets annoyed if he cleans more than twice the time as Emma does or an hour more than," Emma. This means that the value of *tT* cannot be more than twice as big as the value of *tE*, nor bigger than it by 60, otherwise Tom would get annoyed. Formulating this would give:

- 1.  $2t_E \geq t_T$
- 2.  $t_E + 60 \geq t_T$

Since the children need to find the optimal time where they can receive the most happiness from their parents, we can infer that the optimal point maximises the happiness function. Let the rate: "v\("At) at which each child bakes at to be *bE* for Emma, *bT* for Tom and *h<sub>q</sub>*, for Laura. Let the happiness contribution for each clean square metre be *h<sub>e</sub>* and the happiness contribution for each cookie be *h<sub>b</sub>*. The happiness contribution for cleaning would be equivalent to the sum of each child's rate of cleaning multiplied by that child's time spent cleaning and also by the happiness contribution of each clean square metre. Formulating this gives:

$(t_E \times c_E \times h_c) + (t_T \times c_T \times h_c) + (t_L \times c_L \times h_c)$

The happiness contribution for baking would be equivalent to the sum of each child's rate of baking multiplied by that child's time spent baking and also the happiness contribution of each cookie. Formulating this gives:

$H(t_E, t_T, t_L) = (t_E \times c_E \times h_c) + (t_T \times c_T \times h_c) + (t_L \times c_L \times h_c) + ((180 - t_E) \times b_E \times h_b) + ((180 - t_T) \times b_T \times h_b) + ((180 - t_L) \times b_L \times h_b)$

When fully simplified, the happiness function becomes:

$H(t_E, t_T, t_L) = 1.5t_E + 1.2t_T + 0.7t_L + 576$

Since the Simplex Algorithm requires the problem to be written in standard form, we need to re-write the happiness function and the restrictions set so that they are all in standard form. The constraints that we had derived were:

- 1.  $t_E \leq 180$
- 2.  $t_T \leq 180$
- 3.  $t_L \leq 180$
- 4.  $0.6t_E + 0.4t_T + 0.2t_L \leq 150$
- 5.  $t_T \geq t_E$
- 6.  $t_L \geq t_E$
- 7.  $2t_E \geq t_T$
- 8.  $t_E + 60 \geq t_T$
- 9.  $t_E + t_T \geq t_L$



Since the standard form requires them to be equalities, we must introduce slack or surplus variables into each inequality, as well as rearranging the variables, so that all variables are on one side of the formula, while the constants are on the other side. The end result is:

- 1.  $t_E + s_1 = 180$
- 2.  $t_T + s_2 = 180$
- 3.  $t_L + s_3 = 180$
- 4.  $3t_E + 2t_T + t_L + s_4 = 750$
- 5.  $t_E - t_T + s_5 = 0$
- 6.  $t_E - t_L + s_6 = 0$
- 7.  $t_L - t_E - t_T + s_7 = 0$
- 8.  $t_T - 2t_E + s_8 = 0$
- 9.  $t_T - t_E + s_9 = 60$

Therefore, this problem re-written in standard form would be:

Maximise  $H = 1.5t_E + 1.2t_T + 0.7t_L + 576$

Subject to

- 1.  $t_E + s_1 = 180$
- 2.  $t_T + s_2 = 180$
- 3.  $t_L + s_3 = 180$
- 4.  $3t_E + 2t_T + t_L + s_4 = 750$
- 5.  $t_E - t_T + s_5 = 0$
- 6.  $t_E - t_L + s_6 = 0$
- 7.  $t_L - t_E - t_T + s_7 = 0$
- 8.  $t_T - 2t_E + s_8 = 0$
- 9.  $t_T - t_E + s_9 = 60$

And

$t_E \geq 0, t_T \geq 0, t_L \geq 0$   
 $s_i \geq 0, i = 1, 2, 3, 4, 5, 6, 7, 8, 9$

Before we write the equations into the initial table, we need to now treat as a variable and re-write the happiness function so that it is in the same format as the other formulas. The resulting happiness function formula is:

$H - 1.5t_E - 1.2t_T - 0.7t_L = 576$

We can now put this in the initial table for the algorithm.

B	Z	$t_E$	$t_T$	$t_L$	$s_1$	$s_2$	$s_3$	$s_4$	$s_5$	$s_6$	$s_7$	$s_8$	$s_9$	
$s_1$	0	1	0	0	1	0	0	0	0	0	0	0	0	180
$s_2$	0	0	1	0	0	1	0	0	0	0	0	0	0	180
$s_3$	0	0	0	1	0	0	1	0	0	0	0	0	0	180
$s_4$	0	3	2	1	0	0	0	1	0	0	0	0	0	750
$s_5$	0	1	-1	0	0	0	0	0	1	0	0	0	0	0
$s_6$	0	1	0	-1	0	0	0	0	0	1	0	0	0	0
$s_7$	0	-1	-1	0	0	0	0	0	0	0	1	0	0	0
$s_8$	0	-2	1	0	0	0	0	0	0	0	0	1	0	0
$s_9$	0	-1	1	0	0	0	0	0	0	0	0	0	1	60
H	1													576

By using this table, we reduce the amount of notation used and make it much easier to comprehend than if we tried to find the optimal point without this table. To begin with, all the  $s_i$  variables are basic, while  $t_E$ ,  $t_T$  and  $t_L$  are non-basic, so if we set the non-basic variables to 0, we get:

$s_1 = 180, s_2 = 180, s_3 = 180, s_4 = 750, s_5 = 0, s_6 = 0, s_7 = 0, s_8 = 0, s_9 = 60$

This is a trivial step at this stage, but shows the purpose of the B column, to tell us quickly what the solutions are by paring each variable with its solution in the last column, and mimics what will be done later on.

Since the last row has negative entries, in the  $t_E$ ,  $t_T$ , and  $t_L$  columns, it means that H can be increased by increasing either  $t_E$ ,  $t_T$  or  $t_L$  without breaching any restrictions, so is not at the optimal point.

B	Z	$t_E$	$t_T$	$t_L$	$s_1$	$s_2$	$s_3$	$s_4$	$s_5$	$s_6$	$s_7$	$s_8$	$s_9$	$\theta$
$s_1$	0	1	0	0	1	0	0	0	0	0	0	0	0	180
$s_2$	0	0	1	0	0	1	0	0	0	0	0	0	0	180
$s_3$	0	0	0	1	0	0	1	0	0	0	0	0	0	180
$s_4$	0	3	2	1	0	0	0	1	0	0	0	0	0	750
$s_5$	0	1	-1	0	0	0	0	0	1	0	0	0	0	0
$s_6$	0	1	0	-1	0	0	0	0	0	1	0	0	0	0
$s_7$	0	-1	-1	0	0	0	0	0	0	0	1	0	0	0
$s_8$	0	-2	1	0	0	0	0	0	0	0	0	1	0	0
$s_9$	0	-1	1	0	0	0	0	0	0	0	0	0	1	60
H	1													576

Since the  $t_E$  column has the most negative entry in the H row,  $t_E$  will become the entering variable and its column becomes the pivot column. To find the pivot element of the pivot column, we compute the quotient  $\theta$  of each entry in the last column with its corresponding entry in the pivot column. The smallest non-negative quotient will give us the pivot entry and the departing variable. We ignore any negative quotients, because if we were to use those, we would leave the feasible region. In this case, we have two possible pivot entries with identical quotients. Either one can be chosen. For this example, I have chosen  $s_5$  to be the leaving variable. Incidentally, the pivot entry is already 1, so no change is needed to be made to the row.

Now that we have chosen the leaving variable, we add multiples of that row to the other rows, so as to reduce every other entry in the pivot column to 0. This results in the  $t_E$  variable becoming basic and the  $s_5$  variable becoming non-basic. The  $t_E$  variable takes the position of the  $s_5$  variable in the B column.

However, since there are still negative entries in the H-row, this is not the optimal solution.

B	Z	$t_E$	$t_T$	$t_L$	$s_1$	$s_2$	$s_3$	$s_4$	$s_5$	$s_6$	$s_7$	$s_8$	$s_9$	$\theta$
$s_1$	0	0	1	0	1	0	0	0	-1	0	0	0	0	180
$s_2$	0	0	1	0	0	1	0	0	0	0	0	0	0	180
$s_3$	0	0	0	1	0	0	1	0	0	0	0	0	0	180
$s_4$	0	0	5	1	0	0	0	1	-3	0	0	0	0	750
$t_E$	0	1	-1	0	0	0	0	1	0	0	0	0	0	0
$s_6$	0	0	1	-1	0	0	0	0	-1	1	0	0	0	0
$s_7$	0	0	-2	0	0	0	0	0	1	0	1	0	0	0
$s_8$	0	0	-1	0	0	0	0	0	2	0	0	1	0	0
$s_9$	0	0	1	0	0	0	0	0	1	0	0	0	1	60
H	1													576

Now, when we set all the non-basic variables to 0, we get:

$s_1 = 180, s_2 = 180, s_3 = 180, s_4 = 750, t_E = 0, s_6 = 0, s_7 = 0, s_8 = 0, s_9 = 60$

$t_E$  is still equal to zero, which correlates with the fact that the value of H has remained at 576. If we repeat the previous step with this new table, we find that  $t_T$  is the new entering variable and  $s_4$  is the new leaving variable. The pivot element is not equal to 1, so we need to multiply the row of the pivot element by the reciprocal of the pivot element in order to make it equal to 1. In this case, we are multiplying it by 1/6.

B	Z	$t_E$	$t_T$	$t_L$	$s_1$	$s_2$	$s_3$	$s_4$	$s_5$	$s_6$	$s_7$	$s_8$	$s_9$	
$s_1$	0	0	0	1	1	0	0	0	0	-1	0	0	0	180
$s_2$	0	0	0	1	0	1	0	0	1	-1	0	0	0	180
$s_3$	0	0	0	1	0	0	1	0	0	0	0	0	0	180
$s_4$	0	0	0	1	0	0	0	1	0	0	0	0	0	125
$t_E$	0	1	0	-1	0	0	0	0	0	1	0	0	0	0
$t_T$	0	0	1	-1	0	0	0	0	-1	1	0	0	0	0
$s_7$	0	0	0	-1	0	0	0	0	-1	2	1	0	0	0
$s_8$	0	0	0	-1	0	0	0	0	1	1	0	1	0	0
$s_9$	0	0	0	0	0	0	0	0	1	0	0	0	1	60
H	1													576

Now that the pivot element is equal to 1, we can add multiples of its row to other rows in order to reduce all other entries in the pivot column to 0.

This results in the  $t_L$  variable becoming basic and the  $s_4$  variable becoming non-basic. The  $t_L$  variable takes the position of the  $s_4$  variable in the B column.

However, since there are still negative entries in the H-row, this is not the optimal solution.

B	Z	$t_E$	$t_T$	$t_L$	$s_1$	$s_2$	$s_3$	$s_4$	$s_5$	$s_6$	$s_7$	$s_8$	$s_9$	$\theta$
$s_1$	0	0	0	0	1	0	0	0	0	-1	0	0	0	55
$s_2$	0	0	0	0	0	1	0	0	0	-1	0	0	0	55
$s_3$	0	0	0	0	0	0	1	0	0	-1	0	0	0	55
$t_L$	0	0	0	1	0	0	0	1	0	0	0	0	0	125
$t_E$	0	1	0	0	0	0	0	0	0	1	0	0	0	125
$t_T$	0	0	1	0	0	0	0	0	0	0	1	0	0	125
$s_7$	0	0	0	0	0	0	0	0	0	1	0	0	0	125
$s_8$	0	0	0	0	0	0	0	0	0	0	1	0	0	125
$s_9$	0	0	0	0	0	0	0	0	0	1	0	0	1	60
H	1													1001

Now, when we set the non-basic variables to 0, we get:

$s_1 = 55, s_2 = 55, s_3 = 55, t_L = 125, t_E = 125, t_T = 125, s_7 = 125, s_8 = 125, s_9 = 60$

$t_E$ ,  $t_T$  and  $t_L$  have all increased by 125 and the value of J has increased to 1001, so  $H(125, 125, 125) = 1001$ .

If we repeat the previous step with this new table, we find that  $s_6$  is the new entering variable and  $s_3$  is the new leaving variable.

Since the pivot element is not equal to 1, we must multiply the row by the reciprocal of the pivot element, as we have done before. In this case, we are multiplying the row of the pivot element by 6/5.

B	Z	$t_E$	$t_T$	$t_L$	$s_1$	$s_2$	$s_3$	$s_4$	$s_5$	$s_6$	$s_7$	$s_8$	$s_9$	
$s_1$	0	0	0	0	1	0	0	0	0	-1	0	0	0	55
$s_2$	0	0	0	0	0	1	0	0	0	-1	0	0	0	55
$s_3$	0	0	0	0	0	0	1	0	0	-1	0	0	0	66
$t_L$	0	0	0	1	0	0	0	1	0	0	0	0	0	125
$t_E$	0	1	0	0	0	0	0	0	0	1	0	0	0	125
$t_T$	0	0	1	0	0	0	0	0	0	0	1	0	0	125
$s_7$	0	0	0	0	0	0	0	0	0	1	0	0	0	125
$s_8$	0	0	0	0	0	0	0	0	0	0	1	0	0	125
$s_9$	0	0	0	0	0	0	0	0	0	1	0	0	1	60
H	1													1001

Now that the pivot element is equal to 1, we can add multiples of the row of the pivot element to the other rows in order to reduce all other entries in the pivot column to 0.

This results in the  $s_6$  variable becoming basic and the  $s_3$  variable becoming non-basic. The  $s_6$  variable takes the position of the  $s_3$  variable in the B column.

However, since there are still negative entries in the H-row, this is not the optimal solution.

B	Z	$t_E$	$t_T$	$t_L$	$s_1$	$s_2$	$s_3$	$s_4$	$s_5$	$s_6$	$s_7$	$s_8$	$s_9$	$\theta$
$s_1$	0	0	0	0	1	0	0	0	0	0	0	0	0	66
$s_2$	0	0	0	0	0	1	0	0	0	0	0	0	0	66
$s_6$	0	0	0	0	0	0	1	0	0	0	0	0	0	66
$t_L$	0	0	0	1	0	0	0	1	0	0	0	0	0	180
$t_E$	0	1	0	0	0	0	0	0	0	1	0	0	0	114
$t_T$	0	0	1	0	0	0	0	0	0	0	1	0	0	114
$s_7$	0	0	0	0	0	0	0	0	0	1	0	0	0	48
$s_8$	0	0	0	0	0	0	0	0	0	0	1	0	0	114
$s_9$	0	0	0	0	0	0	0	0	0	1	0	0	1	60
H	1													1009.8

Now, when we set the non-basic variables to 0, we get:

$s_1 = 66, s_2 = 66, s_6 = 66, t_L = 180, t_E = 114, t_T = 114, s_7 = 48, s_8 = 114, s_9 = 60$

$t_E$  and  $t_T$  have both decreased to 114, while  $t_L$  has increased to 180. The value of H has also increased to 1009.8, meaning  $H(114, 114, 180)$  is greater than  $H(125, 125, 125)$ , despite it not being the optimal solution.

If we repeat the previous step with this new table, we find that  $s_5$  is the new entering variable and  $s_9$  is the new leaving variable.

Incidentally, the pivot element is already equal to 1, so no change is needed to be made to the row. We add multiples of the row of the pivot element to the other rows to reduce all other entries in the pivot column to 0.

This results in the  $s_5$  variable becoming basic and the  $s_9$  variable becoming non-basic. The  $s_5$  variable takes the position of the  $s_9$  variable in the B column.



B	Z	t <sub>E</sub>	t <sub>T</sub>	t <sub>L</sub>	s <sub>1</sub>	s <sub>2</sub>	s <sub>3</sub>	s <sub>4</sub>	s <sub>5</sub>	s <sub>6</sub>	s <sub>7</sub>	s <sub>8</sub>	s <sub>9</sub>	
s <sub>1</sub>	0	0	0	0	1	0	1/5	2/5	0	0	0	0	2/5	90
s <sub>2</sub>	0	0	0	0	0	1	1/5	-1/5	0	0	0	0	-3/5	30
s <sub>6</sub>	0	0	0	0	0	0	6/5	-1/5	0	1	0	0	2/5	90
t <sub>L</sub>	0	0	0	1	0	0	1	0	0	0	0	0	0	180
t <sub>E</sub>	0	1	0	0	0	0	-1/5	1/5	0	0	0	0	-2/5	90
t <sub>T</sub>	0	0	1	0	0	0	-1/5	1/5	0	0	0	0	3/5	150
s <sub>7</sub>	0	0	0	0	0	0	-7/5	2/5	0	0	1	0	1/5	60
s <sub>8</sub>	0	0	0	0	0	0	-1/5	1/5	0	0	0	1	-7/5	30
s <sub>5</sub>	0	0	0	0	0	0	0	0	1	0	0	0	1	60
H	1	0	0	0	0	0	4/25	27/50	0	0	0	0	3/25	1017

Now there are no negative entries in the H-row. Therefore, we must have reached the optimal solution which is:

$t_E = 90, t_T = 150, t_L = 180$

For which the happiness function is:

$H(90,150,180) = 1017$

In conclusion, Emma should clean for 90 minutes, Tom should clean for 150 minutes and Laura should clean for 180 minutes to maximise the amount of happiness their parents have when returning home.

If the happiness contribution of each square metre was changed by  $\delta$ , so that the happiness contribution for each square metre become  $5.5 + \delta$ , it would change the happiness function to:

$H^I(t_E, t_T, t_L) = 1.5t_E + 0.6\delta t_E + 1.2t_T + 0.4\delta t_T + 0.7t_L + 0.2\delta t_L + 576$

Which can be rearranged to:

$H^I - 1.5t_E - 0.6\delta t_E - 1.2t_T - 0.4\delta t_T - 0.7t_L - 0.2\delta t_L = 576$

If we were to write  $H^I$  in terms of  $H$  and  $\delta$ , the resulting formula would be:

$H^I = H + 0.6\delta t_E + 0.4\delta t_T + 0.2\delta t_L$

Using the last table from the Simplex Algorithm, we can input these new entries in order to find what values of  $\delta$ , allow the solution to remain optimal.

B	Z	t <sub>E</sub>	t <sub>T</sub>	t <sub>L</sub>	s <sub>1</sub>	s <sub>2</sub>	s <sub>3</sub>	s <sub>4</sub>	s <sub>5</sub>	s <sub>6</sub>	s <sub>7</sub>	s <sub>8</sub>	s <sub>9</sub>	
s <sub>1</sub>	0	0	0	0	1	0	1/5	2/5	0	0	0	0	2/5	90
s <sub>2</sub>	0	0	0	0	0	1	1/5	-1/5	0	0	0	0	-3/5	30
s <sub>6</sub>	0	0	0	0	0	0	6/5	-1/5	0	1	0	0	2/5	90
t <sub>L</sub>	0	0	0	1	0	0	1	0	0	0	0	0	0	180
t <sub>E</sub>	0	1	0	0	0	0	-1/5	1/5	0	0	0	0	-2/5	90
t <sub>T</sub>	0	0	1	0	0	0	-1/5	1/5	0	0	0	0	3/5	150
s <sub>7</sub>	0	0	0	0	0	0	-7/5	2/5	0	0	1	0	1/5	60
s <sub>8</sub>	0	0	0	0	0	0	-1/5	1/5	0	0	0	1	-7/5	30
s <sub>5</sub>	0	0	0	0	0	0	0	0	1	0	0	0	1	60
H <sup>I</sup>	1	-0.6\delta	-0.4\delta	-0.2\delta	0	0	4/25	27/50	0	0	0	0	3/25	1017

Since  $t_E$ , and  $t_L$  are all basic variables, we can easily add a multiple of each of their rows to the H1-row to reduce the new entries back to 0.

B	Z	t <sub>E</sub>	t <sub>T</sub>	t <sub>L</sub>	s <sub>1</sub>	s <sub>2</sub>	s <sub>3</sub>	s <sub>4</sub>	s <sub>5</sub>	s <sub>6</sub>	s <sub>7</sub>	s <sub>8</sub>	s <sub>9</sub>	
s <sub>1</sub>	0	0	0	0	1	0	1/5	2/5	0	0	0	0	2/5	90
s <sub>2</sub>	0	0	0	0	0	1	1/5	-1/5	0	0	0	0	-3/5	30
s <sub>6</sub>	0	0	0	0	0	0	6/5	-1/5	0	1	0	0	2/5	90
t <sub>L</sub>	0	0	0	1	0	0	1	0	0	0	0	0	0	180
t <sub>E</sub>	0	1	0	0	0	0	-1/5	1/5	0	0	0	0	-2/5	90
t <sub>T</sub>	0	0	1	0	0	0	-1/5	1/5	0	0	0	0	3/5	150
s <sub>7</sub>	0	0	0	0	0	0	-7/5	2/5	0	0	1	0	1/5	60
s <sub>8</sub>	0	0	0	0	0	0	-1/5	1/5	0	0	0	1	-7/5	30
s <sub>5</sub>	0	0	0	0	0	0	0	0	1	0	0	0	1	60
H <sup>I</sup>	1	0	0	0	0	0	4/25	27/50	0	0	0	0	3/25	1017 + 150\delta

The two constraints we have in finding the possible values of  $\delta$  are:

$27/50 + 0.2\delta \geq 0, 1017 + 150\delta \geq 0$

Re-writing these inequalities so that  $\delta$  remains on one side while the constants remain on the other gives:

$\delta \geq -2.7, \delta \geq -6.78$

Since having a value of less than -2.7 would breach the first constraint before the second one could even be reached, the second inequality is redundant and can be ignored.

Therefore,  $\delta$  can take any value greater than or equal to -2.7 so tht the given solution still remains optimal.

PhD Tutor's note

It was an absolute pleasure to work with A. Abdereshed due to his ability to quickly form new connections of any new material to what he already knew. He also has an exceptional capability to work independently and has proven numerous times that he can tackle work that has not been fully explained to him. In his final assignment he successfully solved an extension to the problem that had not been discussed and wrote everything in the style of a proper mathematician's answer with stated assumptions and full explanations / reasoning as opposed to a typical A-level student's collection of uncommented calculations. The high standard of his work was graded 98%.

The Mathematical Modelling of Sea Surface Temperatures in a Warming Climate



Year 10, Key Stage 4

L. Collins, Priory Academy, London  
Supervised by Dr P. Kowalski, Priory Academy

Ocean temperatures are rising as a result of our warming climate and this may have profound consequences for all life on Earth. To understand how this is happening and how we might prepare for the consequences, we need to understand this process mathematically. To do this scientists must learn how to perform liner regression analysis.

Here, L. Collins from Priory Academy completes a complex linear regression.

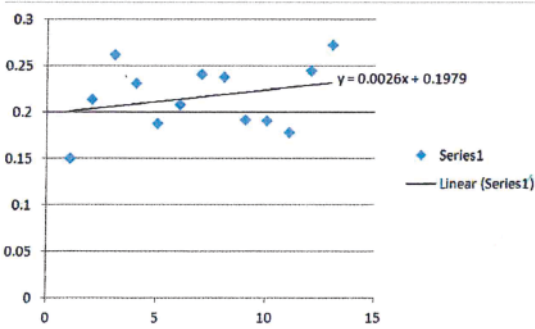
Assignment 5 – Final Assignment

Temperature

0.15	0.238010223
0.213612862	0.191774199
0.261697428	0.190628644
0.231298996	0.178837719
0.187818387	0.244883905
0.208689589	0.272687984
0.241252893	

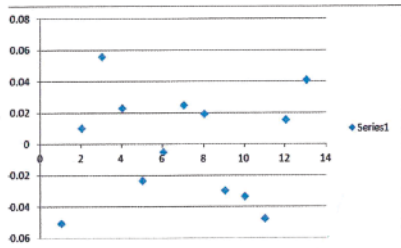
For the above data set derive and plot the following: (use your notes from tutorial 5)

1) Trend Line  $Y = 0.0026x + 0.1979$



Equation of Trend Line:  $Y = 0.0026x + 0.1979$

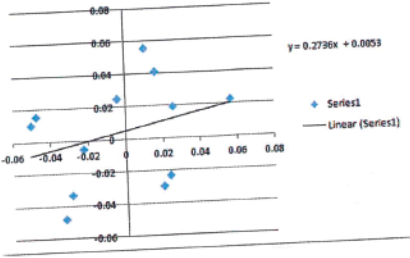
2) Remove Trend



3) Natural Variability

Removing the trendline due to CO2 will leave you a line of natural variability.

4) Equation between  $T_{i-1}$  and  $T_i$   
Temp from previous year  
Temp for following year



Paste here a snippet of what the columns in Excel look like

	A	B	C	D	E
1	temperature	Time(X)	Trend Line	Removed Trend and T1	Ti+1
2					
3	0.15	1	0.2005	-0.0505	0.01051
4	0.213612862	2	0.2031	0.010512862	0.056
5	0.261697428	3	0.2057	0.055997428	0.023
6	0.231298996	4	0.2083	0.022998996	-0.02308
7	0.187818387	5	0.2109	-0.023081613	-0.00481
8	0.208689589	6	0.2135	-0.004810411	0.02515
9	0.241252893	7	0.2161	0.025152893	0.01931
10	0.238010223	8	0.2187	0.019310223	-0.02953
11	0.191774199	9	0.2213	-0.029525801	-0.03327
12	0.190628644	10	0.2239	-0.033271356	-0.04766
13	0.178837719	11	0.2265	-0.047662281	0.01578
14	0.244883905	12	0.2291	0.015783905	0.04099
15	0.272687984	13	0.2317	0.040987984	

Can you explain what you have done when performing the above steps with regard to the physics

1) Trend Line  
Adding the linear trendline will represent the effect of Carbon dioxide on sea surface temperatures each year.  
2) Remove the trend line  
Doing this shows the component of sea surface temperature signal that is related to natural variability. You have removed the cause of CO2 and are left with the natural variability.  
T<sub>i</sub> is the temperatures from the previous years from natural forces  
T<sub>i+1</sub> show the temperature for the following years from natural forces.

PhD Tutor's note

Sea surface temperatures across the world have been increasing steadily since the onset of the industrial era, however, fluctuations about this upward trend are clearly visible. These fluctuations are of great interest to climate scientists because they are associated with the natural variability of the climate system, which to this day is still relatively poorly understood. The work of L. Collins at Priory Academy is an outstanding example of how a model for these fluctuations can be formed using linear regression, which is a statistical technique that is employed by much of the academic community, as well as banks and other business, to study relationships between variables. Whilst her work clearly shows that she has an excellent grasp of the mathematics, and the various mathematical routines in Excel, it is the interpretation of the various components of the linear regression model that stands out. An outstanding piece of work by a dedicated and gifted pupil.



# Observation of the Antennae Galaxies using the Very Large Telescope



Year 10, Key Stage 4

UCL L. Thomson, Parliament Hill School, London.  
Supervised by C. McEvoy, Parliament Hill School

This is my proposal for viewing the Antennae Galaxies using the Very Large Telescope (VLT), in order to ascertain beneficial scientific discoveries to aid further research into other areas of outer space. This proposal will provide facts about the Antennae Galaxies and the VLT, and will express my opinion on why these subjects being viewed will be useful to further work in astronomy.

For this project, the objects I would like to observe are the Antennae Galaxies. These are a pair of interacting galaxies which are undergoing a collision (the initial encounter of the galaxies being some 200 to 300 million years ago), and are entering a starburst phase, where the rapid formation of stars occurs<sup>1</sup>. These two galaxies are known as the Antennae Galaxies because the two long tails of stars, gas and dust ejected from the galaxies, as a result of the collision, resemble an insect's antennae.

It is estimated that 1.2 billion years ago, the Antennae were two separate galaxies. One of the galaxies, NGC 4038, was a barred spiral galaxy and the other galaxy, NGC 4039, was a spiral galaxy. Before they collided, NGC 4039 was larger than NGC 4038. 900 million years ago, the Antennae began to approach one another, then 600 million years ago, the Antennae collided into each other. 300 million years ago, the Antennae's stars began to be released from both galaxies. Today the two streams of ejected stars extend far beyond the original galaxies, resulting in their famous antennae shape. Within 400 million years, the Antennae's nuclei will collide and become a single core with stars, gas, and dust around it. Observations and simulations of colliding galaxies suggest that the Antennae Galaxies will eventually form one elliptical galaxy.

Not only will the observation of these new stars benefit further scientific research into how our universe works, but these two colliding galaxies portray a likely future for our galaxy, when Andromeda hits our Milky Way. The observation of these galaxies will provide insight into the future of our own, and can help astronomers to understand how these collisions benefit the rapid formation of stars.

The telescope that I would like to use to view these galaxies is the VLT. I would use the VLT's infrared wavelength to view the galaxies. This telescope is located in Chile. With optimum weather conditions and right placement on the Earth to view the correct part of space that houses the Antennae Galaxies, the VLT proves to be the best telescope for viewing them. The high-resolution images that the VLT provides of these galaxies will allow astronomers to differentiate between stars and super star clusters that were created in the collision of the two spiral galaxies.

By observing these galaxies, discoveries can be determined such as that the majority of super star clusters formed during this interaction will disperse, with individual stars becoming part of the background of the galaxy<sup>2</sup>. However,

it is estimated a hundred of the massive clusters will survive to form regular globular clusters, similar to those found in our own Milky Way galaxy.

### Scientific rational

I chose this object, not only because it is very likely the future of our galaxy when it collides with Andromeda, but also because it provides interesting scientific information. The age of these clusters differ to the age of most known globular clusters and the rate of star formation is so unusually high that the Antennae Galaxies are in a state of starburst, a period in which all the gas within the galaxies is being used to form stars<sup>3</sup>. This process will not last forever and neither can the separate galaxies; meaning eventually the nuclei will merge, marking the start of the galaxies remaining in partnership together as one large elliptical galaxy.

This object was something that I had never heard of before and I wanted to know more about it. I knew I wanted to choose an object which included either growth or production of hot stars and that somehow related to our galaxy. The Antennae galaxies relate to both these areas as it provides insight into rapid hot star growth, and displays a likely example of the future of our galaxy. Additionally, the Antennae galaxies are the nearest interacting galaxies to our own. The viewing of these interlocked galaxies will provide beneficial research towards how galaxies evolve and their lifespans (especially those that are interconnected); these two points of astronomy are areas that would benefit from in-depth research. These intertwined galaxies are the closest to us, so as a result they prove to be the best option to choose.

Vast concentrations of gas are not only found in the centre of the two galaxies but additionally in the hectic region where they are colliding. In here, the entire amount of gas is billions of times the mass of our Sun. This is an abundant reserve of material for future generations of stars. Observations into galaxies like these provide new insights into the submillimetre universe and prove vital in helping humans understand how galaxy collisions can trigger the birth of new stars<sup>4</sup>.

The scientific community would gain valuable insight into the merging of two separate galaxies into one elliptical galaxy, and how the collision of two similar galaxies encourages fast star growth. Other results that have been found from looking into these galaxies reveal that the Antennae galaxies contain a high number of heavier elements in them too, e.g. magnesium, neon and silicon, which are all needed to form habitable planets. If these galaxies were given enough time to be fully viewed and investigated, life-sources could possibly be found on surfaces of inhabiting planets in these galaxies.


Already, two supernovae have been discovered inside the galaxies, SN 2004GT and SN2007sr. The bright, point-like sources seen in images of the galaxies are produced by material falling onto black holes and neutron stars that are remnants of massive stars. Some of these black holes may have masses that are almost one hundred times that of the Sun. If ESO were to provide sufficient telescope time, the further investigations into these intertwined galaxies would be greatly valuable to further scientific understanding of how the universe functions and evolves. Other vital facts could be found out about possible life sources and rapid star formation, if ESO were to provide the time to view these galaxies.

This background image was taken by the VLT of the Carina Nebula<sup>4</sup>

### Observation of The Antennae Galaxies using the Very Large Telescope

#### The Antennae Galaxies:

- These are a pair of interacting galaxies which are found in the constellation of Corvus<sup>1</sup>
- The Antennae Galaxies are undergoing a galactic collision. Currently they are going through a starburst phase. This means; through the collision of gas and dust clouds with magnetic fields, rapid star formation occurs.<sup>2</sup>
- These two galaxies are known as the Antennae Galaxies because the two long tails of stars, gas and dust ejected from the galaxies as a result of the collision, resemble an insect's antennae.
- The nuclei of the two galaxies are joining to become one giant galaxy.




Hubble Space Telescope shows that this pair of interacting galaxies is much closer than previously thought - 45 million light years instead of 65 million light years.<sup>3</sup>

#### Why study The Antennae Galaxies?

- Most galaxies undergo a major collision in their lifetimes. This relates to us as it is likely to be the future of our Milky Way when it collides with the Andromeda Galaxy.
- The young age of these globular clusters contrasts to the average age of most known globular clusters, which is around 12 billion years old. The formation of the clusters are likely to originate from shockwaves that were generated by the collision of the two galaxies which compressed large, massive molecular clouds.<sup>6</sup>
- The clouds that are imaged contain 16 times as much magnesium and 24 times as much silicon as our Sun.
- These Galaxies are currently going through the starburst phase, which is where many new stars are born. These new specimens of stars may aid further scientific research in astronomy.

#### The Very Large Telescope (VLT)

- The VLT is a telescope facility found in Northern Chile. It consists of four different telescopes, called Antu, Kuéyen, Melipal and Yepun.
- These telescopes are located in Northern Chile where the weather is optimal for telescopes; it is regular and rarely rains. The placement of these telescopes view different sections of space, not visible in the Northern Hemisphere.
- The VLT operates at infrared and visible wavelengths. I would use this telescope to view The Antennae galaxies.



This is a picture of the Antennae Galaxies, NGC 4038 (left) and NGC 4039 (right), using the VLT.<sup>5</sup>

References: [1] Wikipedia-Antennae Galaxies, [2],[5],[6] ESO.org/images; [3] spacetelescope.org, [4]eso.org

### Observations

On the VLT I would use SINFONI (Spectrograph for integral Field Observations in the Near Infrared), which is a near infrared integral field spectrograph fed by an adaptive optics module.<sup>5</sup> This would provide one of the right wavelengths to view the Antennae galaxies. Even though composite and visible wavelengths both display different views of the galaxies, infrared is the wavelength that I would like to view them at.

The apparent magnitude of these two galaxies is 11.2 for NGC 4038 and 11.1 for NGC 4039. Their distance from our galaxy is 45 million lightyears, which is closer than we initially thought. These two intertwined galaxies are found in the constellation of Corvus. Their co-ordinates are: 12, 01, 53 + -18, 52, 10. These galaxies are visible from the VLT in Chile, which is in the Southern Hemisphere, in later September. The distance they are from our Milky Way is 45 million lightyears. They are located 0.25° north of 31 Crateris and 3.25° southwest of Gamma Corvi<sup>6</sup>. To view these galaxies at their prime with the VLT, I would view them in late September (20-09-2017) at 1:00am-2:00am at an altitude of 64°. This is because the moon is not interfering with the visibility of the galaxies, and they are at the correct placement in the sky to see the best results with the VLT.

### References:

- [1] & [6][https://en.wikipedia.org/wiki/Antennae\\_Galaxies](https://en.wikipedia.org/wiki/Antennae_Galaxies),  
[2] & [3] <https://www.spacetelescope.org/images/potw1345a/>,  
[4] <http://www.eso.org/public/unitedkingdom/news/eso1137/>,  
[5] <http://www.eso.org/public/unitedkingdom/teles-instr/vlt/vlt-instr/>
- Poster Images  
<http://catserver.ing.iac.es/staralt/> - visibility website  
<http://simbad.u-strasbg.fr/simbad/sim-fc00> - object info page (including pictures)  
[https://en.wikipedia.org/wiki/Antennae\\_Galaxies](https://en.wikipedia.org/wiki/Antennae_Galaxies) - object information page (includes pictures)  
<https://www.eso.org/public/unitedkingdom/images/potw1140a/> - object and telescope information page (includes pictures)  
<http://www.constellation-guide.com/antennae-galaxies/> - object information site (includes pictures/co-ordinates/altitude..)

### PhD Tutor's note

L. has been an excellent student on my Uni Pathways course. She wrote a very persuasive proposal to observe the Antennae Galaxies and used all the resources available to explain the technicalities of observing such objects, including ideal times and dates to observe them and which telescope would be most appropriate. Her dedication and enthusiasm throughout her tutorials allowed her to excel in an unfamiliar area of study, and to complete her assignment to a standard beyond that expected at A level.



# The Potential Benefit Of Stem Cells As A Therapy For Leukaemia

Year 10, Key Stage 4

D. Hayward, Ormiston Bushfield Academy, Peterborough  
Supervised by A. McNally, University of Cambridge

In 2016, it is expected that 60 140 people will be diagnosed with a form of leukaemia, and 24 400 people will die from it. Between 2008–2012, leukaemia was the fifth most common cause of cancer deaths in men, and sixth in women.<sup>[1]</sup> Clearly, a more effective treatment is required, and stem cells could offer it.

Leukaemia is caused by genetic mutations in cells’ DNA; either activating oncogenes or deactivating tumour-suppressor genes.<sup>[2]</sup> This allows white blood cells (WBCs) to proliferate uncontrollably, creating many genetically identical, either immature or defective, new WBCs, called blasts or leukaemia cells. The bone marrow is often overpowered by the defective cells, and stops forming healthy blood cells, including erythrocytes and thrombocytes.<sup>[3]</sup> As a result, there are fewer healthy blood cells circulating through the body, but many leukaemia cells. Due to a lack of platelets, the patient becomes more susceptible to bleeding and bruising, and is also likely to develop anaemia because of the lack of red blood cells. Also, with no healthy WBCs, the immune system no longer functions properly, and thus, the patient is more likely to develop even very weak infections and be unable to fight them off. In some cases, the leukaemia cells may even attack other body cells.

It is unknown what exactly causes genes to mutate and lead to leukaemia; often mutation is spontaneous, but there are some known substances, such as radiation, benzene, and alkylating chemotherapy drugs, exposure to which can increase a person’s risk of developing leukaemia. Lifestyle factors, such as use of tobacco, and genetic conditions, including Down syndrome and Fanconi anaemia, can also increase the likelihood of acquiring acute forms of the disease, particularly acute myeloid leukaemia. Human T-lymphotropic virus (HTLV–1) is known to cause adult T–cell leukaemia. Also, a family history of leukaemia can increase a person’s risk of developing the disease; relatives are often diagnosed with the same type.<sup>[2]</sup> The danger is much higher in identical twins, with the healthy twin having a one in five chance of developing leukaemia after their sibling has been diagnosed. The risk is even higher if the disease begins in the first year of life.<sup>[4]</sup>

The resulting symptoms of leukaemia include: pain in the joints and bones, swollen, painless lymph nodes, fevers, night sweats, persistent feeling of fatigue or weakness, unexplained bruising, bleeding easily, frequent infections, weight loss, loss of appetite, and discomfort or swelling in the left side of the abdomen, caused by the presence of many abnormal white blood cells in the spleen.<sup>[5]</sup> If the disease spreads to the central nervous system, symptoms such as headaches, migraines, seizures, and even comas can occur.<sup>[2]</sup>

There are four main types of leukaemia, acute lymphoid (ALL), acute myeloid (AML), chronic lymphoid (CLL), and chronic myeloid (CML).<sup>[2]</sup> They are classed by how quickly the disease progresses (acute or chronic), and which type of cells are affected (myeloid or lymphoid).<sup>[5]</sup> Less common types of leukaemia include hairy cell leukaemia and acute promyelocytic leukaemia.<sup>[6]</sup>

Each patient’s prognosis can be very different; it depends on their age, the type of leukaemia they suffer from, how far their disease has progressed, and if it has infiltrated their central nervous system, lymph nodes, or elsewhere in the body.<sup>[2]</sup>

	In Childhood	In Adulthood
Most Common Type	ALL	AML and CLL
General Five-Year Survival Rate	60–85%	61.7%
ALL Five-Year Survival Rate	91.2% (between five and fourteen) and 92.9% (younger than five)	70.1%
AML Five-Year Survival Rate	66.5%	26%
CLL Five Year Survival Rate		84.8%
CML Five Year Survival Rate		63.2%

[2][1]

After observance of the symptoms, leukaemia can be diagnosed through a physical exam, to discern if the spleen and liver or lymph nodes are swollen, blood counts, and a bone marrow examination. The blood test is performed to identify abnormally shaped cells and, particularly, a high WBC count. To make entirely sure of the diagnosis, often a bone marrow aspiration or biopsy is performed also. In an aspiration, a needle is used to extract bone marrow from a large bone, such as the hipbone. In a biopsy a small piece of bone is removed along with the marrow.<sup>[8]</sup> Once the diagnosis is certain, blood chemistry tests or a spinal tap can check if the disease has damaged any vital organs, particularly the liver and kidneys, or if it has spread to the CNS.<sup>[2]</sup>

Treatment depends highly on the type of leukaemia that afflicts the patient, as well as their age and general health. The aim for acute leukaemia treatment is to induce remission, which, with aggressive chemotherapy, is achievable and likely in most patients. However, because the leukaemia cells grow and mature slowly in chronic leukaemia, they also respond to treatment slowly and often only slightly, so it is difficult to achieve total remission. Treatment for chronic leukaemia is usually less aggressive, and focuses on controlling the disease, managing the symptoms, and prolonging the patient’ life, rather than killing all the cancer cells.<sup>[9]</sup>

Treatments for acute leukaemia focus on the control of the disease in the bone marrow and systemically, and are generally divided into several phases: induction chemotherapy, consolidation or intensification therapy, and then, for ALL only, maintenance treatments. The very intense first stage usually lasts a month and is used to take the patient into remission,<sup>[10]</sup> using drugs such as prednisone, vincristine, L-asparaginase, cyclophosphamide, and an anthracycline drug.<sup>[2]</sup> Consolidation or intensification therapy uses antimetabolite medicines<sup>[2]</sup> to kill any remaining leukaemia cells; it lasts a few months, and its intensity can vary depending on the likelihood of relapse.<sup>[10]</sup> Finally, for patients suffering from ALL, lower dose maintenance therapy is used to ensure the cancer stays in remission. This treatment may continue for up to three years, but almost normal activity can be resumed.<sup>[10]</sup> Patients can

also have radiotherapy or injections into the cerebrospinal fluid to rid the CNS of leukaemia. This can also be a prophylaxis measure.<sup>[2]</sup>

Treatment for chronic leukaemia, particularly for CLL, often begins with watchful waiting, and monitoring with blood tests, because the disease is at an early stage and is not yet producing symptoms. Therefore, chemotherapy may only effect the patient by worsening their quality of life.<sup>[11]</sup> In patients with CML, imatinib tablets are usually prescribed straight after diagnosis to slow the disease’s progression. The aim is to achieve remission after eighteen months of treatment,<sup>[12]</sup> however, the disease is likely to relapse. As the leukaemia progresses, chemotherapeutic drugs such as fludarabine, cyclophosphamide, and rituximab are used to control it and lessen the symptoms.<sup>[11]</sup>

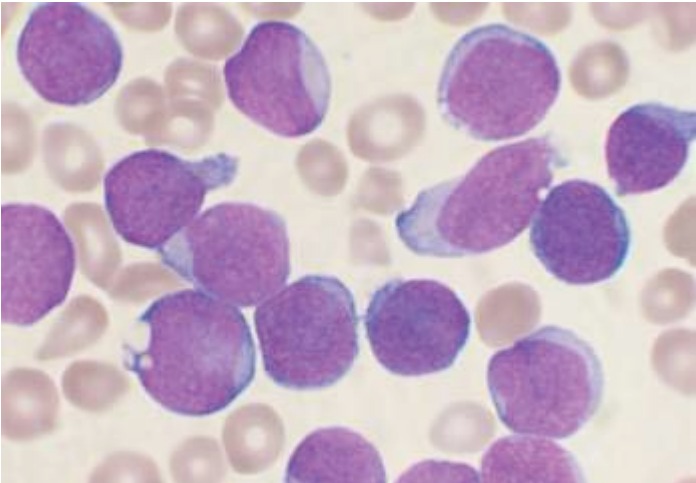
All leukaemia patients can have radiotherapy to shrink swollen lymph nodes, surgical removal of the spleen if enlarged, and other therapies to support the immune system such as blood transfusions and immunoglobulin replacement therapies.<sup>[11]</sup>

Chemotherapy, the administration of drugs that kill rapidly dividing cells, is the main treatment for all leukaemias, and can be taken orally, or by intravenous line. Chemotherapy is generally given in cycles, giving patients time to recover from the side effects in between. Side effects depend on the drugs and dosage that are administered, but most patients suffer from hair loss, nausea, vomiting, mouth sores, loss of appetite, tiredness, easy bruising and bleeding, an increased chance of infection, and infertility in adults.<sup>[13]</sup> Radiotherapy uses high energy radiation to damage localised cancer cells in the brain, spleen, and lymph nodes. Side effects depend on the part of the body that was irradiated; nausea, vomiting, diarrhoea, headaches, tiredness, and dry, red, tender skin where the radiation passed through it, are all common.<sup>[13]</sup> Biological therapy is a treatment that uses living organisms, substances that come from them, or synthetic versions<sup>[13]</sup> that act on processes in cells. They can stop cancer cells from proliferating, kill them, or encourage the patient’s immune system to do so.<sup>[14]</sup> Side effects include rash, swelling, headache, muscle ache, fever, and tiredness.<sup>[13]</sup> Lastly, targeted therapy is the use of drugs that interfere with a specific property or function of cancer cells, generally the molecules that promote proliferation. Targeted therapy can be administered through a pill or injection, and can cause side effects such as swelling, bloating, weight gain, nausea, vomiting, diarrhoea, rash, and muscle cramps.<sup>[13]</sup>

All leukaemia treatments have side effects; in the case of chemotherapy and radiation therapy, this is because they kill healthy cells<sup>[15]</sup> such as skin and intestinal lining cells.<sup>[16]</sup> The side effects can create a general feeling of fatigue and being unwell, which can make everyday life very difficult. Also, infertility in adults can be lasting, so patients may have problems conceiving after treatment has stopped. Because leukaemia itself and treatments such as chemotherapy are so damaging to the immune system, patients are highly susceptible to infections, and find them difficult to fight off.<sup>[15]</sup> This can lead to more serious diseases such as pneumonia, and in some cases, death. Also, there is only a chance that patients will achieve remission; treatment is not fast or easy, and is not guaranteed to work. Whilst current therapies have their merits, there are certainly improvements to be

made in the treatment of leukaemia, particularly regarding their side effects. It is possible that stem cells could one day be a cure.

Stem cells are ‘undifferentiated biological cells’<sup>[17]</sup> ‘that give rise to differentiated cells’<sup>[18]</sup> ‘and can divide to produce more stem cells’<sup>[17]</sup> indefinitely. There are two kinds of stem cell: embryonic and somatic. Embryonic stem cells are found in 3–5–day old blastocysts; they are multipotent, meaning they can give rise to all cells from the three primary germ layers. Somatic stem cells are found in the brain, surface of the eye, intestines, bone marrow, testicles, ovaries, muscles, and breasts. Their function is to replace damaged cells. They are multipotent, meaning they can differentiate, but are more limited than embryonic stem cells, as they can only become cells found in the area where they begin life.<sup>[19]</sup>



A Wright's stained bone marrow aspirate smear of patient with precursor B–cell acute lym–phoblastic leukemia. Picture taken by me.

