



UNIVERSITY OF  
**BATH**

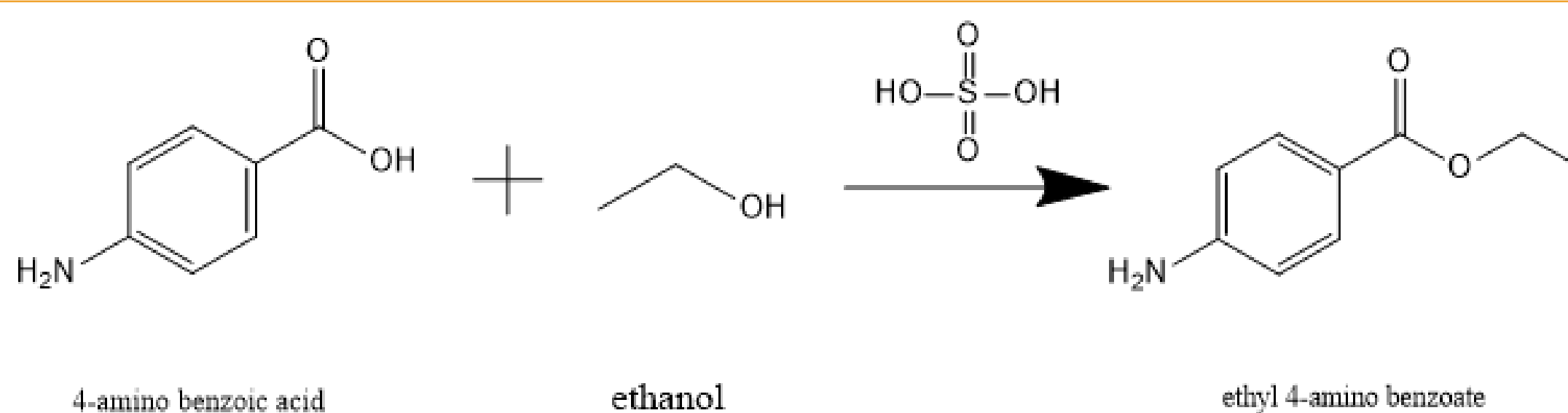
# Synthesis of Benzocaine

## Introduction and Research Questions

Benzocaine is a local anaesthetic used commonly in antiseptic lotions and in after-sun products.

The aim of our experiment was to synthesis Benzocaine from a sample of 4-amino benzoic acid; using techniques unique to working in a chemistry laboratory. We would then develop our analysis skills to determine the purity of our product.

- Is it possible to conduct the synthesis of 4-amino benzoic acid to produce benzocaine, using the techniques learnt both in the classroom and the laboratory?
- Is it possible to determine the yield and purity of the product using chemical analysis techniques?