New research suggests that stem cells can be used to treat many diseases, including leukaemia, and used in medical testing rather than animals. However, many people do not agree with the usage of embryonic stem cells, because an embryo must be killed for the cells to be used in research or treatment. The alternative is using somatic stem cells, but these are only multipotent, so more limited in their differentiation, and are therefore not as useful. Although, living donors can donate these cells, and in some cases, patients can use their own somatic stem cells in transplants.<sup>[19]</sup>

Research is also looking into changing somatic, differentiated cells back into a stem cell–like state. This process was first discovered in 2006 by Shinya Yamanaka; he won the Nobel Prize for Medicine in 2012 for his discovery. Every cell in a human being contains the same DNA, but the transcription factors in each cell’s nucleus control which parts are active and make proteins, and which are dormant. These proteins and the order they are made is unique to every type of specialised cell, so, without transcription factors, cells could not become specialised. In 2006, Yamanaka discovered the four genes that code for pluripotency: Sox2, Oct4, Klf4, and cMyc, and implanted them into adult mouse fibroblast cells. The differentiated cells subsequently became pluripotent, and very much like an embryonic stem cell. The new cells were named induced pluripotent cells.<sup>[19]</sup>

Currently, both autologous and allogeneic stem cell transplants are used to treat leukaemia. Autologous treatments use patients’ own cells<sup>[20]</sup> and allogeneic treatments require a



donor with the same, or very similar, HLA type as the recipient; a sibling is often the closest match.<sup>[21]</sup> The transplants are used to replenish the body's healthy bone marrow and blood cells that have been damaged by the disease and chemotherapy, and induce remission if other treatments have not worked.<sup>[20]</sup> In patients with chronic leukaemia, stem cell transplants can induce a permanent remission. Before the transplant, the recipient must have conditioning therapy, intense chemotherapy to kill leukaemia cells, bone marrow cells and to suppress their immune system. Then, the donor or patient, depending on the type of transplant, will be given granulocyte stimulating factors so the haematopoietic stem cells can be collected from the blood.<sup>[21]</sup> In autologous transplants, the stem cells must be processed, to ensure they are healthy.<sup>[20]</sup> The stem cells are then infused to the patient, and travel to the bone marrow to make new blood cells. In allogeneic transplants, some immune cells are also transplanted, in the hope that they may attack the leukaemia cells.<sup>[21]</sup> All patients will likely experience side effects from the chemotherapy, and allogeneic transplant patients can also be afflicted with graft versus host disease, in which the transplanted cells attack the patient's normal tissue.<sup>[21]</sup> In autologous transplants, this is not a problem because the cells used are the patient's own. Symptoms include rashes, diarrhoea, blisters, and fever. The condition can be fatal, but immunosuppressant drugs,<sup>[22]</sup> steroids,<sup>[21]</sup> and removing lymphocytes from the infusion before transplantation can treat and prevent it.<sup>[22]</sup> Patients may have lasting fertility problems, and women may have early menopause due to the transplant. The effectiveness of current stem cell treatments varies depending on the patient's age and general health, and the type and stage of their disease. The treatment generally requires twelve months recovery and patients don't always survive.<sup>[21]</sup> Also, the transplanted cells need time to create new blood cells, and during this period, the patient is very weak and vulnerable to infections due to the lack of WBCs,<sup>[22]</sup> and may also bleed easily due to the lack of platelets. Transfusions of red blood cells or platelets may be required, particularly if the haemoglobin level in the blood is low.<sup>[21]</sup> Observation, restricted access to people, and antibiotics can all help to prevent infections. Another problem with stem cell transplants is the shortage of donors.<sup>[22]</sup>

Transplants are often too risky for those over sixty, or who have certain medical conditions,<sup>[21]</sup> so, recent research has been dedicated to creating a reduced-intensity stem cell transplant, or mini allograft. The doses of chemotherapy used in conditioning therapy are lower, so less bone marrow is killed and the immune system less damaged, meaning the patient does not become as weak, therefore it is more suitable for the elderly and frail. Generally, donor HSCs and immune cells are given to the patient first to replenish bone marrow, and then, more immune cells, to kill the remaining leukaemia cells, known as a graft versus leukaemia effect. Whilst there are less side effects than regular transplants, graft versus host disease still remains a big issue in this treatment.<sup>[22]</sup> A canine model has proved that the conditioning regimen does not have to be massively intense for the graft to work. Medical trials using low dose total body irradiation or fludarabine, with immunosuppression, have also been done, and there are ongoing trials in San Martino Hospital, Genoa, Italy; MD Anderson Cancer Centre, Houston, Texas, USA; Hadassah University Hospital, Jerusalem, Israel; and Fred Hutchinson Cancer Research Centre, Seattle, Washington, USA.<sup>[23]</sup>

Treatments, known as haploidentical transplants, where the donor's tissue type only half matches the recipient's, have been completed. They are executed when an exact or almost exact donor is not available, which is the case in 30% of patients. Donors are generally parents, siblings, or children of the recipient, and there appears not to be an increased chance of complications, such as GVHD, compared to transplants using HLA matched donors.<sup>[24]</sup>

Research is also looking into using growth factors which enhance the production of immune cells, to reduce the immune system's recovery time after stem cell treatments, to decrease the patient's risk of infection.<sup>[22]</sup> In murine trials, the cytokines IL-2 and IL-7 have been shown to induce remission and increase cell production in the thymus respectively. Human trials using IL-2 have shown terrible side effects in 30% of patients, but for some, it could be a viable treatment option. It has also been demonstrated that priming a patient with IL-2 before a bone marrow transplant creates an antitumour effect that can kill residual disease in mice. Also, using granulocyte-macrophage colony-stimulating factor along with a bone marrow transplant can induce cytotoxicity against tumour cells.<sup>[25]</sup>

Lastly, iPSCs are currently being used in laboratories to study how leukaemia arises, and to test new therapies for it. iPSCs are used because many of them can be made, and converted into leukaemia cells, quickly and easily.<sup>[22]</sup> iPSCs have been made from CML cells, and it is hoped that patient derived samples can be made, and used to study the disease.<sup>[26]</sup> One day, the methods used in the lab to make new blood cells from iPSCs could be used in the clinic as an autologous, GVHD risk free therapy for leukaemia.<sup>[22]</sup> Although, it has been proven that iPSCs differ from embryonic stem cells in a number of significant ways, and more research into their structure and properties should take place before they can be used in the clinic.<sup>[28]</sup>

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#### Programme Officer's comment

This is a very impressive piece of work. Following a powerful introduction, D. has developed a convincing argument for the benefits of stem cells as a therapy for leukaemia throughout; she also really highlights the relevance of this research area. The referencing of a variety of sources to recognise the ideas of others, and inclusion of pertinent data, is a particular strength here. Well done, D!  
– A. Marcuse, Regional Manager, East of England, The Brilliant Club

## How Might Ocean Acidification Affect Marine Organisms by the Year 2300?

### Year 10, Key Stage 4

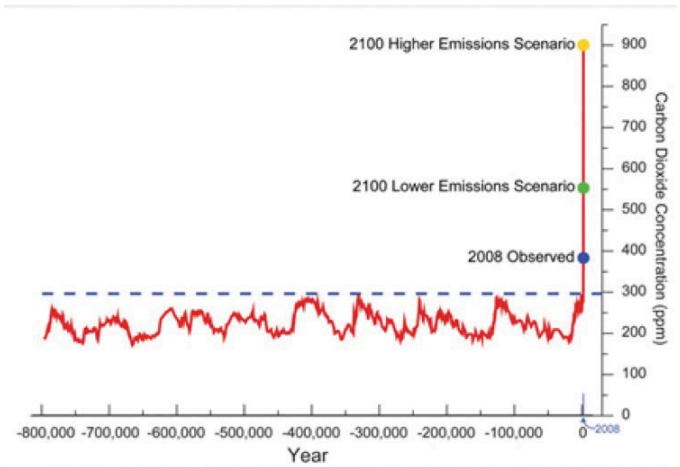
K. Redwelska, Robert Blake Science College, Bridgwater  
Supervised by C. Hird, University of Exeter

#### Introduction

Ocean acidification is the drop of pH in the ocean over a period of time, turning it more acidic. Over millions of years, the pH of the ocean was stable at 8.2, however due to the increase of carbon dioxide in the atmosphere, the current pH value is already at 8.1 – a small change in pH can be a great change in acidity [1], as there is a big difference in the amount of hydrogen ions in a substance. Although this may not seem a huge difference, in the next 100 years, the pH is predicted to drop to approximately 7.7. This means the pH of the ocean will be much lower in the year 2300. Ocean acidification and an increase of CO<sub>2</sub> is an enormous threat to the world and a huge issue that we need to act upon, as it affects organisms in the ocean, but also the environment around us, including ourselves. At the moment, there are only a few species of marine animals that get affected by ocean acidification, but in the future there could be many, many more. Also, it is a possibility that some types of species have the potential to adapt to the changes that ocean acidification is making to the ocean [2]. In my final assignment I have chosen to identify the consequences of ocean acidification on mainly coral reefs, as I strongly believe they are affected and damaged the most, however I will also evaluate the effects on other organisms living in the ocean, such as shells and marine fish.

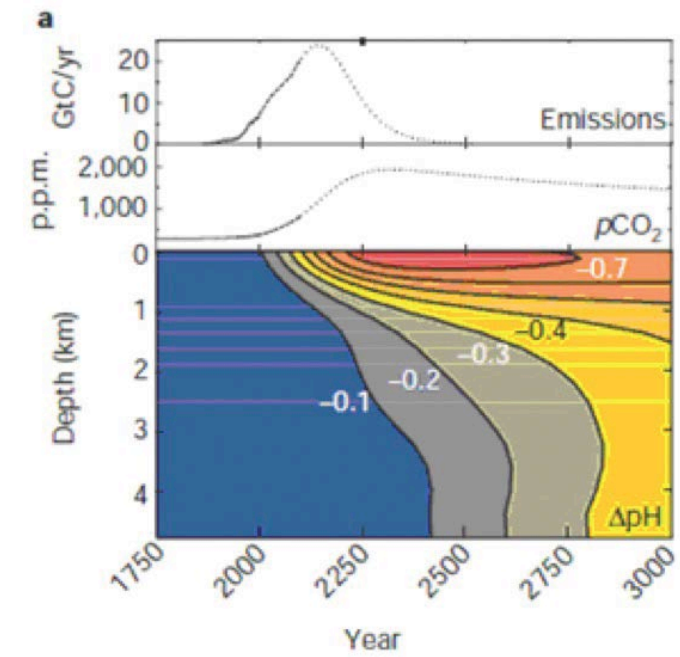
#### Carbon Dioxide Emissions

Carbon dioxide occupies about 0.04% of the world's atmosphere [3]. The composition of gases has been stable for approximately the last 100 million years. However, since the industrial revolution, the burning of fossil fuels has caused the amount of CO<sub>2</sub> in the atmosphere to increase [4]. There are many things in the world that lead to an increase of greenhouse gases, one of them being deforestation. When trees photosynthesise, it reduces carbon dioxide as they use it up in the process. The equation for photosynthesis is: carbon dioxide + water (and light energy) makes oxygen and glucose. By cutting down trees there are less of them photosynthesising and utilising CO<sub>2</sub>. Burning wood also releases carbon dioxide. The rising human population is adding to atmospheric carbon dioxide in many ways [5]. For example, more people are driving cars as technology is advancing, this is also releasing CO<sub>2</sub>. Also, smoking increases carbon dioxide levels in the atmosphere, which is bad for the environment. Another major problem is the burning of fossil fuels by factories, which is causing pollution in the atmosphere, being a threat to humans and animals.



Changes in CO<sub>2</sub> and pH. Justin Witt, 2015 [6]

The graph shows the carbon dioxide concentrations over the years, and predicts the concentration for the year 2100. For 800,000 years, the carbon dioxide concentration ranged from about 200 to 300 ppm. Since 2008, carbon dioxide levels have risen to nearly 400 ppm. The graph also predicts the lower emissions scenario for the year 2100 being 550 ppm, and the higher emissions scenario at 900 ppm, which is relatively at a pH of 7.7. This is shocking, as it shows the amount of carbon dioxide in 2100 could increase to nearly double the amount in 2008, if the emissions are high. This will make the pH levels in the ocean decrease rapidly, which will severely affect marine animals that are vulnerable to the acidity of the ocean.



Ken Caldeira, Michael Wickett, 2003 [7]

This graph shows the CO<sub>2</sub> emissions from 1750 to 3000, and predicts the changes of the pH of the ocean. By looking at the graph, I expect the pH change to decrease about 0.4 units at 1km depth in the ocean, by the year 2300. It also shows that the maximum predicted change in pH at the ocean surface is 0.7 units. However, the pH change will completely depend on the amount of carbon dioxide we will continue to be releasing. Consequently, if the current trends in the graphs continue we should be concerned for



the future and do our best to try and successfully stop the carbon dioxide concentrations from increasing, such as burning less fossil fuels, as this could cause serious issues for the world and marine animals in the near future.

Calcification

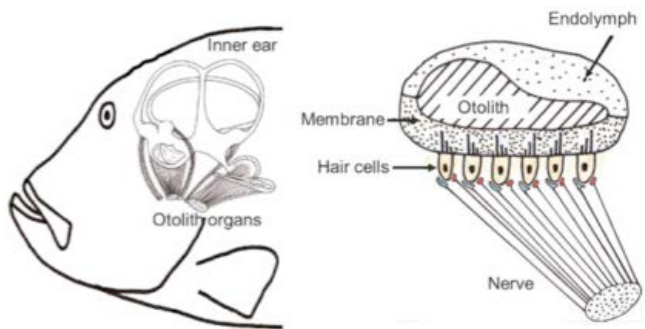
The carbonate chemistry system is a form of buffer system, which acts to maintain a stable pH in the ocean [8]. It works by releasing ions to neutralise any changes caused by new chemicals. This is the carbonate chemistry system for seawater:



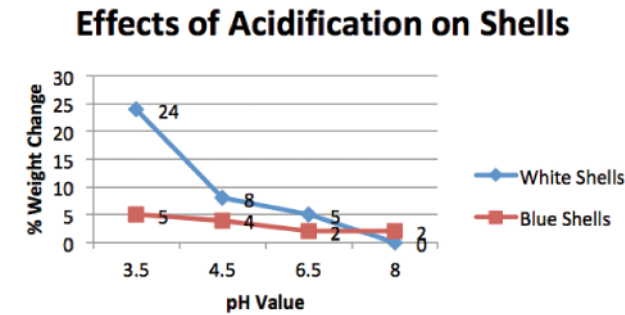
Carbonate is an important chemical for marine organisms that combines with calcium for animals to use to make, grow and strengthen their shells and exoskeletons. An exoskeleton is a hard structure that forms on the outside, instead of the inside of an organism to protect it from its predators. Ocean acidification causes the reduction of carbonate ions in the ocean, which means marine animals do not have enough calcium carbonate to grow. If during the development of an animal their amount of calcium carbonate has been reduced – it is possible that it will not develop properly, and they could be more at risk from predation. There has been a decreased rate of skeletal growth and reproduction in marine animals due to the decrease of pH [9]. For example, decreasing carbonate ion concentrations will lead to weaker, more brittle skeletons for various marine animals. A study of brain corals by Cohen [10] in Bermuda showed that calcification rates have decreased by 25% over the past 50 years and ocean acidification is most likely the main contributing factor. In the future, it is predicted that shells and different types of coral reefs will most likely erode faster than they can calcify [11]. Ocean acidification is a substantial threat to all organisms living in the water which is changing the oceans around the world.

Direct Effects

A direct effect is a clear, primary response to something – in this case, changes in the ocean due to ocean acidification and the increase of carbon dioxide [12]. Ocean acidification can be considered as an ‘environmental stressor’, meaning a change in condition of the environment that causes stress to an organism [13]. An example of a direct effect on calcifying organisms would be them having a deformed shell or weak exoskeleton when growing, with the organism being smaller than the average size of the species. Another example of a direct effect is organisms like fish being eaten by predators, due to the acidity of the ocean damaging their otoliths (a calcium carbonate structure in fish’s ears that can pick up vibrations from the environment). This means the fish cannot sense the predators around them, because their otoliths are weaker and more damaged than they were before.



This proves that ocean acidification has the ability to alter the development of marine organisms, like otoliths in marine fish, which has a great impact on the ability of the marine animals being able to live effectively in their environment. A case study by Phillip L. Munday [14] supports this, explaining the long-term effects on the behavior of marine fish, specifically clownfish, and how ocean acidification severely affects them.



The graph above shows the results of an experiment we carried out recently. It shows us the weight change of the shells in percent, after keeping them in various pH solutions. We tested eight shells in total, four white and four blue to see whether there was a difference in the shells. We labeled 8 Eppendorf tubes with the corresponding shells and different pH solutions. For a fair experiment, we controlled the amount of pH solution, making sure all of the tubes had the same amount. Before the shells went in the tubes, we weighed them so we could compare them afterwards. The shells were left in the tubes for a week. Finally, when they were taken out, they were weighed once again and we calculated the percentage weight change. The results show that white shells had bigger weight changes on average than blue shells. This tells us that some species (or in this case shells), are more at risk than others. The shells eroded more in the acidic solutions, showing that shells in the ocean damage and erode because of ocean acidification. In the future, this could happen much faster and shells may erode more overall, if the pH of the ocean continues to fall.

Indirect Effects

An indirect effect is the secondary consequence of a change in something. There are many direct effects of ocean acidification on marine animals, but alternatively there are also indirect consequences. Fish breathing faster is an example of an indirect effect, as there could be other factors that have an impact on this, as well as ocean acidification. A change in behavior of the organisms and loss of energy are other examples. A decrease in population of a certain species of animal is a big effect. Both an indirect and direct effect of ocean acidification on coral reefs is coral bleaching. The increase of carbon dioxide in the atmosphere and an increase in the ocean's temperature cause the coral reef to become more stressed by the environmental changes. Because of this, the algae that live inside the tissue of the coral, which is the coral reef's primary food source and gives them their significant colour, leaves the coral's tissue [15]. When this happens, the coral loses its major food source and is left bleached, turning a white or very pale colour.



Without the algae, the coral reef is more prone to disease and extremely vulnerable. Corals may survive a bleaching event, but they are more under stress and very likely to be subject to mortality.

Now and the Future

The inputs of carbon dioxide on the environment are endless. One of the main issues is technology. Before, in the industrial period, carbon dioxide was heavily increased with the burning of fossil fuels. Nowadays, most countries are in an advanced period of modern technology, where new ‘luxuries’ that companies produce have a carbon dioxide limit as our society is becoming more reliant on modern technology [16]. This is called ‘Contemporary Industrialization’. However, it would be unrealistic to stop or limit the advancement of technology altogether due to carbon dioxide emissions. Therefore, instead of constantly producing new and advanced products, it would be more beneficial to improve and develop the current technology we have, considering their impact on the environment [17]. Until this technology becomes more environmentally-friendly and more efficient to us, the uptake of carbon dioxide on the atmosphere will continue to increase. Another problem is population size. As the population in the world is constantly increasing, more people are releasing carbon dioxide by doing everyday activities, such as cooking, travelling etc. Most people do not realize the consequences and effects that carbon dioxide is having on our environment from normal, everyday things they do, like driving a car to and from work. If we all consider our carbon footprint and think of ways to reduce the amount of carbon dioxide released – for example using less electricity at home, or using public transport to travel to places, we can potentially stop the chances of CO<sub>2</sub> levels increasing any further.

Conclusion

In conclusion, I believe ocean acidification as we know it today is damaging the marine organisms, and the uptake of carbon dioxide has a serious impact on our environment that we need to change. I think it is important that we must take action and do all that we can to try and decrease the carbon dioxide emissions, as evidence shows if we do nothing about it, the levels of CO<sub>2</sub> will continue to rise and harm our environment even more. Numbers of calcifying marine organisms affected by ocean acidification will start to decrease in the future as they are becoming under threat. We cannot let this happen. Furthermore, if the carbon dioxide uptake in the environment does not increase, we will have nothing to worry about, as the pH

levels of the ocean will not continue to decrease and harm the animals. A study by Bob Yirka [18] in 2015 shows that ocean acidification surprisingly is not harmful to coral reefs after all. The report states that researchers noticed that spikes of phytoplankton blooms occurred during 2010 and again in 2011, and made their way to the coral reef – offering more food than normal for the coral. In contrast, if we would like to save our environment I believe we should adapt our lifestyles to stop increasing the rates of carbon dioxide concentrations. To do this, we should: use biofuels instead of burning fossil fuels, recycle and re-use products, use less electricity, reduce the number of smokers, drive fewer cars and become more active instead, plant more trees to utilize CO<sub>2</sub>, and stop cutting down trees

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PhD Tutor's note

K. was an exceptional student to work with on The Scholar's Programme. Her attention to detail and enthusiasm in her work was apparent from the start which led to her producing work of a significant standard with the inclusion of academic references to demonstrate her comments and opinions. K's final assignment was of better quality than many I have seen produced at undergraduate level and was well deserving of the 1st class grade it received.



# Critical Analysis of the Wakefield et al. Paper (1998) Associating the MMR Vaccine with Gastrointestinal Disease and Developmental Regression Published in the Lancet

Year 10, Key Stage 4

M. Bhatti, Lampton School, London  
Supervised by A. Leite, London School of Hygeine and Tropical Medicine

In 1998, Andrew Wakefield published a case series in the Lancet suggesting an association between the measles, mumps, and rubella (MMR) vaccine and gastrointestinal disease and developmental regression in children.<sup>1</sup> Despite the insufficient data, existence of bias and uncontrolled design, the paper lead to widespread publicity in the UK. MMR vaccination rates began to fluctuate due to the concern of parents across the world regarding the newfound risk of autism after vaccinating their children, thereby exposing their children to the risk of disease and other complications. The Lancet retracted the paper in February 2010, tying Wakefield's fraudulent actions to various epidemics and deaths.

A case series is a descriptive type of medical research study of multiple occurrences of unusual cases, that examines patients' medical records for exposure and outcome in order to generate or test a causal hypothesis. A case series was used as the basis of this study as all twelve children recruited for the investigation had a history of the outcome of interest, in this case, developmental regression. In the hierarchy of evidence, a case series falls amongst the lowest, due to the lack of control subjects, making it prone to bias.<sup>2</sup> This is because it is not possible to compare what is happening with others who do not have the condition or vaccination, and thus, to establish whether the MMR vaccine is associated with autism.

Although 14 age-matched and sex-matched normal controls were utilised for the urine sample<sup>3</sup>, the study defined the controls poorly, as the controls did not have the outcome of interest. This meant that the controls were only used to stimulate 'normal' results from the various tests so that, the investigators would be able to compare the results to those of the patients, and not to calculate the exposure to the risk factor of interest from each of the two groups, like in a casecontrol study. However, if a casecontrol study design was used, the exposure status to the MMR vaccine could be determined for both cases and controls, which could then be used to calculate the occurrence of the vaccine for both the cases and controls; this would enable the investigators to compare the odds of exposure between cases and controls and establish an association as an odds ratio. The main advantages of a casecontrol study design in this study would be that despite the fact that a cohort study provides most direct measurement of absolute risk, a casecontrol study is economical and quick, can be used to study rare or specifically defined diseases, has the most statistical population at risk is unknown. Whereas a cohort study can study only a single exposure or group of related exposures, and the population at risk must be known.

Not only that, but a case series is susceptible to confounding bias where the association between the exposure and outcome becomes distorted by the presence of another variable that is associated with the exposure and is a cause of the outcome. It becomes difficult to identify whether or not there is a confounder that is contributing to the presumed association and adjust for it. The issue with this is that the results of the experiment are incorrect, so the conclusions drawn from them are unrepresentative of what is actually happening in the sample, and are therefore biased. This means that they are not applicable to the rest of the population too. However, matching controls to cases will mitigate the effects of confounders. This is probably why the logic that the MMR vaccine may trigger autism was questioned, as a temporal link between the two is almost predestined: both events occur in early childhood. In this situation, positive confounding bias occurred as the observed association was biased away from the null, as an association between the explanatory and response variable was implicated.<sup>4</sup> Confounding bias is especially significant in a study because it can cause a reported association (or lack thereof) to be misleading.

Additionally, a case series is subject to selection bias because the researcher self-selects the cases. Selection bias is a systematic error that occurs when selecting participants due to the non-random sample of the population, causing a variance between the chances of selection between members, and resulting in a biased sample. Systematic errors can occur at any time of a study and are related to the way the study is conducted. In this study, selfselection was used, as Wakefield et al. choose data that suited their case; they falsified facts and were guilty of deliberate fraud. Wakefield was being paid to conduct the study by solicitors representing parents who believed their children had been harmed by MMR. Nearly all the children had been preselected through campaign groups against MMR. Wakefield even acted dishonestly in failing to disclose how patients were recruited for the study,<sup>5</sup> he was held guilty of scientific misrepresentation as he reported that their sampling was consecutive when, in fact, it was selective. This meant that those in the population that suffered from autism and gastrointestinal disease but were not exposed to the vaccine were ignored so that the results of the study would show a link between the variables and make it seem as if the population too, had similar results. This is not aided by the fact that selfselection makes the determination of causation more difficult. So, not only is the data in the study unrepresentative of the target population about which conclusions are to be drawn, it does not prove that the exposure is, in fact, the cause of the outcome. However, this sampling method can prove useful for rare diseases that there may not be a sufficient number of. The possibility of selection bias should always be considered when defining a study sample, and a more representative selection of random sampling can be used to provide reliable and valid results, as they lack systematic error.

Furthermore, when responses are incomplete, the scope for bias must be assessed. A case series can be very useful in generating a hypothesis that can be tested in further studies. However, in this study, Wakefield searched and interpreted information in a way that confirmed his initial hypothesis, and ignored evidence that could disconfirm his hypothesis, leading to statistical errors and confirmation bias. As such, it can be thought of as a form of selection bias in collecting evidence. To resolve this issue, the case series should have been used to generate the hypothesis, so that Wakefield would not make preconceptions about what he expected the data to be like,

and would instead use an approach to consider situations with different outcomes.

If a case series is retrospective, it will depend on the availability and accuracy of the data records.<sup>6</sup> This was the case in the study as they took histories, including details of immunisations and exposure to infectious diseases, and assessed the children. Wakefield even ordered investigations, including colonoscopies, colon biopsies and lumbar punctures on his research subjects contrary to the children's clinical interests, when these diagnostic tests were not indicated by the children's symptoms or medical history. A simple technique that can be adopted is to increase the frequency and quality of reality checks so that every item of data will experience data quality degradation.

Another issue with the study is the sample size. A study with a small sample size has low statistical power and a reduced chance of detecting a true effect. The consequences of this include overestimates of effect size and low reproducibility of results. Improving reproducibility allows the findings of the investigation to be generalised for the population as interpretations and conclusions drawn from the data have a low variability to those of the population. Variability determines how far the true results of the experiment are from the results of the sample compared to the population using the standard deviation. A large standard deviation indicates a low accuracy of the results since smaller sample sizes get increasingly further away from the entire population, which may lead to bias.

Perhaps the most significant bias in this case series was information bias which results from systematic differences in the way data is obtained on the exposure or outcome. It occurs due to an error in measurement that may be introduced by the observer, participant, or measuring instruments, that leads to incorrect estimates of the association between exposure and outcome. Observer bias occurs when the observers are aware of the aims of the study or the hypothesis and allow this knowledge to influence their observations during the study. By analysing the procedures of the investigation, we can understand how information bias dominated the scandal that Wakefield and his associates enacted: clinicians had found nothing to implicate MMR, but Wakefield had repeatedly misrepresented diagnoses, records and descriptions of the children, to make it seem as if the syndrome had been discovered. Not only that, but at the point when the records were revisited, it was found that not a single case was free of critical mismatches between the paper and their contemporaneous records. In fact, it was discovered that some children showed symptoms before they received the MMR vaccination, some were considered normal months after, and some did not have autism at all. An example of this is child 11; records provided information that indicated that his behavioural symptoms began two months earlier than as had been reported in the Lancet a ,nd one month prior to the boy receiving the MMR vaccination. Furthermore, hospital pathologists who analysed the cases for inflammatory bowel disease and had reported in most of the cases the gut was not affected, yet the Lancet paper reported otherwise.<sup>7</sup> Additionally, in a large portion of the 12 cases the diseases, as portrayed in thean Lcevt a,ried from their hospital and GP records. In spite of the fact that the paper guaranteed that issues occurred within days of the vaccination, medical records showed that this was valid in only one case. Much of the time, medical concerns had been

brought about before the children were immunised. Observer bias strongly affects the validity of a study as the conclusions that have been made are based on biased observations, which renders them unreliable and invalid. To help detect the presence of observer bias, it should ensure that observers are well trained, there are clear rules and procedures in place, a time frame for the duration of the experiment, as well as conducting screening observations for potential biases.

The final disadvantage that I will discuss is that case series does not allow for confidence intervals. This determines how reliable the results of the experiment are. Any study that takes a sample from the whole population, generalises the results to the whole population. This inevitably leads to a possibility of error because the whole population can never be accurately described by a part of it. It is this uncertainty we try to quantify by the use of confidence intervals; these provide a range about the observed effect size of the true mean in the population on either side of the odds ratio and focus on a range of likely values and not just the significant ones. Most confidence intervals have a confidence level of 95 percent. This means that if the investigation were to be repeated, there would be an expected 5 percent chance that the true value is not within the confidence interval.

In conclusion, the Wakefield et al. 1998 paper was dominated by weak evidence and inappropriate use of study design, which made bias inevitable. The paper was instantly controversial and was criticised for its invalidity and further studies were conducted right away. Although they disproved the suggested association between the MMR vaccine and gastrointestinal disease and developmental regression, just by critically analysing the paper, we can understand how imperative the study design is as it affects everything thereupon in the experiment.

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## PhD Tutor's note

M. was a very keen student and it was a joy to work teaching her some key concepts in Vaccine Safety studies. I was impressed with her final assignment, which was written at a very high level. She applied the main concepts to criticise a paper, and she was able to identify its main flaws and propose alternative ways of conducting such a study. She was awarded a 1st, which means she is already performing to an excellent standard at A-Level.

# An Investigation into the Relationship Between Hand Preference and Pseudo Neglect Using a Line Bisection Task

Year 10, Key Stage 4

A. Orgill, Year 10, Friesland School, Nottingham  
Supervised by L. O'Regan, University of Nottingham

### Handedness and the experiment:

Handedness is the preference of one hand over the other for use in tasks where advanced motor skills are required. Individuals who favour their right hands typically have a dominant left hemisphere of the brain; those who have preference of the left hand typically have a dominant right hemisphere. However, those who are left-handed usually show less extreme dominance, as they adapt to do certain tasks with the right hand, due to growing up in a mostly right-handed world. The different assignments of tasks to different sections of our brain show that our brains are asymmetrical.

Left-handed people make up about 10% of the world's population, and thus were rare occurrences in competition over food and resources in prehistoric times. This gave them an edge in terms of competition, as the right-handed opponent they would face would have very little experience of their alternate handedness, giving them an element of surprise. This advantage was not seen however in normal life, as any tools made by a tribe were made for the right-handed end user, and use of sword and shield was an issue, as left-handers would have preferred a shield in their weaker hand, but at the penalty of not protecting their heart.

Historically and more recently, doctors have noticed that damage to the brain potentially causes visual neglect (MacLeod & Turnbull, 1998), which is the inability to recognise one side of the vision, and a more severe, unnatural version of pseudo neglect. Albert (1973), performed a test to find how damage to the right or left hemisphere of the brain affected visual neglect, by asking the damaged participants to cross through 40 2.5cm lines that were spaced apparently randomly across the page, but were in fact systematically placed. The score for each participant incremented with every uncrossed line. The study found visual neglect in 30% of participants with left brain damage, and 37% in right, however the severity of the disorder was much greater in those with right brain damage. Although the tests concluded that damage to one hemisphere did not definitely lead to ignorance of the contralateral side of the visual space, and that the phenomenon was somewhat bilateral, the experiment testing handedness against degree of pseudo neglect attempted to find whether dominance of a particular hemisphere naturally led to a neglect of the opposite side of the visual space, despite how the two conditions link.

The aim of the experiment was to find the relationship between the laterality quotient (how extremely right/left-handed you are), and the degree of pseudo neglect performed in a line bisection task. Pseudo neglect is the healthy tendency for people to show less attention to

one side of their vision, most commonly the right side for right-handers and vice versa, except again, left-handers may show certain right handed qualities. We used the line bisection task as it does not require much technical equipment; it is quick and provides a clear, quantified result. With this test, along with the determination of the laterality quotient, this hypothesis will be tested: the more extreme the laterality quotient, the greater pseudo neglect expressed.

### Method: Participants:

The test was performed on 22 volunteers, 13 of which were female, and 9 were male. Of this group, 19 showed a preference to the right hand for unimanual tasks and 3 showed a left hand preference.

### Required Materials:

For the test, *The Edinburgh Handedness Inventory* (Oldfield, 1971) was needed along with a simple means of writing, such as a pen or pencil, and 4 pieces of paper marked with a horizontal, 24cm line in black ink (Sampaio & Chokron, 1992) that were issued to each participant. An accurate ruler is also necessary for measuring the true midpoint and the amount of deviation.

### Design:

In this test, the dependent variable was the amount of deviation, in millimetres, of the marked midpoint from the true midpoint, and the independent was the laterality quotient of the participant. A variable to be controlled was the length of the line given to participants, as this may have warranted a differing degree of negligence to one side of the line.

It was predicted that those whose perceived midpoint is further to the left of the true midpoint are more extremely right handed due to pseudo neglect of the right side of the paper, which if done with the less dominant left hand, should be more apparent. This is the opposite for those who are left handed. This means there should be a negative correlation between laterality quotient and amount of deviation from the midpoint.

For the results, a t-test was taken to evaluate, using the mean values, whether a difference between two variables is significant or not. Upon a score of 0.05 or less, it can be concluded that the results are 95% accurate, and if not, it is an insignificant difference.

### Procedure:

First, each participant must have filled in the Oldfield questionnaire to determine how extreme their hand preference is. If a choice was not an extreme preference to that hand, it was marked with one plus, if extreme, two pluses and if indifferent in preference, a plus on both sides. Once completed, the number in the left column was subtracted from the number of pluses in the right column, showing the laterality quotient. The higher the number, the more strongly right handed the participant was, and vice versa.

Each participant was given a 24cm line to be placed in front of them, on which they tried as best they could to mark, free hand, the midpoint of the line. This was done twice with the right hand, and twice with the left per participant. Then the participant marked their initials in the top left corner of the page, to identify them and to determine the upside of the page.

Finally, each page had its line measured to find the actual midpoint, this point was marked and compared with the perceived midpoint of the participant. If the perceived midpoint was to the left of the actual, the amount of deviation was marked in minus millimetres, and if right, in positive values. These values were then recorded.

### Results

For the line bisection task, the furthest right average value was 4.75mm, and -15mm the furthest left. This average was calculated from both uses of each hand.

These results calculated as an average of -3mm for the left hand and -2.72mm for the right hand as the distance from the line in the bisection for the entire group.

Fig 1 shows the relationship between laterality index and bisection score. The highest value for laterality as shown by the test was 100, and -76.47 as lowest. This gave an average of 49.53 for laterality.

We used the t-test to determine, using the means of the two variables, whether the result gathered from our experiment was valid. At a result of less than 0.05, the results would be valid, however our t-test worked out as 0.78 so confirmed no real correlation, despite our graph giving a correlation of -0.09, meaning that it has a slight negative correlation, as predicted. This result is very close to 0 however, so could be negligible.

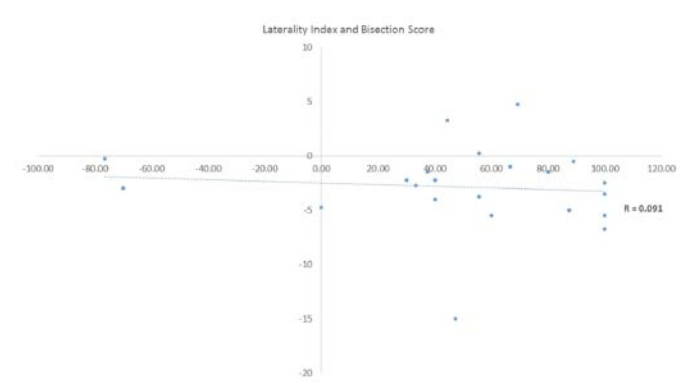


Fig. 1 - Shows relation between Laterality Index and Bisection Deviation:

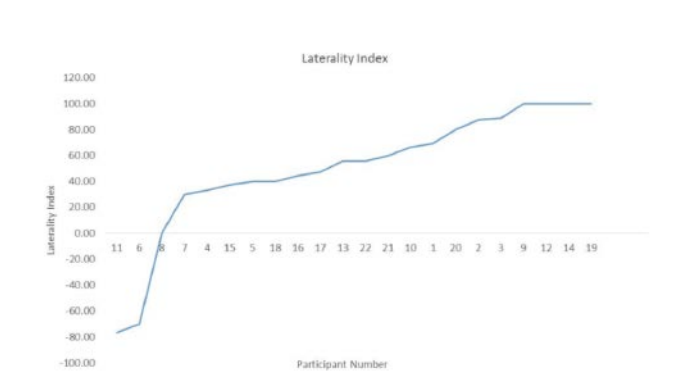


Fig. 2 - Shows the laterality quotient of each participant

### What was found?

The test was to find out whether the laterality quotient of an individual relates to their amount of pseudo neglect as measured using the line bisection task. The test revealed a very slight negative correlation, which was to be expected, however the general amount of variety in results gave

almost no visible pattern whatsoever. A large number of the participants scored values which were very much out of line with what was expected. For instance, participants with very high laterality quotients were scoring fairly close to 0 in the bisection, when expected to score in the negative. In addition to this, the t-test result gave the value of 0.78, which is substantially larger than the requirement of less than 0.05, to prove that the results were 95% accurate. This means the difference of the two means of the variables was not significant. This large number of outliers could be due to the different ways some participants performed the test. Some participants may have been more or less careful in the marking of the line, those who took more time being more likely to mark a very accurate midpoint, as opposed to those who took less time being less accurate. If someone with a high laterality quotient took more time, it could have created an expected low amount of deviation, thus confounding the results.



Left-handed and right-handed scissors.

In general, the test was successful in determining the laterality quotient of the participants, as those who were right handed scored positive, and left handed negative, however inaccuracy was possible due to participants biasing towards what they believe is expected of them when asked questions. An alternative method of determining laterality quotient could have been employed to observe participants, in blind trials, to see what they would do with no knowledge of the question at hand. A test such as the *Bell Cancellation test* (Gauthier, Dehaut & Joannette, 1989) would have been suitable as it allows the observation of the participant's visuospatial attention. This would have been done by asking the participant to cross out any appearance of a bell among the pictures. By tracking which area of the paper has the most cancelled bells, and in which order they are cancelled, the neglect of one side of the page could be determined. Some argue that writing direction could affect the order of cancellation, but this was countered as even those who wrote in languages that go right to left across the page, still showed a negligence of the right overall. A test such as this may reduce bias in answering the question, however would be more time consuming, and would require more materials.



In the line bisection task, it was easy to perform repeat tests, as it simply required the reproduction of the same action. The ease of repetition gives the test greater reliability and will allow for an overall more reliable average to be taken, and any anomalies removed. Confounding variables may have played a part in the unusual results of the test. Orientation of the page in front of the participant could have affected their accuracy, tiredness or dehydration may have hindered cognitive function and in turn caused unexpected or exaggerated results (Benwell, Harvey & Thut, 2014). Repeats were taken to reduce this factor, but different approaches to the task could have also been a cause for different results, as some participants may have taken more time and care in accurately bisecting the line, whilst others may have been quick and casual.

If the experiment was to be redone, it may be beneficial to give each participant a time limit upon bisecting the line, to reduce the variation of technique by each participant, creating more reliable results. Rather than using a questionnaire to determine laterality quotient, an observation could be taken to reduce bias.

Ultimately, despite the use of repeats in the test, the findings were inconclusive. The t-test values show the test was not significant and the correlation was so slight it was almost negligible. To determine whether these conclusions were due to variables which were not considered relevant or because laterality quotient and pseudo neglect are unrelated, would I believe, take another test to deduce.

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# Identify, Describe and Explain the Impact of Three Effective Communication Skills Behaviours in the Transcript That You Receive.

Year 10, Key Stage 4

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Communication skills are arguably the most fundamental element of human interaction; today they are increasingly necessary as the world transitions into a technological society where interpersonal conversation is diminishing. Communication is no longer just information broadcasted vocally and non-verbally (through gestures), progressively it is becoming a transmission of information across written platforms (such as emails, texts and websites). Good communication skills ensure success at work and within social relationships. Without good communication, misunderstandings can occur which can hinder objectives of varying degrees of importance. Research conducted upon the US Joint Commission on Health in 2002 concluded that up to 55% of medication-related errors in US hospitals and more than 65% of deaths were a consequence of ineffective communication (Wright, 2012).

It is of paramount importance, therefore, that we can understand the messages we receive from others. However, studies suggest that it is likely that humans hear only half of what is said to them, understand only half of that, believe half of that and remember half of that (Walker, 2002). To optimise human understanding, it is necessary that we improve our communication skills.

The value and effectiveness of communication skills will be assessed in a model of interpersonal communication – ‘A Family Trip to the Zoo’. The area of focus will be limited to three elements of communication skills exclusively: paraphrasing, empathy and open questions.

Paraphrasing is the skill of communicating to a speaker that their message (and the emotions reflected in the message) have been understood. It invites the speaker to correct the listener if necessary, subsequently reducing the possibility of later misunderstandings. Additionally, paraphrasing the words of the speaker acts as a prompt for them to persist, which can provoke the transmission of more details to further the comprehension of the listener – important, for instance in a doctor-patient scenario.

In ‘A Family Trip to the Zoo’, paraphrasing is used to symbolise a shared understanding between two of the characters, Amy and Andy. Within the transcript, it can be inferred that Amy and Andy have not communicated effectively enough for them to settle their differences regarding their habits for an upcoming car journey. Amy expresses that Andy ‘brings too many things and takes up all the room’, ‘plays music too loud’ so that she can ‘hear the sounds through ear phones’ and ‘eats really loudly and too many sweets’ impacting on her as ‘the smell of them’ makes her ‘feel more travel sick’.

Andy paraphrases this (‘so my games are too loud, I take too much stuff and eat too many smelly sweets that make you feel more travel sick’) to ensure that he has secured an understanding of the issue. His competence in understanding is indicated by Amy’s response of ‘yes, exactly’.

Andy’s use of paraphrasing, beginning with ‘so’, allows Amy to refine his answer if it was necessary. This can ensure Amy feels involved; it shows her that her brother is interested in resolving her complaint and gives her the time and opportunity to correct his understanding if necessary. In addition, as paraphrasing does not encourage an evaluation of a comment, Andy did not provoke a negative reaction from Amy, which could have triggered a further aspersion. In ‘A Family Trip to the Zoo’ there are examples of paraphrasing being used elsewhere – Mum seeks to understand Amy by inferring her feelings from her dialogue, ‘am I right in saying you get frustrated?’. Amy’s response is less directive; ‘ok, well I’ll only try if he tries’, which could indicate that she has not listened effectively to Mum. In a similar scenario, another attempt would be made to maximise the speaker’s understanding.

As paraphrasing seeks to demonstrate to the speaker that they are being listened to (O’Hara, Dixon 2008), it can also promote a rapport between the speaker and listener. This is identified after the incident of paraphrasing in the transcript as the responses between Andy and Amy are considered in contrast to their previous dialogue – ‘I can try and help’, ‘I will try to stop’, ‘would that help?’ in comparison to ‘you are annoying’, ‘you need to’, ‘all you do’. Andy’s attempt to acknowledge the discontentment of Amy by paraphrasing has meant that their conversation is less confrontational. The rapport built throughout the conversation subsequently allows Amy and Andy to reconcile their differences. Whereas previously, they would have acted uncooperatively to retain their habits, they have learnt to understand one another. The impact of paraphrasing in the transcript is significant; it acts as the change from unstructured arguing to considered settling.

Empathy is a core component of a communication skill set. It is defined as having the ability to respond to both verbal and non-verbal cues of a speaker in a caring, humane and respectful way (Bakić-Mirić 2008). The listener’s empathetic response to the speaker is empowering (Della Marta, 2012) in comparison to a sympathetic response being pitiful and victimising. An empathetic response is enriched by the listener’s focus on body language, gestures and careful observations of any silence within conversation as well as tone of voice and language used. This pattern of behaviour, which involves adapting the listener’s responsive content to the emotions conveyed by the speaker, is essential for an authentic understanding.

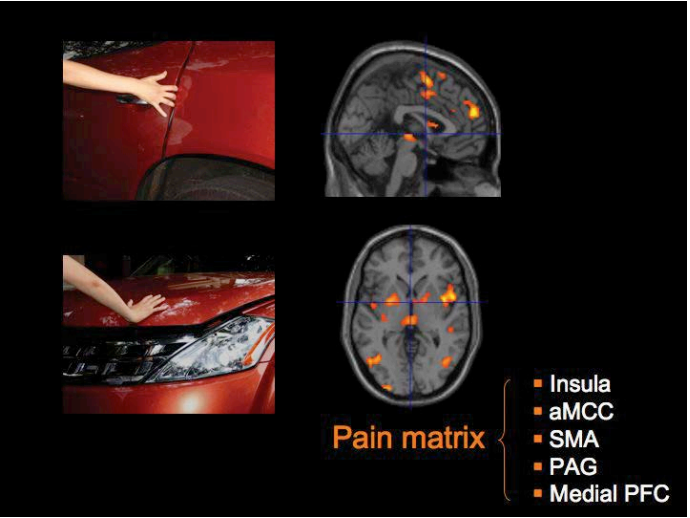
‘A Family Trip to the Zoo’ includes many compassionate responses which could be classified as showing empathy between characters. The first instance of empathy involves Mum and Amy. Firstly, Amy discloses her anxieties relating to the upcoming car journey – ‘well, I get really bored, Andy is annoying and then I sometimes get travel sick’. Mum exhibits empathy in her response ‘I understand that this all can be frustrating’, primarily through use of the verb ‘understand’. Immediately, it communicates to Amy that her fears are rational and are recognised. The description of her angst as ‘frustrating’ is also empathetic; Amy’s

exasperation has been evaluated by Mum using differing language, indicating that she comprehends her situation. This example contrasts to Mum’s initial sympathetic response of ‘Listen you two. I’m sorry that the journey is so long;’, ‘listen’, a command verb denotes that from the outset, Amy and Andy are wrong and unjustified for having an opinion, which therefore must be rectified. The unempathetic style of this response takes form in ‘I’m sorry;’ with little attempt to consider oneself in such a position. Subsequently, the structure of her words appears condescending – the placement of ‘listen’ at the beginning of the speech instantaneously shows disregard for their concerns. Also, this counteracts the minimal compassion found in ‘I’m sorry’.

Empathy is also found in Andy’s answer to ‘do you understand how Amy might be feeling?’. Although Andy does not, he says he ‘can try and help’. This is a good example of empathy despite the lack of shared understanding as it indicates that Andy is non-judgmental, sensitive, open, and capable of imagining another person’s experience (Rosenburg, 2010).

Progressively, the issue impacting on positive relationships between Amy and Andy is resolved, most likely due to Amy’s increased confidence in Andy to settle the irritants and therefore solve her angst. Also, Andy has removed his own opinion on the matter from his language to concentrate on Amy’s wellbeing, which has positively impacted on the duration of the dispute. Otherwise, the conversation would have focussed on the nature of each character instead of the triggers for unhappiness and the process of resolution may have been longer.

Open questions are used effectively within ‘A Family Trip to the Zoo’ to engage the subjects in resolving an ongoing dispute. An open question is an appropriate communication technique employed to probe deeper into the issues concerning a speaker (Jasmine, 2009). Furthermore, they can be used to assist the patient to discuss and clarify what he or she is thinking, concerning, and feeling (Jones, 2009). Although there is a variety of questioning styles to suit each motive in a conversation, open questions are generally operated to gain information, express an interest in or manage the conversation and explore the difficulties and ideas of another.



When children are shown video clips with situations where they see people suffering pain by coincidence, neural circuits related to pain are being activated in their brain.

Within the transcript, open questions are deployed intermittently to direct the conversation on a specific course for the conflict played out between the characters Amy and Andy to be settled.

‘What is your main concern about the journey?’ Mum enquires to Amy and Andy, who have both expressed unhappiness about the duration of the car journey to the zoo. This open question gives both characters an opportunity to gather their thoughts and formulate their feelings surrounding the event. As well as assisting Mum in understanding their judgements, as open questions query attitudes that ‘are on the respondent’s mind at the time of the interview’ (RePass, 1971), Amy and Andy are helping themselves by inserting structured time to logically consider their views. Additionally, with the question being poised indirectly to both characters, it opens a window for discussion between both parties.

However, despite Mum’s attempt to facilitate a constructive discussion around this, Amy is unspecific in her answer regarding Andy’s behaviour (‘Andy is annoying’) and therefore creates an alternative chaotic dispute. If she had explicitly stated in her initial argument the nuisances that Andy creates, there would have been more direct conversation relating to possible resolutions relating to this. It is a lack of attention to detail and inactive listening skills that allow Amy to partially misinterpret the motive behind Mum’s question. She most likely prejudged the content and reasoning behind the formation of the question due to the description of her ‘pulling a face’, potentially because of her relationship with Mum.

Another example of an open question found within ‘A Family Trip to the Zoo’ is ‘what do you mean by annoying?’ asked by Andy in response to Amy’s claims aimed at him. This open question is effective because of the request for more details which leaves little opportunity for misinterpretations and evasion of the topic. Amy is then able to answer this honestly, without feeling overzealous, due to the unambiguous nature of the question. One can evaluate this as being a successful act of communication as there has been clear progression throughout ‘A Family Trip to the Zoo’ from the unidentified issues surrounding the journey to the recognition of the Amy’s concerns first addressed in line one. However, the effectiveness of open questions in the transcript is inconsistent – the response after ‘what can we do to achieve that?’ regarding Mum’s desire for the journey to be enjoyable – is met by Andy and Amy ‘nodding their heads’ and ‘uttering intermittently’. This lack of a response to an open question may stem from the characters’ ineloquence rather than indifference; they may not respond to open questions because they lack the necessary rhetorical device (Geer, 1988).

Throughout the transcript, Mum learns to adapt her questioning style to suit the characters who appear uncooperative; she introduces closed questions ‘do you understand how that must be?’ to allow for shorter, less ambiguous answers. Schuman argued in 1966 that it was ‘the little frame of reference’ that prevented one from being able to ‘form a coherent response’. The advantage of a closed question is that any answer is led entirely by the question itself, whilst still giving opportunities for Amy or Andy to develop their answer suitably, which invites development to an indeterminate extent. The result is that the responses

become more pertinent, ‘no, not really’, ‘okay’, ‘would that help?’ and moreover, a conclusion is reached quickly.

In ‘A Family Trip to the Zoo’, paraphrasing is used to convey a sense of understanding between conflicting characters, as well as allowing characters to reflect on the words of another. The primary advantage to the technique was the discouraging of differing opinions. This led to a conclusive answer, since the understanding between characters was strong. The success of this technique can be measured by the succinct appearance of the speech after the focal incident of paraphrasing in line thirty-four. The location of this is also relevant to the communication skill of empathy. Empathy can be located in the transcript in many of the responses made by Mum, yet empathy becomes an influential skill only when utilised by Andy, therefore one may question its overall effectiveness in the transcript. However, despite his lack of direct understanding, Andy’s attempt to recognise the nuisances Amy faces in the car gives her more confidence in him. Although they may not build a rapport in the duration of the transcript, empathy provokes positive relations between the two, thus achieving the definition of empathy itself.

Open questions are relatively ineffective when used in the transcript, due to the prominent idea theorised by Geer in 1988 that the reluctance to answer fully stems from the characters’ ineloquence. Therefore, closed questions were manipulated by Mum to conclude the dispute.

The communication skills of paraphrasing, empathy and open questions, are all vital to strengthen understanding between parties. However, I believe that a more imperative skill, as demonstrated by Mum with regards to questioning, is to manipulate skills to suit the demand of the speaker. Not only does this secure confidence in all communication skills, but it ensures that one can deliver an understanding to a wide audience with different skillsets themselves.

**Programme Officer’s comment**

This is an exemplary essay, with a sophisticated writing style and clear structure. C. has evidently carried out extensive research into the three communication skills and has referenced a diverse range of sources to provide authenticity. The critical analysis of the transcript is excellent and all points have been well-developed and linked effectively to create a consistent argument. Very well done, C! – A. Marcuse, Regional Manager, East of England, The Brilliant Club

# Psychology: Researching Holistic Processing and Feature Analysis

**Year 10, Key Stage 4**

**L. Castle, Hele’s School, Plymouth**  
**Supervised by T. Dominey, Plymouth University**

## Introduction

Many researchers have been interested in looking into face perception and how human beings can use specific features or the whole face to recognise a person. There are two main types of face perception that are widely researched by experimenters: holistic processing and feature analysis. Feature analysis is where a human only needs an individual feature to recognise a face; holistic processing is where the whole face is needed to recognise a face.

Numerous experiments have been carried out in out in order to figure out whether holistic processing or feature analysis is more effective when trying to recognise a person. One experiment in 1986 done by Rhea Diamond and Susan Carey was looking into feature analysis and whether faces are special and are the only thing that can be recognised from features or whether other objects could also be recognised from one feature. [1] The conclusion to their experiment was that human faces aren’t the only thing that can be recognised from one feature but also creatures like dogs could be.

A holistic processing experiment carried out in 1987 by Andrew W Young, Deborah Hellawell, Dennis C Hay was done to help understand face recognition and the importance of face perception. [2] Their experiment consisted of participants looking at stimuli to see if they recognised the whole face even if it was slightly off centre. These psychologists came to the conclusion that feature analysis is important but it may be easy for a face to be recognised if it’s the whole face.

With the evidence given from previous experiments the topic of face perception is a very important one to be discussed. The experiment that was carried out in this report, to explore facial recognition through holistic processing and feature analysis, took place to help researchers figure out whether facial recognition time was quicker during a holistic processing experiment or a feature analysis experiment. The reason behind trying to find which reaction time would be quicker was to present evidence to other researchers so they knew which method of face perception was more effective.

The hypothesis that was given at the start of the experiment stated below was that holistic processing would have a quicker reaction time than feature analysis when trying to recognise a face. The number of seconds it took the participant to correctly identify the face would be the unit to measure whether the holistic processing or feature analysis reaction time was quicker.

## Method Participants

There were 8 participants that were involved in this psychology experiment: three males and five females. The gender and ages of the participants during the holistic processing condition are as follows. Participant 1 and 4 were paired together as participant one was female and

15 years of age and participant four was male and 16 years of age. These two were chosen to participate because of the one year age range between them. Participant 2 was male and 48 years of age and participant 3 was female and 47 years of age. These two were selected to take part in the experiment as they also had a one year age range between them just like participant one and four. In addition to this the two pairs were either adolescents or of an older age. The gender and ages of the participants in the feature analysis condition are also as follows. Participant 1 was female and 15 years of age, participant 2 was female and 44 years of age, participant 4 was also female and 14 years of age and lastly participant 3 was male and 46 years of age. They were selected by convenience sampling although volunteer sampling and opportunity sampling was also a considered factor when the participants were being selected. Another factor that was considered when selecting participants were the variables that may alter their results. For example, the participant variable would be everything that affects the person during the test. Fatigue is an example of this variable as it may result in a slower reaction time due to the fact that their brain may not be as focused.

## Materials

There were many materials that were used to help carry out the experiment, to make it as successful as possible. The PowerPoint was the main material used throughout the conditions as it provided the participants with the virtual images, they had to try and recognise in the quickest time they could. For each condition there were 19 slides, each with a single pictures for them to try and recognise. The dimensions of the face during the holistic processing were 14cm in height and 9cm in width and the size of the computer screen was 16 inches. The feature analysis had the same number of slides and pictures but the dimensions of the features were 10cm in width and 3cm in height with the computer screen being 14 inches rather than 16.

## Procedures

At the very start of the experiment planning, the type of participants that were chosen to take part were chosen by convenience sampling. This is where the participants are chosen due to the ease of selecting them and how cost effective this method is when choosing people. When the participants were asked, it was their own choice as to whether they wanted to be involved or not to be involved with the experiment. The experiment was agreed by all coordinators of it to take place in a quiet environment with no distractions around them. This was also done to reduce the situational variable which is where the situation can affect the participant, like a room that may be too hot.

When the participants agreed to be a part of the project they had a brief that told them what they had to do during the experiment and whether they had any further questions on it. Once they had been briefed they had to sign a consent form to say that ‘they have read the participant brief and are happy to take part in the psychology experiment’ and that they ‘understand that their data will remain anonymous’ and they are ‘free to withdraw at any time’. This was to ensure they definitely knew what they were signing up to and that they felt comfortable taking part.

The next step to have taken place was to actually do the specific condition with them. The two conditions were done



in the exact same way to make sure that all factors of any variables that could alter the results were eradicated. The participant was asked by the researcher to take a seat in the chair opposite the computer screen. They were then asked if they were ready to start; when they said yes the experiment started. The participant looked at the photo whilst the experimenter started the timer as soon as the picture was shown on the screen, they then tried to recall the name of the person whose features or face was shown on that slide as quickly as possible.

Once the participant had recalled the name, the experimenter stopped the timer and then moved the slide on to show the next picture to be identified by the participant. Once all 19 images were presented to the participant, no results were shown or given to them, but they got a debrief saying ‘thank you for taking part’ and how ‘the aim of the experiment was to investigate which method of face perception led to quickest reaction time’. The debrief also included how they could ‘withdraw from the experiment’ or if they ‘have any questions’ regarding the experiment. When all participants had finished the specific condition no information was passed on to any of them.

Throughout the experiment the researcher should have recorded their reaction time for each image shown and whether the answer was correct, unanswered or incorrect. These results would then allow the researcher to compare the two results of both conditions and figure out which method of face perception led to the quickest reaction time.

Results

Number correct and number incorrect of each participant that took part in each experiment.

Results are shown in table 1 and table 2 below.

Holistic processing	Number correct	Number incorrect
Participant 1	9	11
Participant 2	12	8
Participant 3	17	3
Participant 4	17	3

Table 1- results of number correct and incorrect during the holistic processing experiment.

Table 2- results of number correct and incorrect during the feature analysis experiment.

Feature analysis	Number correct	Number incorrect
Participant 1	3	17
Participant 2	3	17
Participant 3	2	18
Participant 4	14	6

The average reaction time when correctly recognising the face under the holistic processing or feature analysis condition. The results are presented in figure 1 here.

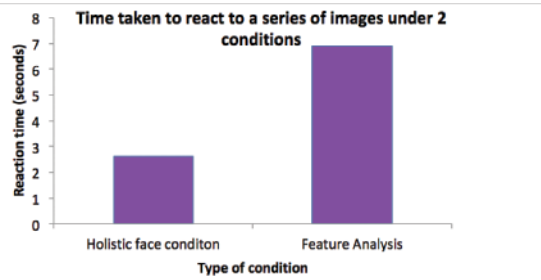


Figure 1- The average reaction time when reacting to an image and recognising the person correctly (seconds).

Discussion

The average reaction time for recognising faces correctly was quicker in the holistic processing condition than the feature analysis condition. In addition to this, the number of faces recognised correctly was done, on average, better in the holistic condition than the feature analysis condition. These results support the hypothesis fully as they show the researcher that holistic processing had a quicker reaction time than feature analysis. Psychologists since the days of Galton (1879) have been interested in finding out which method of face perception is better. A [3] book written by Andrew J. Calder, Gillian Rhodes, Mark H. Johnson and James V. Haxby includes a chapter on features, configuration and holistic face processing. This chapter explains how “a face is not identified by the recognition of its isolated, individual features, but by the integration of these features into a perceived whole” which demonstrates how other researchers have found similar results to this experiments results.

Our study had multiple strengths as during the preparation of the experiment it was decided that it was to be done in a controlled environment, where all participants were tested in the same way. All participants were asked to take part in the experiment in a quiet, undisturbed room where all focus would be on the experiment so we could get the most accurate results. This was done to control the situational variables to make sure that they were controlled to the best of the researcher’s ability to make them as unlikely as possible to affect the results. Another strength to the experiment was that all researchers used standardised instructions, the same brief and debrief to make sure all participants were given the same instructions before the experiment started. This was done to ensure that no experimenter gave an advantage to any participant by giving them extra information before the experiment was completed.

However there were some weaknesses when carrying out our study. One weakness was that the age difference between the groups of participants was fairly large meaning that not all age groups of both genders were tested. This could affect the results of both conditions as the sample of participants that were selected don’t accurately represent all ages and genders when doing a condition. In the holistic processing the age ranges were different to the feature analysis condition affecting the results slightly as people of different ages may recognise different faces. Another weakness was that the study was done in different rooms at different times of the day. This could have negatively affect the results as the brightness of the room from the different times of day could have caused a glare on the screen, impairing the participant’s vision when trying to recognise the face.

In future studies the experiment should try and test a wider range of participants in order to see whether holistic processing is easier when trying to identify a face than feature analysis. The different people that should be considered when being asked to take part in an experiment should be people in different cultures, different genders and a wide range of different ages. Furthermore, there should be a more or less equal amount of every type of participant to make comparing results more accurate and fair; it’s also imperative that the wide range of people in the sample

have to be similar to each other but also different to one another. The sample may also benefit from a survey before taking the experiment on people they know or don’t know to make sure the researcher has a rough idea of who to include in the experiment and who not to include.

The results from this experiment can have real life implications that can benefit many organisations and members of the public. An example of these benefits is that identification is mostly done by a full face photo which is the face perception of holistic processing. Organisations to do with identification, such as passports, use holistic processing as it is easy for a security guard to check they have the right person in front of them. This was also proven in an experiment [4] where they found that configurations are only properly perceived in upright faces meaning that holistic processing is the best method when trying to recognise a face leaving feature analysis no comparison against this evidence. Of equal importance these results can help organisations such as the police to recognise criminals when they have a profile but need to identify them on a low quality surveillance camera. [5] Previous studies have shown that identification, when trying to recognise unfamiliar faces on poor quality surveillance cameras, was easier using holistic processing rather than feature analysis. In conclusion our findings during this study show that on average when recognising a face, human beings find it easier to use holistic processing rather than feature analysis. These findings could be used to help many organisations when choosing how to identify faces as they can now choose the quickest and most effective way of face perception. The findings from this experiment should be taken into consideration when planning an experiment that involves holistic processing and feature analysis to further develop our results to make more accurate and precise evidence.

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PhD Tutor's note

L. produced an outstanding psychological report on face processing and included a variety of references to back up the claims she made throughout. Her report was of an equal standard to many of the undergraduate university reports that I assess on a regular basis. L. should be really proud of what she has achieved, and this recognition is very well deserved – congratulations L.!

The Investigation, Interpretation and Intervention Involving Cholera

Year 10, Key Stage 4

S. Stanton, The Sutton Academy, Merseyside  
PhD Tutor: A. Howell, University of Liverpool

Introduction

To introduce this essay, some context and information must be given. Cholera is an infection of the small intestine.<sup>[1]</sup> Its main symptom is watery diarrhoea for a few days, which can cause severe dehydration and sometimes death if not attended to.<sup>[2]</sup> Also, cholera can cause vomiting and muscle cramps.<sup>[3]</sup> Cholera is mainly spread through water which is contaminated with human faeces.<sup>[2]</sup> This means that factors such as poor sanitation and poverty can vastly increase cholera cases in an area.

These two factors mentioned were both entirely present in London in the 19<sup>th</sup> Century. Due to the very quickly increasing industry in London, everyone used the Thames for everything: sewage, industry, and, most importantly, drinking water. All of the water companies, such as Lambeth and Southwark & Vauxhall, supplied from different parts of the river. This led to the contaminated water getting just about everywhere, and getting worse as time went on, as there were no water treatment facilities or filters. This way of supplying water provided the perfect conditions for cholera to spread and infect thousands of people. There were several epidemics and even pandemics which affected London and killed many people.<sup>[4]</sup> No-one did anything about it as people believed that cholera was caused by bad air called miasma. These conditions allowed for Dr John Snow, a relatively unknown physician, to research these huge outbreaks. Snow did not believe in the so-called Miasma Theory, and wanted to disprove it. He believed that cholera was caused by contamination in the water, and not by bad airs and smell, as was commonly believed. The waves of cases and deaths that cholera caused provided a reason for Snow to pursue research in the area, and to eventually become famous, start the field of epidemiology, and stop cholera from ravaging London and the rest of the world.

Methods

Snow collected most of his data during 1848-1854, during the height of the cholera epidemics. The first thing Snow did was monitor what water was provided where. He primarily observed Lambeth and Southwark & Vauxhall, and saw that both covered nearby areas of London, with quite a lot of overlap.<sup>[5]</sup> However, Lambeth moved their waterworks down the river Thames to a cleaner area. This allowed Snow to see if the water caused cholera, as he now had a control group (a neutral party which can be compared to other groups).

Snow also observed the 1854 Broad Street outbreak. This outbreak involved a single water pump on Broad Street which was contaminated with cholera, and killed 127 people in just three days.<sup>[7]</sup> Snow was close to where the outbreak happened, so he did some research. He asked every house in the area how many people had died of cholera, and found several other details of unusual cases by asking family members and friends of the affected.



Results

Through all of this information, Snow found that cholera was caused by contaminated water. He also found that specific water companies and pumps were more contaminated than companies which drew from other parts of the river. Through his first investigation, he found that the Southwark & Vauxhall water caused eight times more deaths than Lambeth and its new waterworks. These results are shown in this graph:

TABLE IX.			
	Number of houses.	Deaths from Cholera.	Deaths in each 10,000 houses.
Southwark and Vauxhall Company	40,046	1,263	315
Lambeth Company . . . . .	26,107	98	37
Rest of London . . . . .	256,423	1,422	59

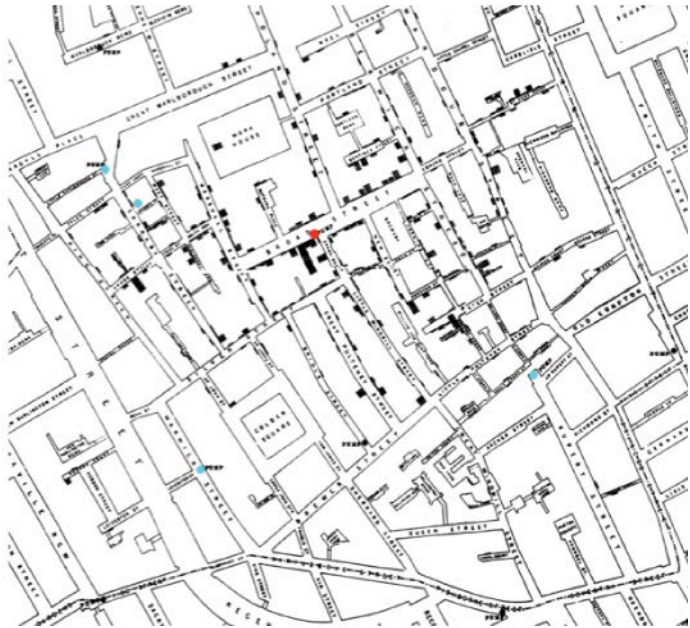
This graph shows a vastly increased number of deaths from Southwark & Vauxhall compared to the other two sources. The rate of deaths is also much more significant, as they had 315 deaths per 10,000 people, Lambeth only had 37 deaths per 10,000, and the rest of London, with 256,000 people, still had a small rate of 59 deaths per 10,000, over five times less than Southwark & Vauxhall’s rate. This allowed him to conclude that the water in that area did contain cholera. The second investigation showed that one particular pump was contaminated with cholera, and the rest of the pumps in that area were safe. It also showed that just about everyone who drank from the pump died, judging by the astonishingly fast amount of deaths from cholera. To show his results, Snow produced a map to portray the locations of cholera deaths:

In this map, the Broad Street pump is represented in red, and some of the other pumps are presented in light blue. As the map shows, there are many deaths (shown by the black bars where houses would be) near the Broad Street pump. Near the other pumps, there are vastly fewer deaths, to the point where the bottom-most highlighted pump has no deaths around it. Snow could use this map to find the source of cholera in the area, and therefore deduce where the outbreak started.

In the 1853-54 epidemic, Snow compared the cholera death rates between customers of the two companies. By observing the first 324 deaths of the 1853-54 cholera epidemic, Snow found that Southwark & Vauxhall’s water had caused a whopping 286 deaths out of the first 314. Through further investigation, Southwark & Vauxhall had 1263 deaths out of 40 046 houses. In contrast, Lambeth had just 98 deaths out of 26107 houses <sup>[6]</sup>.

In the Broad Street outbreak, Snow did a detailed investigation of the outliers. None of the workers at the Broad Street Brewery got cholera, as they had a different pump. The local workhouse had only five deaths among 535 people, and they also had their own well. Lastly, an elderly widow in a area far away from the pump had the Broad Street water delivered, as she liked the water, and ended up dying of cholera, along with her visiting niece. One other detail is that people near other pumps almost never got cholera, with the exception of some people, who

were said to have used the Broad Street pump because it was more convenient (which happened to three children)<sup>[7]</sup>, or in a few specific circumstances because they preferred the Broad Street water.



Discussion

In summary, the results state that contaminated water is the cause of cholera. The results show that people with clean water are a lot less likely to get cholera than people in areas with contaminated water. Dealing with this is very important, as cholera is very dangerous and can quickly kill many people, as the two London investigations show. Another factor that the investigations show is that epidemics can result in the breaking down of society. This is shown by an account from the time, which says “Within a week, three-quarters of the residents had fled from their homes, leaving their shops shuttered, their houses locked and the streets deserted”.<sup>[7]</sup> This conveys that cholera can have a huge societal impact on an area, to the point of leaving it ruined or abandoned. However, it could also make the results unreliable, as most, if not all of the healthy people had left, thus skewing the results.

Cholera can spread very quickly. Several accounts that Snow had found stated that people had shown signs of cholera mere days after attending to someone who also had the disease, such as “in Inveralochy the first case appeared on the 28th of September, three or four days after the arrival of the boat; the sufferer, the father of one of the crew, had been engaged in removing the cargo along with other members of his family. Two other cases occurred in this family; one on the 30th of September, and one on the 1st of October”.<sup>[9]</sup> One account in particular shows how quickly it can spread, as it says “eleven persons in all partook of this food, seven of whom ate it without any additional cooking. Six of these were taken ill within twenty-four hours after eating it, five of whom died”. This shows how dangerous and fast cholera outbreaks can be. This could be biased as all of these cases happened around one area of the UK, that could have been affected by other factors.

Advice for the Government

There are several interventions that the government could use to stop cholera. Firstly, they could introduce vaccinations. Vaccinations can prevent cholera by giving a weakened, dead or alternative virus to a patient in order to give them an immunity to that disease. This is a good solution, as vaccinating a population can completely stop outbreaks, as no-one can be infected. However, there are some problems. Firstly, vaccination can be expensive, as you need to do an extravagant amount of research. Secondly, people can still refuse vaccination, which leaves them vulnerable, and they can end up spreading cholera throughout an area. This would make vaccination much less useful, as someone who refused could end up unwillingly acting as a catalyst to yet another outbreak.

A second solution is to supply clean water when there is a cholera outbreak. Having clean, bottled water delivered to peoples’ homes means that people will not drink the contaminated water, and therefore, they would not get cholera. This is a largely effective solution, except for one problem; this idea is quite expensive. Bottling and delivering enough water for an entire population would come at significant cost. One other problem is that people don’t necessarily need to drink this clean water, despite it being completely free, so there is a slight chance of someone still drinking the contaminated water and getting cholera. Like vaccination, this would make this solution less effective, as this infected person could end up spreading cholera again and starting *another* cholera epidemic, all because they chose to not drink the clean water.

Following on from this problem, another intervention could be to restrict the drinking of contaminated water. This solution is very effective, as no-one can get cholera if drinking the water which contains it is disallowed. This means that it can’t spread, and therefore the epidemic is essentially stopped. However, as with every other concept, there are issues. Completely closing a water supply could cause some people to be annoyed or even outraged by this decision. For example, they tried this with the Broad Street pump, and it caused quite a lot of negative opinions. One of these was, “...we see no reason to adopt this belief. We do not find it established that the water was contaminated in the manner alleged ..., nor is there before us any sufficient evidence.”<sup>[10]</sup>

One other solution would be to thoroughly clean all of the water supplies which are determined to be infected. This is by far the most effective solution, as it entirely wipes out the cholera from the water supplies, and it does not rely on people wishing to take measures against cholera. It also can not be affected by human error, such as bottling the wrong water, or not thoroughly testing the effects of a vaccination. However, this intervention still has its drawbacks. For example, this is the most expensive solution by a huge margin, as it involves using chemicals to wipe out all of the pathogens, including cholera, in the water. Also, it does not stop people from putting more contaminated waste and sewage into the newly cleaned water supplies. Yet another drawback is that depending on what is used, the water may be unusable for some time. In a worst case scenario, a certain cleaning agent could be released along with the water, and poison anyone who drank it.

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PhD Tutor’s note

S. is a bright and articulate student who is very quick to understand new concepts. As this piece of work shows, he is able to think critically and creatively, and present his ideas effectively in writing. He also has excellent oral communication and team working skills. I’m sure he will go far. Well done!

Smoking Still Kills: What can we do to help?

Year 10, Key Stage 4

H.Khatun, Lister Community School, London  
Supervised by K. East, King’s College London

Cigarettes are extremely harmful substances which are known to contain dangerous additives, chemicals and drugs such as nicotine and tobacco. These substances are prone to cause life-threatening illnesses and conditions, including heart disease, lung cancer and severe asthma attacks. Nicotine is an addictive drug found in cigarettes; it provides an immediate “kick” because it causes a discharge of epinephrine from the adrenal cortex. This stimulates the central nervous system and endocrine glands, which causes a sudden release of glucose. This is then followed by depression and fatigue, leading the user to seek more nicotine. In 1988, the Surgeon General report concluded the fact that cigarettes and other forms of tobacco, such as pipe and chewing tobacco, are addictive and that nicotine is the drug in tobacco that causes the addiction. Research shows that when smokers crave cigarettes, they show impairment of basic bodily functions such as the ability to understand language.

Also, other studies show that when smokers are deprived of cigarettes they have increased anger and hostility. These are just a few ways in which this harmful drug affects smokers on a day-to-day basis. Also, the effects of nicotine mean that more smokers have an increased chance of long-term and short-term illnesses of tobacco which include: earlier menopause, premature hair loss, chronic coughing, vision problems, gum disease and much more. In addition, cigarettes also contain tar and many gases including carbon monoxide. The tar found in cigarettes exposes users to the risk of emphysema, bronchial disorders and other conditions. The carbon monoxide in tobacco smoke increases the chance of cardiovascular diseases among smokers.

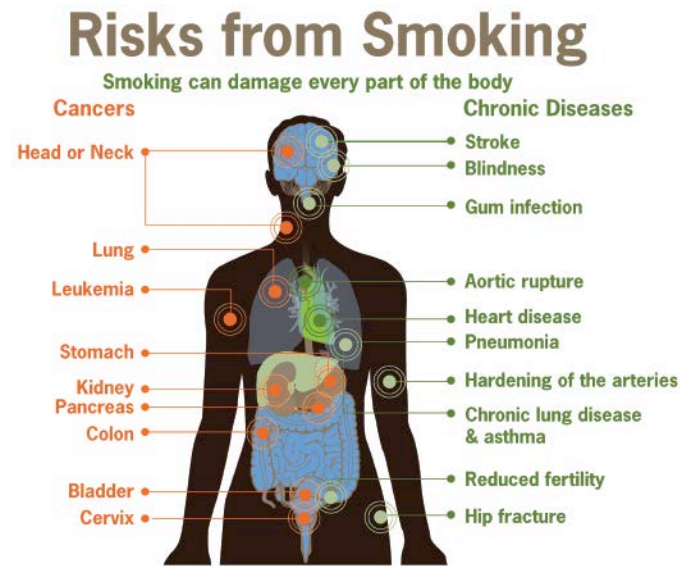


Other factors that contribute to the reason why smoking is harmful is the fact that it leads to passive/second-hand smoking. Second-hand smoke can cause lung cancer and heart disease amongst non-smoking adults and The Environmental Protection Agency has concluded that it causes sudden infant death syndrome, ear problems and slows lung growth amongst children (Tobaccofreemaine, 2017). Second-hand tobacco smoke is also dangerous when exposed to pregnant women as it can cause early preterm delivery. Also, passive smoke exposure causes 600,000 premature deaths per year (Mojibyan et al., 2017). Due to the extremely dangerous effects of smoking, many policies have been introduced in order to stop people smoking and effectively stop the dangerous impacts of smoking. The policies that will be discussed are as follows: (increased) taxation on cigarettes, plain packaging on cigarette packets and smoke free policies.

Taxation on cigarettes has been authorized to prevent people from buying cigarettes (especially adolescents and teenagers). It also generates a large sum of money for the NHS and other public services, from those who do purchase cigarettes. The total amount of tax on the average cigarette pack, in the UK, is £6.17, approximately 77% of the retail price. Joanna Cohen of the Johns Hopkins Institute for Global Tobacco Control has stated that: "Taxes are a win-win situation. Smokers smoke less and governments increase their revenue so taxes are our most effective strategy and a win-win proposition" (VOA, 2017). Also, based on clear evidence, the Surgeon General has called raising prices on cigarettes "one of the most effective tobacco control interventions" because increasing price is an effective method to reduce tobacco consumption among lower income groups and target those vulnerable at a young age to smoking. It also reduces tobacco consumption among pregnant women which prevents thousands of abortions and still-born births, and saves many newborns from suffering from smoking-affected births and related health consequences. In addition, taxation on cigarettes prevents passive tobacco smoke exposure amongst non-smokers, especially children and pregnant women.

Taxation on cigarettes encourages smokers to quit smoking or cut-back their exposure to the harmful substances found in cigarettes. This reduces the amount of deaths and illnesses caused by smoking every year. Tobacco companies have not reacted to this policy positively as they argue that raising tax on cigarettes does not reduce adult smoking. Also, as people cut-back on tobacco consumption, an increased amount of income is lost for the tobacco industry. R.J. Reynolds: "Together with manufacturers' price increases in recent years and substantial increases in state and federal taxes on tobacco products, these developments have had and will likely continue to have an adverse effect on the sale of tobacco products (Boonn et al., 2017)." Although the public are not completely satisfied about spending an increased amount on cigarettes, the majority are still willing to pay and others are glad that the government have reacted by contributing to end smoking. In addition, the government have reacted to this policy positively as they are gaining money from the increased tax on cigarettes and are able to spend this money on public services including the NHS.

In May 2016, in the UK, plain packaging on cigarette packets was introduced to act as a deterrent and prevent people from buying cigarettes. The cigarette packs have health warnings and were developed using the "most repulsive colour". The aim of plain packaging primarily targets teenagers and young people as it does not entice them into buying cigarettes, rather it acts as a restraint. Evidence from studies, research and the internal documents of the tobacco industry identify packaging as an important part of tobacco promotion. Plain packaging reduces the ability of the pack to mislead and increases the effectiveness of health warnings which increases quitting behaviour (Australian Department of Health, 2017). Research in which adolescents were instructed to use plain cigarette packs and were asked about their feelings towards them confirmed results that plain packaging increased negative perceptions and feelings about smoking. Also, it contributes to the decline in second-hand smoking as many people are ashamed to smoke in front of others and hide their cigarette packs.



Comparing branded cigarette packs alongside plain cardboard packaging, plain cigarette packs are significantly less attractive. Studies also show that unappealing packaging either reduces tobacco consumption or instigates the behaviours mentioned previously. In addition, smokers feel cigarettes taste worse in plain packaging and a likely outcome of this policy is that there will be less demand of tobacco products. Although this policy has had a positive effect on quitting behaviour, it has come under scrutiny from the tobacco industry. Tobacco companies expressed concern that plain packaging would increase the sales of counterfeit cigarettes. In addition, Roy Ramm, former commander of Specialist Operations at New Scotland Yard and founding member of The Common Sense Alliance stated that it would be "disastrous if the government, by introducing plain-packaging legislation, [removed] the simplest mechanism for the ordinary consumer to tell whether their cigarettes are counterfeit or not."

Other arguments against plain packaging include its effect on retailers, smuggling and much more. However, evidence points towards the fact that plain packaging has reduced cigarette purchase and consumption and has had an overall positive impact- the British Medical Journal

explained that before plain packaging implementation in other countries such as Australia, 20% of smokers wanted to quit, but after this policy was introduced 27% of smokers want to quit (Wikipedia, 2017). This illustrates that soon the policy will have a positive impact on the UK. This also shows that people have had a positive reaction to the policy in the sense that their behaviour towards smoking has changed. Another, tobacco control intervention that has been commissioned is the smoke free policy. The UK smoke free policy was fully implemented in 2015. It banned people from smoking in public places, including cars, to reduce passive smoking, especially the levels of tobacco smoke inhaled by children. The policy not only reduces smoke exposure amongst non-smokers but also encourages people to quit as the policy is not convenient to smokers. Also, the policy interferes with social norms, as if people are restricted from smoking, smoking is deemed rejected by society which discourages people from taking up smoking. After this policy was introduced, Stop-smoking services reported that client numbers had increased by 15% and there was also a 17% reduction in heart attacks among non-smokers (Pell et al., 2008). In addition, the air quality in pubs has massively increased after the ban. This is clearly illustrated in evidence that shows that before the policy was introduced, non-smoking bar workers were inhaling 4-6 times more tobacco smoke than the average non-smoker. However, after the smoke free policies had been implemented the levels of tobacco smoke were reduced by approximately 76%. The public have had an extremely positive reaction to this policy and the majority of the public comply to this law as research shows that 87% of all public premises and vehicles display the correct non-smoking sign. Also, 76% of people support smoke free policies in public places. Many people believe that smoke free law has led to health benefits and cleaner environments. The annual Smoking Related Behaviour and Attitudes survey reported that there was a decrease in the number of people allowing smoking in their home.

This shows the impact this policy has had on the public's view on smoking and its harmful nature. In addition, businesses have received a positive reaction from workers after the implementation of smoke free law- 59% of businesses reported positive reactions from staff (UK Department of Health, 2017). Although the policy shows signs of improvement in the amount of people smoking or taking up smoking, some people disagree with smoke free law in pubs compared to areas such as banks and post offices or restaurants. Many argue that smoking rooms could be put in place for those who wish to smoke in pubs and that the policy has caused many pubs to close due to lack of business. British Beer & Pub Association chief executive Brigid Simmonds states that it will be unlikely that smoke free law would be reversed and admitted that it "hit the pub trade hard" and led to pub closure (MorningAdvertiser, 2017). However, most of the public and businesses agree and comply with this law and believe that it has had a positive effect on the environment and people's health.

In conclusion, the long term and short term effects of smoking are vicious and extremely harmful to smokers and others around them. These policies, along with others have been put in place in order to prevent these effects. The policies mentioned are extremely effective and meet their objective. They work to save people from the dangerous

drugs found in cigarettes (and other forms of tobacco) including nicotine, an extremely addictive substance. Taxation on cigarettes ensures teenagers and young adults are financially restricted from buying cigarettes, whilst also collecting large sums of money for our country's public services from those who can afford to pay for cigarettes. Plain packaging on cigarette packs aims to work as a deterrent and discourage people from buying cigarettes and effectively warn them of the health issues caused by smoking.

The smoke free law prohibits smoking on public premises and in cars, saving thousands of non-smokers (second-hand smokers) and smokers every year. Although some of these policies have gone under critical observation by the public and tobacco industry for the reasons mentioned previously, overall, they've had a positive impact on smokers and non-smokers by providing a cleaner environment and contributing to end smoking and its dangerous, threatening effects. In addition, these policies work together and aim to encourage users to quit smoking and provide a supportive environment.

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### PhD Tutor's note

Teaching at Lister Community School was incredibly enjoyable and rewarding. All of the pupils were very bright and engaged with the sessions brilliantly from the start, and I was amazed with the high standard of work they consistently produced. Specifically, H.s final assignment was of a notably high standard. She demonstrated an excellent understanding of the topic, outstanding critical thinking and evaluation skills, and an ability to reference appropriately. She thoroughly deserved her First-Class mark of 84%, and it's a great pleasure to see her work published in The Scholar.



# Assessment of the Challenges to the Realisation of Nuclear Fusion: Nuclear Safety for Fusion

Year 12, Key Stage 5

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### Abstract

Development and selection of suitable materials to withstand the conditions of a fusion environment is a key step to turning nuclear fusion energy from a theoretical and unreachable energy source into an economically accessible energy option with the potential to meet the raising energy demands of the world's growing population. Assessment of challenges and opportunities associated with fusion materials are given throughout this report, through analysis of different literatures and scientific findings in the field, highlighting the current progress made within fusion materials development, as well as providing an overview of most significant challenges still to be resolved and recent plans for finding solutions to these issues.

Extensive research has been carried out in the fusion materials field, producing many new ideas and solutions such as: recycling and clearing radioactive and tritium activated materials; production of new low activation materials reducing radioactive waste and radiation damage to the reactor components; and testing currently developed materials, using fission neutrons and high-energy electrons. Despite these achievements, modelling and testing using fusion conditions is unavailable, as the fusion condition testing facilities such as the International Fusion Materials Irradiation Facility (IFMIF) are currently in the design stage, therefore restricting materials research opportunities, until construction of the facilities. Withstanding all of the required fusion conditions: high heat and neutron loadings, thermo-mechanical stress, along with resistance to continuous radiation damage still poses a problem to be overcome. This is the case with many of the current challenges and solutions developed, which overall reinforces the fact that further research in fusion materials is required, as well as extra funding for the construction of fusion facilities where new material could be tested against similar conditions to the fusion environment. Pushing and developing the fusion materials technology forward, to find new or improved solutions to all of the impactful challenges, still remaining unsolved should be prioritised.

### Introduction

The total population of humans living on earth has reached 7.4 billion according to the most recent approximations provided by the United Nations Department of Economic and Social Affairs, Population Division and Worldmeters in June 2016 [1]. Current estimates also highlight that our population is still increasing, with predictions of the world's population reaching 8 billion by the year 2024 and 10 billion by 2056 [1]. Due to this rapid population growth, human energy consumption will definitely rise, causing higher energy supply demands from current energy usage of 14 TW, as high as up to 25–60 TW before 2050 [2, 3, 4]. Figure 1 illustrates the breakdown of the world's energy supply, emphasising that our main energy supply was and still will be originating from fossil fuels, for the next several years [5].

The high usage of fossil fuels brings many environmental concerns such as: climate change, acid rain and many more, developing a greater interest in renewable and non-fossil energy sources [2, 6].

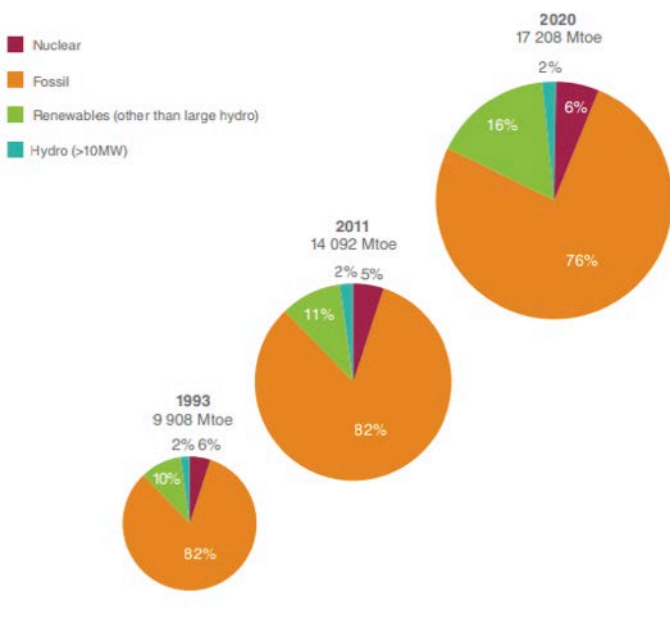


Figure 1 – Total Primary Energy Supply by resource 1993, 2011 and 2013

Nuclear power is one of the areas of interest and a strong contender as a main environmentally sustainable energy source [2, 7]. However, nuclear power is often criticised due to issues such as: radiation safety, disposal of radioactive waste, as well as finite supply of materials required e.g. uranium [7]. These concerns are well justified, nevertheless they mostly apply to fission, whereas fusion should be able to generate clean and safe energy without producing CO<sub>2</sub>, SO<sub>2</sub> or any radioactive waste in the process and with an infinite fuel stock, due to deuterium being able to be obtained from the ocean and tritium being produced by the “transmutation of lithium”, using high energy neutrons created during the deuterium– tritium (D-T) fusion reaction [7, 8].

Even though fusion energy possesses the possibility to meet the growing population's energy demands, it is rarely included in any energy assessments, as it is a far too theoretical idea, with too many challenges still unresolved [2]. Therefore, further research and technological development is still needed before fusion energy is available for usage [7, 2].

Challenges associated with fusion power can be roughly grouped into three main categories: “plasma control, power extraction and material selection” [7]. Materials for fusion face many challenges, because of the complex fusion reactor conditions, including “radiation heat flux, chemical compatibility and thermo-mechanical stresses” [2, 7]. Modelling and testing materials for these conditions is also a challenging matter, as experimental facilities which produce these conditions are unavailable or being designed [3, 9]. Modelling challenges also lie with the time scale radiation damage takes effect, which could span over several years [7, 8]. Therefore, this assessment will focus on the challenges associated with material selection, as well as the opportunities and current progress in this field. Giving an overview of what the challenges are, how they

are currently being solved and planned to be solved, as well as providing a personal reflection on the topic matter.

### Literature review

Current research focuses on materials facing the harsh environment found inside the fusion reactor. In his 2005 journal article, Zinkle has stated “the development of fusion structural materials may be the greatest challenge ever undertaken by materials scientists” [2]. Extensive research has been carried out on the challenges materials will have to face. Due to this research, development of roadmaps for fusion materials were able to be created such as those produced by the European Materials Assessment Group (MAG) [9, 10].

### Withstanding the harsh environment

Components which face the most challenging conditions, are the first wall and the plasma facing components such as the blanket and divertor [7, 11]. These components must withstand high temperatures, therefore materials selected must have sufficient creep resistance (“material's ability to resist any kind of distortion when under a load over an extended period of time”) and good resistance against high temperatures [7, 12]. The divertor, for example, has to be capable of handling thermal energy loads as high as 204 MW, as well as coming directly into contact with the plasma itself [13, 14]. This results in elements of components, for example the divertor tiles, requiring frequent replacement due to damage from the high heat loads, but also due to high fusion neutron loads. [10, 13, 15].

The plasma facing components area of the reactor is heavily effected by plasma ion erosion. High fluxes of neutral and charged particles which have escaped from the plasma bombard the plasma facing components causing “sputtering” of atoms in the materials of the plasma facing components, whose effect is intensified when materials used contain more impurities [8, 16]. These sputtered atoms as a result can affect the plasma temperature, by causing radiative cooling, therefore selected materials' effect on plasma has to also be taken into account, as well as plasma's effect on the fusion materials [7, 16]. Another significant issue is caused by high neutron loadings of approximately  $8 \times 10^{14}$  neutrons cm<sup>-2</sup> s<sup>-1</sup>, which can have different effects on fusion materials at different melting temperatures (T<sub>m</sub>) of a material and at different neutron radiation damage stages, measured in dpa (displacement per atom). “Volumetric swelling” caused by the formation of vacant voids occurs at 0.3–0.6 T<sub>m</sub> and >10 dpa and “high temperature He embrittlement” at > 0.5 T<sub>m</sub> and >10 dpa, when high energy neutrons collide with materials causing displacement in their atoms, creating numerous “dislocation loops” or “void formations”, which over time reduce the durability of the materials used [2, 7, 8]. Swelling and embrittlement can then also take place within these materials, as helium and hydrogen atoms, products of the fusion reaction and the decay products of “transmutation elements”, enter the vacant “dislocation loops” [7, 8, 16]. However, other main effects also take place at much lower material's melting temperature. “Irradiation creep” takes place at <0.45 T<sub>m</sub> but still at >10 dpa radiation damage and “radiation hardening and embrittlement” occurs at <0.4 T<sub>m</sub> and much lower radiation damage of only >0.1 dpa. The last major effect of neutron radiation is “phase instabilities from radiation induced precipitation” taking effect at 0.3–0.6 T<sub>m</sub> and >10 dpa [2, 4, 7, 8, 9, 13].

The high neutron radiation environment present inside the fusion reactor is also responsible for the production of radioactive materials. Neutron activation is responsible for

the creation of radioactivity in the materials used, as the process of neutron activation entails, atoms in the materials capturing neutrons from the radiation, causing them to increase in mass and to enter the excited state. Tritium retention is another factor, which induces radioactivity in the fusion materials, especially in the first wall materials, due to contact with tritium during D-T fusion [9, 16].

### Current research

Developing new materials, with the ability to meet the requirements of the fusion reactor's environment, for use in particular in the blanket, first wall and the divertor, has been one of the main focusses of current fusion materials research. High emphasis has been put into developing low-neutron activation materials. “SiC composites, vanadium–titanium–chromium alloys, and advanced martensitic steels” have been given a lot of attention, due to their low- activation values. The SiC composites currently require the most research out of the three materials listed, this is due to the material being developed originally for aerospace usage, and therefore it has never been implemented into a structure which experiences “mechanical, thermal, and hydraulic loading” for extended periods of time [8]. Martensitic steels have been given a lot of attention, with efforts to ensure new steel alloys contain seven to ten percent chromium (Cr) along with tungsten (W), replacing Molybdenum (Mo), vanadium (V) and tantalum (Ta), to reduce neutron activation levels from the currently used 9Cr–1Mo and 12Cr–1Mo alloys [8, 13]. Vanadium–titanium–chromium alloys are materials which have been established in 1960s and 1970s, thus the current research mainly focuses on the effect irradiation has on them, due to a pretty good level of understanding of mechanical properties of these materials already [8]. Through current research, a set of “baseline materials” have also been established for different components including: reduced activation ferritic martensitic steel (RAFM steel) for the breeder blanket structure; as well as tungsten and copper alloys for plasma facing components and “high-heat flux materials”, however these materials are not suitable for every project e.g. for the demonstration power station (DEMO). The temperature at which DEMO will be operating already prevents copper alloys from being used [9, 15, 16]. Other experimental materials have also been proposed such as oxide dispersion strengthened steel (ODS steel), which uses “nanoscale oxide particles”, to improve resistance against thermal energy; and coating materials made from tungsten or graphite, for example, with microcrystalline or nanocrystalline diamond, to shield the component from the heat loads [7].

Apart from research based around finding new materials, there has been an increased interest in learning from fission power plants and using them as testing facilities for newly proposed materials, by irradiating them with fission neutrons. Moreover, recycling and clearing activated materials has recently started to be researched further, with plans to learn from disassembling fission reactors to solve the issue of radioactive waste being deposited underground [9, 17].

### Discussion

Although extensive research has been started in the field of fusion materials, there are still many key challenges associated with the topic and current progress, still unresolved or just beginning to be looked at.

### Modelling and testing

One of the most significant challenges for fusion materials is testing and modelling them. The International fusion materials irradiation facility (IFMIF) is currently in the



designing stage, therefore materials can't be fully tested for their capabilities to withstand damage caused by 14MeV fusion neutron irradiation, before the facility is built or other fusion environment producing facilities such as the international thermonuclear experimental reactor (ITER) are completed [3,9,13,15]. Current methods of testing materials include irradiation through fission neutrons, irradiation by high-energy electrons and irradiation by high-energy ions [3]. Data provided by these methods was able to be applied to some components of a fusion reactor, for example the vacuum vessel for DEMO can be tested using fission spectrum neutrons, which rarely exceed 1MeV [9,15]. However, there is an issue testing plasma facing components, as the conditions they will be experiencing are within the fusion neutron's energy range and extrapolating the current results from fission neutrons and high-energy electrons, would most certainly provide invalid results due to absence of factors like He gas production [7, 9]. The simulation of a complete fusion environment is not possible in non-fusion facilities such as fission reactors and "accelerator-based neutron sources", causing significant problems for projects such as DEMO, as sufficient testing on materials has to be completed before they can be implemented into the DEMO design [9, 10]. On top of this, radiation damage in materials can take up to several years to develop, and current testing methods only expose materials to radiation for short periods of time, providing no date for long term effects of radiation damage [7]. Therefore, development of more advanced testing facilities should be a priority in fusion materials research. Facilities currently under design, such as IFMIF, could be scaled down in order to start testing sooner, providing data for projects like DEMO, with development plans in place to transition from the starting smaller scale facility to a bigger one in the future [9]. Alternatively, fusion nuclear science facilities (FNSF) can be established, which would be small D-T fusion reactors, reducing problems with the overall cost of construction and operation, as well as tritium supply, providing "prototypical fusion nuclear environment" for testing [10]. In the meantime, research with non-fusion facilities should carry on, where appropriate.

Withstanding all of fusion's environment conditions Fusion materials have the tendency to fulfil several of the properties required to withstand the fusion environment, but not all. For example, graphite is a great thermal conductor and has low atomic weight, which makes it a good material for the divertor, however, its flaw is reactivity with hydrogen, producing "volatile hydrocarbons", resulting in the need of new materials being developed through joining of elements to meet more criteria points. Table 1 illustrates this principle by describing the different advantages and disadvantages of materials considered for fusion materials [7].

material	advantages	disadvantages
beryllium	low Z, getters O	low Tm, toxic, high physical sputtering yield, brittle
tungsten	high thermal conductivity, high Tm, low sputtering yield	high Z, brittle
CFC	low Z, high thermal conductivity, high Tm	high chemical sputtering, brittle, dust generation
diamond	low Z, high thermal conductivity, high Tm	brittle, dust generation, possible amorphization, poor conductor

Table 1- Advantages and disadvantages of fusion materials in terms of properties

Compatibility of different materials based on their "Operation temperature window" is also challenging. Different materials experience radiation embrittlement and thermal creep at different temperatures, providing

a challenging situation, as not all materials can be used together. Figure 2 illustrates the operating window for some fusion materials being considered for use, portraying that materials don't perfectly operate in the same temperature frame and experience radiation embrittlement and thermal creep at different times, therefore further research in developing new materials has to be maintained, improving characteristics a material lacks in to bring different operation frames closer together [18].

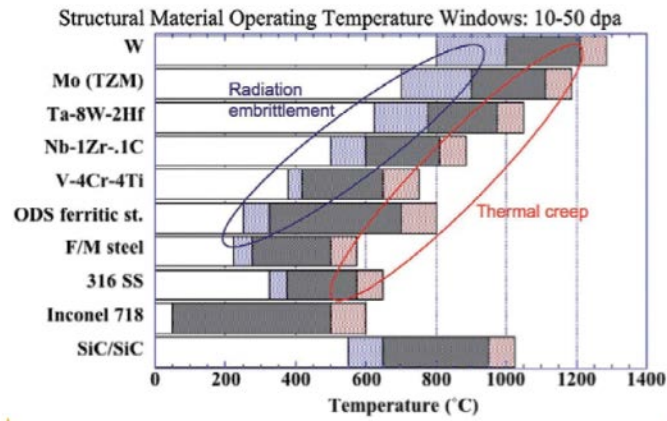


Figure 2- Structural material operating temperature window

### Radioactive waste and recycling

Tritium retention and high neutron loading in fusion materials produce radioactive waste which has to be disposed of [11]. The production of even low level radioactive waste defeats one of the fundamental principles of fusion: producing clean energy, without creating any harmful waste products [7]. With high environmental and political concerns about radioactivity and the deposition of radioactive materials underground, the idea of recycling and clearing has been created [11, 17]. Recycling and clearing used materials helps to solve two issues with fusion materials. Firstly, it lowers the amount of radioactive waste produced, and secondly it helps to replenish the supply of rare materials required for replacements of damaged components [11, 14]. For example, 560 tonnes of beryllium needs to be replenished every five years due to radiation induced swelling. Nevertheless, for recycling and clearing to be able to take place, remote handling techniques and technologies have to first be developed fully [9, 10, 11, 13, 17].

Impurities in materials such as Niobium (Nb), Molybdenum (Mo), and silver (Ag), common in metallic alloys, highly increase the activation level of the materials. A solution to this issue is using the developed low activation materials discussed in the literature review [4, 8]. By using low activation materials the issue of strain on material supplies is also partly resolved, as the components don't have to be replaced as often due to less radiation damage in addition to less atom sputtering produced. However, using only materials from these three groups restrains material usage options [8].

### Conclusions

There are still numerous challenges in the way of achieving an economically feasible and sustainable energy source, which could save us from relying so heavily on fossil fuels. However, these challenges are not unpassable and with the current development moving forwards in the fusion materials field, fusion is definitively still an open option for the future. Creation of new materials, will certainly play a key role in the future of fusion materials, as many varied materials with unique roles,

will have to be produced to withstand the demanding fusion environment. Significant emphasis, will also definitely be placed on developing testing and modelling facilities, which go hand in hand with the production of new material blends in alloys and composite materials.

### Personal excerpt

Fusion materials pose a huge barrier for the development of fusion as a source of economically viable energy for the future. The structural materials dictate whether or not the fusion power plants will survive to produce sustainable and reliable energy for the years to come. Without appropriate materials to withstand the harsh fusion environment, radiation damage effects such as thermal and irradiation creep, radiation embrittlement and volumetric swelling, would greatly hinder the reactors' efficiency and ability to produce fusion energy. The high demand for fusion material testing facilities and increasing pressure to solve the issue of radioactive materials being produced, will definitely lead research into that path. The modelling and testing facilities will enable scientists to check materials against conditions similar and identical in some cases, such as testing with 14MeV neutron radiation, to fusion reaction conditions, helping to develop and test new materials, which is another path I believe fusion materials research will follow, due to the specialised characteristics material have to contain to survive the severe fusion conditions.

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### PhD Tutor's note

M. is an outstanding student. It is impossible to fault his effort, and his extraordinary desire to always understand more. The research piece he prepared exhibits qualities equal to those seen in university level work, and he showed rigour in both his understanding and in his communication of the complex ideas that were explored. This is reflected in his first-class grade of 87%. M. was a delight to work with, and his eagerness to discover ensures that he will no doubt fully apply himself to whatever challenges in life he decides to take on next!.

# Population Genetics

Year 12, Key Stage 5

R. Khan, Featherstone Sixth Form, London  
Supervised by J. M. H. Tsang, Imperial College London

### Introduction

<sup>(1)</sup> Population genetics is the study of variation and the distribution of alleles in particular populations and communities. It is a branch of evolutionary biology and implements a range of different theories to explain why certain things happen to populations (for example, the Lotka-Volterra model explains predator-prey dynamics) and how these events and interactions can affect the genetic variety and frequency of alleles in the population. It also demonstrates how certain occurrences (which happen to be the main approaches to explaining and helping us understand evolution) such as natural selection (due to natural disasters, hunting, and food shortage), mutation (of genes) and selective breeding can lead to major alterations of the genetic variety available in the population and therefore sufferable consequences. Understanding these consequences helps us to identify ways of preventing them from occurring and helps us to maintain the balance of life.



### Hardy-Weinberg Principle

The Hardy-Weinberg principle acknowledges the coexistence of different species that feed (the predators) and that are fed on (the prey). This can be displayed in the form of predator-prey equations (as shown below) to present how the interactions of different species affect the growth or decay of their populations and growth as communities overall.

In population genetics studies, it is important to be able to identify genetic variations in populations and to analyse and quantify them by the frequency of alleles present. Any particular gene will have some variations called alleles, which may result in different phenotypic traits, for example different pigmentation. However, this sort of thing usually only occurs if the genotype interacts with the environment, therefore different pigmentation may also occur due to environmental influences (phenotype), such as getting a tan, for instance.

The Hardy-Weinberg principle is also known as the Hardy-Weinberg equilibrium, model, law and theorem. It is frequently used as a method of measuring whether proportions of a genotype in a population vary from that which is predicted by the Hardy-Weinberg equation (as shown below).

Five conditions are required in order for a population to remain at Hardy-Weinberg equilibrium: A large population



from which to breed

- 1) Random, not selective breeding and mating
- 2) No mutations occurring that change allelic frequency
- 3) No immigration into or emigration out of the area
- 4) No natural selection that decreases genetic variety <sup>(2)</sup>

In addition, the basis of the model states that in a particular population, the frequencies of alleles and genotype maintain a consistency between generations (as long as no other external stimuli are involved, such as evolutionary influences). <sup>(3)</sup>

The following equation is used to estimate the frequency of different alleles (variations) of a gene in a population:  
 $p + q = 1.0$

Where  $p$  = the frequency of the dominant allele  
And  $q$  = the frequency of the recessive allele  
So,

$$(p + q)^2 = 1$$
$$p^2 + 2pq + q^2 = 1$$

As you can see, binomial expansion (which is a shorter method of expanding binomial expressions that have been raised to some power as it would take too long to write out the entire thing) is used to expand the equation and to indicate how often each of the three genotypes appear:  
 $p^2$  is the frequency of the homozygous (two of the same allele) dominant AA.

$2pq$  is the frequency of the heterozygous (two different alleles, one dominant, one recessive) Aa.

$q^2$  is the frequency of the homozygous (two of the same allele) recessive aa <sup>(4)</sup>.

This helps us determine the amount of possibilities of genes and how many different variations are likely to exist to them in a population, and helps to keep track of the organisms living in the environment and what can be done to help protect and conserve them. (Such as trying to prevent natural selection by decreasing the likelihood of natural disasters occurring, like floods - which could be controlled by adding barrier defences or campaigning to raise awareness for the environment and stop global warming).

#### Worked example:

##### Question:

In a population of ladybirds, the colour red (R) is dominant over the colour yellow (Y). 20% of all of the ladybirds in the particular population are yellow. Calculate the percentage of butterflies in the population that are heterozygous (one dominant gene and one recessive gene) and the frequency of homozygous dominant (two dominant genes) individuals.

##### Answer:

The equation is  $p^2 + 2pq + q^2 = 1$ . So in order to obtain values for  $p$  and  $q$ , we look at the information given to us in the question. Yellow is the recessive gene which means that it takes a homozygous recessive complex for a ladybird to be yellow. As 20% of the population of ladybirds are yellow,  $q^2 = 0.2$ . To work out  $q$ , we find the square root of 0.2 which is 0.447213595. This is the frequency of the recessive allele (Y).  
 $p + q = 1$

To find  $p$ , we rearrange the equation:

$$1 - 0.45 = p$$

This gives us 0.55.

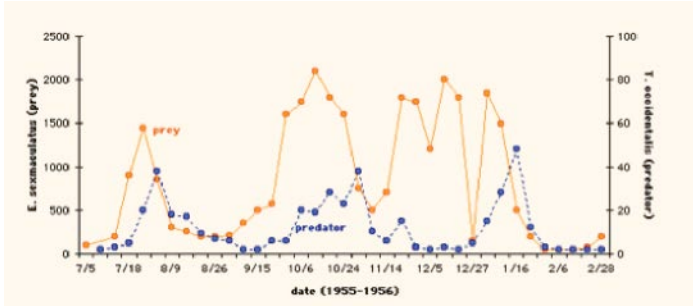
Finally, to answer the main question, the percentage of heterozygous ladybirds is  $2pq$  which is 0.495, and the frequency of homozygous dominant ladybirds is  $p^2$  which gives us 0.3025. <sup>(8)</sup>

#### Predator-Prey Equations

The Lotka-Volterra model is a model that is used to present predator-prey dynamics as the evolution of one can influence the other. It was developed by Alfred Lotka and Vito Volterra around 90 years ago.

The model is based on a number of things. One of them is that it (the model) assumes that whenever the predator population is absent, the population of the prey will increase rapidly as there are fewer threats present killing them off. Following this assumption, once the predator population eventually increases due to an increase in resources and food supply, they will likely hunt all the prey quickly and thus also grow in numbers, reducing the population of the prey. Thirdly, the model does not take into account any environmental influences such as a natural disaster or a similar epidemic that could possibly wipe out a species. It is also assumed that the prey has an unlimited food supply and ability to reproduce (unless predators get involved first). Finally, it is also assumed that the predators do not switch to a different type of prey. This gives the theory low internal validity, as in real life circumstances, it is more likely that the predator would feed on something else, rather than die.

This entire concept is very simple and straightforward, as well as high in importance, as it helps scientists understand what they can do to maintain these communities. It is the interaction of the predator and the prey that influences the dynamics of each population, and allows biologists to use the Lotka-Volterra model to predict the outcome of said interactions, for example if one species is about to die out, or another is about to increase largely in population. This information helps prevent sudden outbreaks, for example preventing a widespread locust epidemic, or by breeding animals (like predators) in captivity to maintain the balance of life and the environment. <sup>(5)</sup>



The model is accompanied by a set of 2 predator-prey equations, one of which describes the change of the predator population, and the other showing the change of the prey population. These mathematical models and formulae also aid us in predicting the outcome of predator-prey interactions.

$$\frac{dx}{dt} = \alpha x - \beta xy$$
$$\frac{dy}{dt} = \delta xy - \gamma y$$

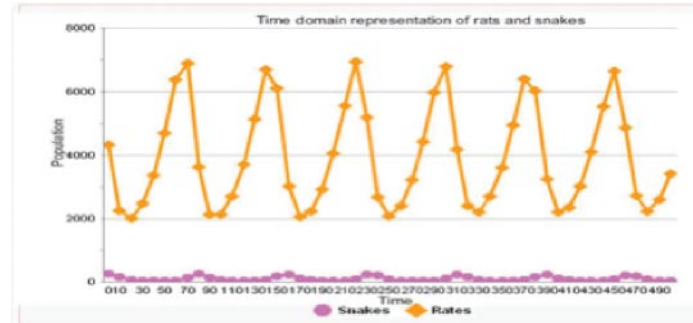
$x$  represents the number of prey  
 $y$  represents the number of predators  
 $\frac{dx}{dt}$  and  $\frac{dy}{dt}$  represent the growth rates of the populations of the predator and the prey over a period of time  
 $t$  represents time  
 $\alpha, \beta, \gamma$  and  $\delta$  are 'positive real parameters' that describe the interactions of the predatory species and the prey.

As mentioned previously, it is assumed that the prey have unlimited food supply from which they can grow in number exponentially. This is exponential growth and is displayed in the prey equation by the expression  $x$ . It is further assumed that the rate of predation (the number of predators successfully preying on other animals for food) is proportional to the rate of predators and prey meeting or interacting. This is shown in the prey equation above, by  $x$  and thus allows us to see that the exponential growth of the prey ( $x$ ) minus the rate at which the prey is preyed upon (in simpler terms, the rate at which predation occurs) gives you the total change in the number of prey present in a population.

Moving onto the predator equation, the term  $x$  is used to present the change of growth in the predator population. This equation is very similar to that of the prey equation, however since the predator is less likely to be preyed on by a larger form of predator, the equation differs slightly as a different constant has to be employed because the rate of growth of the predator population is not always exactly equal to the rate of consumption of prey. The expression used to show the absence or 'loss rate' of members of the predator population is  $y$ . Reasons for these absences vary, for example it could be due to death from natural circumstances or something less morbid like emigrating to a different location. Either way, the results are the same as there is 'exponential decay' - the complete opposite of the 'exponential growth' the prey population face.

Therefore, the predator equation suggests that the change in growth ( $x$ ) minus absence/natural death/emigration etc. ( $y$ ) gives you the change in the number of predators present in a population <sup>(6)</sup>

Graphs can be created on online simulators to visually display what the equations represent and show predator-prey dynamics in action. Here is an example using snakes as predators and rats as the prey: <sup>(7)</sup>



The graph shows that as time progresses, the population of the rats continues to fluctuate and then suddenly drop, however they increase and decrease in the high thousands, whereas the population of snakes tends to keep relatively low even when there is a high prey population available to feed on.

#### Conclulsion

It is clear that both the Hardy-Weinberg model and the Lotka-Volterra model explain how interactions between species and certain events taking place can heavily impact the allele frequency and diversity in a population. The Hardy-Weinberg theory is used to measure the availability of genetic variation and suggests a population may remain at equilibrium as long as there are several factors present. Predator-prey cycles explain how predation, a factor that is not taken into consideration in the Hardy-Weinberg principle- can reduce the allele frequency of a population by killing off many of its members. However, on the other hand, as one of the conditions for Hardy-Weinberg equilibrium is that no natural selection takes place, it can be suggested that predation is a form of natural selection, which would mean that the relationship between the two models, though it is not often recognised, is quite complementary as one helps to explain the other and vice versa.

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#### PhD Tutor's note

R. Khan has produced a polished essay based on her own self-motivated research and has referenced her use of external resources meticulously. The essay is well thought-out with an interesting attempt to link Predator-Prey dynamics and the Hardy-Weinberg principle. I am impressed that critical judgement has been shown to highlight not only the strengths, but the weakness in the assumptions behind those theories. Overall, it is a coherent essay and provides real pedagogical value for the reader.

## If I was given the opportunity, would I go to space?



Year 12, Key Stage 5

S. Abduljalil, Longfield Academy, Kent  
Supervised by R. Nisi, Longfield Academy

Ever since the Russians first Vostok orbit around the Earth in 1961 humans have been venturing into space, achieving what was once unimaginable. After 37 years and 38 missions, they had managed to launch the first of many instalments of what has come to be known as the International Space Station (I.S.S.). Two years following the initial I.S.S launch, humans started living in I.S.S. and in the 17 years since there has been a continuous human presence in space. The crew manning the station consists of six astronauts, the majority of which are Russian or American with the rest consisting of either European, Japanese or Canadian members. The crew carry out vital experiments and install new components to the I.S.S that help us have a better understanding of space. In the 56 years since the first human in space, scientists have not only learned more about our planet but also our galaxy and our universe and about human physiology and psychology in space. If given the opportunity I would love to help with the ongoing, never-ending venture for knowledge of the universe, however, I don't think I would be a viable candidate for a space exploration or even a stay at the I.S.S.

Conditions on Earth and space are unquestionably different and this causes a high quantity of complications for space venturers. If a human were to suddenly end up in outer space in a pair of jeans and a t-shirt they would undoubtedly die within minutes, the gases in their body would rapidly expand causing the person to almost explode. Then the lack of oxygen would inflict an intense feeling of suffocation which would result in oxygen deprivation and would cause the person to lose consciousness. After just 20 seconds from the moment they ended up in space, the individual would be far from living.

Evidently, they don't send astronauts into the harsh environment without a spacesuit. Space suits provide an optimum and mobile environment for the astronauts wearing them. They regulate body temperature preventing the body from freezing at  $-157^{\circ}\text{C}$  using the body's heat and the suit's insulation, and also protecting the body from  $121^{\circ}\text{C}$  heat [2] using the cooling water tubes worn inside the suit. The suits also offer protection from space dust that travels at speeds faster than 1,700 mph [2] and could easily penetrate a person not wearing a spacesuit. In space, the sun's light is as bright and dangerous as ever not only producing intensely bright light but also strong radiation, because of this the space suits are equipped with gold-lined visors to combat this issue and protect the astronauts' eyes.

The space suit does not solve the issues with the conditions of space inside the I.S.S. For one, the inside of the I.S.S and all of space has microgravity which imposes an issue as the human body relies on gravity to correctly distribute its fluids around the body. With microgravity, the body's fluids, such as the blood, tend to pool towards the head and chest. This causes blocked sinuses and a weaker heart as it doesn't need to pump the blood around the body that hard, but

when the body is re-introduced to the force of gravity the body's fluids return to being evenly distributed and the problem disappears. However, the "zero gravity" in space can cause more long term damage, for instance, an increase in eye pressure. This can pose a problem when an astronaut returns to Earth from space, as it can permanently alter the shape of the eye and thus affect how the eye focuses light onto the retinas causing them to experience long or short sightedness.

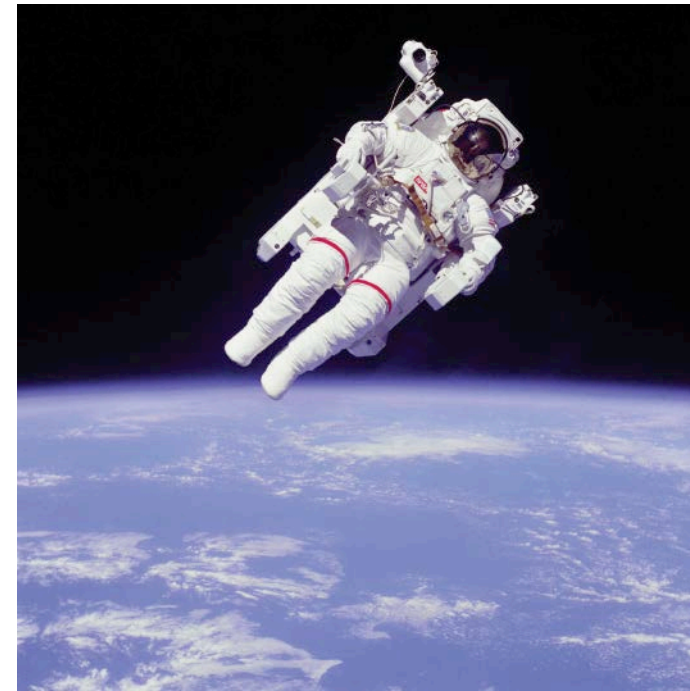
British astronaut Tim Peake experienced back problems on return from his stay on the I.S.S.[1] because the spaces in between his vertebrae increase in length due to the lack of gravity. In space, this doesn't cause any issues apart from some pain however on Earth the spine needs to be compressed in order to hold the weight of the human body upright. The spine normally re-compresses within a couple of weeks, however, in Tim Peake's case it took a lot longer which caused him issues with mobility and lifting anything with weight. This is due to the lack of gravity, without gravity the body starts to lose its muscle mass because the body's muscles become inactive as they aren't being used to hold itself upright or having to lift anything.

In an average stay at the I.S.S., the body can lose up to 40% of its muscle mass.[3] In order to tackle this muscle atrophy astronauts are required to partake in two hours of compulsory exercise including cardio, running on a harnessed treadmill, and weight training everyday. Astronauts not only go through muscle loss but also a loss of bone density, this condition is named spaceflight osteopenia. 1% of bone mass is lost monthly in space due to the nutrients in the bone being used up by the body because in space the body does not need them as they don't have to support themselves against Earth's gravity. In an attempt to resolve this problem scientists have tried to incorporate more nutrients such as calcium into the astronauts' diets, however, it has not managed to completely resolve the issue. They also haven't found a solution to regain muscle strength so astronauts like Tim Peak have to deal with the consequences. Astronauts go through a 45 day reconditioning schedule where scientists try to rebuild what was lost during the astronaut's period in space, however once again it is not a straightforward rehabilitation, complete re-adaption can take as long 3 years and results are not guaranteed.[3]

Astronauts are in their prime and are the physical embodiment of health. However, I, on the other hand, am far from that. My body would not be able to keep up with the physical demands of an astronaut with the two hours of compulsory daily cardio and weight training. Not only that, but I don't believe that my body would be able to function with a weaker heart even if it is only temporary, I am not the fittest of people and a reduced oxygen flow would not help with that fact. This is why I do not think that I am physically able to participate in a space mission in the role of an astronaut. However working on the mission from Earth, helping to plan and prepare for a mission would be a more suitable and fitting role for me.

The launch and reentry are the most complicated and dangerous part of a space mission. Without proper planning and preparation, the space mission could become potentially fatal and disastrous, like the 2003 Columbia launch in Louisiana. During this launch, a small piece of

insulating foam from the external tank came loose and hit a wing of the orbiter. [8] The extreme heat from the re-entry accompanied with atmospheric gases destroyed the wing causing the whole spacecraft to become dismembered. Unfortunately, none of seven crew members on board survived. I think it could truly have been prevented by ensuring the previous foam shedding they had observed had been fixed. This is another reason why I would rather help astronauts enter space by making improvements to the design of the shuttle to allow astronauts to feel safe and trust the crew on Earth with their lives knowing that a tragedy like that will not happen again.



Untethered U.S. astronaut Bruce McCandless uses a manned maneuvering unit. Photo taken by Robert "Hoot" Gibson

When trying to return to Earth after a space mission, it is the crew on Earth's job to ensure the angle of entrance is correctly calculated to ensure the descent is as comfortable as it can get. The angle is normally  $40^{\circ}$ [11] but in order to land in the correct location many mathematical calculations are involved. If the angle is too shallow then the spacecraft will not enter the atmosphere but instead be deflected off of its surface, too steep and the astronauts could have a ballistic re-entry and face up to 10G which is enough to render the astronauts unconscious.[11] Inside a spacecraft that has entered the atmosphere correctly the astronauts are exposed to a much milder 3Gs, which is enough to just about lose your vision.[11] With the spacecraft reaching speeds of around 8000m/s [11] the force is strong enough to pin the astronaut's body deep into their chairs and causes them to not be able to move at all as if they were temporarily paralysed. Not only do astronauts have to be fit enough to withstand that, they need to be able to land and find their way out of the spacecraft and potentially find their way to the team waiting for them on land if they land away from the calculated landing site. It is for this reason that I would not like to travel in space as the re-entry is notorious for its complexity and the extreme conditions that astronauts have to go through in order to return home.

In order for a space mission to be successful it is not only the astronauts that need to be protected from the conditions in space but also the equipment they use up there. Instruments

and satellites must be designed with the conditions of space in mind to be able to protect the payload that they contain. Payloads are the 'brain' of the satellite, they are the very expensive tools that collect and record the important data from space and send it to receivers based on Earth. They are the most important part of a satellite or instrument which is why their protection is taken very seriously. They need the protection to be as light as it can get so it can be launched without needing too much energy. This allows the cost of fuel needed to propel the satellite into orbit to be cheaper. They also need protection from the sun, when they are not in the shade of the Earth, as space is much hotter than the surface of the Earth. However, electronics, like those in the payload, work more efficiently under cooler conditions. To combat this problem the satellite is shaded by heat-resistant materials like ceramic cloth which allows electronics to function at a more familiar room temperature.

Micrometeorites are also a threat to the condition of the payload.[6] Satellites have a sacrificial layer built in that turn the debris into smaller particles, this causes the damage to the satellite to be minimised. However, it can cause the strength of the layer to deteriorate and leave the payload susceptible to damage from more micrometeorites. Damage can also arise from expansions and compressions in the metal materials in the payload due to the drastic temperature changes and the atoms gaining and losing kinetic energy, the changes in temperature make the materials less durable and strong. These damaged satellites don't tend to be repaired so once a payload is damaged it is no longer useful. However it can not be disposed of the same way we dispose of electronics on Earth. Satellites must have enough stored energy to either propel itself further away in Earth's orbit or to allow it to fall out of orbit and burn up in our atmosphere. They store this energy in the form of batteries and solar panels. Larger instruments used for missions further away from Earth require many more solar panels and batteries, which causes it to increase in mass. These instruments are not only heavier because of this but also because they contain large storage spaces for the data they collect and transmit to Earth. This proves to be very costly, however, the data it collects makes it worth this cost. To me, helping combat problems associated with electrical and mechanical components in space is not only interesting but also very important for the success of the mission, which has made me more firm with my decision to not go to space but instead be a part of the research from Earth. Without the research from the engineers and scientists on Earth, space flight and travel would not be able to take place, so being on the team that makes this possible would be a great opportunity.

Many people think that sending people to space is pointless, but without human space travel we wouldn't have access to much of the information we have on space today. Although I wouldn't personally go to space, I strongly believe that the roles that astronauts perform in space are necessary and important. The role of an astronaut is to be an engineer whilst at the same time being a scientist and a teacher and also a public figure. It is an extraordinary and fulfilling job, however, it is not an easy job. Their days spent on Earth are all spent on preparing for working in space, and their lives in space are spent sticking to an extremely tight schedule to ensure they are fulfilling all of their roles as an astronaut. Whether it is maintaining and repairing the I.S.S. that is constantly damaged from heating and radiation and requires regular equipment updates that the astronauts carry out, doing research or public outreach.



In the few hours the astronauts get to themselves they spend it being a teacher and a public figure. They create videos to educate the public on space, whilst getting to inspire many generations, they even run charity events to raise money for projects on Earth. Whilst doing all of this they help make the public aware of the valuable research they are funding.

With the I.S.S. being one huge lab in the sky it makes sense that the most important role an astronaut has is carrying out experiments. Sending humans into space to do these experiments can prove to be expensive and require a lot of government funding however, contradictory to popular belief, many experiments actually require a human to monitor and regulate the experiments, this is because humans do the tasks that computers and robots can't do. While in space many experiments have been done on topics such as the growth of plants in space, fluid dynamics, combustion and osteoporosis. In order for human life to potentially thrive in space, we would need to be able to grow and produce our own self-sufficient food supply and that is the reason they have experimented with the growth of plants in space. Astronauts have to monitor the growth of the plants and bring samples of the plants back to Earth so that researchers on the ground can investigate how the microgravity has affected the plant's regular growth so they can find ways to grow crops in space.

Humans have to drink in order to survive but in the I.S.S with microgravity fluids such as drinking water are in pouches to allow the astronauts to be able to use the water without it floating around the station.[9] All fluids in space act very differently as the regular actions fluids can do on Earth are changed, the surface tension and capillary forces cause the fluid to not flow and pour like it would under the forces of gravity.[10] Astronauts carry out many experiments to find ways to deal with this, and they have successfully created a container which is able to pour liquid as if microgravity wasn't present. Experiments like these increase the likelihood that humans could possibly live in space. These experiments test how the components of regular human life would work under microgravity.

These experiments are not only interesting but they are essential if we are considering sending humans to live in space. It would be extraordinary to perform these experiments in space and take on the role of an astronaut, many people would look up to you and rely on you for this valuable information. Going into space to perform these experiments would enable you to see everything first hand which sounds amazing. However for reasons I have previously explained I would much rather stay on Earth and interpret the data and experiments the astronauts had done. That way I could still be part of the research without having to go through the rigorous training for space travel.

All the experiments that have taken place in the I.S.S. help provide the research that would be the foundation of the possibility of humans living in space. With this research a mission to Mars is becoming feasible, however, the trip to Mars will be extremely complicated and expensive. If given the opportunity to travel to Mars I would not take it, it has never been attempted so many complications could take place. Voyagers would have to deal with conditions like those in the space shuttle for a much longer period of time compared to travelling to the I.S.S. Another issue would be

with the amount of fuel and storage the spacecraft would have to have in order to be able to sustain the prolonged flight, launching a spacecraft like this would prove to be extremely expensive and funds for the project would have to be raised over a long time from private sources. Not only that but the voyagers would have to be trained just like astronauts to be able to survive the extreme speeds and G Force the aircraft will be exposed to. So for now at least I do not think a journey to Mars will take place until more research on life in space and space travel has been carried out.

After researching the benefits and difficulty of space exploration I have decided that if given the opportunity to go to space I would not. The work astronauts do in space is beyond extraordinary and without it, we would be clueless about space and how life can be sustained in the unique conditions of space. The preparation for being able to go to space to carry out their work is extreme and very physically demanding. The training, in fact, is so physically demanding that I would not be suited to go through it. Moreover, the alterations the body goes through in space would be too extreme for my body to cope with, such as muscle deterioration and spaceflight osteopenia. The rehabilitation programme after the space voyage, that allows the body to adapt to the Earth's G-force once again, doesn't sound appealing to me either. Due to these reasons, I would not be able to go to space, however, I would love to have a hand in the research that scientists and engineers do to be able to send people to space.

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<https://youtu.be/fX8g3wcUY5I> <https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-a-spacesuit-k4.html> [https://www.nasa.gov/audience/forstudents/9-12/features/F\\_Astronauts\\_Work.html](https://www.nasa.gov/audience/forstudents/9-12/features/F_Astronauts_Work.html)

PhD Tutor's note

S. was a joy to work with and her engagement throughout the course was infectious. Her essay is well thought through and she reflects thoroughly on the need for humans to be in space, but also the dangers and challenges connected to this. It is inspirational for all to see that she would like to be a part of solving some of these challenges.

What we Know About How Plant Shapes Form

Year 12, Key Stage 5

R. Dempsey, Thurston Community Collge, Thurston  
Supervised by C. Mansfield, University of East Anglia

Introduction

Various factors are involved in the formation of the diverse shapes of plants from the basic primordia. These determine growth direction and growth rates at both the tissue and cellular levels. Plant diversity is a term used to describe all of the variation that exists in the plant world. These variations include differences in size, shape, colour, lifestyle, chemical composition and physiological processes. The different adaptations of plants are not only essential for their own survival (for example, in pollination or nutrition acquisition), but also the survival of all other life on the planet which are reliant on them. Plants also maintain the balance of gases by using up excess carbon dioxide in photosynthesis and releasing oxygen. All of these uses for plants cannot be achieved through a complete lack of diversity by only one species of plant existing. For example, a cotton plant cannot be used for construction but has other uses in clothing. The shapes appear different once the plant is more developed but are very unapparent while the plant's meristems are just beginning to differentiate. The shapes of plants develop at the level of both cells and tissues. Tissues show areas of promotion and inhibition and display either isotropic or anisotropic growth; these characteristics may be directly influenced by polarity. Growth at the cellular level is primarily dictated by microtubules; however, expansins, polarised proteins, other proteins and gene expression may also play an important role by creating differential growth rates. The growth at this microscopic level proves crucial for the shape of the overall plant and so is essential for the creation of plant diversity. Throughout this essay, the factors determining growth at the tissue and cellular level will be discussed, along with the techniques used to study them, such as computer modelling and microscopy.

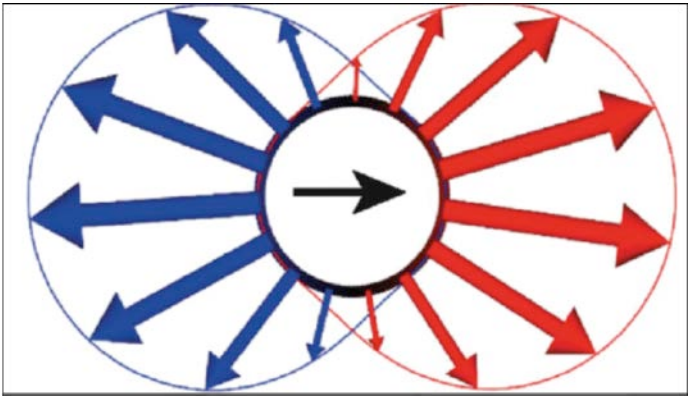


Figure 1 The polarity of a cell resulting from the mutual inhibition of neighbouring molecules with opposite polarities [3].

Tissue Growth

The most noticeable differences in plant shape are at the tissue level, particularly in areas such as the stem, leaves and petals. These diverse shapes are determined by differences in growth rates and growth directions.

The growth of tissues may be isotropic or anisotropic; isotropic meaning that growth is invariant with respect to direction, whereas anisotropic is variant growth in different directions [1]. One explanation of differential growth directions is the theory of plant tissue and cellular polarity. Polarity is the asymmetric distribution of cellular components along an axis in a cell, or the distribution of whole cells in a tissue, leading to the particular patterning of plant tissues and the plant's overall shape [2]. There are many different models of how cells may orientate themselves individually and co-operatively with other nearby cells. One model assumes that neighbouring cells can compare concentrations of auxin, determining how they align themselves [3]. Other models suggest that polarity is established via different interactions of molecules at the surface of the cells [3]. Most models depend on asymmetric cues and neighbouring cells that are also polarisable; however, one model proposes a framework without these factors [3]. This model suggests that inactive forms of molecular complexes inside cells and active forms of these molecules attached to the cell membrane all interact with one another [3]. The active components promote the activation of similar inactive components in the cell and inhibit the oppositely polar active molecules [3]. The model suggests that there are tissue organisers that influence whether the cells point away from or towards these organisers which are placed at various points in the tissue [3], thus aligning the cells along a particular axis. This model ignores the effect of different intracellular concentrations of substances such as auxin, and deems environmental factors irrelevant in the formation of plant tissue development and its effect on polarity, when it is known that plants are able to develop differently as a result of the environment, even when they are nearly fully developed [4].

Differential growth rates in tissues are equally important in the formation of plant shape. Gene expression in tissues can be mapped to identify genes that coordinate expression of proteins in localised areas [5], leading to differential growth rates in certain parts of the tissues.

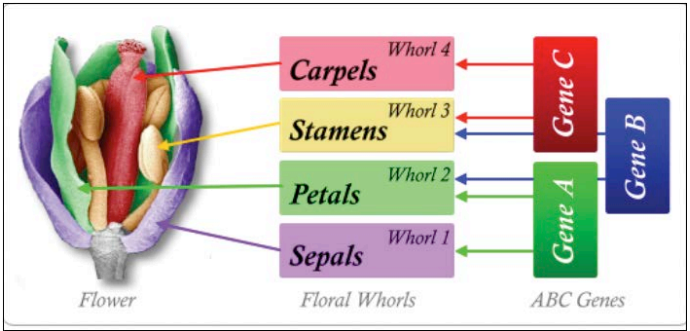


Figure 2 The four whorls are determined by the controlled combination of the ABC genes [8].

*Arabidopsis thaliana* is a model organism for studying plant biology for a variety of reasons: its genome is nearly fully sequenced, the life cycle is short and it is easily cultivated in restricted space [6]. I will discuss the formation of the *Arabidopsis thaliana* flower and its individual petals. An external stimulus will trigger the differentiation of the meristem into a flower which will lead to mitotic division [7]. Then the different floral organs are grown via the interaction of ABC genes. The ABC model suggests that three different classes of genes are required to form the different parts of the flower, while some also co-operate to form other parts [7].



I suggest that the polarity field in the petal runs along the proximodistal axis, diverging at the base and converging more at the tip. This asymmetric polarity leads to anisotropic growth of the petal, along with differential growth rates. There is a very low growth rate at the base of the petal and perhaps complete inhibition between petals, whereas there is a higher growth rate in the middle of the petal that spreads out towards the edges. The growth rate sharply decreases when reaching the tip of the petal but it is not completely inhibited.

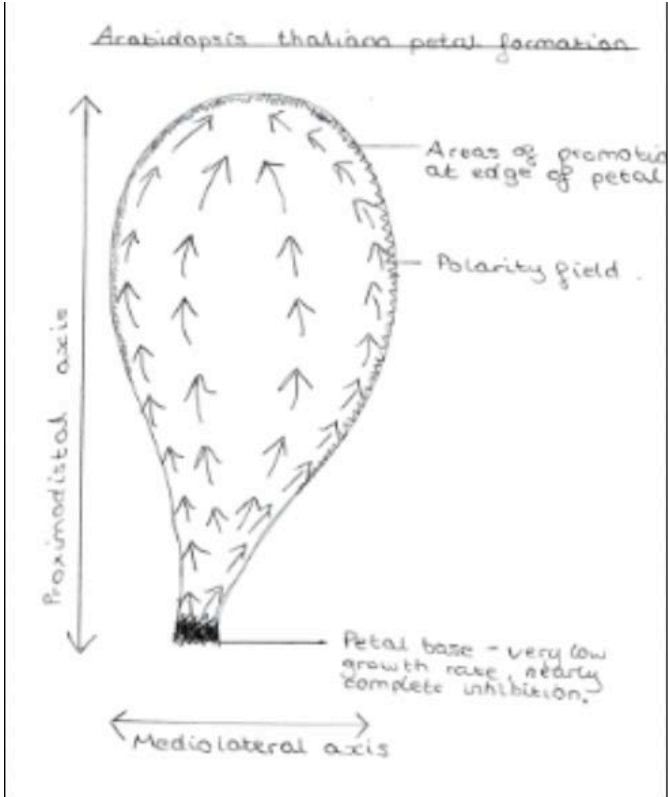


Figure 3 Diagram of the formation of the Arabidopsis thaliana petal.

There are many suggested explanations as to how individual cells align themselves to form the correct overall orientation in a tissue; however, there may also be another purpose to collective alignment of tissues that need to grow: the arrangement of polarised proteins. PIN1 is an auxin efflux carrier, meaning that it transports auxin out of cells by actively transporting it through the lipid bilayer of the plasma membrane [9]. Since auxin is essential for both cell elongation and division, PIN1 has a central role in regulating the shape formation of plants [9]. The PIN family are polarised proteins that have the most supporting evidence, as PIN1 is exclusively found on one side of the cells, for example in the early stages of development in the lateral root primordial [10]. Since the auxin is transported through one side of the cell membrane by PIN1, growth will be parallel to the polarity field, leading to anisotropic growth if all cells are arranged similarly. Polarised proteins are essential to the directed growth of the primordia and of the apical meristems to form the complex, anisotropic shapes of the plant.

The controlled expansion and division of the cells is determined by microtubules. Microtubules are long thin structures composed of many subunits of the protein tubulin [12]. Microtubules consist of protofilaments which have two forms and are arranged longitudinally [12]. The

two forms have differing sequences of amino acids and are called  $\alpha$ -tubulin and  $\beta$ -tubulin [12]. These bind to form an  $\alpha\beta$ -tubulin heterodimer which acts as the subunit for the microtubules [13]. The direction of cell expansion is not only determined by the localisation of polarised proteins, but also the arrangement of cortical microtubules. The rigid cellulose cell wall resists the expansion of the cell, and so the way the cellulose microfibrils are arranged decides the direction of cell expansion [14]. The cortical microtubules are attached to the cytoplasmic surface of the plasma membrane and channel the enzyme complexes as they produce cellulose microfibrils [14], therefore the microtubules determine the density and arrangement of the cellulose in different areas of the cell. The microtubules are perpendicular to the direction of cell elongation and cellulose microfibrils are placed parallel to the microtubules [16], leading to an apparent constraint of growth where microtubules are most dense. The differential growth rates of individual cells allow the formation of a collective tissue in a particular shape, leading to the diverse shapes of plants. Microtubules have an important role in this.

Microtubules are not just essential for cell expansion, but also cell division. The direction of cell division is determined by the preprophase band at the beginning of mitosis [14]. This band is primarily made of microtubules [14] and so they are needed for the initial division of the cell. A phragmoplast forms during cytokinesis which is a template for the assembly of the cell wall in the plane of division and is made of microtubules [17], and so microtubules are needed not only for controlled cell expansion but also for various aspects of cell division.

Plant cells also contain expansins to further control the expansion of cells via the loosening of the cell walls. Expansins are proteins in the cell wall that induce expansion of the cells; however, the exact mechanism of how they do this is uncertain [18]. It is clear that a key characteristic of expansin action is the increased stress relaxation in the cell wall which continues with the presence of expansins [18]. One theory is that expansins weaken the non-covalent forces between glucans (such as cellulose) which is supported by some evidence but has not been proven [18]. There are two types of expansins:  $\alpha$ -expansins and  $\beta$ -expansins [18]. One hypothesis suggests that grass pollen allergens are distant expansins and have expansin activity [19]. To test this, Zea m1 was extracted from maize pollen and its activity was tested in plant cell walls [19]. It was found that not only did the Zea m1 act in the same way as expansins, but it was also selective in the substrates that it affected: there was far more prominent activity in grass cell walls than dicotyledonous walls [19]. There is very little research into this area and similarities between grass pollen allergens and expansins does not necessarily mean that they are related. Therefore, these results may not be very valid, as the association between grass pollen allergens and expansins should not automatically lead to conclusions about expansin specificity, particularly when there is so little other supporting evidence.

As well as furthering cell expansion and overall tissue growth, expansins may have other roles, such as in pollination. It has been suggested that they break hydrogen bonds between the cellulose in reproductive organs, loosening and softening the stigma and thereby facilitating pollination [20]. Mollet *et al.* (2013) have found several expansin genes expressed in dry pollen grains, during pollen growth and in Arabidopsis stigma [20]. Therefore, I believe that expansins do have a significant role in plant cell growth and so the overall formation of plant

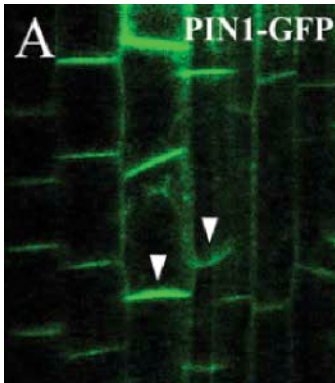


Figure 4 GFP-tagged (Green Fluorescent Protein) PIN1 in the stele of wild-type roots, with the arrows marking the polarity of the PIN1 localisation [11].

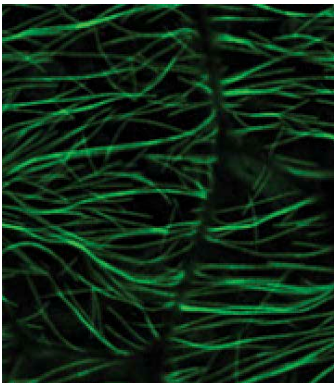


Figure 5 A micrograph showing microtubules in a helical arrangement in the cell wall of Arabidopsis cell walls [15]. They are arranged transversely across the cell which will lead to longitudinal growth.

shapes, but also have further roles. However, little research has been done in this area, and with further study, the full significance of expansins could be realised.

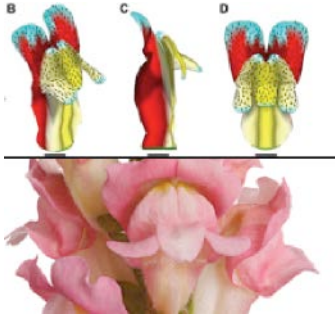


Figure 6 Computer model of the fully formed snapdragon flower on GFTbox (top) [22]. Snapdragon flower (bottom).

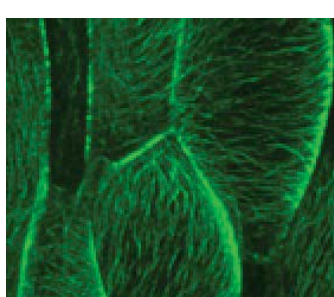


Figure 7 GFP-tagged microtubules in Arabidopsis cells [26].

Scientific Techniques

Biologists aim to predict the growth and formation of plant shapes and tissues by taking into account all known factors that will affect such growth, however, this is very difficult and time consuming and so computer models are used. A computer model is a computer program that simulates a real-life system [21], in this case, the formation of plant tissue shapes. An example of a program used to simulate growth is GFTbox (Growth Factor toolbox) [22], in which the user must input the direction and rate of tissue growth. There are many advantages to computer modelling: it saves a lot of time; it can easily display 3D concepts; it tests predictions and allows the researcher to focus experiments when predictions are incorrect; and it can test many parameters at a time to show the effect of many factors co-operating, such as polarity fields and promotion/inhibition. However, there are disadvantages: the model is made by researchers but if the theory is incorrect and not supported by enough valid data then all predictions could be wrong; advanced technology and knowledge is needed; and biological variations and mutations are difficult to predict. Overall, computer modelling should be used as it is a valuable tool in research by saving time and easily testing many parameters, however the predictions should not be assumed to be correct when they are based on theories.

Various types of microscopy are useful in studying plant development, particularly at the cellular level, with electron microscopes having much higher resolutions and magnifications than optical microscopes [23]. There are

many advantages of using microscopes in plant research, such as: multiple sizes and levels of cells can be observed; time-lapse imaging can show changes and development over time; and changes in levels of gene expression can be seen. On the other hand, incorrect inferences may be made about cellular influence of plant shape formation when simply observing the cells. Also, it is very expensive and fixing cells often damages or kills them, particularly in electron microscopy [23]. Although microscopy may not be completely objective, as human inference is involved, I think that microscopy is extremely useful in all research as well as plant development, due to its ability to study the cellular level and identify individual substances and genes.

A particularly useful type of microscopy is fluorescence microscopy. This is an advancement of ordinary optical microscopes in that light of a certain wavelength illuminates the cells and specific chemicals absorb and re-emit the light at a different wavelength [24]. The re-emitted light is then separated from the much weaker reflected light by using a spectral emission filter so only the desired coloured chemical(s) can be seen at the same time [24]. However, fluorescence microscopy seriously limits the time that a sample can be observed, as the chemicals accumulate damage from excited electrons in a process called photobleaching [24].

A recent development in fluorescence microscopy is the use of green fluorescent protein (GFP). It absorbs energy from light at a wavelength of 400nm (violet) and re-emits light as a green colour [25]. Since the gene for GFP has been isolated, cells can be genetically modified so that the protein is made with GFP already bound to it [25]. However, not all organisms can have GFP genetically transferred to them; only those that have nearly all their genome sequenced can have this done to them which limits GFP's use.

Genetic modification (GM) is a controversial topic. GM is the transfer of selected genes from one organism to another. It has benefits in research, such as in the use of GFP and how that is applied to both plant and animal research. It may also be able to influence the shapes of plants and their formation; for example, the alteration of ABC genes may lead to complete changes in the formation of the reproductive organs of plants, or the alteration of the extent and location that polarised proteins are expressed may influence the direction of plant tissue growth. GM crops produce a much higher yield and can be made insecticide resistant, vastly improving the lives of those in poor climates and much needed for the world's growing population. However, some people are concerned about the long-term health impacts, with a vast amount of studies into this area being funded by those who own genetically modified crops who have vested interests. Also, there is concern that they could contaminate non-GM crops and can cause superweeds that are resistant to herbicides. In my opinion, GM is needed, particularly in research. The potential risks are worth taking as they are outweighed by the benefits of vastly improving the world's nutrition crisis. There needs to be more objective research into the long-term health effects of GM crops and more control of GM crops should be handed over to the public sector to prevent business interfering with human and plant welfare.

Conclusion

A variety of factors affect the growth and formation of plant shapes that are so diverse and important to our survival and theirs. Individual cell polarity and polarised proteins co-operate to form collective tissues; however,



more research is needed into how exactly cells collectively align themselves. Differential growth directions work simultaneously, with differential growth rates caused by areas of promotion and inhibition determined by gene expression and the localisation of proteins, much like the polarised proteins. Microtubules and expansins are also essential for controlling cell growth rates by determining the density and rigidity of the cell wall, with microtubules being needed for both cell expansion and division. The studying of proteins such as microtubules is made more effective by the use of fluorescence microscopy and GFP. The general use of microscopy and computer modelling is fundamental to make the study of plant development easier and more effective, either by making predictions at a tissue level by testing many parameters, or by examining individual cells and their components. The complex process of plant shape formation is due to many factors that need more research, particularly expansins and polarised proteins, as a complete understanding of this process has the potential to impact our lives significantly through genetic modification.

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#### PhD Tutor's note

I thoroughly enjoyed working with Ryan through The Scholars Programme. His final assignment was an outstanding achievement, discussing complex biological concepts in relation to plant development, and would score very highly at undergraduate level. His curiosity and passion for learning were evident throughout the course, and particularly in the extra reading and research included in his essay. These skills and achievements will be invaluable for Ryan in furthering his scientific knowledge at university.

# Arts and Humanities

## To what extent does Harry Potter and the Philosopher's Stone use Cinematography, Editing and Mise-en-scene to Manipulate the Responses of the Viewer?

Year 9, Key Stage 3

C. Pallant, Fulwood Academy, Fulwood  
Supervised by E. Nichols, Lancaster University

To what extent does the Hollywood blockbuster of your choice use cinematography, editing and *mise-en-scene* to manipulate the responses of the viewer?

This essay will examine Harry Potter and the Philosopher's Stone – the first film of the franchise. All films use cinematography, the four aspects of *mise-en-scene* – “setting, lighting, costume and staging” and editing to make the viewer empathise or sympathise with Harry and therefore, create an emotional bond with Harry and other characters. The story line of this film is very magical and the viewer will not necessarily be able to relate to this. However, aspects like cinematography ground the characters in reality. Rowling achieves a connection between the characters and the viewers by “...*incorporating aspects that people are going to be able to identify with*” (Vin Diesel). These aspects are shown through effective cinematography, editing and *mise-en-scene*. Phillips adds to this by saying cinematography “*uses everything the camera does to guide our expectations in a thousand subtle ways.*” I believe these “*subtle ways*”<sup>v</sup> to be a major reason for many relationships between viewer and character in this film, so I will be arguing that cinematography, *mise-en-scene* and editing help the viewer empathise with the characters through manipulation of those factors.

The film starts with our first meeting with Harry. A high shot looking down on baby Harry is used to make him look helpless and weak. This contrasts with later in the film, when he has done something amazing that appeared impossible. The camera zooms into an extreme close up of Harry's scar which edits to a flash of white light and the title screen. The cinematography and the *mise-en-scene* work together to show Harry as very newly born because he is wrapped unclothed in a shawl with the camera looking down on him. During this Dumbledore and McGonagall are wearing costumes that are linked to the stereotypes of wizards. We also get our first showing of magic with McGonagall's shadow morphing from cat to human in off screen space. Not showing us magic directly at first creates suspense which is built further by the flash of white light. This glow spreads from Harry's scar; foreshadowing the rest of the film. The film editor David Mitchell says that he does not like flashbacks or foreshadowing because he believes them to be out of date. However I believe foreshadowing promotes the relationship between viewer and character even if the flash of magic takes Harry away from reality before bringing him back to it.

The idea of magic is interesting to the viewer – they very likely wish to be Harry, so they find shared interests in the characters to make themselves feel more magical. I believe this opening to be a major part in the audience empathising with the characters – especially Harry because what is a better way to empathise with someone than if you see yourself in them?

After the title sequence time has passed – Harry is now 11 years old and living with the Dursleys. The Dursley family is a very important part of Harry's development as a character. In a scene with Mr Dursley on Dudley Dursley's birthday, Dudley pushes Harry over to get him out of the way. We look down on him as he falls so the audience can see how helpless he is in that moment. We pity him. However, although this is the same technique used as when we first saw Harry as a baby there is a major difference – the camera then pans down so we are on Harry's level again. This shows resilience. The camera is showing us that despite the *mise-en-scene*, with Harry wearing an oversized T-shirt (we assume to be previously owned by Dudley) he has self-respect and over the years of living with the Dursleys he has become stronger. The audience seeing the world through his eye level also makes it easier for the viewer to relate to him. When Harry gets up the camera angles show the power imbalance between Harry and Mr Dursley as he gets told off for smiling at his cousin's misfortune. A reverse shot is used to show Harry's smile vanish as he gets up. Mr Dursley and Dudley believe themselves to have a higher status than Harry. The relationship we witness through the camera shots changes how we see the Dursleys. As the audience has already sided themselves with Harry, Mr Dursley is reinforced as a villain and, with Harry as the protagonist, it means that so far in the film good and evil have been presented in a very black and white way.

After the incident with the snake at the zoo Harry is yelled at by Mr Dursley before being shoved under the stairs for mentioning magic. Mr Dursley opens the shutter to say “*magic doesn't exist*” and the bars on the shutter create shadows on Harry's face. The low-key lighting and close up camera shot creates “*both a sense of place and a mood and ... also reflect [s] a character's emotional state of mind*”. We feel how trapped Harry feels with the Dursleys. After his statement Mr Dursley slams the shutter putting both the audience and Harry into darkness.

This scene could symbolise different things such as Harry losing hope or the Dursley's keeping him in the dark about his parents. Portraying the symbolism through the use of low key lighting makes it more personal to the viewer because it is open to the viewer's interpretation and enables them to create a meaning they can relate to. This effect also enables the audience to experience the darkness with Harry and fuels the mutual hate the audience and Harry have for Mr Dursley. This creates a stronger bond between Harry and the viewer.

The smooth panning shots show the owls' grace and beauty and provide a break from the fast cutting of the previous scene and the shaking camera movement in the next. This scene's differentiation in style also demonstrates the change that has just happened; turning the mood from hopeless to magical. Jerky cinematography and camera movement are also used to show the chaos and volume of letters arriving in the next part of the scene. The inclusion of an extreme close-up within the sequence shows that Harry feels differently from his family, reinforcing for the viewer

that Harry does not fit in. This is added to by the dozens of owls surrounding the Dursley's house and contrasting to the neighbourhood around it. This is a visual representation of Harry's uniqueness- the house being a metaphor for him (with the other uniform houses being muggles). These differences are finally making what happened when Harry was a baby seem plausible and being a form of revenge for Harry. We later find out the culprit of this *mise-en-scene* change to be Dumbledore who becomes a main role model for Harry. Their relationship has already been hinted at with us knowing that they have the same sense of humour (with the owls). The similarities that Harry and Dumbledore share are normal at Hogwarts and become the reason many viewers relate to Harry- they want to fit in.

Even with this letter tornado Harry still is not able to read the letter which means Hagrid has to deliver it himself. He is presented as being the father figure Mr Dursley never was, as he brings cake, remembering Harry's birthday. The cake's message is misspelt and is squashed, but both Harry and the audience can only think of the effort Hagrid put in – which immediately makes him seem to be a caring, good character. Hagrid and Harry are very similar in *mise-en-scene* as both are wearing worn dirty clothes in a way that makes them stand out. Hagrid will have been the first character to put Harry before Dudley as we know from the contrast of Dudley getting thirty-eight presents and Harry writing a happy birthday message to himself in the dirt. This newly introduced love Hagrid has for Harry (which the audience already know about from Hagrid's tears at the start of the film) is a key part of development for Harry.

The trust portrayed by Harry towards Hagrid and the balance in status Hagrid shows back, leads the audience to extend all their positive feelings about Harry onto Hagrid. As a result, the viewers are pleased and not surprised when Hagrid – a member of staff – breaks the rules to tell Harry and his friends about the Philosopher's Stone. The set, costumes, lighting and cinematography for London and Diagon Alley make the distinction between magic and non-magic very clear and Harry and Hagrid immediately fit in as they enter the magic world of Diagon Alley. As Harry walks into Diagon Alley we see a close up of the wonder on Harry's face which then becomes an eye line match. As an audience we feel wonder at where he is; further strengthening the bond between both the audience and Harry and the bond between Harry and Hagrid. As Harry starts walking the camera does not move – giving us an extra few seconds to look at the surroundings. The camera stays on Harry's level for most of this scene. This is important because it means we see the world from his perspective (as a child looking up at everything) – making it feel more important. Even when the camera changes angle for Hagrid to talk to Harry, Harry still is not looked down upon which suggests to me that all previous power imbalance shots are due Harry believing the power imbalance rather than the other person. This adds an extra level of connection between the audience and Harry. This is the first time in the film Harry has been on the same level as an adult. Although it could be argued that this is due to him being distracted, I believe it is a reflection of Hagrid and Harry's new relationship as equals. Hagrid has achieved in a very short space of time what the Dursleys could not. This contrast is very much needed to quickly build Harry and Hagrid's relationship.



Hagrid takes Harry to Gringott's to get money and as soon as Harry enters the mindset of power imbalance returns. This shows Harry's fear of being there – something which the audience can relate to. The *mise-en-scene* of the goblins sitting on high stools and low camera angles makes them look more intimidating. As the Goblins would have chosen the furniture themselves it says a lot about their defensive personality – “*Goblins are not the most friendly of creatures*” (Hagrid). This use of camera angles compensates for their small stature. This is the first time that Harry has been looked down on in Diagon Alley but instead of it being specific to him it is fear to an authority figure – this is a difference in how he perceives power. The lighting and colour of the bank also support Hagrid's comment about goblins as the colour scheme is dark.

A very important part of Harry's fear is when he speaks to a goblin to withdraw money. The goblin peers right over the high table and looks down at Harry at an extreme angle. This is unrealistic and makes me believe that Harry's mind is making this scene more dramatic because of fear. As a viewer we see what Harry sees and this factor makes me believe the lighting, colour and furniture used are not accurate of how they would look but are instead accurate of how Harry perceives them. A fact that supports this is that for the whole bank scene Hagrid is confident and the lighting does not darken when Hagrid talks to the goblins whereas with Harry the lighting is used to change the mood. Hagrid leads Harry through the bank without leaving his side adding more belief that Hagrid is becoming a father figure to Harry.

The positive and negative relationships Harry forms throughout the film are a central part of the plot. The cinematic techniques used create the relationship that the viewer builds with Harry and enable the audience to feel part of the story. The shared experiences that the viewer makes in their mind, give them and Harry a unique friendship. Ultimately it is the skill in the editing, cinematography and *mise-en-scene* that enables the viewer's response to be manipulated into creating an emotional bond with Harry and other characters. This skilled use of cinematic techniques to create bonds between the audience and characters is the best magic of all.

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## Consequentialism and Deontology: Do the ends justify the means in the case of euthanasia?

Year 7, Key Stage 3

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Euthanasia is a term that is often defined in many different ways, as there are many categories of it. Euthanasia is the act of painless killing of a patient, who is suffering from a terminal illness or is in a permanent coma. In order to find out whether it is morally right, it is usually divided into three sections: voluntary euthanasia, non-voluntary euthanasia and involuntary euthanasia. These three types of euthanasia differ greatly, so I will explain each one carefully. This essay will also explain the potential views of different people and whether they think that euthanasia is right or wrong. I will also include my personal opinion- I will argue for the consequentialist view. These three types of euthanasia differ greatly, so I will explain each one carefully. First of all, voluntary euthanasia is when the patient requests it - this means that the euthanasia is performed entirely because of their own wishes. Non-voluntary euthanasia is when the patient is unable to specify whether they want to be killed or not, but it is believed that they would want it if they were able to indicate their wishes; non-voluntary euthanasia would normally be performed if a person was in an irreversible coma. Finally, involuntary euthanasia is when the patient wants to continue living and they are killed anyway - this means they are killed against their will.

Secondly, whether you support consequentialism, deontology or utilitarianism reflects in your overall view. Consequentialism is when someone looks at the outcome of the action/actions, hence the name “consequentialism”. This means that they would base their opinion on the consequences of the action, not the action itself. Deontology is when someone looks at the action itself. This means that they just look at the action, regardless of how beneficial the consequences are. Utilitarianism is when someone looks at how much happiness the action causes, without the consideration of how it is actually caused.

Furthermore, we can use this information to determine if the ends justify the means. For example, there could be a young woman (surrounded with many friends and a loving family) who has terminal cancer. She only has a few days to live and she is in tremendous pain; because of this, she has requested to undergo voluntary euthanasia. By undergoing it, she is going to end her immense pain and take control of her life. On the other hand, by doing this, she will devastate her family members and cause her close friends to mourn her death for a long time. Depending on your perspective (such as deontology, consequentialism and utilitarianism), you will decide whether it is right or wrong. I will discuss these, as well as my own opinion on matters such as non-voluntary euthanasia.

Firstly, a consequentialist might say euthanasia can be justified if it has a valid reason. For example, if someone was in agony and was going to die soon regardless, then

it would be justified. This is because keeping them alive is against their will, and by forcing them to go through that pain is inhumane. If that person was able to end their suffering swiftly and take control of their illness, then they should be provided with the means to die. Also, if they want to die (or people believe that it is the only way to end their pain), then they should be allowed to undergo euthanasia. They might say that non-voluntary euthanasia can be justified if their family truly believes that it would be best for them, and there was no other way to cure them or wake them up from a coma. They might say also that involuntary euthanasia is wrong, because they are killed when they want to continue living. Involuntary euthanasia results in unhappiness for the victim and their family, as they were killed against their will and didn't have any illness.

On the other hand, a deontologist - no matter which form of euthanasia - might say that the action of ending a life is wrong. They might say that euthanasia is killing someone and no matter the reasoning, it is not justified. They might also point out that life is extremely precious, and they should enjoy the rest of it for as long as they can. They could also say that euthanasia causes devastation to the people around them, and they should let themselves die naturally. They may suggest that euthanasia devastates the patient's family, and may cause arguments amongst the victim's family. The family of the patient may blame themselves for the patient killing themselves earlier than their actual death, causing upset in the family. Also, any person in the world would be free to undergo euthanasia and that could be dangerous. If there was a mistake in the hospital and someone believed they could die, they could easily commit suicide - even though they are actually healthy. Allowing euthanasia could cause people to make regrettable decisions and feel as though they have nothing to live for, therefore killing themselves for no reason.

Thirdly, a utilitarian might say that euthanasia can be justified, but only if it results in the largest amount of happiness possible. They might say that euthanasia can make the suffering person happy, as it ends their pain swiftly and allows them to take control of their illness- this results in a large amount of happiness from the patient. In contrast, euthanasia can cause a lot of grief and distress from the patient's relatives, therefore their death did not make the surrounding people happy. They may also argue that euthanasia impacts the people around the patient in a negative way, even though the patient is glad that they are finally at peace. They may point out that, in many cases of euthanasia, there is more pain caused than pleasure, which affects the overall happiness level. But euthanasia can be right, because the family and friends can appreciate that it was an important decision and that they were in too much pain to continue living happily. If they truly loved their deceased relative, they would respect their choices and understand that they were going to die without the euthanasia even if they hadn't undergone it.

In addition, I believe that euthanasia can be justified if the person has consented to it (or if their family believes that it is right for them) and that they undergo euthanasia as a last resort because of their pain. A suffering person deserves the right to die - it is their own body and they should be able to do what they want with it. I think that it is wrong to prevent someone from having euthanasia, as they'd have to be desperate to want to commit suicide in the first place and

it is against their will to keep them alive. I think it can only be justified if the patient is suffering from a terminal illness, is in a lot of pain because of a condition, or is in an irreversible coma. On the other hand, I think that euthanasia cannot be justified if the patient is not in any pain and just doesn't want to live anymore- life is too precious to be thrown away in a heartbeat. If the person has a terrible life, they should not be given euthanasia; after all, they can change their lives around and treasure the fact that they are living. If a person was killed without a valid reason, then their whole life would have been wasted - they could've done something with their life, for example becoming a doctor and saving lives, or curing a disease.

In conclusion, euthanasia can be viewed differently depending on a person's beliefs. Consequentialists, deontologists and utilitarians may or may not believe that euthanasia can be justified. Personally, I am a consequentialist and I argue that we can only justify euthanasia if it benefits the patient and the people around them. I believe that if euthanasia can have a good outcome, it should be allowed, even if the action itself is seemingly wrong. On the contrary, most deontologists think that the action of killing someone is wrong, therefore it doesn't matter what the consequences are - their religion (such as Christianity) may also influence their overall view. Finally, utilitarians seek the largest amount of happiness possible, regardless of what form of euthanasia it is - if it makes everyone happier, then it can be justified. So, to sum it all up, euthanasia can never be defined as right or wrong: it depends on the situation and the beliefs of the person reviewing it. Euthanasia is a difficult topic, and it will continue to be argued over by different people for many years to come.

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### Programme Officer's Comment

The subject of euthanasia is a difficult one to approach academically, given how emotive it can be. This author makes a calm and considered argument, based on complex philosophical principles. They show clear understanding of both the concepts employed, but also of the complexity of the issue at hand, and handle it extremely sensitively and maturely. They use the philosophical vocabulary clearly and with ease, positioning themselves as an expert on the topic. This means that their conclusion, where they introduce their own opinions on the topic, is compelling – they have considered all the different approaches and come to a sound conclusion. Thank you for such an interesting piece.  
– Dr N. Day, Area Director, North of England, The Brilliant Club



# Can you identify and explain, using case studies, the various factors that influenced the ‘fictions, fakes and mistakes’ in the eighteenth-century historiography of Roman Britain?

Year 9, Key Stage 3

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Supervised by A. Montgomery, Birbeck College, University of London

In the eighteenth century, many wealthy scholars spent their time studying ancient history – and many were particularly interested in the history of Roman Britain. These people were known as *antiquarians*, and they studied and recorded history from Roman Britain – this was the period in which Britain was part of the Roman Empire (from AD43 to AD410).

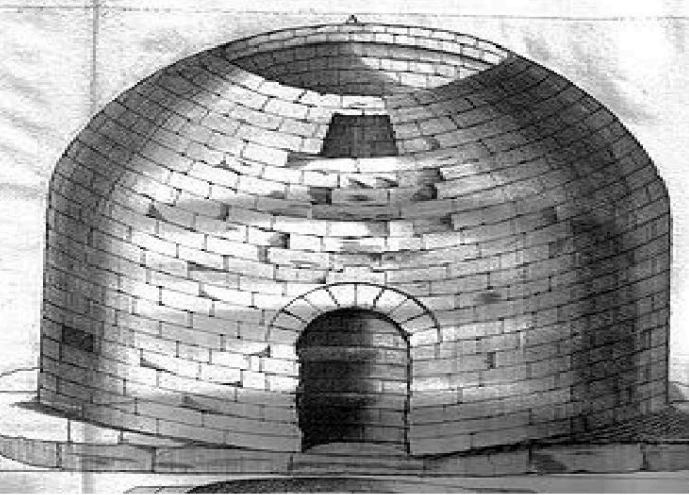
However, due to various influencing factors, the history of the ancient Roman involvement in Britain as documented by eighteenth-century antiquarians was often inaccurate, incomplete, or even completely fictitious – these were the “fictions, fakes, and mistakes” in the recording of this history. Sometimes these inaccuracies were down to unavoidable human error – sources in the eighteenth century were often very difficult to understand, and there were plenty of misunderstandings and mistakes. Other inaccuracies were less innocent. Many of the antiquarians had very strong opinions about the history they studied, and these views could influence their interpretations of evidence or lead them to manipulate sources – painting a picture of history that would support their own pet theories. There was forged evidence as well – some as a result of this same influencing bias, and some created simply from a yearning for wealth and reputation.

In this essay I will be exploring these factors, which I believe most influenced the “fictions, fakes and mistakes” in the eighteenth-century antiquarian’s recording of the history of Roman Britain: patriotism, an admiration of the Romans, and the many unreliable sources.

Personal bias is an issue for any sort of recording of history, but it seemed particularly disruptive to the documentation of Roman Britain’s history in the eighteenth century. Between the antiquarians of the eighteenth century, there were two conflicting opinions that could influence the way they interpreted and recorded history. At the time, most of the antiquarians interested in Roman Britain had a great admiration for ancient Roman civilisation and envied their culture, empire and architecture. It was a custom for young, wealthy scholars studying the era to go on a ‘Grand Tour’ of the old Roman empire during their studies – this involved visits to famous Roman sites and monuments around Europe, and the antiquarians often brought back valuable souvenirs – artefacts, or examples of Roman art and design. When the Romans conquered Britain, the antiquarians imagined that they brought civilisation to a land of primitive

“savages” – one eighteenth century antiquarian described the invasion as “the auspicious era of our happiness, when the bright rays of polite arts flew over on the wing of Roman eagles”(William Stukeley, in an unpublished book about Julius Caesar, 1726, p.33). These antiquarians wanted to celebrate that Britain had once been a part of the Roman Empire which they so admired, and went to great lengths to do so, often making the histories they recorded inaccurate.

In the eighteenth century, a small, round Roman temple known as Arthur’s Oven was one of the best-preserved Roman structures in Britain, but some antiquarians were disappointed that it was not as grand as the ancient Roman architecture that they envied – Sir John Penicuik wrote in a letter to a friend, Roger Gale: “Nobody doubts of it being Roman, though a very plain piece of work”. Others, such as William Stukeley, (notably an author of many books admiring the Romans), even attempted to describe the small temple as a British equivalent of a Roman temple that was admired in the eighteenth century: “I imagine the reader is prepossessed into my own opinion that it may well pass for an imitation of the Pantheon or Rotunda at Rome” (*Account of a Roman Temple*, 1720, p.15).



Top: Arthur’s Oven, Britain. Bottom: the Pantheon, a famous temple in Rome

However, not everyone was as convinced. Some were more doubtful of the significance of Arthur’s Oven. One nineteenth century antiquarian, Robert Stuart, said of the fascination with the temple in his book *Caledonia Romana* (1845, p.184) “It was examined, measured, and re-measured, again and again, even to the minutest detail, with a care and devotion, many would say, somewhat to excess”.

Comparing the two temples, it can be seen that Arthur’s Oven is not particularly similar to the Roman Pantheon, and it becomes quite clear that these antiquarian’s admiration and high expectations of the Romans affected the way they tried to present this source.

Another influential example of the antiquarian’s admiration for the Romans affecting their studies were the forged manuscripts of the *De Situ Britannia* (*The Description of Britain*). In the 1740s, antiquarian Charles Bertram produced a text with accompanying maps, detailing the locations of ‘lost’ cities and towns in Roman Britain – supposedly written by a fourteenth-century English monk. Although by the late nineteenth century it had been completely discredited and said to be “plainly a clumsy forgery” by the head librarian of Windsor Library, it is easy to see why antiquarians were happy to believe it for so long. It gave new, extensive information about the Romans in Britain, and even showed that more of Britain had been conquered than previously known: a wonderful find for any antiquarian who admired the Romans. The text was very influential, and Bertram became famous – whether he created the forgery wishing to further boost the admiration for the Romans, or with a desire for riches and reputation in mind, he certainly understood what was influential and popular amongst the antiquarians of the time.

Clearly, there was also some patriotism here on the part of the antiquarians that tampered with sources – they admired Rome, but soon wanted to find great Roman things in England and Scotland too: their own countries. Rosemary Sweet notes on this in her 2004 book *Antiquaries: The Discovery of the Past in Eighteenth-century Britain* (p.156): “As pride in British domestic and imperial achievements grew over the course of the century, the inherent tension between celebrating Roman dominion over Britain and establishing a genealogy of British liberty, independence and civilisation deepened”. Patriotic antiquarians often had great pride in their own country and disagreed with the idea that the Ancient Britons had been uncivilised barbarians. Alexander Gordon speaks of “the bravery of our heroic ancestors (The ancient Britons) against those whom Tacitus calls *Raptores Orbis*, The *Plunderers of the World* (The invading Romans)” and “The noblest and most successful resistance of any to the violence of the usurping Romans” (*Additions and Corrections by Way of Supplement to the Itinerarium Septentrionale*, 1732, p.i-ii). Although this patriotic belief was at times in conflict with many other antiquarian’s deep admiration for the Romans, the effect it had on the way antiquarians presented history was not dissimilar.

James MacPherson’s controversial poems ‘*The works of Ossian*’ were an example. In the eighteenth century, the young Scotsman James MacPherson released volumes of poems ‘translated’ from third-century Gaelic manuscripts which he claimed to have found in the Scottish Highlands. The poems included tales of dramatic battles between the Caledonians and Romans. Even in the eighteenth century, many people believed that the poems were forgeries concocted by MacPherson himself, as he was never able to produce the originals that he claimed to have. Today, it is generally believed that much of the content in the Ossian poems was created by MacPherson himself, and not ancient at all. Even so, the poems became international bestsellers, and MacPherson became very rich. A prominent

literary scholar from the period, Samuel Johnson, believed the poems were fake and dismissed Gaelic as “The rude speech of a barbarous people” in his book *A journey to the Western islands of Scotland* (1775, p.267) – this was a common view of the Caledonians and their culture by eighteenth-century antiquarians. The romantic tales were a fresh contrast to the negative opinions many antiquarians held, that the Caledonians had been uncultured “barbarians”, and brought Scottish culture to international fame for the first time. This is interesting to note considering the fact that MacPherson was very interested in Highland culture and literature and was Scottish himself – perhaps it was patriotism, and a desire to show his country in a more positive light that led him to construct these forgeries.



The eighteenth-century antiquarian’s tendency to manipulate sources to fit with their own beliefs was something that was not helped by the fact that many of the sources they used were often unreliable and difficult to understand and could lead them to make mistakes. Rosemary Sweet described problems with some early sources used by the antiquarians in her book *Antiquaries: The Discovery of the Past in Eighteenth-century Britain*: “All of these sources were problematic and the wealth of alternative readings which they allowed ensured constant debate” (2004, p.157). And of course, when there were gaps in the antiquarians’ understanding, guesswork and speculation inevitably slipped in, making these sources very easily exploitable. A common issue was assumptions that artefacts and sources were from the Roman period, when closer inspection would have revealed that they were not even Roman at all. This was an issue with coins – antiquarians loved to collect them but the discovery of a Roman coin did not necessarily mean a Roman site would be nearby, as an eighteenth-century antiquarian might assume.

A famous example of a misattribution of a source to the Romans was the case of collector Dr Woodward’s ‘Roman’ shield. Woodward acquired the shield in 1693, believing it to be an ancient Roman depiction of an army of Gauls invading Rome in 390BC. The scene closely follows a description of the battle by real writers from Roman times, and so Woodward mistakenly assumed the shield had been made then.



However, Woodward was also a collector of various Roman artefacts and souvenirs; suggesting that he too was an antiquarian who admired the Romans. This would probably explain why Woodward was so determined to believe that the shield was Roman, despite being challenged by antiquarians such as Sir John Clerk of Penicuik, who raised doubts over the shield's age and near-perfect condition. It is in fact now believed to be of French origin, made sometime in the sixteenth century.

Another issue was the lack of any sort of regulatory checks on books and manuscript texts published in the eighteenth century. History books were not checked for bias or accuracy as they would be today – anyone could publish a book if they had enough money. Writers often used myths and legends in their books rather than factual evidence and it could be hard for an antiquarian to separate fact from fiction. Charles Bertram's *De Situ Britannia* influenced various theories of history for well over one hundred years, until 1845, when the text was discredited as a “clumsy forgery”. Even after being discredited, there were still publications that referenced the fictional locations from the text, such as Ordnance Survey maps, and a nineteenth century edition of the *Encyclopaedia Britannia*. Other things were particularly problematic especially because of the time period. History in the eighteenth century was primarily the study of the wealthy elite as these were the only people who could afford an education. Consequently, many historical monuments were damaged and destroyed by people who might not have seen any importance in an ancient Roman piece of architecture. Arthur's Oven, the temple that fascinated many of the antiquarians studying Roman history, was destroyed by a wealthy baronet in 1743, and the stones were used to build a new dam for a river – much to the dismay of the antiquarians who admired it.

In conclusion, there were a lot of problems with the way antiquarians documented Roman Britain's history in the eighteenth century, and some of them could have been easily prevented. The Pro-Roman or Pro-Britain debate was a very influential one, and it is easy to see how it affected the way antiquarians documented history. Although the antiquarians in the eighteenth century also made more mistakes than we would expect from historians today, there were reasons for this – lax controls on the publishing of history allowed biased or fictitious information to circulate freely and lead to even more mistakes. As ever, there were people who created fictions and forgeries from a straightforward desire for money or reputation, as is to be expected with any field of study. It was the coupling of these influencing factors, together with the antiquarians' tendency to allow personal opinion – be that a patriotic pride in their own country; or a deep-rooted admiration of the Romans – to influence their work that proved most disruptive to the eighteenth-century studies of Roman Britain.

**PhD Tutor's note**

I was very impressed with the pupils at Oaklands School, all of whom showed a high level of enthusiasm and willingness to tackle complex ideas. In particular, W. Farr's final assignment was truly outstanding, both in its content and its presentation. In this essay she displays not only a strong understanding of the concept of historiography, but she has also engaged closely with the time periods we studied and added many of her own interesting analyses. She is definitely a star historian in the making!

# Compare and Contrast the Use of Sound as Art in the Shozyg and Eargong to Identify and Evaluate the Musicality of Both Instruments in Hugh Davies' Terms

Year 9, Key Stage 3

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The shozyg being played

Hugh Davies has done much to simultaneously clarify and blur the differences between sound art and music, writing of the 'complementary links between music and the visual arts'1 going back to the earliest automata and 'through his electronic music research and documentation... (representing) electronic music for the first time as an apparently coherent, international, interdisciplinary praxis'.2 Davies created many categories into which all music should, theoretically, fit if it is to be classified as music, and not just unconnected sounds: what he called 'this proliferation of different names for what is basically the same kind of music'.3 The purpose of this was to broaden common perception and acceptance of sound art. Davies applied his beliefs of what music was to some of the instruments which he made, to identify what is more musical or artistic out of multiple instruments, such as his 'shozyg' and 'eargong'.

Both the shozyg and the eargong are unique, compared to more conventional instruments, because of their artistic properties. Where many instruments' purpose is to produce art in the form of music, both the shozyg and the eargong are partly art in themselves (a continuation of the experiments of John Cage and Harry Partch, who 'used materials chosen for their sculptural as well as auditory qualities'4). This seems so, firstly, because neither instrument's sound product can actually be heard, without the aid of a solid medium through which the sound can travel. In the eargong's case, this medium is two pieces of string tied around the top of the grill that forms the eargong. The user of the eargong must tie both strings around their fingers and put them into their ears. This is mainly what makes the eargong so special, as it achieves what the shozyg does, without the need for any electronics, while maintaining an extremely simple and seemingly unsophisticated design.

The shozyg also works like the eargong in that one must use a special feature of the instrument to actually hear it, but the shozyg uses technology to achieve this – a multitude of contact microphones placed inside it. The shozyg is made up of a group of found objects with the potential to produce sound, such as a spring or a fretsaw blade. A contact microphone is connected to each object in the shozyg, which is contained in a copy of the shozyg encyclopedia. One could argue that the shozyg is less expressive than the eargong and that being dependent on technology seems almost like cheating, as the sounds that are being produced by the shozyg are not real and genuine, but manifestations of a computer (Davies comments in Art and Sound, that in the 20th Century “The use of electricity in sound and art became extremely diverse, ranging from the simplest motor to fully computerised sound synthesis.”5) rather than purely acoustic. However, the contact microphones are not nearly as significant a part of the shozyg as the found objects which make it up. Additionally, in modern day society, where technology is so advanced and prominent, it is no peculiarity to have an instrument that relies on technology. One could argue that despite being older than the eargong, the shozyg is far more modern, due to its application of this technology.

One very notable difference between the two instruments is the shozyg's ability to create a clear distinction between its sounds, although not nearly as much as a conventional instrument such as a violin. It can play one sound, followed by another, and another to create music with a sense of variation in pitch and timbre, almost producing notes. The eargong lacks this ability, as when playing with it, one will be restricted to the sound of someone kicking a grill, and no matter how one kicks it, the next sound will always be almost identical to the one before. One could perhaps define the musicality of an instrument by assessing its application to different forms of music. The shozyg can generate more notes than the eargong, as well as rhythm; whereas the eargong can only produce rhythm, with utterly monotonous tonal content. This would suggest that the shozyg is more musical, because it has more musical potential, as its design creates more possibilities for the creation and performance of music than the eargong's does, through containing a greater melodic diversity.

Others, however, might argue that the eargong is closer to a drum, or some other percussion instrument, than the shozyg is to any other conventional melodic instrument, and that a drum can be used to play even more modern music than the shozyg. However, the eargong is simpler than other percussion instruments, and contains less that can make and vary its sound, and is therefore able to offer less potential to make music than the shozyg. The eargong can make clear patterns and rhythms with just the one general sound it can produce, and although the shozyg is also somewhat limited in being able to do this – seemingly making sounds randomly – it would seem that the shozyg can still do more in terms of making music, as the eargong is not able to produce notes, or even just sounds with different pitch and timbre.

Hugh Davies said that something can be more artistic or musical if it was purposely made to be so. In doing this, Davies suggested that an object's artistic value is also partly dependent on the creator's intention, as different people will identify different things as art. A musician, for example, may view a piece of art differently to a painter. Therefore, there is

another way of comparing just how 'musical' two pieces of music or instruments are. If a person who couldn't play any musical instrument wanted to play one 'correctly', they would most likely find a percussion instrument the easiest to play, for its simple way of generating sound. This is the same for the eargong and the shozyg. A complete beginner would be able to produce much more music with the eargong than the shozyg, as they already have access to everything that the eargong offers, virtually maximising its musical potential. The same person might be unable to exploit all of the shozyg's features so well, and may feel restricted to using the same parts repeatedly, and therefore fail to see it as musically as they might the eargong. The eargong would likely be a far more productive and 'musical' tool to a beginner who tries both instruments for the first time.

For a person who is equally adept at both instruments however, this would not be the case. This is because a skilled player of the eargong may well play more complex music than an eargong beginner, but the difference would be less extreme, than that of a skilled shozyg player compared to a shozyg beginner. The professional shozyg player may be more explorative than the the beginner, utilising every feature of the shozyg, opening many possibilities for creating more and different music, and so increasing its musical potential significantly. Therefore, it is likely that the shozyg would be much more suited in a professional performance, for example, where there is one professional player, performing to an audience. And the eargong would be more suited to a gallery situation, where many, completely inexperienced and random people are simply experimenting for their own pleasure.

This is made even more apparent by the fact that it is in the eargong's physical nature to be heard by no more than one person, while the shozyg does not have this limitation. The eargong would therefore not do very well as the tool of a performer. The audio of the shozyg, being dependent on technology, can be easily modified, however, for amplification to a larger audience through means such as loud speakers. The one-person hearing system of the eargong may therefore seem a disadvantage, but in a gallery, it could be viewed as useful. Here, the eargong could sit amongst many other artworks which are being looked at by many different people, who might be distracted and annoyed if they could hear the product of someone else's use of the eargong.

Art galleries are generally for the experiencing of existing creations of artists, whereas the preparations for a concert or other performance are for the active creation of art. This would suggest that the shozyg is more suited as a tool for creating music, rather than being looked at and played with by the public. One could say that this means that the shozyg is the more creative instrument out of the two, and also, once again, the most versatile as, with the aid of technology, it too can be heard only by its player, if they use headphones.

The shozyg is capable of producing much clearer and more complex sounds than the eargong, but is still far from being what is normally thought of as a 'conventional instrument'. It is abstract, certainly unconventional and can maybe only really be considered to be an instrument because of Davies' definition of what produces sound and/or music. However, its unconventionality brings a certain freedom to it. With it, one can make sounds (or 'objets sonore' as Pierre Shaeffer would have called these unidentifiable sounds), into an abstract artwork or a piece of organised music, by using each sound in



a different way, either more organised, with rhythm and notes in an appealing fashion, or more chaotic, with sounds connected in far more artistic, and less transparent ways. The eargong, which also lies halfway between art and instrument achieves its results differently from the shozyg. The shozyg is capable of creating bizarre sounds unlikely to be heard anywhere else and generates a sensation of exploration and new boundaries and this is achieved purely through the sounds which the shozyg can generate. The eargong however displays its artistic properties through the way that it communicates its sound. The eargong is so interesting because of its innovative way of communicating sound through a piece of string. Its source of sound may be mundane, but the way that it allows itself to be heard is fascinating and original.

Edgard Varèse once defined music as ‘organised sound’<sup>6</sup> and this is crucially why many would think that the shozyg is a more musical device than the eargong. The shozyg can organise sounds or, to some extent, notes into an appealing order, as well as being able to create a more abstract collection of sounds. The eargong, on the other hand, can achieve very little difference in the sounds that it makes, making its musical properties dependent on the artistic contributions of its strange method of transmitting sound.

Both of Davies’s instruments are undoubtedly works of art, tampering with the fine line between abstract art and music. I am, however, of the opinion that the shozyg is a more musical instrument than the eargong, because the shozyg can produce a far wider variety of sounds, giving the user more options to play with when creating music. The shozyg may be dependent on technology, but today, that is definitely positive, making it a more useful and versatile instrument, as it can be connected to different technologies to achieve different things more suited to different places. The eargong may not be able to play as many different sounds as the Shozyg, but the sound that it does produce is one of wonder, perhaps because of the unique platform through which it communicates its sound. However, the shozyg shows that it is possible to create music as well as more abstract art with an unconventional instrument, through only simple changes to the medium of the expression of music, such as the use of custom scores..

**References:**

- 1 Davies, Hugh: ‘Art and Sound’ from ‘The Grove Dictionary of Art’
- 2 Mooney, JR (015) Hugh Davies’s Electronic Music Documentation 1961–1968. Organised Sound: an international journal of music and technology, 20(1). 111 – 121 (10). p.2
- 4 Davies, Hugh: ‘Art and Sound’ from ‘The Grove Dictionary of Art’
- 3 Mooney, JR (015) Hugh Davies’s Electronic Music Documentation 1961–1968. Organised Sound: an international journal of music and technology, 20(1). 111 – 121 (10). p.6
- 5 Davies, Hugh: ‘Art and Sound’ from ‘The Grove Dictionary of Art’

**PhD Tutor’s note**

L. has the most brilliantly creative mind, which is able to grasp really big ideas. It was a pleasure to work with him on his journey into areas of the arts he had not come across before and to see him deal with these new ideas head on. He has the invaluable ability to see various faces of an argument at once, a skill which will serve him well in whichever mountain he now seeks to climb.

**Early 20th-Century Avant-Garde Poetry**

**Year 9, Key Stage 3**

**M. Culley, Heartland High School, London**  
**Supervised by E. Heinz, Birbeck College, University of London**

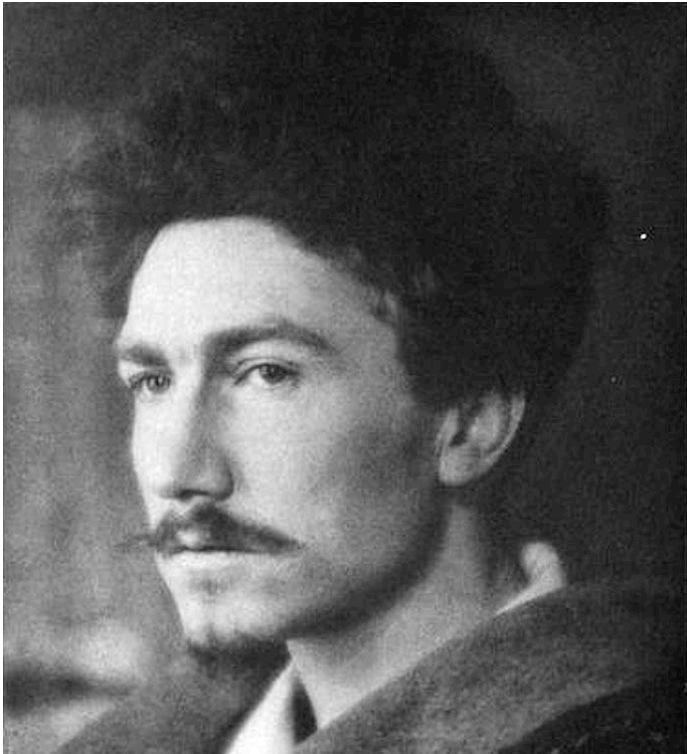
During the early Twentieth Century there was an explosion of innovation in writing and art that contradicted the traditional style used repeatedly prior to this movement. Within this large movement there were many smaller groups that had their own values and beliefs that generally opposed each other, for example the Italian Futurists (led by F.T. Marinetti) were much more in favour of shocking people and taking inspiration from the fast changing development of technology that drew them away from poetic tradition which they believed should be destroyed. This contrasted with the views of the Imagistes (led by Ezra Pound) who became so called ‘experts’<sup>1</sup> on traditional poetry before they wrote their modernist pieces. Another equally important Imagiste, T.S.Eliot, wrote a quote that gave the perspective of many of these upstart groups, stating that: ‘Novelty is better than repetition’.

The Italian Futurists would agree with this quote and support it to a more extreme extent than others because they themselves believed that literary tradition (which they viewed as repetition) should be destroyed.<sup>2</sup> This shows that to the Futurists, tradition could be seen as repetitive and very similar to other literature which was not of the Futurist style and therefore would have upset them as it contradicted many of the things they wrote in their manifesto. They would also interpret the ‘Novelty’ part of the quote as new work tailored to shock and create change as again this supports the manifesto of this group. To sum up, the Futurists didn’t value poetic tradition as they felt it limited their work because it follows lots of grammatical rules, repeating traditional literature. They did value poetic innovation as it allowed them to use their so called ‘words in freedom’ and convey the changing technology in the world around them as well as destroy other innovative techniques that weren’t as radical as words in freedom such as free verse which was used by Imagistes such as Ezra Pound.<sup>3</sup>

Unlike the Imagistes, the Italian Futurists valued traditional work very little and wanted to burn all the libraries and museums as they were places that preserved tradition that they felt restricted them. Therefore they took inspiration only from the rapidly changing world around them and created words in freedom as for them free verse was not modern enough any more. Words in freedom threw any grammar or spelling rules away and was tailored to shock audiences and critics alike; the work looked nothing like poems at all and was not made to please but almost to spark change or riot. The only similarity to Imagiste work was its clearly boundary-pushing style that caused audiences to feel extremely strong emotions almost instantly.

An example of their words in freedom style is a poem by F.T.Marinetti called *Bombardment*, which is based on a battle Marinetti reported on\* and takes on an almost incomprehensible shape that has completely distorted words. For example, the word ‘vibrate’ is used multiple times in an almost onomatopoeic way via the repeated

use of the letter ‘r’ in each one. This is an example of what Marinetti called words in freedom which allowed words to do what they want and in this case they are chaotic in their form to convey a battle with machinery which was a topic the futurists favoured and took inspiration from due to the fact that it was changing constantly, particularly at the time of the movement. This piece, whilst chaotic, is clearly carefully written as it contains what looks like calligraphy, with the balloon in the middle and the word ‘vibrate’ forming radio signals. The point of this piece being so dramatic (describing a battle) and different is to completely upset and shock audiences which was one of the main motives of Futurist poetry.



Ezra Pound

In comparison to the Italian Futurists, the Imagistes valued traditional work as much as their modern work because they still used older techniques mixed with free verse to make it a novelty. This allowed them to be experts on poetry and value the past and still create beautiful works. Contemporary critics viewed art and literature as things that should be pleasing, putting them behind the Imagistes who created work that was pleasing whilst still pushing boundaries.<sup>4</sup>

In contrast, the Imagistes may not agree because firstly they themselves believed that they should know as much as possible about traditional poetry and poets; they wanted to become ‘experts’ on poetry before creating their ‘Novelty’ work. This indicates that they would regard this quote as opposing their methods as it seems to belittle the past as repetition. They themselves see both traditional (repetition) and innovation (novelty) as equally important in creating their work. To sum up, the Imagistes valued literary tradition as much as innovation because they believed they must study the old to create the new. This suggests that they repeat the use of one typical technique and shape it into a novelty.

An example of this re-sculpturing of a repeated technique is Ezra Pound’s *In A Station of the Metro*.<sup>5</sup> The poem itself is made up of one metaphor split into separate words. The poem is clearly free verse (a modern technique that involved presenting a stanza in an odd way) but it retains its Imagiste style through the use of a language device (metaphor). This mix of novelty and repetition clearly presents the Imagiste’s favoured balance of the two. The metaphor within the poem compares ‘the apparition’ of faces in a crowd to petals on the bough of a tree. This can be seen to say that each face is different and has its own colours and shape like a petal. The faces are also made more significant and brighter against a dark almost dirty object. This could be an extended metaphor for a train station, which the title also suggests, and how humanity’s creations are large and dark whilst the humans are beautiful. This shows a contrasting message to that of the Italian Futurists as it challenges the changing world around us that they celebrate and take inspiration from. This displays a possible conflict between the two parties who argued over whether tradition or innovation was a more valid style when creating poetry, which was at a turning point with newer generations finding less value in writing poetry filled with emotion and lacking originality in structure and sometimes even content.

Another modernist was John Rodker who didn’t identify as a member of these contrasting groups but saw poetry as way of communicating to the outside world from what he called the ‘void’.<sup>6</sup> He was born lower class and that didn’t enable him to read much older poetry and he himself said he liked to shock audiences. Therefore I think the quote by T.S.Eliot applies heavily to Rodker and his work. An example of one of Rodker’s first works is his poem *Item*. The poem is shocking as it holds less of a normal shape than that of *In A Station of the Metro* but similarly has a metaphor as the only verse. The metaphor compares a heart to some strings in a bag. The bag itself is very exotic as it is peacock blue and satin but only holds some pieces of string. You can also see that the strings, or the heart, is carried around as it is in a bag. The complexity and confusing manner of the metaphor links to the idea that Rodker enjoyed to shock himself and others. His poems, however shocking and odd with their typography, were completely separate to that of the Italian Futurists.

Unlike the Imagistes, John Rodker wasn’t highly educated and thus new little of poetic tradition and probably didn’t value it as an important part of helping to craft his work. However he did use free verse similarly to Imagistes and favoured it when creating his work as you can see in *Item*. This use of free verse shows that like the Imagistes he valued innovation or novelty work which shows a strong similarity between him and the group. To summarise this, he valued tradition little as he had minimal access and valued innovation as a key part of literature like the Imagistes.

In contrast Rodker had more similarities with the Italian Futurists who, like him, valued literary tradition to the lowest extent and aimed to create innovative work that shocked audiences. However they used different styles to shock: free verse and words in freedom. Words in freedom valued a much more shocking and modern style that transformed their poetry into what looked like collages or calligraphy which shocked people more so than Rodker’s free verse which although different and innovative clearly made the work look like a poem still leaving a trace of tradition within his work.



Another way to look at how these groups valued old versus new, or tradition versus innovation, is through the main purpose of their works. In John Rodker's case, he wrote poetry to establish contact whilst 'hanging in the void' and that they were made to shock, demonstrating that he was completely focused on innovation as traditional work was made to seem beautiful like a work of art but modern work is generally made to change, innovate and shock, to create change via strong reaction. With the Imagistes (particularly Ezra Pound) they wanted to rid poetry of emotion but not the actual element of poetry itself thus splitting equally the ratio of innovation and tradition, placing them in the middle as they intended to use both to create work 'free from emotional slither'.<sup>7</sup> Finally, the Italian Futurists wanted not just to spark riot through upsetting their audiences but also to destroy buildings like museums that celebrated the past and ignored the contemporary revolution in machinery, as well as those who worked to preserve the past like archaeologists, therefore showing that they didn't value tradition and saw it as an enemy to their shocking words in freedom style and valued innovation completely as it captured exactly what their art and literature was.

In conclusion, it is clear that during the early Twentieth Century, the avant garde groups that led this revolution in culture not only fought the critics, and sometimes tradition, but also each other with their contrasting views on new art and literature. This sparked conflict that changed culture, as the First World War changed societies and warfare globally. These groups have had a lasting effect on poetry that we see today with people such as T.S. Eliot lauded as one of the 1900s most influential figures regarding change within literature particularly. Lastly, despite the other prfound changes that took place during the Twentieth Century, I ask you to consider how much art, literature, and how we view the two, have been shaped and influenced by this collection of groups and figures. While extreme in some of their beliefs and dramatic in their methods of attempting to create change, the Futurists can be seen as laying some of the foundations of the art and literature that we see today, over a century after they created their first groundbreaking works.

**References:**

- 1 Taken from Ezra Pound's 'Few Dont's by an Imagiste'
- 2 Stated in The Founding and Manifesto of Futurism (1909)
- 3 Taken from F.T.Marinetti's essay 'The Destruction of Syntax'
- 4 Taken from The critical reception of poem (1914)
- 5 This poem was published in the magazine Poetry in 1914
- 6 A quote from John Rodker describing how he felt when writing poetry
- 7 A quote from Pound on how he wanted poetry to be.

**PhD Tutor's note**

M is a keen student who was very engaged in our course on modernist and avant-garde poetry. His essay demonstrates an understanding of the subject matter and a level of formal analysis that goes well beyond what would be expected for his Year group and was accordingly rewarded with a 1st class mark. He was a pleasure to work with and I wish him all the best for his future academic career.

**'Women must write about women and men, men'.  
(Cixous): To what extent do you agree with this statement in reference to the work of medieval women writers?**

**Year 10, Key Stage 4**

**S. Whittle, Wodensborough Ormiston Academy, Wednesbury  
Supervised by C. Harrill, University of Birmingham**

Throughout this course, a range of texts which both support and contradict this statement have been explored. The ones being considered in this particular essay will be Christine de Pizan's 'The City of Ladies' and two versions of 'Lanval'. In the latter instance, both Marie de France's and Thomas Chestre's will be considered. In reference to the work of medieval women, it could be argued that men should write about men and women should write about women. This is due to the misogynistic views that society possessed in the medieval era. Men would often slander women through their writing to display them as inferior members of society, which would make it unfair as people would only see men's side of things.

In Christine de Pizan's "The City of Ladies" , she creates the character of Lady Reason who is a strong-minded woman of rational thoughts. On the other hand, the character of Christine juxtaposes with that of Lady Reason because she is highly influenced by the documentations she reads. She is a symbol for women at that time, who have only been exposed to male views and because of this women find it hard to differ between the truth and lies made by men. Christine de Pizan emphasises to her readers the volume of texts which are tainted, "many books of different kinds". As we learn later in the extract, all of the books she has read are, it seems, primarily written to "slander" women. Therefore, the fact she owns books of such variety demonstrates how misogynistic views were widely shared and presented by writers who all "speak with one voice", specifically of male gender. This demonstrates how all writers have the same view on women. None of the accusations or ideas about women has ever been proven wrong, because all writers are men and no females felt able to challenge their views. However, it is said that philosophers are "constantly correcting each other's opinion" meaning that just because they all share opinions and add on to each other's ideas of how awful women are, doesn't mean it's right. Describing the philosopher's opinions as a mistake, implies that it is a mistake for men to speak badly of women and portray them in a bad light and it is something that needs to be corrected. Therefore, Christine says that writers write "such awful, damning things about women and their ways". Talking about writers collectively, really emphasises how it is not just in one book written by a man that slanders women, but the majority. This shows the scale and severity of the issue at hand and how important it is for women to do something about it now before the issues escalate.



Christine de Pizan lecturing men

The book of 'The City of Ladies' mainly explores the idea that a person should make judgments and decisions based purely on personal knowledge and experience. Lady Reason attempts to help Christine come to her senses "out of pity", which could suggest that, as a reassured woman, she is tired of seeing young vulnerable and naive women suppressed by the patriarchal views of male writers. Texts written by men are described as "a pack of outrageous lies" and it is Christine's naivety which has led to her taking "what they come out with as the truth" means that Christine has not yet experienced fully the harsh remarks made about women and she is inexperienced in interacting with others. Due to this she has become completely dependent on what she reads in books, meaning she has only had the views of misogynistic philosophers on which to base judgments. Christine is not using her personal interactions with other women as evidence to prove that the men writing are lies. She tells Christine that the "misconceptions" have "clouded" her mind. Which suggests that through writing, male figures in society are almost brainwashing young people to think as they do, and training the younger generation to fit into their society by carry on the tradition of slandering women. Christine de Pizan shows that in order for people to be exposed to an accurate representation of women, women need to stand up and rebel against the male writers who are falsely portraying them. Men will never write honestly about women because they do not want them to seem superior to men. No male writers will go against these misogynistic views because they all share the same views and wish to maintain their superior status.

Furthermore, Thomas Chestre's version of 'Lanval' portrays the male character in the story to be heroic and strong in a stereotypical masculine way. Contrary to Marie de France's version of Sir Lanval, the king is said to have "came home happy from hunting" in order to show he's a dominating male figure. This also emphasises how later on in the extract Guinevere, who's is also being portrayed stereotypically through misogynistic views, is making their marriage a misery. The fact that the king came home "happy" after hunting but was left "furious" after interacting with his wife supports the idea that it is women who make men's life a misery in marriage. However as said in "The Book of The City of Ladies", "what husband ever gave his wife the power over him to utter insults". In medieval times women were simply not powerful enough to make their husband's life such a hardship. They were seen as second class citizens, and this

is the way men liked it. In order for society to remain this way, men write badly about women in order to suppress them further and to ensure that men are in power. Chestre's version is very much in favour of the male characters. In this version, the women are presented as an evil annoyance. Tryamour "blew such a breath that she never saw again", showing that women are not just evil and deceiving towards men but towards women too. Therefore presenting the idea that women are the inferior members of society because if they can't be nice and honest to each other, they surely cannot be nice to men and shouldn't be trusted. Mary de France's story of Lanval juxtaposes greatly with Chestre's because it doesn't portray women in the same way. Although Marie makes it apparent that Guinevere is not completely innocent, she doesn't slander women as a whole, nor does she slander men. The characters in Mary's version are more honestly portrayed. This would have showed society at the time that women should be allowed to write in order to portray a more honest representation of reality. Contrast this with reading a piece written purely to make a specific gender seem more superior to the opposite sex. However, both pieces explore the idea that men in particular, address minor, trivial issues within society that do not really matter and will not better society or life as a whole, but instead reinforce men's superior role.

In conclusion, it is apparent from the evidence that has been presented, that men should write about men as they have experience in their lifestyle, their gender and their role as men in society. However, it is also apparent that women are able to write about men as they are more likely to give honest accounts of them. Women seem to just to want to share things from a female's point of view as they only wish to portray them honestly, as opposed to having a hidden agenda that insults or belittles men in society. However we cannot be completely sure of this. On the other hand, men of the time had lives they enjoyed. They did not want women to become educated enough to challenge their views, or encourage other women to oppose the norm they had created. Were women able to write as they wished, men felt they would try to challenge male misogynistic views and allow other to see they had been educated on lies. Therefore, as shown by Lady Reason, men thought they should ensure members of society only read male-dominant views. It is for this fact that men should not write about women. Only women should write about the female gender as they have personally experienced what it is like to be a woman in a patriarchal medieval society. In an ideal world men and women would be able to write freely about each other without having to worry that they are being slandered by the opposite gender. They should also be able to know that what they are reading is a true, accurate representation of that gender's experience. At this point in time, however, this is sadly not the case.

**PhD Tutor's note**

It was a pleasure working with S. during our tutorials at Wodensborough Ormiston Academy. She was always a lively participant in our sessions, and engaged with the difficult issues both of feminist theory and medieval literature with nuance and care. Her essay reflects a subtle and detailed understanding of the problems inherent in speaking within a literary tradition that is against you, and shows a deep and complex understanding of the medieval literature we covered together.



# How Did Reading Shape Society and the Lives of Individuals in the 18th Century?

Year 10, Key Stage 4

S. Opera Faparusi, Holloway School, London  
Supervised by S. Bankes, Open University

This essay will examine the ways that reading shaped society and the lives of individuals by helping to develop national and individual identity in the eighteenth century. It will examine the ways that reading helped to spread power throughout society by referring to the ideas of Jurgen Habermas; it will consider the role of reading the literature in building a sense of national identity through the development of patriotic songs and a canon of British poets; and it will show how these changes influenced the lives of individuals.

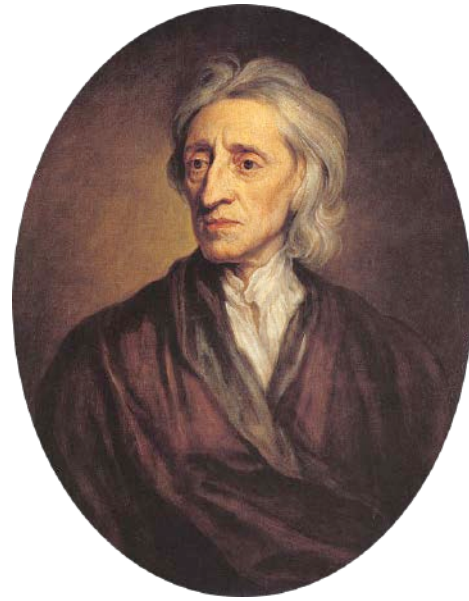
## The Meaning of 'Identity'

First of all what is the meaning of 'identity'? This single noun causes controversy; the reason for this is the tension within its definition, which I have come to learn is 'a close similarity or affinity'.<sup>[1]</sup> The Latin origin 'idem' means same, however, in the society we live in today, it has acquired multiple meanings such as "traits defining who or what a person or thing is" or "the fact of being who or what a person or thing is".<sup>[1]</sup> These newer definitions offer the notion of differentiation in the modern world. The contrast of sameness with having characteristics that makes us different shows us how the definitions of this distinct word clash. Whilst the notion of sameness refers to the ongoing aspect of our character which defines us, we are also reminded that this sameness within ourselves differentiates us from the essence of others. It is also important to remember that whilst we remain essentially the same in many respects we nevertheless change and develop throughout our lifetimes. We have come to learn that our features and attributes contribute to the identity that labels us, we are all varied in nature and this contributed to the self or distinction the world sees.

What could have influenced this change of definition? The philosopher, John Locke (1632-1704) put forward the idea that people are born the same since we are born with minds like empty cups. Locke asked his readers to imagine 'the mind to be, as we say, white paper, void of all characters, without any ideas' and he asks them to think about how it comes 'to be furnished'.<sup>[2]</sup> This lack of foundation for who we are allows external factors to help develop our mindsets and so-called 'identities'. This allows us to infer that we build who we are and who we come to be by allowing things to influence us such as the environment we live in, the people we surround ourselves with, etc. Therefore, as babies we are 'clean slates' on which we can embellish our identities with new found characteristics by using our developing reason to reflect on our experiences. Locke's ideas subsequently caused people to think more meticulously about education in the 18<sup>th</sup> Century

There are various things that can impact who we turn out to be in everyday life and this essay will focus particularly on reading. Throughout our lives we are bombarded with information which we look at and comprehend the meaning of by interpreting the language or images of

which it is made<sup>[3]</sup>. This happens everywhere like billboards, advertisements, social media, signs, etc. Things that are widely available influence the way we think, the way we interpret the world, and how we act. The information we read, which is everywhere, subliminally indoctrinates the way we are and what we believe in or agree with. An example of how reading influences your identity is newspapers you read which usually reflect a particular political view and so can reinforce your judgments and political prejudices. The first newspapers emerged in the early years of the 18<sup>th</sup> Century. The broadsheets like *The Times*, founded in 1788, shape your political views; 'gossip' papers like *The Sun*, which promote false imagery of the human body and nature, makes us think certain ideals are normal and to be desired despite being unrealistic. In addition, social media especially, which is predominant in adolescents' lives, has a major impact on the way we think in the early stages of our lives. Adolescents are subject to subtle and not so subtle advertising on social media telling them what to buy and how to improve their lives and they are subject to peer pressure molding their sense of self. Algorithms direct us to a pool of ideas, which we appear to return to repeatedly.



Portrait of John Locke, by Sir Godfrey Kneller. Oil on canvas, 76x64 cm. Britain, 1697.  
Source of Entry: Collection of Sir Robert Walpole, Houghton Hall, 1779.

Reading is just one of the influences that help to shape our identities and many of the issues we encounter in our reading lives today can also be seen in the way that people used books to shape their interactions with other people in the 18<sup>th</sup> Century. Similarities can also be seen in the way literature was used helped to define and shape the identity of the whole nation in important ways.

## The 'Public Sphere' and Extending Power in Britain

The content of this section will be an argument in which I will draw upon the ideas of German sociologist Jurgen Habermas, articulated in his book *The Structural Transformation of the Public Sphere*, to show how coffee houses created centres of conference which brought about a shift of social and economic power from the authority of the courts to groups of individuals in the late 17<sup>th</sup> and early 18<sup>th</sup> Centuries.

In the early 18<sup>th</sup> Century, realms of the nation's social life in which something approaching public opinion could be formed<sup>[4]</sup> were called public spheres; through these

discussions the general public could influence political action.<sup>[5]</sup> For the average man, the local coffee house offered the opportunity to enter into the 'public sphere'. In this space, men were able to converse about scientific topics, social and economical politics, news, contemporary ideas and literature, which was important in providing a focus of discussion. These debates allowed commoners to start to develop a 'public opinion' about how the country should be governed. These views challenged the government and became recognised for their relevance at the time.<sup>[6]</sup> This shows us the change in the balance of power, seeing as the government had to acknowledge the public's viewpoints and take them more seriously.

Habermas describes how "critical debate was ignited by works of literature"<sup>[6]</sup> meaning that different kinds of literature influenced these discussions, such as newspapers, poetry, essays and journals. These meetings about literature influenced different groups to develop more formal identities, each having distinct identities and interests. This allows us to infer that literature with a specific topic, could prompt definitive deliberations. For instance, in the 18<sup>th</sup> Century, 'several science societies were either formed in, or run from, coffee-houses'.<sup>[7]</sup> New journals, such as the *Spectator*, voiced the opinions of the public and presented ideas of interest to the public which were available for regular people to read.

Conversation within these coffee houses allowed social barriers to be challenged within England. As said by Habermas, "the 'wealthy shopkeeper' visited the coffee house several times... this held true for the poor one as well."<sup>[6]</sup> This proves that "the coffee house" did in fact embrace "the wider strata of the middle class,"<sup>[6]</sup> they weren't selective, making it "easier to access the relevant circles of the public sphere".<sup>[6]</sup> Coffee-houses only admitted men, women could not participate and this ensured that the kind of power this discussion bestowed was only accessible to men. It didn't matter about social status therefore, everyone was on common ground and were all peers; everyone was deemed equal. However, in France there were salons which allowed women as well as men in the discussions, however these did not have as much influence.

The public sphere has enabled the people of today to have freedom of speech and voice their opinions no matter what they may be. There are many examples of where these modern discussions occur, for example blogs and social media. Both of these allows you to articulate and proclaim how you feel about anything and people can do the exact same in return. Being articulate and being able to communicate well gives power and literature plays a key part in this process. When we read widely, we develop better communication skills; our vocabulary that we use in everyday life is greatly influenced by what we read

To conclude, as a result of the public sphere, the public were able to attain more power in England. Their voices were heard not just orally but through literature, which also stimulated certain opinions that were vital in creating the world we have today. Literature was instrumental in creating a public sphere because it provided material for discussion which drew people together. The coffee houses incubated these perspectives that created 'public opinion' thus allowing the 'public sphere' to give regular people just as much say as those who were higher up in the hierarchy of England and this helped to change the identity and

the shape of the nation'. This kind of debate encouraged individuals such as James Lackington and Thomas Spence to dare to change their lives and try to reach out to others and I will explain later in this essay.

## Literary Canons and National Identity

First and foremost, I shall explain what a literary canon is. This term refers to works which are considered to represent a nation and have a special cultural status. For example, one could talk about the canon of Elizabethan drama, which would include the works of William Shakespeare. In the 18<sup>th</sup> Century patriotic songs such as 'Rule Britannia' and 'God Save the King', the British national anthem, materialised, creating a huge sense of nationalism across the country.<sup>[8]</sup> Much like a patriotic anthem, canons can bring people together because they contain values or moral aspirations specific to their nation. As I will argue, literature can, and did, shape the nation and in doing so instituted an impression of patriotism. The historian, Linda Colley, stated in her book that "through reading or hearing others read Protestant publicists like Bunyan and Foxe... protestant Britons learnt that particular trials were the necessary fate and eventual salvation of a chosen people."<sup>[9]</sup>

We can infer that the 18<sup>th</sup> Century was also a period of time when people read certain writers, such as John Foxe and John Bunyan, to assert their religious identity and celebrate what made them and their country distinctive. Distinct literature and canons, helped create a face for a nation of people because their contents were relevant and exhorted readers to develop a sense of duty, patience and fortitude.

Moreover, Thomas F. Bonnell, a critic and historian, described a process in which literature and poetry provided a potent instrument to explore the altering identity of the nation: "a nation comes of age at different times, publishers in Great Britain represented the nation to itself in maturity. This coming of age was expressed in distinctly material terms, as the poets of the nation - its classics, its worthies - began to be reprinted and sold to the public in one extensive multi-volume collection after another."<sup>[10]</sup> An example of a key person who played a vital role in this process was a printer named John Bell, who printed pocket-sized, uniform editions of the works of British poets. By doing so he placed British poets on a pedestal, granting them the same respect as the greatest Latin and Greek authors; this encouraged people to read British literature because these works of literature were highly valued and appreciated. These books could even be bought with special displays. This shows us that aesthetics were key when selling books, seeing as there was a belief that once the collection was completed it made you appear highly intelligent. The reasons causing this to be significant were that as a result of printers producing their classic series consisting of only white, British, male authors, it brought people together due to the fact that these books shared certain values that were eminently important to the public, allowing a concept of solidarity and unity to be created.

Bell only includes white male poets in his series in 1796, such as Ambrose Philips, John Dyer, Gilbert West, etc., despite there being prominent female poets at the time such as Charlotte Smith, Laetitia Pilkington, Lady Mary Wortley Montagu, etc., who didn't get the same recognition as their male peers since the ideas and intellectual output of men was afforded a higher status at this time. This suggested



that men were exceptional writers with higher intellects than women since they were situated on a podium above all who did not fit in the same criteria as them.

Literature today is also used to characterise a sense of national identity. We have proclaimed certain authors to be 'ours', as if we own their works, for instance, Charlotte Brontë, Charles Dickens, Rudyard Kipling, Jane Austen, etc. In the society we live in today students are made to study a "range of classic literature fluently", making sure all children "develop the habit of reading widely and often".<sup>[1]</sup> These classical works happen to be from the British Isles in which we inhabit, showing us that the Department of Education believes that British literature is more influential and needs to be appraised within the educational system. In addition, literature, despite the current educational circumstance and prior acclaimed authors, has become more diverse, writers of different ethnic backgrounds and nationalities have been embraced in the country we live in, such as Chimamanda Ngozi Adichie, Benjamin Zephaniah, Anita Desai and others. Today we recognise a much broader range of talented writers in our country which reflects the values we aspire to as a nation.

Today, just as in the 18<sup>th</sup> Century, literature has become a basis for the way the nation sees itself and projects its values and aspirations. The words printed in our books and displayed on our screens help to create an image for the country and therefore a canon did indeed help shape the country and its individual identity.

**Individual Readers: James Lackington and Thomas Spence**  
It was not only national identity but also individual identity that was shaped by reading in the 18<sup>th</sup> Century. People read for entertainment, to communicate and, most importantly, to gain knowledge. This could influence the way people developed, depicting ideas of morality and a sense of good and bad. This suggests that reading, in terms of impacting people's lives, was clearly of great importance.

James Lackington's life is a great example to show how literature was used to forge a new identity as he completely redefined and reinvented himself and he used his reading to do so. He was born into a poor family in rural Somerset in the middle of the 18<sup>th</sup> Century but after learning to read he became the owner of one of the biggest bookshops in London, the Temple of the Muses. He identified himself as a 'Gentleman' by the end of his life and had the wealth, the house and accessories to support this claim. He recognised it was not enough to be wealthy if you wanted to be acknowledged as a 'Gentleman' and a successful person; you needed to be able to talk about the things that people with power valued and that meant literature. In each of Lackington's works, he "chronicles his extensive reading, exhorting others to follow his example. His autobiographies offer a persuasive account of the power of reading to transform a life".<sup>[12]</sup> Although he stated that reading could transform people's lives, he used the aesthetics of books to make him feel and look powerful. Lackington had to amass what the philosopher Pierre Bourdieu has called 'cultural capital'; this means that he had to appear to be in possession of the values and the judgments that went with being a gentleman. These values and judgements were

disseminated through journals such as the *Gentleman's Magazine*, the *Monthly Review* and the *Critical Review*.

Literature was valued throughout the 18<sup>th</sup> Century and one of the many men who promoted reading was Lord Chesterfield. In his letters to his son, he recommends books to him stating that "the principal object of your stay there, is the knowledge of books and sciences; which if you do not, by attention and application, make yourself master of, while you are there, you will be ignorant of them all the rest of your life; and, take my word for it, a life of ignorance is not only a very contemptible, but a very tiresome one..."<sup>[13]</sup> By Chesterfield stressing the importance of books in life we can see that literature was fundamentally a key part of the basis of life; a life without it was boring and worthless. In addition, Isaac Watts declared, when considering why we should read, that "reading is that means or method of knowledge whereby we acquaint ourselves with what other men have written or published to the world in their writings. These acts of reading and writing are of infinite advantage; for by them we are made partakers of the sentiments, observations, reasonings and improvements of all the learned world, in the most remote nations, and in former ages, almost from the beginning of mankind."<sup>[14]</sup> Implicitly we are told in this statement that by reading widely from the best authors, readers will become better people. Both men pushed the ideology that literature would consequently improve life for the reader.

However, Thomas Spence's life proves this to be wrong in the material sense, although it might have made him feel as if he helped others. He was the leading English revolutionary of his day and was hailed as England's 'first modern socialist', with an unbudgeable commitment to individual and press freedom and the common ownership of the land. He was born in Newcastle in 1750, and was also born into poverty and, unlike Lackington, he lived a poverty-stricken and persecuted life. He read many radical writers such as Thomas Paine, William Godwin and Voltaire as well as writers such as Æsop and the works of bishops who were very influential at the time. Thomas Paine's works were banned as he had been declared a traitor. In Spence's case, reading did not bring him wealth although his actions were for the greater good and he used his reading to challenge and provoke the government. He also used literature to change the English language to help people learn to read and write more easily. This can be seen in one of his works called *The Constitution*, "dhe objekt ov dhr mishun"<sup>[15]</sup>, in which he creates words using phonic sounds to make it easier for people to read. He also changed the lyrics of 'Rule Britannia', in which he expressed his thoughts on allowing people more freedom in what they were allowed to read. "Then zealous be your press to the free, And you'll secure your liberty,"<sup>[16]</sup>. All his work was for the greater good but he was not appreciated for his good nature.

Literature was used to help create people's individual identities however, it did not always leave people wealthier but perhaps left them more fulfilled. As you can see, two men from very similar backgrounds, Lackington and Spence, did not come to the same end proving Watts and Chesterfield wrong despite having good intentions.

In conclusion, I have found that reading and literature were very influential in the 18<sup>th</sup> Century; they helped develop national and individual identity, created the public sphere and extended power in Britain to the citizens, they also became a basis for the way in which the nation saw itself and projected its values and aspirations. In addition, some of my findings were shocking, for instance, the fact that there was segregation between genders in terms of admittance into coffee houses for important discussions and acceptance of work into famously acknowledged literary canons of the 18<sup>th</sup> Century. To summarise, reading did shape society and the lives of individuals in the 18<sup>th</sup> Century.

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### PhD Tutor's note

I am delighted that S.'s work has been selected for inclusion in *The Scholar* because she demonstrated so many scholarly qualities during the time I taught her. She worked hard, organised her time well always submitting work promptly, was not afraid to share ideas in class, and used her creative and constantly curious mind to produce excellent work. This essay demonstrates the wide research that she undertook and also her ability to reflect intelligently on the ideas we discussed and to communicate her thoughts to others. Any university would be extremely fortunate to have S. as an undergraduate and I wish her well in the future. I enjoyed teaching in Holloway School and I'm very grateful to S. McDonald for all her support during the term.

## Re-inventing Art: Banksy and Kara Walker

### Year 10, Key Stage 4

**J. Stevens, Sir Christopher Hatton Academy, Wellingborough**  
**Supervised by K. Morozova, Open University**

Throughout the 20<sup>th</sup> century, art was constantly being re-invented. Art became a means to address politics and revolution, and many artists at this time adapted to portray issues in society. Through artists like Marinetti and his 'Manifesto of Futurism' which started a movement which captured uprising, revolution and energy, to the Dada movement attacking the German government and liberating its people, art came a long way. But now, in the 21<sup>st</sup> century, political art has died down somewhat. In this essay, it will be argued that while British street graffiti artist Banksy and African American contemporary artist Kara Walker (both 21<sup>st</sup> century artists) may not have changed the world through their work, they have both re-introduced the idea of political art into the mainstream, in a way that has not been apparent for some time. In their use of the popular and instantly familiar, they address social issues and critique stereotypes in a way that easily connects to the people – rather than to a purely elitist audience. I have chosen these artworks because they both depict similar attitudes towards racism, segregation and equality, but in very different forms and mediums.



Banksy, mural on a beachfront wall, Clacton-on-Sea, 2014

Banksy's untitled mural, featuring five grey pigeons and a migratory bird, was painted onto a wall in Clacton-on-Sea in 2014. This artwork appeared a week before a UKIP by-election that was dominated by arguments on immigration. The pigeons hold up signs like 'Migrants not welcome', 'Go back to Africa' and 'Keep off our worms' towards the more colourful, supposedly foreign bird. It clearly depicts the problems surrounding immigration. UKIP continues to argue that current government controls on immigration are insufficient, and recently revealed their own plans to create a Migration Control Commission to bring down net immigration. This would increase border staff by 2,500 and define rules to discern EU citizens from non-EU citizens. (Oakden, 2017). Banksy seems to be reflecting on this increased attention towards immigration, using birds as a metaphor for social argument.



Not too long after his mural was painted, it received a complaint because it 'could be seen as offensive and racist' and was taken down. (Johnston, 2014) Yet, as with many artworks that depict racism, should we not see his work as holding up a mirror for us to recognise our own tendencies? Political art is designed to make us step back and rethink, to question our own moral boundaries and social conscience.

Kara Walker's artwork is called *My Complement, My Enemy, My Oppressor, My Love* and is featured in the Whitney Museum of American Art. She has created many other works using drawing, painting, projections and film, but she is most well-known for this room size tableaux depicting numerous images of 'sexuality, violence and subjugation'. This is accomplished through the simple medium of black figures upon a white background. (Walker, 2007). The black figures are shown in many harsh and grotesque positions, portraying the image of slave men, women and children in severe, stereotypical forms. The imagery is designed to have immediate impact, the posture of the figures quickly showing their subjugation, and the effect is startling. It demands an emotional response, but a complex one, whereby social and historical guilt are used to encourage thought about today. Have our attitudes changed? Are we, or are we not in a better world? As history and politics are simply the past and the present, this is a clever means of urging debate.

Banksy's objective with his mural is to display the current problems of immigration in a light-hearted and understandable way. As not all people will understand the problems of immigration, especially the young and inexperienced, Banksy seems to know that there is a stronger chance these people will understand the migration of birds, specifically the colourful bird seen in the artwork. By dumbing down the idea of immigration to a flock of birds flying across the world, we can look at the mural and think of immigration as a basic process instead of an antagonistic activity performed by, possibly, an enemy. It also makes the whole question of 'friend or foe' seem a little silly, so that we question our own concept of this. But because the subject matter was contentious, it was taken down very early on, so his message hasn't reached as many people as he might have hoped.

In contrast, Kara Walker's objective is anything but light-hearted. She intends to portray the violence and cruelty of the slavery through flashes of 'real' stories from which she clearly draws her vivid imagination. All the twisted pictures around the tableaux depict black slaves and the environment that they were forced to work in. The use of silhouette is simple in this scenario – instantly the figures are indeed black, but more importantly they are faceless and therefore robbed of identity. The cruelty is apparent and hideous, providing an effective visual message to the viewer. Where Banksy tries to make a joke out of the strong message he is sharing, Walker captures every detail in gruesome accuracy.

Each artwork has achieved its purpose to a certain extent. Banksy's mural was controversial and taken down very early, but the council who removed the mural took a beating for it. The public lashed out, with responses such as, 'It is astonishing that people as cretinous as you have the power to make decisions affecting the public environment.'



Kara Walker, *My Complement, My Enemy, My Oppressor, My Love*, Whitney Museum of American Art, 2007

(Meredith, 2014) As a result, the image of the mural started blowing up online and Banksy himself posted pictures on his website of the mural and the wall after it was obscured. This viral promotion reached a far bigger audience than the mural alone could ever have done – and preserves a place in history for this political piece. This proves that Banksy's art will never truly disappear, and his political messages will continue to be found and shared.

Kara's tableaux was also seen as controversial and her silhouette image has been moved from museum to museum since its first airing at the Walker Art Centre in 2007 – from the Musée d'art moderne de la ville de Paris in 2007, to the Whitney Museum of American Art in 2007-2008 and the Hammer Museum, Los Angeles in 2008. (Walker, 2007). It's clearly a popular piece of art that pulls in a crowd, which then creates debate. Not all people have agreed with the violent message of racial stereotypes she is conveying. Betye Saar, another African American artist, who bases her work on racial issues, published her response – 'I felt the work of Kara Walker was sort of revolting and negative and a form of betrayal to the slaves, particularly women and children; that it was basically for the amusement and the investment of the white art establishment.' (Saar, 2017, p. 71). Although working towards the same purpose of destroying racial hate, Saar finds Walker's methods offensive and, as she says, a 'betrayal' to all the slaves who just want to be free. Yet this in itself raises argument and in so doing, forms part of the political activation Walker seems to promote.

Banksy's creative medium is constant, and it is no different with the mural. He uses spray cans to create very detailed street graffiti artworks. It is difficult, but also risky, to form intricate pictures with such a wide 'brush'. Graffiti is a social problem and it is illegal. It defaces public property and many people feel it makes the environment look ugly. (Crime Prevention, 2017). Banksy has to work fast and without anyone seeing him to avoid getting caught. He also prizes his anonymity, so wishes to remain private regardless of any legal threat. But he creates art with his spray cans. Art that has become popular and highly commercial. In his dominance with graffiti art, his work has become acceptable in society – which must in itself be a dilemma. We have to question whether he feels his politics remain clear in light of this commercial angle. By using such an urban method to create his pieces, he effectively makes his artwork very down to earth. Anyone noticing a new piece of his work must expect to see something vandalised,

but instead find themselves greeted with an unexpected message and a recognisable visual 'voice'. This may be why his dark humour and euphemistic messages seem so strong. Kara Walker's medium is a lot more deliberate and purposeful, created for an intentional public display in a mainstream gallery.

The use of silhouette in this particular piece entails placing black shapes onto a white or blank background. This was a particularly popular art form in Victorian times, but less so after the invention of photography. This simple procedure can look and feel extremely effective, and it has been practiced and brought back into fashion by people like Kara Walker and Charles Burns, a leading UK silhouette artist. (The Roving Artist, 2017). In Kara Walker's piece, the silhouettes are completely black with no details inside, showing that Kara Walker is not addressing how the slaves feel on the inside, but the way in which they are treated by the environment around them, shown by the drastic contrast of black and white in her work. Also, the vast white background in her tableaux reflects the constant white privilege that can be seen in America, particularly in the time of the slave trade which began in the 17<sup>th</sup> century. (History.com, 2009). Finally, she displays the silhouettes wrapped around a circular room. This could represent the fact that we are constantly exposed to racism all the time – that it surrounds us and still forms a big problem in our society.

Banksy's message about migration and immigration is conveyed simply. In the image, we see five grey, boring pigeons of a fairly large size to the left compared to the smaller and more colourful bird on the right. It is clear to the viewer that the grey pigeons are the dominant species in this situation. The colourful bird is looking back at the larger birds suggesting that it is moving away, forced by the pigeons to go somewhere else. This is very similar to Walker's message about how certain races might have dominance over each other. The pigeons appear to be protesting against the colourful bird with very believable placards. Some are serious and malicious, like 'Go back to Africa', while 'Keep off our worms' is very much related to the joke that Banksy is making about migrating birds. However, it still carries the message that some people are denied access to certain things. Another interesting thing is the change in the background. The pigeons reside on a much smoother section of the wall, while the migratory bird is forced onto the rougher section. This shows a very thoughtful approach on Banksy's behalf at displaying the difference in quality between two different racial classes, suggesting that the migratory bird, or immigrants in the literal sense, have a 'rougher' lifestyle.

Kara Walker's choice of visual interpretation is much less subtle. She captures every gruesome detail of the animosity of the plantation slavery with the intricacy of her silhouettes. The fountain shape is a really powerful image. It shows two black figures forming the twisting and grotesque shape of the water feature, like they are becoming part of the horrifying place they must work in, reflecting the constant beating and whipping for punishment on the plantations. (The Abolition Project, 2009) In a way, she is trying to show that the bruises and injuries from these beatings form the landscape of the plantations and the destructive nature of the slave owners. What looks to be water gushing out from openings on the figure's body, can be interpreted as blood,

representing the unrelenting punishment on the slaves and the consequences that this causes. Other powerful images in the artwork include a man getting thrown carelessly onto a wheelbarrow, a man standing behind a woman and abusing her, several figures holding weapons in their hands and many images of enslaved children among the chaos. The whole artwork is portraying the violence of the slave trade, and the intent within Kara Walker's chosen message.

Another interesting thing to note is the difference between both of the artists' culture. Banksy is British, and a lot of Brits like to make jokes about politics. Through satirical and offensive humour, we make fun of politicians and the media, and some of this humour is shown in Banksy's image. In contrast, Kara Walker is African American, and therefore haunted by the experiences of the slave trade. This seems to permeate her technique, bringing a more harrowing level of impact to initiate debate.

Overall, both of the selected artworks convey very similar messages, but the main difference is the level of severity within their images. Banksy does not hesitate to make a joke and a euphemism in his message of immigration, whilst Kara Walker does not hold back in including every harsh detail of her message about the slave trade. This difference is extremely important, because we get to see how two artists can interpret similar problems in a deeply contrasting way. If artwork addressed every issue in the same way, we would never receive a different visual perspective and maybe miss a viewpoint. Banksy and Kara Walker both achieve their aims in the way that they see is right. They do what it takes to get their artwork known to the world – Banksy takes to the street and social media, whereas Kara makes sure that her work is well stocked in many museums. They deliberately provoke controversy within their work and approach. Not all people will agree with their methods, but this is the point where all debate begins, and what Banksy and Kara Walker clearly seek. They want people to step back and think about their own attitudes and question how they should improve in the future.

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#### PhD Tutor's note

J. was one of the quieter members of the group: he always needed time to think about every complex issue that we discussed, but, whenever he felt ready to contribute to the class discussion, his answers to my questions showed not just his natural ability, but also a level of maturity unusual for Year 10 students. He chose one of the most difficult topics that we discussed in class, did his own research and devised an original and very ambitious argument full of interesting ideas and perceptive observations. I am very proud of his work and wish him all the very best for the future. Any university will be lucky to have such a brilliant student!



# Friend or Foe? European Relations with South Africa During the Period of Apartheid 1948– 1994

Year 10, Key Stage 4

L. Fuchs, Weston Favell Academy, Northampton. Supervised by H. Crosfield, Royal Holloway, University of London

Apartheid is a Dutch term used to describe separateness. Specifically, this term is commonly applied to racial segregation; the keeping apart of people depending on their ‘race’. Race is a social construct that was created in the 16th Century and implies that skin colour affects people’s worth or characteristics. This idea was further developed during the reign of European empires and, specifically in South Africa, by the British Empire.

The white colonists’ approach of exploiting an ‘indigenous’ civilisation and their ideas about how race affected individual worth mirrored Columbus’ original exploitation of Native Americans. The British colonist Cecil Rhodes famously said “we must treat natives where they are in a state of barbarism to a different way to ourselves. We are to be lords over them”. This statement is not only easily compared to Hitler’s ideas of an Aryan race, but was more reflective of Apartheid’s policies than Henrik Verwoerd’s description of Apartheid as a “policy of good neighbourliness”. Verwoerd tried to excuse the inexcusable by declaring the policy as “misunderstood”. The similarities between Aryan teachings and Apartheid policies is astonishing considering how little opposition was raised to begin with. It took until the Boycott Outspan Action’s (BOA) Inspan girls’ actions to fully widen our morality to respond to discrimination in a post-colonial context.

The South African Apartheid occurred between 1948 and 1994 under the National Party, although its antecedents can be found in the 19th Century. It was the separation of whites from ‘non- whites’ in the form of both Petty and Grand Apartheid, which began when South Africa shook off its ties to Britain and became independent and ethnically Dutch white forces gained the political majority, even though they were demographically in the minority. The segregation policies had already existed, but this new, all-white government, began increasing the focus on them and enforcing their upkeep dramatically. Some argue that Apartheid was just an extension of earlier segregationist practices introduced by the colonists (Karel Roskam, 1960), but in either case the result was the oppression of the majority, the privileging of the minority, and the crippling effect that such a policy was bound to have on the development of society as a whole.

In this essay I will discuss the different relationships between Europe and Apartheid-era South Africa by evaluating the factors that may have influenced Europe to develop a friendly or unfriendly attitude towards Apartheid.

Being a foe of Apartheid meant being against its policies

and the regime as a whole. This could be expressed and acted upon in numerous ways, for example a foe of Apartheid with international influence would create solidarity with opposition groups, like the ANC/PAC, and be wary of trade deals with South African companies, as well as educating people on the harm that was being caused. The general public could join or organise protests, donate to funds like the IDAF and take part in activism like the City Group Non-Stop Picket. This was particularly effective because it caught people’s attention. It was a high-visibility campaign whose constant presence helped create a culture and sense of community (Gavin Brown 2011). A foe of Apartheid would also choose not to emigrate to South Africa, as they would know that they are taking jobs from the black population. An anti-Apartheid group would need to discourage immigration to South Africa as each immigrant could make the country and the Apartheid regime stronger. In 1997, BOA was involved in an anti- white migration campaign that included sensible arguments for and against emigration to South Africa (Karel Roskam, 1975), to help inform the population and help them make educated choices. Some of the leaflets also played along with stereotypes of black violence in order to frighten people away. The campaign was a combination of threats and logical debate that sought to provoke a response from South African migrant organisations in Holland and tourist bureaus as well as repelling the potential migrant. There were also numerous boycotts across Europe, including the BOA and the EFD (Peter Lang 2010) boycotts, as well as the publicity of the Inspan girls and the Rivonia Trial.



Sign from the Apartheid era in South Africa.

In terms of diplomacy, foes of Apartheid could try to exert influence on the situation. For example, UK Prime Minister Margaret Thatcher tried to influence the situation without causing direct conflict. This policy, pursued by both Margaret Thatcher and Ronald Reagan, was known as constructive engagement, which was a policy of macro interventionism though investment in the late 1960s (Leggasick & Innes 1977). It was criticised, however, as being ineffective because, being a series of subtle changes, it was too slight and insubstantial: people wanted things to change more quickly. The idea was to be a friend to the black workers and the government, but this was impossible because of how divided the society was both physically and emotionally. For example, a lot of money was invested in Barclays, with the intention of bettering the working conditions for black employees, but the money only

really increased the wages of the whites and didn’t benefit the black workers very much. Constructive engagement prioritised supporting capitalism, in a similar way to the Truman doctrine, by improving the living conditions of the people that may otherwise support communism out of desperation. However, because of the principles of capitalism, the people in charge were unlikely to give the extra money to the suffering black workers and more likely to keep it for themselves.

Boycotts such as the BOA were often criticised as harming the black workers who may lose what little pay they had. However, a statement from the South African Congress of Trade Unions (SACTU) dispelled this by stating that ‘we do not shrink from any hardship in the course for our freedom. As it is, we are starving... trafficking in the fruits of Apartheid can never be in the interest of those who suffer under Apartheid’ (1963). This shows us that the European public, when it took more drastic measures against Apartheid, was more helpful than the ‘diplomatic’ attempts of Thatcher.

The social impacts of Apartheid affected both the white and ‘non-white’ population. Not only did the ‘non-white’ population suffer constant abuse and reminders of their inferiority, the white population often felt themselves to be more important than their ‘non-white’ fellow human beings. Outside influence was needed to shake this illusion, show support and increase morale amongst those suffering under Apartheid’s policies. The UN’s influence on the Rivonia trial, and the funds from Europe that made it possible (the International Defence and Aid Fund in particular), gave the black South Africans new hope and forced the pro-Apartheid citizens to accept that the world didn’t wholly approve of their actions. However, with World War Two in recent memory, many countries were reluctant to involve themselves in any kind of conflict, which would cost money, lives and morale. Even if Europe had been a definite foe of Apartheid at the time, the population and the countries’ resources weren’t ready for another conflict, whether against the USSR, who could have gained power had South Africa changed sides politically, or against the South African government in support of an Anti-Apartheid uprising.

People who felt very strongly about Apartheid often took their own initiative to undermine the power of the National Party when their country didn’t act politically. For example, the women of the Evangelist Church of Germany organised a boycott of produce grown in South Africa in protest. So even if Europe was not predominantly for or against Apartheid to begin with, solidarity groups and movements were forming.

Margaret Thatcher said at the commonwealth in Vancouver in 1987 that the ANC was a ‘terroristic organisation’, which shows us how she perhaps put herself in a favourable position with the South African government even though she negotiated for Nelson Mandela’s release from prison (Richard Dowden 2013). However, it was not just anti-Apartheid groups that could act independently and from a different viewpoint as their government as, in that same year, the British ‘young conservatives’ proudly displayed placards with their new slogan: ‘Hang Nelson Mandela’.

A social movement is when people work together to collectively achieve a joint aim relating to changing a social order, in this case bringing about the end of Apartheid. The anti-Apartheid movement was made up of groups and individuals who sought

to bring about change by informing the population about Apartheid, by disseminating information, by organising more individuals and by taking direct, public action like protests. The City Group’s non-stop picket is an example of such an action. There were also symbolic events, such as the renaming of roads. The anti- Apartheid movement developed steadily, and the more anti-Apartheid ideas were put into practice, the more a country became a foe of Apartheid. For example, the EFD’s Fruit boycott, which involved everyday individual action, was part of a much larger movement, without the individuals being part of a larger organisation.

The anti-Apartheid movement worldwide formed a network of organisations across Europe that made the abolition of Apartheid their main concern. It also aimed to be a ‘non-partisan’ organisation, meaning that it would appeal to people of varied political ideals united for the future of South Africa (Gurney, 2000). The extent to which a country was a friend or foe of Apartheid could be measured in how developed the movement was in that state. Håkan Thörn said in 2007 that ‘the pressure of an increasingly visible anti-Apartheid movement... did have a substantial effect on the disinvestments of global corporations’. This tells us that the movement was successful, as it influenced the relations between corporations and South Africa. However, the movements were successful to varying degrees. Britain’s politics with South Africa, for example, were influenced little by the anti-Apartheid movement until the 1970s, which shows us that Britain acted, at least for a while, as a friend to Apartheid. Independent shows of defiance often achieved little more than to garner attention, but not the attention of the people they needed to influence. Very pro-Apartheid governments often had many investments in South Africa, Britain amongst them (Gavin Brown, 2013). In fact, Britain, with Thatcher adhering to constructive engagement, was the highest investor in South Africa in 1985, with £25 billion investment, over 10% of Britain’s foreign investment (Helen Yaffe, 2013). The movement in Britain didn’t influence the government enough to change its standing until much later on.

Many people failed to make the connection between racism abroad and racism at home. However, the BOA, for example, didn’t just combat the racist attitudes of Apartheid in South Africa, but also at home where less attention was drawn to them. One might expect that after fighting against the genocide of the Jews by the Nazis, such racial discrimination as was embodied by Apartheid would have received little support in Europe. However, it did, partly because enlightenment ideals hadn’t yet spread to include non-white groups and partly because of political tensions that were arising between the USA and USSR as each envisioned a different future for the world and embodied completely opposite ideals. The rise and fall of the tension between the two superpowers is known as the Cold War. The western world was reluctant to oppose the South African government for fear of losing their support (Alex Thompson 2005). The West didn’t want South Africa to ‘fall’ to communism and was apprehensive to support the ANC or PAC, as both (although notably the PAC) had connections to and received funding from the USSR, and subscribed to some Marxist ideals. Indeed, the largest supplier of computers and technology to South Africa was the US, because they wanted the support of the South African government, even if it meant they were directly supporting Apartheid.

US companies also paid lots of taxes in South Africa, which



paid for the police, weapons and prisons that maintained the Apartheid system (Parsons, 1985). They were scared that if the PAC or ANC rose to power, South Africa would become another communist satellite state. The Soviet Union already controlled some very mineral- rich countries, and South Africa had large amounts of metals, coal, platinum, diamonds and gold. The West didn't want these resources to fall into Soviet hands. The extent to which the situation was affected by fear of the spread of communism was shown in the Rivonia trial, where one of the accusations levied at the ANC was "acting in (destructive ways) to further the objects of communism". This was perhaps one of the issues that made the ANC's growing popularity so concerning, and the support of them difficult, for many European governments. When the Soviet Union began to fall in 1989, there was no longer such a strong incentive to support the regime. The change in relations at that point shows how significant the threat of communism was in influencing the West's approach to Apartheid.



The South African Native National Congress delegation to England, June 1914. Left to right: Thomas Mapike, Rev Walter Rubusana, Rev John Dube, Saul Msane, and Sol Plaatje

One of the most influential socio-economic factors that contributed to relations between the West and South Africa were the 'blood-ties' between the Dutch and the Afrikaner South Africans. South Africa was the Netherlands' only 'daughter' country in terms of culture and so the attention it was given by the public and media was out of proportion to its remoteness and political significance. The relationship to South Africa often relied heavily on past relations. The blood-ties in the Netherlands created a unique sense of responsibility between the governments. Therefore, Afrikaners had strong ties to Holland, where some of the pro-Apartheid groups were formed (Grundy 1974). Many of these groups argued that the white South African government should be unopposed by outsiders who didn't understand complex South African ideas in regard to race (Grundy 1975). Many Dutch citizens migrated to South Africa to profit from the cheap labour, good living conditions and guarantee of a good job. During the era of the colour bar, whites in South Africa earned 70% more than those in England (Clark and Worger, 2004), which spurred migration.

The media was perhaps one of the most important factors in the fight against Apartheid because it had such a big influence on the attitudes towards Apartheid worldwide, which were the most important thing in the rise or fall of

the system. Europe, at the beginning of the regime, was largely apathetic, and attitudes had to change in order for protests to occur, funds to be raised and boycotts to be organised. In the end the mass media shook off its passivity, largely due to the UN's increasing interest, and the topic was discussed internationally on a much larger scale than before, with the UN declaring 1982 the International Year of Mobilisation for Sanctions Against Apartheid. In a conference in Berlin the year before, the UN had urged all media workers to "mobilise world opinion on Apartheid", which was of importance not only because the mobilisation of awareness had advanced from street protests to global media, but also because finally an organisation of major political influence had voiced an opinion on Apartheid and acted (Greg Guma 1981).

When the media did decide to focus on the issue, it gave a comprehensive view of the atrocities committed in South Africa and showed the world the Rivonia trial, which was only possible because of Funds from the IDAF and pressure on the South African government. It was a very useful tool in educating the world on the situation at hand in a reliable, trustworthy and efficient way. Furthermore, compared to the passive approach in the 1950s, the media gave significant coverage of the Sharpeville Massacre in 1960 and this merciless killing of innocents, the youngest victim being nine years old, shocked the people of Europe into action. The effect of this was shown by the way the UN dealt with South Africa, as before they had reluctantly accepted South Africa's rebuttal of their involvement by saying it was part of the internal affairs of the country and not of the UN's concern. After Sharpeville, the UN became more openly critical of Apartheid, which led to their supporting the Rivonia trial. The IDAF's funding of the Rivonia trial, and that the European people contributed to the enforcing of human rights was an act of solidarity that was partly encouraged by the horror people had felt hearing of the Sharpeville massacre.

Apartheid was a conflict of opposing ideologies. Europe had to overcome its past culture of racial oppression and its capitalist society of everyone working for their own interest to begin to condemn South African Apartheid. Overall, Europe's relations with Apartheid developed to such an extent that, at the decline of the Soviet empire, when there was no longer a diplomatic need to appeal to the South African government, Europe no longer supported the National Party and the ANC rose to power.

**Programme Officer's comment**

A fantastic essay with a remarkably mature approach and understanding of a complex issue. L manages to use a range of sources to build a cohesive and assertive argument around the factors that underpinned European relationships with Apartheid-era South Africa. With the strong grasp of historical skills, use of language and essay structure – this could easily be mistaken for a piece of undergraduate work – a great achievement, congratulations! –J. Loudon, Area Director, West of England, The Brilliant Club

**Early Twentieth Century Avant-Garde Poetry**

**Year 10, Key Stage 4**

**L. Tregenza, Mounts Bay Academy, Penzance  
Supervised by D. McFarlane, University of Exeter**

During the early twentieth century there was an explosion of innovation in writing and art that contradicted the traditional style used repeatedly prior to this movement. Within this large movement there were many smaller groups that had their own values and beliefs on topics that generally opposed each other. For example, the Italian Futurists (led by F.T.Marinetti) were much more in favour of shocking people. They took inspiration from the fast-changing development of technology that drew them away from poetic tradition, which they believed should be destroyed. This contrasted with the views of the Imagistes (led by Ezra Pound) who became so called 'experts' on traditional poetry before they wrote their modernist pieces. Another equally important Imagiste, T.S.Eliot, wrote a quote that gave the perspective of many of these upstart groups; the quote stating that 'Novelty is better than repetition'.

The Italian Futurists would have agreed with this quote and supported it to a more extreme extent than others because they themselves believed that literary tradition (which can be represented via the word "repetition") should be destroyed. This shows that to the Futurists, tradition could be seen as repetitive and very similar to other literature which was not of the Futurist style. It would therefore have upset them as it contradicted many of the things they wrote in their manifesto. They would also have interpreted the 'novelty' part of the quote as new work tailored to shock and create change, as again this supports the very strong manifesto of this group. To sum this up, the Futurists didn't value poetic tradition as they felt it limited their work because it follows lots of grammatical rules which is also a feature of traditional literature. They did value poetic innovation, as it allowed them to use their so-called 'words in freedom' method. This conveyed the changing technology in the world around them, as well as destroying other innovative techniques that weren't as radical as words in freedom, such as free verse which was used by Imagistes such as Ezra Pound.

However, unlike the Imagistes the Italian Futurists valued traditional work very little. They wanted to burn all the libraries and museums as they were places that preserved tradition which they viewed as restrictive. They therefore took inspiration only from the rapidly changing world around them, and created words in freedom as for them free verse was no longer modern enough. Words in freedom threw grammar and spelling rules away. It was tailored to shock audiences and critics alike; the work looked nothing like poems at all and was not made to please but almost to spark change or riot. The only similarity to Imagiste work was its clear boundary pushing style which caused audiences to feel extremely strong emotions almost instantly.

An example of their words in freedom style is a poem made by F.T.Marinetti. The poem is called Bombardment. Based on a battle on which Marinetti reported, it takes on an almost incomprehensible shape that has completely distorted words. For example the word "vibrate" is used multiple times

in an almost onomatopoeic way via the repeated use of the letter "r" in each one. This is an example of what Marinetti called words in freedom which allowed words to do what they want. In this case the words are chaotic in their form in order to convey a battle with machinery which was a topic the Futurists favoured, and took inspiration from, due to the fact that it was changing constantly, particularly at the time of the movement. This piece, however, is clearly carefully written. It has forms of what looks like calligraphy, with the balloon in the middle and radio signals as the words vibrate. The point of this piece being so dramatic (i.e. describing a battle) and different, is to completely upset and shock audiences which was one of the main motives within Futurist poetry.



Giacomo Balla, Abstract Speed + Sound, 1913-1914 From: [www.guggenheimcollection.org/site/artist\\_work\\_lg\\_11\\_1.html](http://www.guggenheimcollection.org/site/artist_work_lg_11_1.html), PD-US, <https://en.wikipedia.org/w/index.php?curid=1180321>

In comparison to the Italian Futurists, the Imagistes valued their modern work just as much as traditional work, because they still used older technique and mixed it with free verse to make it a novelty. This allowed them to be experts on poetry, value the past and still create beautiful works. Critics at that time were very focused on art and literature as being "pleasing" which put them behind the Imagistes who created work that was aesthetically pleasing whilst still pushing conventional boundaries.

In contrast the Imagistes would not have agreed because firstly they believed that they should know as much as possible about traditional poetry and poets. They wanted to become 'experts' on poetry before creating their 'novelty' work. This demonstrates that they would regard this quote as opposing their methods, as it seems to belittle the past as repetitive, thereby placing it under a negative spotlight and ridiculing it. They viewed both tradition (repetition) and innovation (novelty) as being equally important in creating their work. To sum this up, the Imagistes valued literary tradition as much as innovation because they believed they must study from the old to create new. This suggests that they repeat the use of one typical technique and shaped it into a novelty.

An example of this re-sculpturing of a repeated technique is found in Ezra Pound's "In A Station of the Metro". The poem itself is made up of one metaphor split into separate words. The poem is clearly free verse (a modern technique that involved presenting a stanza in an odd way) but it retains its Imagiste style through the use of a language device (metaphor). This mix of novelty and repetition clearly presents the Imagiste's favoured balance of the two. The metaphor within the poem compares 'the apparition' of



faces in a crowd, to petals on the bough of a tree. This can be seen to say that each face is different and has its own colours and shape, just like a petal. The faces are also made more significant and brighter against a dark and almost dirty object. This could be an extended metaphor for a train station, which the title suggests also suggests, and how humanity's creations are large and dark whilst the humans themselves are beautiful. This shows a contrasting message to that of the Italian Futurists as it challenges the changing world around us, which the Futurists celebrated and from which they took inspiration. This displays a possible conflict between the two parties, who argued over whether tradition or innovation was a more valid style when creating poetry. Poetry which was definitely at a turning point with newer generations finding less value in writing poetry filled with emotion and lacking originality in structure and sometimes even in content.

Another Modernist was John Rodker, who didn't identify as a member of these contrasting groups, but saw poetry as way of communicating to the outside world from what he called the 'void'. He was born lower class which didn't enable him to read much older poetry. He said he liked to shock audiences. Therefore I think the quote by T.S.Eliot applies heavily to Rodker and his work. An example of one of Rodker's first works is his poem "Item". The poem is shocking as it holds less of a normal shape than that of "In A Station of the Metro ". but similarly has a metaphor as the only verse. The metaphor compares a heart to some strings in a bag. The bag itself is very exotic as it is peacock blue and satin, but only holds some pieces of string which in turn are a complete contrast to the bag. You can also see that the strings or the heart are carried around as if they were in a bag. The complexity and confusing manner of the metaphor links to the idea that Rodker enjoyed to shock himself and others. His poems, however shocking and odd with their typography, were completely separate to those of the Italian Futurists. However despite the random presentation, all these works were clearly carefully crafted as the reader can see through the interesting ideas that this poem presents.

Unlike the Imagistes, John Rodker wasn't highly educated. He knew little of poetic tradition and probably didn't value it as an important part of helping to craft his work. However he did use free verse similarly to Imagistes, and favoured it when creating his work as one can see in his poem "Item". This use of free verse shows that like the Imagistes he valued innovation or novelty work. To summarise, he valued tradition little as he had minimal access to it, but similarly valued innovation as a key part of literature, just as did the Imagistes.

In contrast Rodker had more similarities with the Italian Futurists. Like him they valued literary tradition to the lowest extent, and loved to created innovative work that shocked audiences. However they both used to different styles to shock: free verse and words in freedom. Words in freedom valued a much more shocking and modern style which transformed their poetry into what looked like collages or calligraphy. This shocked people more so than Rodker's free verse which, although different and innovative, clearly made the work look like a poem. This left a trace of tradition within his work.

Another way to look at how these groups valued old versus new, or tradition versus innovation, is through the main purpose of their works. In John Rodker's case, he wrote poetry to establish contact whilst 'hanging in the void'. His poetry was made to shock which allows us to interpret that he was completely focused on innovation, as traditional work was made to seem beautiful like a work of art. In contrast, modern work is generally made to innovate and shock in order to create change via a strong reaction which draws attention to a movement. With the Imagistes (particularly Ezra Pound) they wanted to rid poetry of emotion, but not the actual element of poetry itself, thus splitting equally the ratio of innovation and tradition. This therefore placed them in the middle as they intended to use both to create work 'free from emotional slither'.

Finally, the Italian Futurists wanted not just to spark riot through upsetting their audiences, but also to destroy buildings like museums that celebrated the past rather than the contemporary revolution in machinery, as well as those who worked to preserve the past i.e. archaeologists. This to show that they didn't value tradition and saw it as an enemy to their shocking words in freedom style, and that they valued innovation completely as it captured exactly what their art and literature was. In conclusion it is clear that during the early twentieth century, the avant garde groups which led this revolution in culture not only fought the critics and sometimes tradition, but also each other with their views of how new art and literature should be contrasting wildly. This sparked conflict which was as effective in changing culture as the First World War was in changing societies and warfare globally. These groups have, however, had a lasting effect on poetry that we see in our society. Poets such as T.S.Eliot are seen as one of the 1900s most influential figures regarding change, particularly within literature. Lastly, despite the other amazing changes and people behind them during the twentieth century, I ask you to consider how much of the art, literature and ways we view the two have been shaped and influenced by this collection of groups and figures. Though viewed as very extreme in beliefs, or dramatic regarding their methods in attempting to create change, they can be seen as some of the foundations of art and literature that we still recognise now, over a century after they created their first groundbreaking works.

**Programme Officer's comment**

This incredible essay seems to reflect the fresh and exciting approach of the early-twentieth century Avant-Garde poets that are its subject! It is a really enjoyable and informative read, with an impressive interpretation of some challenging texts. Great academic work should inspire its reader to explore the topic further themselves and this essay certainly made me go away and look up the work of F. T. Marinetti, in particular. L has written a very well-structured piece of work with high level analytical skills, congratulations!  
– J. Loudon, Area Director, West of England, The Brilliant Club

**Explain why the Normans were Perceived as Different from Other Ethnic Identities in 11th-Century Sources?**

**Year 10, Key Stage 4**

**R. Boote, Year 10, Preston School, Yeovil**  
**PhD Tutor: T. Chadwick, University of Exeter**

Ethnicity and identity are constructed and relational. The Normans were made up of many different ethnicities, however they all had one Norman identity. They were described as warlike by 11th Century writers, who discussed their fighting tactics at the battle of Hastings, their clothing and hairstyles (as shown in the Bayeux tapestry), and their leaders. These factors are what medieval writers, as well as leaders, would use to give a nation of people a sense of identity and unity.



A segment of the Bayeux Tapestry depicting Odo, Bishop of Bayeux, rallying Duke William's troops during the Battle of Hastings in 1066

The Normans were men of the North (Norsemen) who also had Danish heritage and ancestry. They also claimed heritage from other cultures, for example when Rollo conquered the city Luna and Dudo wrote of how he pretended to die and then took over the city, they evoked the Grecian story of the Trojan horse, using this to claim Trojan ancestry. The Norman Ducal Family tree originated with Rollo (846-931) who negotiated with the King of Francia to give them the land that became Normandy and formed the base from where the Norman expansion began.

Othering was a common practice used by 11th Century writers, as well as in modern times. This is where a nation tries to describe weaknesses in other countries to make their nation seem more advanced. The Normans used this to make their leader seem strong and ferox (fierce). For example, when the French broke a truce with the Normans and then begged Rollo to spare them, making the Franks seem weak, Rollo felt justified in being ferocious when killing them. The Franks also used othering against the Normans, to make themselves seem a more peaceful nation than the Normans. This makes the Normans different from the Franks, creating an image of the Normans as warlike. Furthermore, other 11th Century

sources describe the Normans as monstrous, othering them to make people scared of the barbaric Normans and spur them on to defend their land that the Normans might try to conquer.

An 11th Century source suggests that the King of Francia was made weak when his own advisors were working in their own interest to accumulate wealth. They allowed Rollo to take advantage of the situation in Francia in an effort to obtain land in what would become Normandy. Also the source describes the Normans as destroying land and properties and describes them as 'pirates', implying that they are uncontrollable and that their leader may not be able to control his men. This contrasts the 'savage' Normans to the peaceful Franks, and casts the two nations as different, giving the Normans a negative identity as being warlike.

However, Dudo suggests that Rollo was being strong when taking the land of Normandy and doesn't focus his writing on the Normans being barbaric. Instead he writes about how Rollo refused to kiss the King's foot when he was given the land that would become Normandy. Instead he had one of his warriors to do it instead. This shows how Rollo's actions can be justified and can make him seem stronger than the King of Francia, portraying the Normans as better than the Franks. However, Dudo was hired by the Normans and was therefore biased towards them, describing them as stronger and a better nation than any other.

At the battle of Hastings, the Saxons had the advantage of high ground but were disadvantaged by the fact that their soldiers had already fought a battle at Stamford Bridge and had travelled across the country to reach Hastings. The Saxons had an almost impenetrable shield wall, however when Franci Mercenaries retreated, some of the Saxons followed, contributing to the wall breaking. Once the wall was broken, the Norman cavalry charged in and the archers helped to further destroy the wall.

The Bayeux tapestry, shows the difference in the use of weaponry by the Normans and Saxons. The Saxons used round shields so that they could overlap when standing in the shield wall, which they were very reliant on during the battle. They also used Housecarls to protect their king and to fight the Normans. However, they were dependent on the high ground and William the Conqueror used his cavalry to destroy this advantage because the horses could easily charge up the hill. The Normans also used mercenaries, Danish and French soldiers, who had different ethnicities but were united by their Norman identity. They also had archers that aimed to fire arrows over the shield wall.

The Franci mercenary retreat helped the Normans to win the Battle of Hastings, however the Normans and the Franks viewed the retreat in different ways. William of Poitiers was Norman and told Duke William Chaplain that he thought the retreat wasn't shameful because the soldiers thought their leader had fallen and they did turn to fight the Saxons that followed them. This broke the shield wall allowing the Norman cavalry to charge in and break it further. Poitiers depicting the retreat in this way allowed the Normans to feel braver than the Franks, giving them an identity of being courageous for not retreating.

However, Guy Bishop of Amiens who was a Frank and whose relatives were at the battle, writing in the 12th Century viewed the Franks' retreat as cunning. He believed this was a tactical move by the Franks and suggested that they



retreated on purpose so that the shield wall would break to follow them. However, Guy Bishop would be biased because he is a Franc, therefore might want to show the Franks in a better light. He tries to suggest that the Franks are cleverer than the Normans, making the Normans seem less cunning as the Francs.

Hair can show identity, due to it being easy to change, and can give a person a sense of identity through fitting into a particular group. The use of facial hair shows the Normans and the Saxons were different; the Normans were clean shaven; however the Saxons has long moustaches. This shows that the Norman civilians would feel part of the shared Norman identity through a simple medium like facial hair, it also shows how medieval sources depicted the differences in ethnicity. Furthermore, the Normans had the backs of their heads shaven and hair on the top of their heads, this contributed to the shared identity of the Normans and made the Normans different to other ethnicities allowing them to feel more unique.



Battle of Hastings.

The Bayeux Tapestry shows the difference in Saxon and Norman clothing. The tapestry displaying the difference between the Norman and Saxon soldiers, allowed Normans to feel included as they could see figures in the tapestry that looked similar to them; the representation made the Norman identity stronger. However, the Bayeux Tapestry is not a source that included civilian clothing because the Normans that weren't fighting in the battle were not represented; this may have pushed them further from the Norman identity as they did not feel included in this aspect of being Norman. However the Bayeux Tapestry is a cultural artefact which united the Normans, making them feel victorious from winning the battle.

The Normans saw William the Conqueror as a strong and tactically astute leader, who led them to victory at the Battle of Hastings. They saw him as an organised and wise ruler, who was in the Ducal family tree, suggesting he was a natural leader like his ancestors.

At the Battle of Hastings, William fought alongside his troops and also fought on the ground three times when he couldn't fight from his horse. He rallied the troops by them just seeing him fighting, making them identify as being strong like him because he was fighting alongside them. However, this was reported by William of Poitiers, who knew William the Conqueror, therefore this commentary could be viewed as biased.

In contrast to this, mercenaries recruited by the Normans, like the Francs, saw William as a brave leader, who was dedicated to his subjects, but at the same time brutal and not afraid to show his ruthlessness in battle. This goes against what William of Poitiers writes and could affect the Normans' sense of identity by making their leader seem too merciless, which could make them scared of him.

In conclusion, battle tactics, clothing and hairstyles, as well as their strong leader, contributed to the Normans sense of identity. Although the Normans were made up of many different ethnicities, they created a 'Normanness' and were united through the Norman culture. Othering didn't just exist in medieval times and still exist in modern society. Ethnicity and identity cannot exist without contact between separate cultures because otherwise those differences cannot be seen. Contact between the Normans and the Saxons, as well as the Francs, allowed the differences between their cultures to be seen, strengthening their respective identities as unique to their particular group. However, by the 12th Century the Normans' ancestry and heritage was in decline and eventually the Norman identity was lost.

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#### Programme Officer's comment

R. has produced an outstanding piece of work here, relating important and complex issues with current day relevance, such as the construction of identity, to the context of the 11th Century. This is a great read conveying a deep understanding of the historical context, a sharp analytical approach to sources and an impressive ability to develop unique arguments. Congratulations to R. on this brilliant assignment.

– J. Loudon, Area Director, West of England, The Brilliant Club

## How Did Friendship Achieve Equality in 1790s Radical England?

Year 12, Key Stage 5

H. Trenkic, The West Bridgford School, Nottingham  
Supervised by G. Harvey, University of Lincoln

Equality was the central aim of radical political movements in the 1790s; the 1789 French Revolution placed political focus on reform and equality, and the words *Liberté*, *Égalité*, *Fraternité* resonated across the world. The optimistic radical ideology took root in England, where radical pedagogy sought to breed a new generation of thinkers concerned with equality, radicals explored the pursuit of equality even in the pecuniary world, and fraternities such as the London Corresponding Society aimed to organise and further the radical movement. The extent of success of these movements – success being the achievement of equality in both the movement itself, and in society – is indicated by the presence of friendship, with friendship defined, when combining the ideas of Aristotle and Cicero, as the presence of trust, truth and sentimentality in a relationship. Friendship was essential in achieving equality in the aforementioned examples due to its abilities to create respect, stimulate progress, and intersect reason, education and organisation with sentimentality. Inequality in pedagogy and pecuniary affairs was neutralised easily by friendship. In the case of fraternities, however, friendship's varying forms solved some problems, but caused others; whilst the power of friendship to create equality is evident through examination of the organisation of fraternities, the roles of women and black people in fraternities, and the political essays of William Godwin, Thomas Holcroft's epistolary novel *Anna St. Ives* indicates the dangers of blindly attempting to follow a path of 'friendship'. Nevertheless, Godwin's *Enquirer* can again be used to show that when the correct form of friendship is applied to a situation, it can ultimately help pursue equality both in, and through, fraternity.

'*Liberté*, *Égalité*, *Fraternité*' seemingly indicated that fraternity would be considered of equal importance as individual liberty and equality. Yet in fraternities without friendship, the latter was often sacrificed in pursuit of the former two, and vice versa. Friendship, claimed Cicero, can make each 'treat the other as himself', generating the most basic form of friendship: respect of individuals. Without friendship, ordinary people, who joined radical fraternities to demand a voice in decisions of the government, found their voices yet again drown amongst others; members of fraternities lacked the respect to listen to one another. This handed a motivation to corrupt to the masses: to be heard, they would have to hold an unequal proportion of power. In France's Jacobin Club, members motivated by the inability to voice their opinions could easily rise to unofficially dominate the Club. This removed stability – divisions were made on the whims of leaders, forcing unwilling members to choose sides. In the absence of respect, discussion turned into argument. Combined, the instability and arguments made the pursuit of equality in society inefficient. Friendship between members, however, can prevent such internal inequality and reduce the inefficiency created by instability. The London Corresponding Society encouraged friendship, community and individual equality through rotations of



Eugène Delacroix – Erich Lessing Culture and Fine Arts Archives via artsynet  
Romantic history painting. Commemorates the French Revolution of 1830 (July Revolution) on 28 July 1830.

elected positions, and divisions 'small enough to give every man his chance to speak'. It was not the organisation alone, but the intersection of it with the sentimentality of friendship that made it successful. The assured respect of individuality, encouraged by friendship, removed a motive to dominate the society. Through friendship, fraternities can become more equal, and therefore more stabilised, which would make them more efficient at achieving their goal: equality in society.

One could argue that added voices increases dispute, but friendship, by intersecting Aristotle's and Cicero's ideas of sentimentality and truth, turns cold dispute into sympathetic discussion. Godwin's belief, '(that) truth... must infallibly be struck out by the collision of mind with mind', indicates discussion is vital; only the respectful discussion of a community bound by friendship can bring the 'truth' (the theory of equality) into grasp. The practice of allowing all to have a voice by generating respect through friendship should both ensure equality within the fraternity, and the pursuit of equality to be more easily achieved.

The path to achieve equality would also require friendships between fraternities, not just within them; the greater the numbers in friendly co-operation, the more extensive the 'collision of mind with mind'. In a more literal sense, their co-operation would allow fraternities to co-ordinate movements for an easier fight for equality, working together against the government's persecution. This had been attempted in the French Revolution, but their fraternities were grouped and fuelled by fear – as shown by Robespierre's final speech to the Convention – and were therefore ineffective at equally collaborating. Robespierre, amongst others, did 'not desire the support, nor the friendship of anyone' – this was the root of the descent into a bloodbath, where the battle of equality became a battle for factional superiority. Friendship can prevent the original motive from being lost; friendship between fraternities would, through producing respect, eliminate the urge to corrupt, and, through co-ordinated planning, allow for efficient strategies to arise. The London Corresponding Society and Society for the Constitutional Information attempted this; their friendship led them to arrange conventions in Edinburgh. Even when the first was



foiled by the government, their perseverance to organise another demonstrates the power of friendship in enhancing co-operation. Friendship could, therefore, aid the pursuit of equality both within fraternities and for society itself, by mitigating co-operation of the movement's factions to spur on the movement as a whole.

As well as bringing together and equalising individuals and societies, friendship could stimulate their progress in pursuing equality. Godwin's *The Enquirer* claims friendship can lighten difficulties and aid people in performing 'labours that are almost more than human' with ease. The pursuit for equality, as explained, was laborious work. Hence, according to Godwin, friendship could make the pursuit of equality through the radical movement an easier feat.

This power of friendship, to help the seemingly impossible become reality, was vital in particular to those excluded from the customs of fraternities: women and black people. Their path to the pursuit of equality would be more laborious than that of a white man, and near impossible if fraternities were absent of friendship. They were supposedly insignificant; *The Declaration of the Rights of Man and Citizen* excluded them. Slavery was not explicitly mentioned, let alone condemned, and Olympe de Gouges' 1791 response, *The Declaration of the Rights of Women*, explained how women had been excluded from the *Declaration's* promises. French radical women were later persecuted by the Jacobins – Gouges was executed, female societies outlawed, and feminist protests quashed. Fraternities of the French Revolution sought to pursue their *own* equality; their absence of friendship with the rest of society meant they cared not for those not included by the boundaries of fraternities.

Friendship could reduce this inequality, helping surpass the masculine stem of 'fraternity' and the racism of the time. It created ungended, uncoloured sympathy, and eased the 'labour' of marginalised voices entering radical networks. By forming a friendship with Thomas Hardy when lodging at his flat, Olaudah Equiano became involved in the London Corresponding Society. Although his movements were 'casual', limited to a few meetings with Irish radicals and 'blistering responses' to newspapers, his sentimental presence in the society, through his friendship with Hardy, ensured equality for black people would be considered. Friendship also allowed feminist writer Mary Wollstonecraft, who had been in danger in France, to enter English radical networks. Her first publisher, Joseph Johnson, showed remarkable 'generosity' by agreeing to publish a woman's work in a 'man's world', and inviting her to stay with him whilst he searched for accommodation on her behalf. He was also her mentor, spurring her on when she 'broke down' with nerves halfway through writing her political pamphlet, *A Vindication of the Rights of Men*, encouraging her to learn French and German, and helping her develop her revolutionary ideas. The combination of sympathy and strong reason made their friendship 'one of the most important... of Mary's life'. Mary's friendships with other radicals through Johnson also helped her navigate the 'taboo territory' of the male radical network. The words of friendship she received from fellow radicals, such as Thomas Paine's description of her as a 'comrade in arms', convinced her to persevere in her pursuit of equality when she received misogynist backlash after printing her name on the second edition of *Rights of Men*. Her later friendship with Godwin, in the form of marriage, cemented

her presence in the radical movement, ensuring the pursuit of equality for females was recognised. The friendship in the stories of Equiano and Wollstonecraft indicates, then, that through friendship, even the most marginalised voices could find a path into the radical movement, truly making the movement a pursuit of equality for all.

Unfortunately, despite friendship benefitting the pursuit of equality through fraternity in many cases, misuse or incorrect application of 'friendship' by societies could create inequality itself. Radical fraternities often included 'friend' in their name – such as the Friends of Mankind and Society of the Friends of Truth – because attempts to pursue equality could be through friendship's supposedly sentimental and caring aspect of assisting one-another. This 'useful'-ness, Godwin states, can make a society equal and, therefore, 'universally happy'. Holcroft suggested that friendship of a community with society is far more important than individual friendships through his epistolary novel *Anna St. Ives*, where the character Frank Henley seems prepared to sacrifice his relationship with his own father because they will 'never have the same opinion' on Frank's intent to 'serve society'. Holcroft writes Frank as the ideal pilgrim of altruism advocated by fraternities, yet whilst such societies claim they are 'Friends of the People', Frank's relationship with society is not friendship. Cicero stated that friends would 'dare to give true advice with all frankness... even sternness', and Frank's letter to his friend Oliver, where he speaks of his 'determination' to 'convince' a man with man 'vices' of his 'folly', aligns perfectly with this. However, the sentimentality and care Aristotle defines as friendship are absent. Frank's language demonstrates his lack of care; he wishes to hubristically 'convince' a 'man' of 'his folly', rather than help a friend overcome difficulty. The lack of friendship makes their relationship unequal – Frank asserts himself as being of a higher status than the man, for he is convinced that the man requires his help. Furthermore, Frank's description of his actions as 'duty' displays them as mechanical and devoid of care, but also as mere servitude. In blindly serving society as instructed by the radical 'friendly' fraternities, individuals not only fail to be friends to society, but become inferior to the fraternity themselves in their submission; their servitude makes them irreparably unequal.

Yet this may not always be the case; friendship within the fraternity can allow for the message of altruism to be more effectively imparted, which would create a better friendship between the fraternity and society. This, in turn, could further the pursuit of equality for all. Consider the fraternity advocating altruism a master, and the members of the fraternity as pupils. According to the ideas set out in Godwin's *The Enquirer*, if the master paces the knowledge required by the pupil, altruism, 'within (the pupil's) reach', and allows the 'pupil (to) go first, and the master (to) follow', the pupil's independent learning curve should motivate and compel them to seek their own improvement. Such education can only be achieved through 'more than a common portion of cordiality and affection'. Hence, better friendships within fraternities could allow members to employ better friendships with society, as improved radical pedagogy enables the members themselves to realise what to do. They now no longer have a 'servitude' to the fraternity, only a sense of responsibility that will encourage them to 'assist each other', as Godwin states a man should have, and allow society to become equal. Hence, incorrect application of one of the conflicting forms of friendship could create

problems in achieving equality for fraternities. However, establishing internal friendships would allow the message of altruism to be effectively imparted in a way that encourages the members to have a self-awareness and responsibility, rather than blindly serving. Their subsequent friendships with the members of society they choose to help would not only make the two parties equal in each other's eyes, but would be more effective at achieving equality in society.

Friendship can aid the pursuit of equality through the radical movement in numerous ways: by creating respect, by lightening difficulties, and by using sympathy to make reason, organisation and education more successful. Through respect it creates equality within and between fraternities. By making the impossible easier, and turning argument into discussion, it brings the theory of equality into grasp. It allows marginalised voices to be equally considered by creating ungended and uncoloured respect. Yet sometimes, an intent to pursue friendship could lead to inequality, when members of fraternity see themselves as having to 'serve'. This mechanical servitude, devoid of sympathy, does little to further the pursuit of equality. But friendship again can amend this, in a different and more natural form. It seems, then, that friendship should not be forced – the 'Friends of Mankind', servitude of Frank Henley, and organisational features of the Jacobin Club are ineffective and unequal without a natural integration of friendship, as within the London Corresponding Society and through open-minded individuals like Johnson and Hardy, who rejected misogynistic and racist mind-sets. Allowing friendship to take a natural course will result in the correct form being matched to a situation. Then, friendship will help equality flourish.

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#### PhD Tutor's note

It was a delight to work with H. as part of The Brilliant Club tutorials at West Bridgford School. Her essay demonstrates an outstanding ability to engage with complex ideas and materials, and bring these together with remarkable, and indeed unique, independence and creativity– her work far surpassed A-level expectations, and I would have been glad to receive this as an undergraduate submission. I was particularly impressed by her thoughtful and critical contributions to tutorial discussions, and have no doubt that she will be an invaluable presence on any undergraduate programme.

## The Man Behind The Prince

Year 12, Key Stage 5

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Supervised by C. Favero, **Open University**

The Renaissance was a period of a great surge of rediscovery– rediscovery of the ideas of centuries past. It was a time of a change in attitudes and thinking, of incredible progress, a time of challenge, of moving forward. The Renaissance, beginning in Italy before spreading to Europe, was marked by a sense of recognition of what had been lost and what was required: knowledge, the need to learn. This was a period of rebirth, reflection and reform. Geniuses flourished, talents blossomed, in all areas of society. From the sciences, the arts, the travels and voyages of exploration, the countless inventions, the beautiful architecture, and the changing attitudes to religions and politics. There was a growth of interest, and excitement: no limit to the activities or discoveries. A period of creative freedom, the Renaissance was a representation of a revolution in the understanding of the world and has left behind a defining legacy of what it means to make a difference. A number of individuals come to mind, who were responsible for this. Leonardo da Vinci has been termed as "The Renaissance man". The genius of the time, more than any other figure, he epitomized the humanist ideal. A man interested more in humanity, and the world around him, than the divine. But I would like to explore a different man, one who excelled and influenced an area which da Vinci did not explore – that of politics. He explored new depths creatively, challenging systems and attitudes in a way which has his name surrounded in controversy. He remains a source of endless intrigue.

He is often described as a fictional character, a man who inspired the creation of Shakespeare's villains, it has become difficult to remember him for the Renaissance politician he was. This man's name? Machiavelli. I intend to explore this man who 'has been described as aloof, as standing to one side of life "with a sarcastic expression continually playing around his mouth and flashing from his eyes". I intend to explore the side of Machiavelli that is so commonly ignored, his better attributes: his wisdom, his honesty and his notable value to politics.

Machiavelli has been praised for having been one of the most significant 'figures of the Renaissance and of the intellectual history of the Western world'. This is definitely a surprising claim since Machiavelli had actually been an outsider of Florence's public office from the year 1512, after having been Secretary to the Second Chancery in Florence. This position, within itself, was influential for it involved diplomatic missions to cities within Italy and the outside nations. It was this position which gave him the experience and the expert knowledge of politics, campaigns and aided him in establishing a Florentine militia. Similarly, his arrest, the loss of his position and his exile equally contribute in the assertion that Machiavelli is, for the most part, deserving of being regarded as one of the 'giants of the Renaissance'. For, it was because of his time away from politics that he achieved notoriety. It was during his exile that, Machiavelli wrote and published *The Prince*, in the year 1513.

It was this work, *The Prince*, which remains still as one of the most controversial pieces. Machiavelli was driven by the life of Cesare Borgia. For Machiavelli, Cesare represented The



Prince. Machiavelli praises Cesare Borgia almost excessively. For example he writes, in reference to Borgia, 'There was one man who showed glimpses of greatness, the kind of thing that made you think he was sent by God for the country's redemption'. Historians regard Borgia as having been Machiavelli's muse, an inspiration for his politically realistic book.: This is supported strongly since 'Machiavelli uses Borgia over and over again as an example of what a ruler should do'. He even says, 'I wouldn't know what better advice to give a ruler new to power than to follow his example'.

This work, The Prince has been his most popular, because of its controversial content, and the arguably disturbing context of this literary piece. He wrote The Prince just a short time after his time imprisoned and the constant torture he endured. And it is because of the historical context of his writings that many historians have debated, at great length, that 'Machiavelli wrote out of resentment'. It remains a source of great debate that some of the 'most profound and insightful political thinking thus far in the European tradition' was quite simply a product of bitterness. His work still remains important today, in spite of the story of its origin. The controversial content within his work has inspired a stir in political movements. Through his work, Machiavelli introduced politics as a study in its own right. Before his contributions 'politics was strictly bonded with ethics, in theory if not in practice.... Machiavelli was the first theorist to decisively divorce politics from ethics, and hence to give a certain autonomy to the study of politics'. In spite of the controversy which has been attributed to him, and has led to the term 'Machiavellian' being used as an insult to describe a morally corrupt individual, Machiavelli's The Prince reflects his deep-rooted wisdom. His book is still seen as 'a "how to" manual of maintaining control of foreign lands'. Interestingly, however we must take care to note that 'Machiavelli did not invent "Machiavellism" and may not even have been a "Machiavellian" in the sense often ascribed to him'. It is for this reason, I have made it my endeavour to explore the man behind The Prince.

Some historians view Machiavelli as an individual who has been misunderstood, and described with words which belittle him, and of which he is not deserving. Therefore, we must take what we have learned about him with an objective eye since a lot of Machiavelli's words have been misinterpreted into something different. Not that this is completely the fault of historians, for it is widely noted that Machiavelli's 'writings are maddeningly and notoriously unsystematic, inconsistent and sometimes self-contradictory. He tends to appeal to experience and example in the place of rigorous logical analysis'. An example of this is with the phrase 'the ends justify the means' which Machiavelli was never heard to have said though many of his critics claim otherwise. 'Still, looking at his lifestyle and political conduct, Machiavelli strikes as a moderate; if The Prince contains the precepts he cultivated on the field, it is arguable that the most suiting interpretation of the treatise is a moderate one'.

Though, to get a better glimpse of his genuine character we can read some of his other writings, for example his letter to Francesco Vettori, (10 December 1513), in which he commends Vettori. He writes 'I am extremely pleased to see how methodically and calmly you fulfill your public duties. I exhort you to continue in this manner, because whoever forgoes his own interests for those of others sacrifices his own and gets no gratitude from them'. Francesco Vettori was an Italian diplomat, politician and writer from Florence and one of Machiavelli's main personal correspondents. Machiavelli's

wisdom is also evident when he writes of the act of putting others first. Easily, however, one can state that this line hints at bitterness and hurt regarding his exile from Florence and the people he had once served. He goes on to write, in the letter, about his reservations regarding his work The Prince, and the idea of presenting it to Giuliano de' Medici, who had been alive at the time. He writes 'Against presenting it would be my suspicion that he might not even read it and that that person Ardinghelli might take the credit for this most recent of my endeavors'. This line implies that Machiavelli did have enemies, and it can be said that it was these enemies, such as Ardinghelli, who tarnished Machiavelli's name. Or possibly pushed Machiavelli to become more driven in his efforts. This same letter does indeed, suggest Machiavelli's determination but not quite to the point of ruthlessness. Rather, this letter only presents the positive character of



Portrait of Niccolò Machiavelli by Santi di Tito

Machiavelli, for example his patient nature and his admirable persistence. Machiavelli writes 'And through this study of mine, were it to be read, it would be evident that during the fifteen years I have been studying the art of the state I have neither slept nor fooled around'. Similarly, we learn of the values Machiavelli was brought up with and maintained. Near the closing of his letter he writes 'There should be no doubt about my word; for, since I have always kept it, I should not start learning how to break it now. Whoever has been honest and faithful for forty-three years, as I have, is unable to change his nature; my poverty is a witness to my loyalty and honesty.' Are these the words of a morally corrupt, cynical man? There is no doubt that this letter presents an entirely different image of the man: a determined, wise, reliable realist.

It is likely that it was *this* man, or this side of Machiavelli, who Maurizio Viroli saw when he wrote: 'If we elect Machiavelli as our political mentor, therefore, we will benefit from his astute understanding of political life in general and of grand political action in particular, and, made aware of the qualities

of a great political leader, we will be in a better position to choose such a leader, if we should encounter him or her. Machiavelli has yet another virtue of the good political advisor, namely, honesty'. Other historians share this same opinion, for honesty and sincerity are two values Machiavelli himself wrote of possessing and, they look to Machiavelli as a man with realistic ideas. A man who confronted the true side of politics, rather than hiding it away and giving a vague description. He was the voice in the head of politicians, echoing that which they were afraid to say, in a bold fashion. Viroli supports this claim, he writes of Machiavelli's honesty and his unnerving 'habit of speaking frankly even to very powerful people... he was not afraid of challenging the most revered beliefs of his time. "Contrary to common opinion, I maintain that....." is a phrase that we find many times in his writings'.

Though historians, such as Maurizio Viroli, are careful in their interpretations of Machiavelli's work, so many understand that his influence in other aspects of the Renaissance period is very minute in comparison to his influence in politics. So, for example outside of political leaders, and republican ideologies, military investments, Machiavelli's work is of little use. Similarly, historians acknowledge the claim that The Prince, in particular, was written to serve more as a job application, than a general political book. The purpose of its existence being to gain the new Medici duke, Lorenzo di Piero de' Medici's approval. As a source writes: '..Machiavelli was articulating only what he believed that the then-current rulers wanted to hear, so that he could win back their favour. On this view Machiavelli himself might not have believed everything he wrote in The Prince, but he thought that a cold amoral attitude to politics might impress his superiors, thus leading to his reinstatement in government' This claim holds considerable weight since Machiavelli dedicated The Prince to de' Medici. He had written the book in the hope that 'it might win him back his political career. His plan backfired. Machiavelli remained in exile for the rest of his life. His legacy was his name and his manifesto which came to symbolize a new breed of politics, shrewd but devoid of morality.'

His book was his personal expression of how an ideal leader should behave, quite possibly how he would behave. This book showed Machiavelli's remarkable understanding of how leaders really think, and how politics plays out. His work was very instrumental in revolutionising our understanding of politics and, historians tend to agree quite easily with the statement that Machiavelli was a political practitioner- one who never received the chance to fully prove himself. This is not at all to suggest that Machiavelli was the ideal candidate, for he is sometimes regarded as a man who was 'far ahead of his time'. For one thing, Machiavelli's ideas were heavily controversial, and that remains an understatement. He felt wars were necessary, and believed that by waging wars, we will be able to achieve peace. Equally, he felt good leaders should exercise terror and fear through the use of violence, but not do it themselves so that the leaders would not be seen as unpopular. For example, one of his infamous sayings is 'Before all else, be armed'. However, even these words aren't entirely radical, for one could interpret them as promoting the message that preparation is essential. But these other interpretations aren't always supported, and it happens to be because of controversy which surrounds him, that the term 'Machiavellian' has found its way into the English language. It has always been a prevalent word, particularly used as an insult, to describe a morally corrupt and ruthless individual. Someone who has a cunning mind, an unscrupulous demeanour and a deceptive

and sly character, especially in politics. During an interview with John O'Rourke, Jared Diamond explains that it is because of the way Machiavelli's legacy and memory has been painted that Machiavelli 'is frequently dismissed today as an amoral cynic who supposedly considered the end to justify the means'. Diamond then explains how Machiavelli was actually 'a crystal-clear realist who understands the limits and uses of power'.

Therefore, upon reflection, maybe we need to alter our definition of the term 'Machiavellian'. For, I no longer regard it as an insult. Just a term inspired by the name of a complicated, misunderstood man. I would much rather take it as a compliment. Machiavelli was a man who left behind a powerful legacy in the world of politics, he continues to shape our views of politics today. He was a man unafraid to speak his mind, even when dealing with heavily convoluted thoughts. An individual with a legacy at all, is something we can't say of everyone. Machiavelli made his mark in the Italian Renaissance, a time when geniuses were coming forth, when ideas were being challenged. The opportunity for him to put his thoughts to use was there, he was just never granted that chance. Perhaps, it was politics which was not yet ready for him. He was a man whose ideas were never appreciated. We should give his work the chance it never had, no doubt his work remains in the limelight but, we should take a read of it objectively. We should treat his work as the means to learn more about the man with ideas that were a little too advanced for the period of rebirth, but not treat his work as the only means to know him.

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PhD Tutor's note

I had the pleasure of teaching a course on the Italian Renaissance at Lordswood Girls' School: the topic is not easy but the pupils really showed interest and determination in all aspects of the course. S's work and participation in particular was always of excellent quality and showed a lot of initiative, curiosity and a distinctive ability to critically analyse the content and present it to a high standard. Her final essay was exceptional, original, full of complex and nuanced ideas and worthy of university level writing.



# Using a range of primary and secondary sources from both the Scholars Programme and elsewhere compare and contrast what it meant to be poor in the south of England between 1800 and 1834.

Year 12, Key Stage 5

D. Gunn, Sir Christopher Hatton Academy, Wellingborough  
Supervised by C. Beardmore, University of Leicester

## Introduction

The 19<sup>th</sup> century was a time of extreme upheaval in Britain. The consumer revolution had created a middle class within the country, and the Industrial Revolution was about to send the empire to the top of the world. However, there were other stories equally as relevant as those of the innovators, entrepreneurs and monarchs – these are the stories of the poor. Life in poverty from 1800 – 1834 was one of the strangest periods to have been in such a position. The increased affluence of the nation, along with the increasingly democratic and powerful government, meant that there were calls to help the poor more so than had been in the past. The Old Poor Law, created in 1601, had become more widespread since its inception but its focus on parish-based relief meant that there were numerous inefficiencies that prevented it from having the impact it used have. The sudden population expansion meant that those who needed relief had to work harder to get it; the system was in desperate need of reform by 1834.

Poor people in the early 1800s were not (on the whole) in a state of absolute poverty, but they were in a situation whereby they were often reliant on the parish for their wellbeing. Steady work or long-term employment was increasingly difficult to come by, especially due to the massive influx of workers from the agricultural regions into the industrial powerhouses of the north (Manchester and Liverpool) and the southern equivalent which overshadowed them both – London. Mass unemployment, lack of food, and increasingly austere conditions had become the key issues the poor faced in England.

This dissertation will examine the lives of the poor between 1800 and 1834; the final years of the Old Poor Law, before the new legislation was passed in 1834. Whilst some have argued that Britain was the best place in the world to be poor, this view is somewhat undermined when factors such as the limited income, living conditions and subsequent political outcry (the 1830 Swing Riots) are taken into account. As such, to be poor was (as one might expect) a lifelong struggle for the people of southern England. The lives of the poor – their economic, social and political poverty.

## Economic

Economically, the poor in the south of England were the lowest of the low. The so-called Speenhamland Counties (named after the 1795 meeting where the system was devised (Wikipedia, 2016)) were those at greatest risk of poverty, with the likes of Sussex, Buckinghamshire and Wiltshire receiving

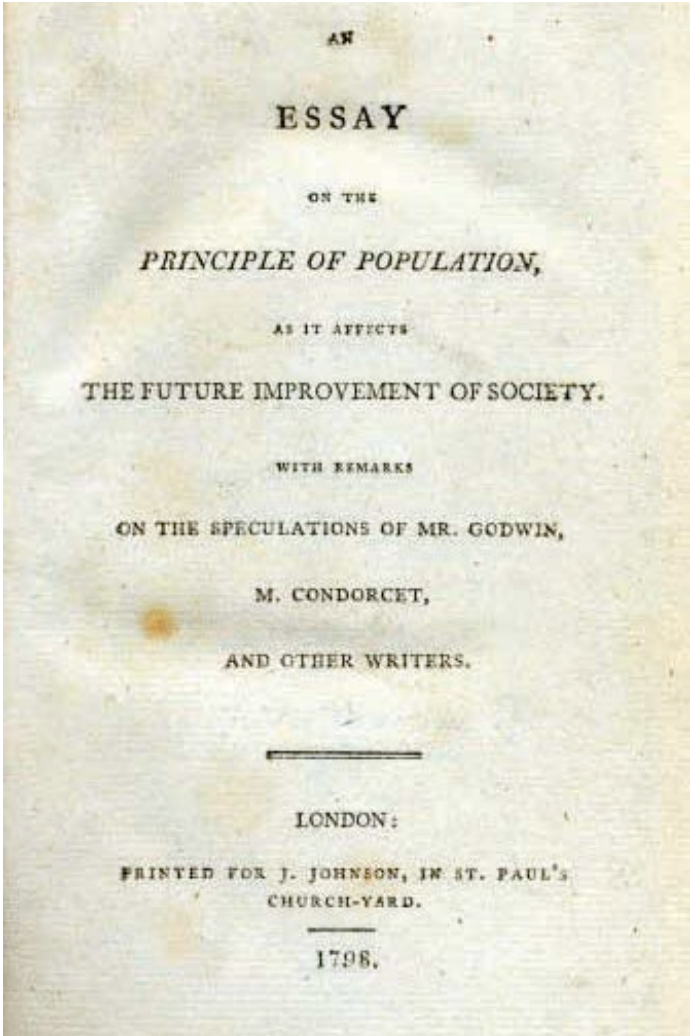
the highest rates of outdoor relief per head from 1800–1834 (Blaug, 1963). These counties were particularly poor due to their agrarian economies and lack of industrialisation – they relied on growing wheat as their sole source of income, but this way of life was unsustainable for such an overpopulated region. As Mark Blaug says: “substandard wages...are part of the mechanism which disguises a pool of surplus manpower in an under developed country”, indicating that the lower wages that were paid, despite the assistance from the Poor Law, were not enough to keep families in the rural south of England from poverty, especially with so few jobs available.

There are a number of reasons for the unemployment in the south of England. One is the seasonal variation that wheat-growing entails, with there being a three to four month period where many labourers were not required. However, due to family ties to the parish and reliance on their area for work, market forces failed to take full effect. Instead of population redistribution (similar to the north of England), many essentially part-time labourers remained in their towns and waited for the harvest to come in, and with it their jobs. In years of strong harvests, the system was manageable, with outdoor relief reducing as harvests increased (ibid, 1963). However, in years of poor harvests such as in 1812, poor relief in Sussex soared to 33.1 shillings per head (where the national average was 18.8s).

The unpredictability of the harvests and the lack of options for those in the south of England exacerbated what had always been a traditionally poor region. To further the misery of the poor, England had been at war with France, leaving it with debts and mass demobilisation (it has been estimated that during this time, 300,000 soldiers and sailors were returning home from the Napoleonic War (Bloy, 2016)). This influx was admittedly felt more strongly in the cities, but there was something of a ripple effect into the countryside, as proven by the increase in poor relief across England in 1812.

This increase was not just due to men returning from war. 1800–1850 saw a huge increase in the population of England, which in turn put more strain on the already limited employment opportunities of the rural population. Thomas Robert Malthus predicted that the population of Great Britain was increasing out of control in 1798 when he published his book, *Principles of Population*. He said that: “whatever may be the rate of increase in the means of subsistence, the increase in population must be limited by it”, essentially meaning that the country should not live beyond its means. He theorised that whilst food production would increase at an arithmetic rate (i.e. 1, 2, 3, 4...), population would increase geometrically and exponentially (i.e. 1, 2, 4, 8...). This same logic can be applied to the availability of work in rural areas – as population increased, so would jobs, but at such a proportionally low rate that the number of people would forever increase at a greater rate than the jobs available to them.

These economic sources provide a bleak picture of the state of the rural, southern poor. They were employed in unstable jobs, leading them to require more poor relief than anywhere else in Britain. They were further impacted by overpopulation, but there was a lack of motivation to find work due to their reliance on the poor law to provide for them. They remained in the squalor they had always lived in, with little scope to improve their lives.



Title page of en:Thomas Robert Malthus's en:An Essay on the Principle of Population, J. Johnson, London, 1798. Immediate image source: Leeds University Library.

## Social

This factor is broad, and encompasses living conditions as well as the clearly subordinate position of the poor in English society. Poverty-stricken families were often forced to write to beg for poor relief, as under the terms of the Poor Law, the Speenhamland system they relied on to supplement their income was available only by a request from their parish. This meant that regardless of where the person currently lived, they were entitled to contact the parish council of their birthplace and ask for support. Steven King, one of the foremost historians on nineteenth century poverty in England, advocates the use of pauper letters, saying: “They provide a unique window on the lives, experiences and feelings of the poor”. They are most valuable source we have for the nature of this arrangement between the paupers and their parishes; these letters are invaluable in gaining an understanding of not only why the poor were asking for money, but also *how* they asked for relief and the nature of the dialogue between the council and the families from far-flung corners of the country.

The letters we will use for this insight are from a family called the Soundys who lived in Battersea. Under the terms of the poor law, they were not entitled to relief there as they were born in Pangbourne in Berkshire, a Speenhamland county. They wrote a number of missives between 1810 and 1820 to the parish council in this town asking for money to help them through the various trials that poverty in the 1800s gave them.

By reading the letters, one gets an incredible understanding into what the family were like. They were numerous, with James and Frances Soundy generally the writers of the letters, but they reference their children, Charles and Mary, who are also “Perrishoners” (sic) of Pangbourne. Frances appears to be the writer of the two letters we will examine and whilst her primitive style of writing is difficult to decipher, it gives us an understanding of how the education system for the poor taught them – they were able to write by recognising letters and attributing them to sounds, hence the numerous spelling errors. Frances also writes extremely graciously, with many of the sentences beginning “Honorable gentillmen”, as she wanted to appear respectful to them given that their help had the potential to save her family. What is plain to see, however, is that Frances understands how the system works – she does not reference her large family inadvertently. It is instead to make the council aware that if they deny them the relief they need, they have the right to turn up in Pangbourne and demand relief there. This would be problematic for the Parish, as they would be legally obligated to provide them with shelter as well as the money they had originally declined.

Early in the first letter, Frances mentions that her husband is “out of work this fortnight”, indicating that he is likely a man with no permanent position and travels to where there is work. Battersea fields (where they lived) was not the urban environment we would now recognise – it appears to be a significant rural area during this period where farm labour was required and James Soundy may well have been employed as such a worker. This links to our earlier findings about the rates of unemployment and the instability of work in the rural south; many men would have had working lives like this and would not have known where the next wage packet would come from. James was likely put out of work due to a poor harvest or saturation of the job market, especially if younger, fitter men were available in the highly competitive environment.

Whilst she was cunning, there are elements of true sadness to Frances’ letters. One account describes how “mhy (sic) poor child was a fortnight before she was Buried”, due to her not being able to pay the undertaker for the burial. Space would have been short for them with the number of people they had in the house, therefore it is highly possible that the deceased child would have been in the home alongside the family for two weeks. Admittedly this family was not in absolute poverty, but to have to endure such conditions would have been extremely difficult. These stories are repeated throughout accounts of the poor, and whilst they may have had the basic amenities of shelter and some meagre food, any surprise expenditure took a massive toll on the family. Often they would have to go without essentials to meet these extra bills.

It was not just those at the bottom who were aware of the problems in Britain. The prominent poet, Percy Bysshe Shelley published his convention-defying, aggressive sonnet, *England in 1819*, where he bemoans “A people starved and stabbed in th’ untilled field”, proving that the lives of the rural poor were not mysteries to the upper classes, they were just easier to ignore. This is an incredibly useful source, as Shelley only has fourteen lines to which he can administer the key problems he feels England is facing; for the poor to have such a major role in the poem is indicative of their plight.



The social standing of the poor is clearly low, as would be expected, but the deeply personal stories provided by the Soundys' letters and the heartfelt cry from Shelley proves that this anger at their conditions was not a struggle in which the poor were alone. However, whilst Shelley could write the word "starving" due to its emotion and rhythm, for those experiencing it this would not be an artistic device but a very real, and very cruel, truth.

**Political**

The rural, southern poor were criminally under-represented by Parliament. They had no say in the workings of government as there was not complete suffrage, and there was a complex structure around who could and couldn't vote based on land ownership and constituency boundaries . However, this did not concern the vast majority. Paupers' only contact with government was their parish, and as such they were the ones they riled against when circumstances conspired against them and pushed them past what they could tolerate, as in the case of the 1830 Swing Riots.

These were a series of attacks on agricultural property beginning in Kent in 1830. Threshing machines had been making the job of threshing corn more efficient by using fewer men to achieve a greater yield and farm owners installed them all over the Speenhamland counties to maximise their profits. The workers were already competing for jobs and too poor, uneducated or simply too far away from any form of industry to take up another trade. Seeing machines do their work, faster and more efficiently than they could, was too much. Machines all over the south of England were destroyed, with one account given by Charles Sandys in Canterbury stating that a "desperate Gang amounting to upwards of 200 persons" destroyed the threshing machine in the town. He was a Clerk of the Magistrates and as such would likely have been a more upper-class individual – the magistrates certainly would have been – and little sympathy was shown by many in the legal profession towards the rioters and their anger, with reports of 2,000 protestors brought to trial in 1830–31.

The scale of the anger concerned the land-owners who made up the government, and many point to the Swing Riots as one of the key moments which pushed the Prime Minister, Charles Grey, of the Whig party to implement a series of reforms, culminating in the Poor Law Amendment Act 1834, also known as the New Poor Law.

**Conclusion**

In conclusion, it must be accepted that the woeful conditions of the poor were unacceptable. A great deal can be learned from the conditions the poor lived in, with a strong emphasis placed on the importance of ensuring that everyone has not only the basic necessities that they need to survive, but the tools to make themselves better people. The people we have studied all have a lack of self-improvement in common, because there was simply no scope to allow it in the nineteenth century. Life revolved around survival and making sure that you were able to provide for your family's next meal; leisure and education were luxuries that simply could not be afforded.

From a modern perspective it is easy to see this as a purely academic study, with no relation to our lives now. But this is the first time in English history since the nineteenth century where quality of life is decreasing. A new class of poor is a very real possibility, and there is no better way to prevent that than by looking back to the past and learning where we went wrong before. As Marx said, history repeats itself "first as tragedy, second as farce" – we must ensure that we learn the lessons taught by these tragic conditions and avoid ever recreating them.

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**Programme Officer's comment**

This is an impressive piece of work. D. demonstrates an excellent understanding of the historical context and shows a broad knowledge of the political, economic and social condition of the poor in early nineteenth-century England. In his nuanced analysis, he is able to draw out regional complexities of the condition of poor whilst situating their position within a broader international context. Through his impressive use of secondary and primary sources, D. reaches a strong and convincing conclusion. The article is also written, structured and referenced to an extremely high standard. Very well done!  
– B. Jenkins, Programme Officer, East of England, The Brilliant Club

# Social Sciences

## A Letter to the Lord Chancellor on Restorative Justice as a Viable Alternative in the Criminal Justice System of England and Wales

Year 9, Key Stage 3

E. Clayton, Dykehouse Sports and Technology College, Hartlepool. Supervised by A. Olayode, University of Durham

The Rt. Hon. Elizabeth Truss MP  
Lord Chancellor and Secretary of State for Justice  
Ministry of Justice  
102 Petty France  
Westminster, LondonS, W1H 9AJ

Minister Truss,

May I please introduce myself, my name is *E* and I am currently studying at Dyke House College, Hartlepool. I am formally writing on behalf of the UK public to state that the current criminal justice system has its disadvantages and the function that it provides is increasing in irrelevancy for certain types of offenders, especially young and petty ones. In this letter, I intend to outline issues and limitations in the criminal justice system, state three types of restorative justice approaches and discuss three different restorative justice models and how they could be beneficial in the UK. I will be considering how restorative justice approaches can reduce re-offending rates and studying cases to strengthen this argument.

**Challenges facing the criminal justice system**

There are many challenges currently facing the criminal justice system and prison system in the UK, including overcrowding in jails, costly court sessions, petty criminals being persuaded by more serious criminals in jail, influencing them to commit more serious crimes on their release. Also, prison can sometimes be seen by the less fortunate, who may live in unstable conditions i.e. homelessness, as a more attractive living option for them, offering shelter and food. This reiterates the belief by some, that under-privileged people could be more prone to committing crimes, suggesting to some extent that the prison system isn't always the best punishment. When prison is the only punishment given, the offender does not get to see the consequences and impact of the crime they have committed on their victim and are more likely to do the same thing, or worse when released. This is where restorative justice practices differ, and statistics show that restorative justice reduces re-offending rates by 14%.

**Solution to the criminal justice system**

I feel that the most viable solution to reduce re-offending rates within the criminal justice system is restorative justice practices. The various stages within it allow the victim and the offender to discuss the offence and help to resolve what has happened. It can be used anywhere to prevent conflict and repair harm caused by a previous crime.

When restorative justice meetings occur, they allow the two parties to discuss a suitable punishment for the offender, sometimes with the influence of family members or youth advisors. Restorative justice practices are very different to criminal trials. One of the main differences is that they are undertaken in a much less formal atmosphere. A courtroom is a very formal setting including the offender, the victim, a judge, the jury, court officials, barristers, and members of the public, which could all be a very costly and daunting process to both parties. Statistics show that for every £1 spent on Restorative Justice, £8 is saved from what would have been spent in the traditional criminal justice system. At the end of the trial the offender is either found guilty or not guilty of the crime and if found guilty the judge alone will decide on the punishment, without any influence from others. Restorative justice practices involve victims of crime throughout the process, enabling them to have an input into what is felt to be a suitable punishment, which could help them to move forward after the crime.

**Three types of restorative justice practices**

There are three different types of restorative justice practices used within the criminal system. The first example is victim-offender mediation, which is when the victim of a crime has a one-to-one meeting with the offender and is monitored in case any conflict occurs. This practice is mainly used for less serious crimes and allows the victim to try to make the offender understand the affect the crime has had on them. An advantage of this method is that the victim is entitled to a fair suggestion of the punishment the offender should face. However, this isn't always suitable, depending on the relationship of the two parties, for example, if the victim has a pre-existing judgement of the offender, this could prejudice their opinion of them and perhaps encourage them to suggest a harsher punishment, meaning it could possibly be unfair to the offender. This method differs to a criminal trial, as the atmosphere isn't as tense and allows the people involved to have a fair say. A statistic to support this is that 85% of the people who took part in this process were satisfied with the outcome.

Another method is conferencing, which involves the families of both the victim and the offender. Again for the safety of both parties, the meeting is monitored. An advantage of this method is that having loved ones around them may be comforting and supportive for both parties. A disadvantage of this method is that the family may interfere too much and could over-exaggerate to influence their side of the story. This method mainly differs from a criminal trial because both parties have people close to them supporting their reasoning. Research from a professor of criminology at the University of Cambridge suggests that the rate of re-conviction was decreased by 28% from those who attended a restorative justice meeting.

The final method of restorative justice is sentencing circles, which is when the victim, offender, their families and the police are involved with deciding the punishment of the offender. An advantage of this method is that there are more trained people to examine the meeting and agree with what is being suggested as a punishment. A disadvantage of this method is that it starts with a prayer, this could offend or upset non-religious people, making them feel uncomfortable. Furthermore, a room full of people could be quite daunting and tense.



It could make some people shy and unable to express themselves as much as they would in a one-to-one meeting. This method differs from a criminal trial because it is much more informal. People could also be more relaxed, allowing everyone to have a their fair say.

All methods of restorative justice are more cost effective than criminal trials, analysis from the Restorative Justice Council and Victim Support showed that providing restorative justice for adults in 70,000 cases would save £185 million without using the criminal justice system over two years.

**Three restorative justice models**

Restorative justice practice features many different models used in various countries. They all have different structures that are followed, however they all have the same aim: to come up with a solution to a crime that is fair on both parties. One example of a model is the 'Sycamore Tree Project', mainly based in Durham, UK. It is an intensive 5-8 week in-prison programme that allows victims to visit prisons and meet with the offender of the crime they were affected by. During the meeting, effects of the crime, the harm it has caused and how to make things right are discussed and a trained facilitator opens topics such as responsibility, confession and forgiveness. The offender is encouraged to explore ways of becoming a better person after the crime and the victim focuses on their journey towards healing from the incident. After the course, both parties meet for a public celebration. The statistics say that 5,000 prisoners showed significant changes in their attitude after completion of the programme. I believe that the Sycamore Tree Model would be beneficial across the UK for less serious crimes. One reason supporting my judgment is that it gives victims a voice and allows them to recover from crimes that affected them. It also allows prisoners to learn from their mistakes and could encourage them not to re-offend, 'I will never forget the people I met there as they have changed my life', is what a prisoner said on completion of the programme.

Another example of a model used in San Francisco is 'Community Works'. This organisation fights against racial inequality. People who are poor and disenfranchised, including a disproportionate number of people from ethnic minorities, populate the prisons, and the majority of public funding given to these people is not for education or healthcare, but for policing and incarceration. Community Works' aim is to change this inequality. Statistics show that in the US, one in three black males have a chance of being imprisoned during their lifetime and that one in nine black children have an incarcerated parent. The programmes that Community Works' offers are to help clients and their families to live to their full potential and keep them out of prison. The main focuses of the organisation are: family services, youth development, restorative justice and violence prevention. They believe that when the community responds to those in crisis, things that have gone wrong can be healed and they can have a voice in the matter. In my opinion, I believe that this method could be successful in the UK, due to racism and inequality issues also present in this country. I believe that this would give people an opportunity to have a voice and speak for themselves without being dictated to. A statistic to support my argument that Community Works could be successful in the UK is that in traditional justice 45% of offenders are rearrested within 18 months, whereas using restorative justice methods, only 26.5% are. The last example of restorative justice I will look at is used in New Zealand. The justice system there aims is to provide advice to the government on justice

legislation. One of the programmes used in New Zealand is known as the 'investment approach to justice'. Its purpose is to increase crime prevention and decrease harm from crime for victims. This method could be beneficial in the UK because it could possibly teach offenders to be responsible citizens and could also give guidance to others, who have not broken the law, to help prevent them from doing so. Due to the help from this organisation, the number of adults in court has decreased by 27% since 2011. Furthermore, this method could also be beneficial because it could support emotionally affected victims who had been affected by a crime. Studying a survey from 2013, statistics show that 33% of victims suffered from fear, 23% from anxiety and 21% from depression. This method could help improve these percentages.

To conclude, I have stated various reasons as to why the current criminal justice system is not appropriate for all crimes and have provided strong points for you to evaluate. I believe that restorative justice has a place in the criminal justice system, leading to successful outcomes in a number of criminal cases with proven statistics. I hope that you are able take all of my points into consideration and see restorative justice as a viable solution to certain crimes.

Thank you for taking the time to read this letter. I would very much welcome a reply to hear your thoughts if you are able.

Yours sincerely

E. Clayton

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**Programme Officer's comment**

Producing an academic text of this type is very challenging – the author must strike a fine balance between a persuasive letter and a robust, well referenced, academic argument. This letter is a fine example of such a balance. The language employed throughout is mature, and the author makes confident use of legal terminology. The statistics and sources used are compelling and strengthen the argument, but are well-integrated enough to avoid seeming clumsy in the letter format. The letter is well structured, building evidence for the author's argument, leading to a convincing conclusion. Were this letter truly to be sent to the Minister, there is little doubt that they would be compelled to examine the issue further.  
– Dr N. Day, Area Director, North of England, The Brilliant Club

# A Letter to the Lord Chancellor on Restorative Justice as a Viable Alternative in the Criminal Justice System of England and Wales

**Year 9, Key Stage 3**

**L. Fitzpatrick, Dykehouse Sports and Technology College, Hartlepool. Supervised by A. Olayode, University of Durham**

29<sup>th</sup> March 2017  
Ministry of Justice Headquarters  
102 Petty France  
Westminster  
London  
SW1H 9AJ

Subject: Restorative Justice as a Solution to the Disadvantages of the Criminal Justice System

Dear Mrs. Truss (Lord Chancellor and Secretary of State for Justice),

I am writing to discuss my views about the current Criminal Justice System (CJS) and to highlight potential solutions to re-offending rates. I intend to talk about the inadequacies of the prison system, my interpretation of Restorative Justice and three models on Restorative Justice.

I believe the CJS is angled very much at preventative measures around re-offending rather than punishment. Some would concede that we have gone too far in trying to rehabilitate and punishments no longer are befitting of the crime. I hold the belief that people need to address re-offending as opposed to metering out inadequate sentences and failing to tackle underlying issues such as drugs and social matters. I would suggest that some re-offenders are now simply taking advantage of the often-used system to avoid harsher punishments, for example, community punishments and drug-testing orders which are regularly breached but rarely prosecuted.

It appears there are countless underlying issues not being addressed. For example, there are clear definitions in 'class' as opposed to that of many years ago which was reserved to 'upper' and 'working'. It is now recognised that we have almost 'lower class', namely generations of people who have never worked and reside in low socio-economic places where acquisitive crime and subsequent re-offending rates are high. To put this 'lower class' into context, people abuse the CJS as a means of making money (short remands to sell drugs in jail) or to simply have a less chaotic lifestyle.

Historically, prison was seen as harsh punishment, providing relief for society who had suffered at the hands of offenders. In the last 20 years, however, the idea of prison has changed from punishment to education, given that the general prison population are from lower class backgrounds. Incarceration is aimed at providing education, life skills and other desirable qualities that will minimise reoffending. Sadly, illegal drug sales and addictions inside and outside prison undermine this process.

A different and arguably better way to approach offenders and victims is through Restorative Justice, which is an alternate form of dealing with crime by engaging both offender and victim in post-offence negotiation. This can be used if the victim and offender both agree to participate. There are different ways in which it can be conducted and figures would suggest that this method is successful. Statistically, the reoffending rate for those who receive a Youth Conference Order is 54% compared to a rate of 63% for those who receive community sentences. Participants in Restorative Justice as part of a sentence have a reoffending rate of 19%. Offending in the UK can be tackled through reprimands but recidivism rates can be improved through Restorative Justice trials.

After research into the impact of Restorative Justice, I feel a good illustration of this is an account by a rape victim. By engaging in Restorative Justice, she was helped to come to terms with the situation, however, did not propose to find answers to avoid disappointment. She did embark with an open mind hoping to disperse of her negative thoughts regarding the offender.

**Types of Restorative Justice**

There are three acknowledged types of which are generally used worldwide: Victim-Offender Mediation, Conferencing and Sentencing Circles.

**Victim-Offender Mediation**

Victim-Offender Mediation encompasses three participants, the victim, the offender and an eligible mediator. During this meeting, opportunity is given for the offender to communicate with the victim and talk about reasons for committing crime, its impacts and provides opportunity to apologise. This is beneficial because it is open to less-confident victims and impacts on the offender and reduces reoffending rates.

The impact upon the offender is to help them realise the affects of their behaviour and to address any questions. Although this may not reassure the victim fully, it provides some closure to a traumatic experience. The meetings are uncompelled and are not always effective, requiring cooperation from both sides. From 1995, victim-offender mediation sessions based around acquisitive crime e.g. theft, 95% of meetings have proved to be successful.

**Conferencing**

Conferencing is a practical discussion in deciding a suitable punishment and establishing reasoning for the committed crime. This scheme of Restorative Justice involves the victim or a representative, the offender and his relatives, a youth advocate and often a police officer.

This situation would only arise once the offender has pleaded guilty and served part of their sentence. Similar to previously, the parties require agreement for the Conferencing to ensue. The conference starts with a narrative of the offence from a police officer and seeks participation from victim and offender. Any further attendees in support of the victim contribute; however, the opportunity is not as accessible to those present in support of the wrongdoer. Different to the first model, the family of the offender agree on a strategy applicable to the offender to minimise the chance of further offending. For those who met their victim, the frequency of reoffending fell by 27%.



Sentencing Circles

A Sentencing Circle is used in more severe cases where the victim or offender may not feel assured talking openly. Participants are: the victim, relatives, offender, police officer, a judge and any other additional roles if necessary, for example, youth court members or social workers. Also forming a second circle of chairs will be professionals or interested parties. The room is organised in a structured format, dividing the two parties on either side of a circle of chairs and the principal of the discussion in the centre. This model is run comparable to a courtroom, where you must be directed to speak by the judge. The idea of a stand-in-speaker for the victim would be beneficial in communicating the views of the victim particularly in more serious matters.

It often begins with a prayer followed by a discussion upon addressing the impact of the offence. This form of Restorative Justice may not be the best way to increase confidence after a loss through a crime; however, it allows people to examine causation factors. Management of the sentencing circles, determine that the victim must only voice or share voluntarily, and no one but the judge must deliver the outcome. Criminals are less likely to offend 15 months post to the circle, rather than 15 months prior.

Models of Restorative Justice

Within Restorative Justice, there are many organisations, which offer support and guidance. The organisations that I have chosen to discuss are Sycamore Tree (UK); Restorative Opportunities Program (Canada) and the Victim-Offender Reconciliation Program (Australia).

Sycamore Tree: UK

Sycamore Tree is a programme that serves to teach the principles of Restorative Justice, and operates in 34 prisons in the UK. Prisoners on the programme explore victim awareness, and are taught over a six-week period the impact of the crime on victims, offenders and the community. Another point is what positivity it would have on the prison system and the victim if the offender admitted responsibility for their actions. The justification behind my choice is that many offenders are ostracised because they have not been understood and simply revert to type. The staff help them open up their thoughts regarding victims and crimes and discuss reasoning behind the crime. I feel this is beneficial because many victims are poorly represented, so by allowing criminals to realise the impact of offending assists in deterring them in the future.

A former prisoner advocates that as an offender, you visualise yourself as the victim rather than other people. He quotes "I never looked at a victim, I didn't have any victims. I always call myself the victim". After hearing a victim's story, he didn't realise the severity of the crime and impact made on someone's life. After writing a letter to the victim whose house he had entered, he has not reoffended. In comparison to the 60% of offenders that are predicted to re-offend within 2 years. He is now part of the 73% who are no longer offenders due to the help of Sycamore Tree.

Restorative Opportunities Program: Canada

Restorative Opportunities (RO) is a correctional service of Canada that is available to people who have been affected by a crime – victim or by proxy such as a family member. This Restorative Justice is based around victim-offender mediation. This is voluntary and its aim is to 'suit the needs of the participant'. This procedure is not focused on reaching

a settlement, but rather an open communication between the two parties. I have chosen this model as an example of Restorative Justice as it is an opportunity for people who have unique needs and don't want to follow the traditional CJS.

A victim was attacked in a pub. The attack resulted in 50 stitches in his face and elbow, and inability to move his arm. Through Restorative Opportunities program he quotes, "I figured the Restorative Justice process would help, but the shock was how much it helped me". I hold the viewpoint that this program would be beneficial if it was introduced in the UK given its offender focus. In my opinion the most important part of a case is the effect that something has had on the victim. RO shows that 0% of offenders returned to custody within 3 months, compared to 2.1%, and only 2.6% who returned within a year. In contrast to 92% that did not experience Restorative Justice.

Victim-Offender Reconciliation Program  
Information and Resources Centre: Australia

Victim-Offender Reconciliation (VOR) is a Restorative Justice group based in Australia that works with a consenting victim and the offender to come face to face with each other examining their issues. A trained mediator supervises this voluntary process. They suggest that the crime is 'personalised' so offenders should absorb the consequences of their actions, and it also stipulates victims (often forgotten by the CJS) to share their views about the situation, contributing to the healing process of both parties. I have chosen this, because I feel the idea of 'letting the victim speak' is important in recognising the impact of crimes. I feel that this would be beneficial in the UK because it is 'victim focussed' and conveys their views to the offender rather than through a third party such as the Police. Surely this is more impactful than simply viewing it as 'another one of the 200,000 crimes recorded every day'.

A victim of theft remained close to her sons' friends after his death. This changed when a cheque was stolen and attempted to be cashed at a shop. She says, "I wanted to repair our relationship". She consulted VOR, after being advised by a neighbour. Through this process the friendship was resumed after her views were heard. Overall, it is shown that those offenders who participate in VOR had a 34% lower rate of reoffending than non-participants.

I feel that the CJS in the UK is slowly moving in the right direction in using Restorative Justice as a medium to understand and prevent offending as opposed to a solely punishment-based approach. Statistics support this. We now need to strike a balance and identify quickly what works and what is being abused to prevent problems festering and growing.

In the interests of justice, punishments are inevitable, however, understanding offending is important and we need to almost adopt prevention rather than cure ideologies. Having the foresight to tackle issues before they manifest themselves is vital – Restorative Justice and early intervention not only aims to prevent future crimes it also caters for understanding between victim and offender to aide with closure.

Thank you for taking your time to consider my thoughts.

Yours faithfully,

L. Fitzpatrick

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**Programme Officer's comment**

Producing an academic text of this type is very challenging – the author must strike a fine balance between a persuasive letter and a robust, well referenced, academic argument. This letter is a fine example of such a balance. The language employed throughout is mature, and the author makes confident use of legal terminology. The statistics and sources used are compelling and strengthen the argument, but are well-integrated enough to avoid seeming clumsy in the letter format. The letter is well structured, building evidence for the author's argument, leading to a convincing conclusion. Were this letter truly to be sent to the Minister, there is little doubt that they would be compelled to examine the issue further.

– Dr N. Day, Area Director, North of England, The Brilliant Club

Should Pharmaceutical Companies be Banned from Funding Disease Awareness Campaigns?

Year 9, Key Stage 3

J. Parry, West Monmouth School, Pontypool  
Supervised by R. Williams, Cardiff University

I will be covering my opinion on whether pharmaceutical companies should be permitted to fund disease awareness campaigns. The problem with this is that it causes a conflict of interest where the companies are supporting a good cause of informing people about a disease, however, it is generally only to increase sales of their drugs. The disease in question is usually aggressively promoted in such a fashion that it encourages, and in some cases, pressures, people to purchase a particular drug, which is exclusive to the company who backed the campaign.

This is known as disease mongering, an issue which proves harmful to society by promoting 'diseases' in order to encourage the sales of drugs. Disease mongering comes together effectively with medicalisation and pharmaceuticalisation, as the 'disease' being promoted is often not a disease at all – but instead, a condition socially constructed to appear negative or requiring medical treatment. By highlighting symptoms that are common and can be in certain degrees of severity, disease mongers manipulate people to believe they have a life-threatening illness – when they might only have a natural case of hair loss.

For example, before 1987, people who were anything other than heterosexual, were considered to have a mental illness.<sup>[1]</sup> This has now been corrected as society has progressed, although some conditions remain in need of de-medicalisation, as they are being used to convince people they need to buy medicine. Consequently, I agree that pharmaceutical companies should be banned from funding disease awareness campaigns, but only to an extent. I will justify my case and examine opposing arguments throughout this paper while analysing evidence to support my claims.

A mile-long list of disadvantages can be drawn for why drug companies funding campaigns is bad; however, there are some positives. And with a firm law in place to prevent conflict of interest, these positives can live their potential and become useful to society. Firstly, the law. My proposal is that pharmaceutical companies should only be allowed to fund disease awareness campaigns to a small percentage, like 1% or 3%. This will prevent the desire of greed and selfishness, as the campaign will not be so biased and will present its information in a helpful way to the audience – not a positive way to the drug company.

Furthermore, it would be good as it allows the creators of the campaign to confer with the company about any issues concerning particular medications,<sup>[2]</sup> improving the campaign. However, if the law was removed, the advantages would quickly become overshadowed with the negatives. The disease awareness campaign would turn into a drug advertisement in disguise because if the drug company has funded nearly all of it, the initial priorities will transform to those of the drug company. Disease mongering like this will lead to further problems, all of which will demonstrate detrimental effects on people.

Inappropriate medicalisation carries the dangers of unnecessary labelling, poor treatment decisions, iatrogenic illness, and economic waste, as well as the opportunity costs that result when resources are diverted away from treating or preventing serious disease. At a deeper level, it may help to feed unhealthy obsessions with health, obscure or mystify sociological or political explanations for health problems, and focus undue attention on pharmacological, individualised, or private solutions.<sup>[3]</sup>

This article explains that disease mongering is also harmful to real diseases that are actually causing deaths and suffering throughout the world. People are spending too much time and money on medicalised conditions, and as a result are forgetting about what really matters.

'Pulling Together', a disease awareness campaign developed in 2005, appears to be another valuable source of information



from Depression Alliance – “the leading UK charity for people with depression.” (Amelia Mustapha)<sup>[4]</sup>. However, upon further inspection, it is revealed that the survey was in fact funded by pharmaceutical companies ‘Lilly’ and ‘Boehringer Ingelheim’<sup>[4]</sup>. The key statistic the survey shows is that 85% of patients with depression believe that their quality of life is affected by their aches and pains. What I found to be quite misleading though, is that the phrase ‘aches and pains’ is mentioned 22 times in the survey results, although the most common symptom, low mood – which 93% of the patients had perceived as the main symptom, and 87% had discussed with their doctor – was only mentioned once.<sup>[4]</sup> Moreover, on page six of the document, ‘aches and pains’ is spelled out in very large letters, beneath a graph which is unrelated to aches and pains.

Other key information includes: fatigue being the fourth main symptom of depression; almost half (48%) of the 33% that had discussed general aches and pains with their doctors said they did not explain it was a symptom of depression, and 61% of those with general aches and pains were taking additional medicine to antidepressants to manage them. This information leads me to believe Depression Alliance are attempting to portray psychosomatic pain (physical pain caused by a mental stimulus) as a key symptom of depression, in order to help Lilly and Boehringer Ingelheim sell a drug<sup>[4]</sup><sup>[5]</sup>. And, after further investigation, I found that Lilly and Boehringer Ingelheim, in fact, had produced a drug which treated both depression and psychosomatic pain, a few months before national depression week.<sup>[5]</sup>

This illustrates disease mongering almost perfectly as drug companies funded a disease awareness campaign which fortunately tied in very appropriately with their new drug. Also, the drug they produced was a one of a kind and tackled two different problems at once. However, the one problem, psychosomatic pain, is hard to diagnose and the propaganda surrounding the illness could deceive people into thinking Lilly and Boehringer Ingelheim’s new drug is the only solution. Also, many people who have depression often have other illnesses. It isn’t uncommon for people to have depression as a side effect of chronic conditions or even cancer which causes pain. The survey doesn’t actually show or consider why the patients were in pain, they just presented that it was due to depression. If Depression Alliance hadn’t relied on the two pharmaceutical companies as their only source of funding, the campaign could have been a lot more honest and unbiased, as they wouldn’t be pushing certain facts out so assertively to influence people. Furthermore, it was recently announced that Depression Alliance had merged with the charity Mind, a charity who are strongly against receiving funds from pharmaceutical companies, and since then, have stated that they do not have the support required to run national depression week this year.<sup>[6]</sup>

A second campaign, British Lung Foundation’s COPD Awareness campaign, was actually not funded by a pharmaceutical company, but a company that makes devices which help people with lung diseases.<sup>[7]</sup><sup>[8]</sup> This shows how other companies can follow the same path as drug companies to promote their products by promoting a condition. The campaign resulted with 22% of the 586 people (128 people) being referred to their GP for further testing, which potentially means that they will end up purchasing the products of the ‘Living Well Alliance’, the device company who funded the campaign. And that is not to mention the 63% who had no previous knowledge of COPD, who could end up owning a

device out of pure paranoia or uncertainty. Personally though, I do not believe that this example was very effective at disease mongering, as devices for COPD are relatively expensive which means it is unlikely for someone to buy one unless they really need it.<sup>[9]</sup>

On the other hand, there is the opposing argument. This is that pharmaceutical companies should be allowed to fund disease awareness campaigns completely with no restrictions whatsoever. Thinking optimistically, this will benefit the creation of campaigns, because they are highly expensive to produce, especially if it was to be broadcasted globally and professionally. The drug companies will not be afraid to provide more than sufficient funding for the campaign, given that they will receive the means to subtly promote their company or drugs through the campaign. Although this will easily allow for disease mongering, the campaign will hopefully be able to give some information of use, and could, theoretically, let people be diagnosed early and prevent them from going to the hospital, potentially helping out struggling healthcare systems like the NHS<sup>[10]</sup>. Cancer awareness campaigns are notably good at this<sup>[11]</sup><sup>[12]</sup>, however one paper reckons that early testing can lead to false positives.<sup>[13]</sup> This means that healthy people are being diagnosed to have cancer, and are having to undergo unnecessary treatment to, for example, have lumps removed.<sup>[13]</sup> Aside from this, though, there is little else beneficial to anyone other than the drug company. Drug companies funding charities’ efforts to raise awareness of dangerous diseases are not in vain, as the campaigns are gaining the audience they need to survive. However, the question of how serious these diseases are is becoming more prominent, and the stigma surrounding the honesty and intentions of the campaigns is growing promptly. But if a barrier was to be installed – a restricting law – to prevent conflict of interest, then perhaps it should be allowed. If in the future these problems are resolved, then our society will be one step closer to liberty.

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**PhD Tutor's note**

This is a clearly written and persuasive letter on the merits of restorative justice in the UK context. The author builds their argument in a persuasive manner, discussing different types of restorative justice, then exploring various models of restorative justice in practice, which could be used as examples. The author draws on a variety of different sources in evidencing their claims, which strengthens the points they put across. They make particularly compelling use of statistics, in arguing that a move to a restorative justice model would be preferable to – and indeed more effective than – the current Criminal Justice System. The reader would struggle to find fault with such a well-considered argument – well done!

– Dr N. Day, Area Director, North of England, The Brilliant Club

**To What Extent did ATV News Reinforce or Challenge Popular Stereotypes of Asian Immigrants?**

**Year 12, Key Stage 5**

**L. Gabriel, George Spencer Academy, Stapleford  
Supervised by R. Yemm, University of Lincoln**

After the Second World War and the partition of India in 1947, migration from South Asia to the UK was more popular than ever. For the Southern Asian immigrant it was the prospect of a better life that drove their migration to the UK, however, the benefits of their migration were not without downsides. For Britain, these Asian immigrants were invaluable for post- World War Two reconstruction by filling various labour shortages. However, the mass migration from India came between 1965 – 1974 with 134,000 Indians moving to Britain, specifically the Midlands area – an area of key focus in this essay. From that time South Asian culture, particularly Indian restaurants and cuisine, was becoming more and more distinguished in British society and there was a clear prospect of ‘multiculturalism’. Nevertheless, that is not to say that the South Asians had fused completely with the British people during the period between 1960-1990, and there was still a great amount of hostility towards the immigrants, largely due to the popular stereotypes of Asian immigrants that many British people could not forget. One could argue that the local TV news of the Midlands: ATV News, played upon these fears and popular stereotypes of Asian immigrants and actually made the racial tension in Britain a lot worse. These common stereotypes of Asians, such as being unhygienic and diseased, were clearly reinforced in many forms of local media, not only TV but also in local newspapers. This essay will demonstrate that many of the interviews on racial issues between 1960-1990 clearly reinforced popular stereotypes of the time. However, what seems to be unclear is whether or not ATV News actually formed the opinions and attitudes towards the Asians in Britain and ‘shaped reality’, or rather just reinforced stereotypes which already existed, and therefore simply ‘reflected reality’. In this essay I will be analysing three news clips from ATV News and will argue that although often the reporters can seem sympathetic towards the Asian population in Britain, there is never a strong opposition to the popular stereotypes of Asians at the time. Instead, ATV only seem to highlight the separation between races in the Midlands and create a more ‘us versus them’ atmosphere.

In 1963, ATV news conducted an interview with a young Asian boy after he had just passed his ‘11 Plus’ examinations, to go to grammar school. At the time, a popular stereotype of Asians was that they were ambitious and driven, which is supported by a newspaper article published in the 1970s describing Asians as those ‘who put learning before leisure’. But often this ambition was said to be forced upon them by their family, as rather than simply encouraging their children, it was assumed that they put a lot of pressure on them and a stereotype was created of the ‘possessive mother living out her ambitions through her children’. This stereotype is greatly reinforced in this ATV News clip through the interviewers choice of questions such as ‘what does your father want you to be?’, which is one of the first

questions asked, reflecting its significance to the reporter. Not only does this question reinforce the stereotype of the authoritarian Asian parent, but also his choice of the word ‘father’ instead of ‘parents’ reinforces the patriarchal stereotype in the Asian home and the more passive and ‘submissive Asian woman’. There is a constant mentioning of this Asian boy’s parents throughout the video, and the last quarter of the video focuses primarily on them and almost drifts away from the supposed topic of the video by assuming that ‘[his] parents can’t speak any English at all?’ in a condescending tone. It seems here as though ATV News is trying to emphasise and give evidence of the lack of integration of Asians into the British lifestyle.

The visual imagery in this report does not spark any major discussion, as the shot establishes the location of what looks to be a school, which supports the basis of the report. The majority of the report uses a close-up shot, which intimately focuses on the face of the Asian boy. With this shot the audience can recognise the emotional response of the interviewee, and in this case the boy’s facial expressions seem to differ, as when he is talking about his education and the subjects he enjoys, he seems a lot more comfortable. In contrast to when he is asked about his parents he appears more uneasy and puzzled, as though he was not intending to be asked about such things.



Undoubtedly, the popular stereotype of the ambition of younger Asian’s as imposed upon them by their parents is strongly reinforced in this ATV News report. On analysing the report, it clearly seems to steer the Asian boy in a particular direction which may suggest that the topic of the interview, the boy’s achievement in passing his exams, was just a convenient excuse to accentuate some of the issues many British people had with Asians, such as the lack of integration, and to indirectly show the audience that these issues are still prominent.

Similarly, in Smethwick (a small town near Birmingham, which in 1964 elected the notorious anti-immigrant Conservative MP Peter Griffiths), the local newspaper ‘The Smethwick Telephone’ often contained articles heavily reinforcing the unhygienic stereotype of Asians, such as the account of the ‘overcrowding...in Indian house’. Although there might be some truth to this account, one has to question whether the same story would have been published if it was ‘overcrowding...in a white house’. Therefore it is fair to say that, the local news, (not purely ATV but other forms of



media as well), was not always reporting to inform others of an important issue, but to reinforce a popular stereotype of Asians.

Another ATV news report, first broadcast in 1976, shows reporter John Swallow interviewing people in Leicester about the Asian tradition of doorstep painting to celebrate the Diwali festival. Pre 1970s Britain was described as ‘multicultural’, due to its varying demography post immigration, however the idea of ‘multiculturalism’ came on the scene in the 1970s, which refers to attempts of both the British and the immigrant population to understand each other and work together. This news report is evidence of this new concept of ‘multiculturalism’, as it displays the attempt to encourage white people to participate in the Asian tradition and bring the community together.

Although ATV News may have had good intentions with this report by trying to make local people get involved, they did not fail to reinforce popular stereotypes of Asians at the time. Particularly with Asian women, who were stereotyped as extremely passive and subservient. In this clip, Swallow interviews three Asian women whilst they are decorating their doorstep and his use of language and tone of voice clearly reinforces this stereotype. Swallow states ‘that’s very clever’ in a very patronising tone, as if he is speaking to a child. In comparison to how he speaks to the next male interviewee, we can see Swallow being a lot more condescending and gentle towards the women, as if he does not want to say anything to upset them because of their supposed weak and fragile character. It also reinforces the isolated stereotype and the separation between the Asians and the British. Swallow refers to how ‘when it’s our Christmas we put a Christmas tree in the house don’t we’. His use of the personal pronouns such as ‘our’ and ‘we’ emphasises this separation as Swallow detaches himself and the white people from the Asians who celebrate Diwali. He even ends one interview to an Asian woman with ‘Happy Christmas!’, even though the whole point of the interview was to inform people about Diwali, not Christmas. The fact that he cannot even wish them ‘Happy Diwali’ just highlights his arrogance and the inability of certain people to even acknowledge another cultural festival, let alone get involved with it. Swallow questions a white man and asks ‘have you decorated it like the Indians do?’, the phrase ‘like the Indians do’ again reinforces that separation by making them sound totally separate.

On analysing the visual imagery in the report, the facial expressions clearly inform the audience about how the people are really feeling without having to explicitly say it. The advantage of visual imagery for TV news is that often the images suggest something and the audience can interpret how they like, and therefore ATV News in this case can have ‘some degree of manoeuvre not permitted through language use’. Swallow conducts a few Vox pops with white people on the street, to get their views about the doorstep painting. With the first white female interviewee, the audience can see her smiling and biting her lip, which appears as though she is trying to refrain from laughing. Just from her facial expression the audience get the impression that some of the white people in Leicester are not taking this community event seriously and are practically mocking it. In complete contrast, the facial expressions of the next white male interviewee are pure shock and bewilderment, as if he cannot believe why he even has to justify his lack of participation in the Asian practice. Just by watching this news report, we can blatantly see the continuing hostility many of the white people had towards the Asians and their inability to come

out of their comfort zones to accept and try to understand different cultures.

Cinematic techniques used in this news clip such as the camera shots are also extremely noteworthy. An interview at the beginning shows an Indian woman sitting on her doorstep and the reporter is seen in the shot crouching down to speak to her, or possibly ‘stooping down’ to her level. This appears to be quite condescending and often it is what one does when they are speaking to a child. The weak stereotype of the Asian woman is reinforced again as she is not given the chance to stand and look the reporter in the eye and therefore appears quite shy, which reflects her supposed submissive relationship with her husband.



ATV Today, ‘Doorstep Painting’, first broadcast 19th October 1976, MACE, University of Lincoln.

Moreover, the fact that they interview all of the Asians in the first half and all of the white people in the second half of the clip, just highlights the separation between the groups and the differences between them. One could argue that the clip displays how the Asians living in Britain are still holding onto their cultural heritage and therefore the hostility of the white people towards these new cultural traditions is natural, as just like the Asians, they are loyal to their British cultural heritage and possibly threatened by anything drastically different. This may be true but completely contradicts the concept of ‘multiculturalism’, which was supposedly more distinguished in the 1970s. This report casts the prospect of ‘multiculturalism’ as more idealistic and infers that what actually existed was a ‘mutual tolerance’. This is further supported by how Asian culture, particularly the cuisine, was becoming popular in Britain, yet in 1972 a letter written to and published in the ‘Leicester Mercury’, a local newspaper, describes how ‘the smells of curry are bad enough’. This just proves that many British people liked the idea of ‘multiculturalism’ when going out for a tasty curry, but only wanted it on their terms. In other words: they wanted to enjoy Asian culture when it suited them, but at certain times it needed to be contained. Also, the fact that this was published in a local newspaper reveals it was not purely ATV who reinforced popular stereotypes and its use

of blunt and startling language shows the lack of remorse that the local press had when openly sharing these offensive public opinions. ATV News may have had the best intentions with this news report: to encourage white people to join in with the Asian traditions but this is not entirely convincing. If anything, from the reactions of the white people and in particular John Swallow and his snide remarks, the report actually discourages involvement and adds further to the ‘us versus them’ undertone in Britain. Overall, undoubtedly ATV News reinforces the stereotypes of Asians in this news report, particularly by portraying Asian women as very passive and inferior.

The final news report involves an interview with a male Asian shop owner in Leicester who sells traditional saris, and is explaining how they are apparently becoming more popular with Western women. The basis of the news report seems positive, as it shows the reporter trying to learn about Asian culture by asking many questions about the saris. Also by admiring them, it may have encouraged more Western women to buy them and further the idea of ‘multiculturalism’. However, that does not mean the news report does not heavily reinforce popular Asian stereotypes.

The fact that the Asian shop owner is male reinforces the hardworking, ambitious stereotype and also reiterates the controlling male stereotype as he is the one who owns the shop and is asked all the questions; rather than the women. Furthermore, the women in this report have little time to speak compared to the male, and this lack of voice reinforces the subservient female and dominant male popular stereotype of Asians.

The visual imagery used in the report when focusing on the women shows them parading around in their saris, with the intention of being looked upon and glorified. One could interpret this as emphasising how the Asian woman is purely there as an object of desire and reinforces the stereotype of the Asian women as ‘submissive but dainty sex objects’. The use of ‘the noddy’ camera shot in the beginning shows the reporter agreeing with what the interviewee is saying, this is fairly positive as it implies a real effort by ATV to understand an aspect of the Asian culture. However, the use of an extremely close up shot on one of the Asian women’s face, appears as though it is focusing on her beauty rather than filming the saris, which was the intention of the interview. Therefore again the desirable object stereotype of Asian women is reinforced purely through the camera shots. Although this report seems to raise real hope of the combination of the Asian and Western women through sharing fashions, it ends rather negatively, with the reporter saying ‘the Western women might think a skirt and blouse would be easier’. This ends the report with a closing message that ultimately highlights the difficulty and effort it takes for the white and Asian communities to integrate.

Local TV news, in this case ATV News, is created to focus on light hearted, community stories which people living locally can associate with. The majority of the people in the Midlands would have associated with these three news reports as by the 1960s immigration itself became less of an issue, but it was the immigrants themselves who were seen as causing a problem. ATV News seemed to focus a lot on racial issues, which you can understand given the attitude at the time, however it seems as though often they would link a story back to racial concerns to make it

seem as though they are the initial problem. There were many popular stereotypes of Asians at the time, and there is no doubt whatsoever that ATV News reinforced these stereotypes. In some cases, it is fair to say that ATV can be sympathetic towards the Asian immigrants; but ultimately their choice of questions and the cinematic techniques used make it impossible as a viewer not to recognise the stereotypes being reinforced. Some may argue that ATV News is purely reflecting some pre-existing tensions, and if we recognise these as stereotypes then clearly we are already aware of them.

Of course, stereotypes have to come from somewhere, but ATV makes no effort to challenge these popular stereotypes but instead reinforces them so heavily that the stereotypes are exaggerated. To conclude, this essay has demonstrated that ATV did reinforce these popular stereotypes of Asians, and only created a more hostile environment in Britain which divided the whites and the Asians even further, and possibly partly contributed to the continuing racial tension Britain faces today.

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### PhD Tutor's note

L. was a pleasure to teach. She showed a keen interest in the topic and this comes across in her work. I was very impressed with L.s ability to use both primary and secondary source material throughout her essay and her excellent analysis of the news reports discussed throughout. L. also demonstrated an ability to properly reference sources and her writing was to a high standard. I wish her the best in whatever she decides to do in the future.



# Can Mother Tongue Education Promote Social Justice for Indigenous Minority Groups?

Year 12, Key Stage 5

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Mother tongue education refers to the teaching of students within public and private schools in their first home language. By doing this it can be argued that social justice, which describes a fair distribution of opportunities and privileges within a society, will be promoted for indigenous individuals who may have become marginalised from the social majority. Many feel that by employing mother tongue education the cultural heritage of indigenous groups may be preserved along with the self-worth of many communities: schools are known to play a key role in the assimilation of minority groups, resulting in many young children learning in a language which is not their own. In fact, students have previously been punished for speaking their mother tongue within schools and whilst this is not common today, a strong message is seemingly still communicated to them that if they desire to be accepted, any loyalty to their home language and culture must be abandoned. This could potentially result in a subsequent loss of their mother tongue as they may become less likely to pass it down to future generations. This tells us that mother tongue education can be highly important in the process of promoting social justice for indigenous minority groups as without it, the native community will face extremely damaging effects. This essay will therefore focus on providing insight into the ideological and practical factors surrounding the importance and relevance of mother tongue education, such as the different models of mother tongue education, success rates, and the time and cost that it may require. From these ideas, it seems that mother tongue education is indeed highly capable of promoting social justice for indigenous minority groups. However, it is also clear that there are major challenges which need to be overcome in order for the practice to prosper.

To begin I will discuss some of the ways that mother tongue education may be implemented. There are two main models of mother tongue education: the transitional model and the maintenance model. In the transitional model the mother tongue is used as a bridge between the first and second language, thus it is only taught during the first few years of schooling. In contrast, the maintenance model places higher value on the first language, and bilingualism is sustained throughout the student's education. Both models can be said to have positive and negative consequences. Firstly, the transition model appears to some as tokenistic because it only provides short term education in the mother tongue, which may not promote as much justice as the maintenance model which sustains the mother tongue. This may also affect the fluency of the children's mother tongue language too. Despite this, the transitional model in fact appears to be the most popular. This could be because it is thought to be slightly easier to implement, or possibly due to reasons discussed in my next paragraph such as how when teaching starts in the mother tongue the experience of education becomes more natural.

The maintenance model has also provided evidence of success. In Ethiopia, local language education policy, which combines long-term mother tongue education with Amharic and English (thus bilingualism), has resulted in lower dropout rates and higher retention. Additionally, in Guatemala, grade repetition in bilingual schools is roughly half that of traditional schools, and dropout rates are 25% lower. This tells us that mother tongue education is able to provide justice for younger generations of indigenous minority groups as they are able to gain sufficient qualifications and have a beneficial experience of schooling.

A student's experience of schooling correlates directly to their success and it is proven by UNESCO that young people do in fact learn better in their mother tongue. A child's learning starts at home in their mother tongue and an abrupt change in this learning style e.g. learning in the second language can damage their progress. It is evident that by using mother tongue, schools can help children to relate their learning at school with experiences brought from home. This means students are more likely to engage in the learning process by asking questions and communicating knowledge with confidence, ultimately helping to affirm their cultural identity. It is documented that globally there are 50-75 million marginalised children who are not enrolled in school. On top of this, children whose primary language is not used within schools are more likely to drop out early on. Accordingly, as mother tongue education allows children to perform better in education this style of teaching can be said to promote social justice for indigenous minority groups. Additionally, research has shown that when teaching starts in both the teachers and learner's mother tongue, the experience of education becomes less stressful for all. As a result, teachers are more able to be creative in designing their materials and approaches for the classroom, which is likely to lead to further improved learning outcomes.

Furthermore, this can also inspire pupils to go on to have successful futures too: by having native speaking teachers it demonstrates that a second language is not the only thing that can bring the pupils success. This opposes a popular idea that having a second language is completely necessary to gain a place in the global market and shows that native peoples are still able to earn a living whilst speaking their own indigenous language.

Thus, mother tongue education can help to promote social justice for indigenous minority groups as it can help to encourage wider society to place higher value on their way of life. For example, in Peru, which first introduced mother tongue-based bilingual education in 1952, the prominence of cultural differences in education is acknowledged, and respect for these is promoted along with harmonious interaction between members of different cultures. This has aided in broader socio-political change, such as by helping to gain recognition for indigenous cultural and linguistic rights, thus demonstrating one way that mother tongue education can promote social justice for these groups. Without mother tongue education it is likely that increasingly less value will be given to minority groups from society, which may result in a depletion of the world's languages and the cultural knowledges that are carried through them. Mother tongue education can therefore promote justice by highlighting key areas that need further attention from wider society for indigenous minority groups.

Despite this, it also indicates that there are still problems to overcome in this area. For example, the division between indigenous and non-indigenous populations in many countries means that indigenous values are marginalised in favour of the dominant non-indigenous society. Additionally, in Peru the programme has only reached rural indigenous children as parents in the non-indigenous Spanish speaking society are not expected to send their children to these schools, credibility of the programme is restricted, and indigenous parents are led to believe that mother tongue education is in fact second class to the leading style of teaching.



International Mother Language Day Monument in Sydney, Australia, unveiling ceremony, 19 February 2006

Furthermore, some indigenous parents believe that due to social and economic opportunities it would be more beneficial for their children to learn the national language is best served by being proficient in either English or Luganda (the dominant regional language). This is due to the fact that in numerous countries a high value is placed on international languages and local language instruction is, as mentioned previously, seen to represent a second-class education. This may lead to less community support for mother tongue education programmes, and could lower the self-worth of indigenous peoples, showing that if these programmes are not carried out efficiently, they may in fact hinder the development of social justice for indigenous minority groups. Despite this, it is clear that if they are efficient, much justice is promoted.

On the other hand, one key argument is that whilst mother tongue education may promote social justice for some indigenous minority groups, this may not happen for all. An example of this is seen from a case study which focuses on the issues surrounding language rights and variation for sign language within the Netherlands. This study demonstrates that in order to create a curriculum with relevant materials for students who wish to study in their mother tongue sign language, a standardised lexicon is required. Without this, government officials state that the language cannot be recognised. However, multiple issues have in fact stemmed from this arrangement. Firstly, the process of producing a standardised lexicon in any indigenous mother tongue risks misrecognition, which refers to the selective and preferential treatment of specific groups – this may cause certain groups to feel excluded, thus meaning that they would not gain full social justice despite mother tongue

education being in place. Furthermore, the argument from officials that the language would only be recognised if it becomes standardised may be said to demonstrate the idea that indigenous minority groups are in fact ultimately subject to the authority of higher powers, showing that they do not have a fair say, which could potentially infringe on basic human rights. This could therefore mean that although mother tongue education may be in place in some countries, it still may not promote total social justice for all indigenous minority groups as they may only have limited control over the programmes.

Alternatively, the Netherlands case study could potentially offer a positive outcome: if indigenous languages are standardised, this could lead to a wider population of peoples learning the languages as they could be more accessible. This could lead to these languages being taught in schools, and may also result in indigenous minority groups being able to communicate on a broader spectrum thus offering increased chances of social justice. This can therefore link back to the topic discussed in the previous paragraph as it highlights the need for wider society to become more open to learning about different cultures; if this happens, it is more likely that minority groups will gain the justice that they deserve.

Allowing indigenous minority groups to gain the justice they deserve through mother tongue education presents some practical challenges. For example, it is likely that the initial implementation of these programmes will be expensive. This is evident in the case study from Peru in which a mother tongue-based education programme received limited government support and minimal funding. This resulted in a lack of resources which in turn produced poor learning outcomes, making it harder for the programme to gain community support. In this case it is clear that external assistance with funding is vital in order for mother tongue education to work. On the other hand, a Papua New Guinea case study revealed that financial sustainability can be in fact be achieved through increased community involvement, such as by helping to develop materials e.g. an alphabet wherever possible and aiding in the training of teachers. Despite this, for the system to become mainstream, mass materials would need to be produced, which would indeed still be costly. One solution offered by Ball is to simply translate already existing texts/ materials. This proved successful in the Kenya Institute of Education which produced just one book and translated it into various languages rather than producing different books in every mother tongue. However, whilst this could help to overcome the financial challenge involved, it may pose the notion that real knowledge is simply that of the metropole. By solely translating materials that exist in the mainstream curriculum, the opportunity to create a unique curriculum for mother tongue based learners is disposed of. This could possibly mean that indigenous minority groups would not gain full social justice through some mother tongue education programmes as they are still subject to mainstream criteria. Creating new materials could therefore mean that, although costlier, more justice would be promoted.

Another practical problem revealed by the Papua New Guinea case study is that of time. Firstly, the transition model (as described in my first paragraph) only provides three years of mother tongue schooling. This limited period



may affect the fluency of students in their mother tongue and thus possibly not provide full justice. Additionally, time is another concern in terms of the period needed to develop strong materials, to train teachers and to develop a new alphabet. This therefore implies that in any mother tongue education programme, gradual phasing is important. Although social justice can evidently be promoted through these programmes, much time and care must be taken.

In conclusion, it is clear that mother tongue education can help to promote social justice for indigenous minority groups. This form of instruction can help to cultivate wider recognition of the rights of indigenous groups, and can also offer young students the opportunity to prosper in their academic life. On the other hand, it is also clear that there are challenges that need to be overcome for mother tongue education to promote true social justice. Time and cost play a key role in this because if the programmes are not planned with care, it is likely that mother tongue education would be hard to achieve, especially in countries with less stable economies. Furthermore, if the tuition is not implemented morally, such as by disregarding certain members of indigenous communities, an infringement of human rights may occur. However, whilst these factors are undoubtedly important, it seems that mother tongue education is a major tool in the promotion of social justice for indigenous minority groups, and could provide even more integrity if paired with other methods, such as reviewing current laws and policies that may be hindering the advancement of these groups, too. It can be therefore be concluded that despite the challenges it is faced with, mother tongue education can indeed play a significant role in promoting justice for indigenous minority groups.

**PhD Tutor's note**

S. was an absolute pleasure to work with. She engaged with the topics of the course in a very thoughtful and sophisticated way. Her final essay was beautifully written, carefully structured, and showed great levels of insight. I have no doubt that S. will excel in her future studies."



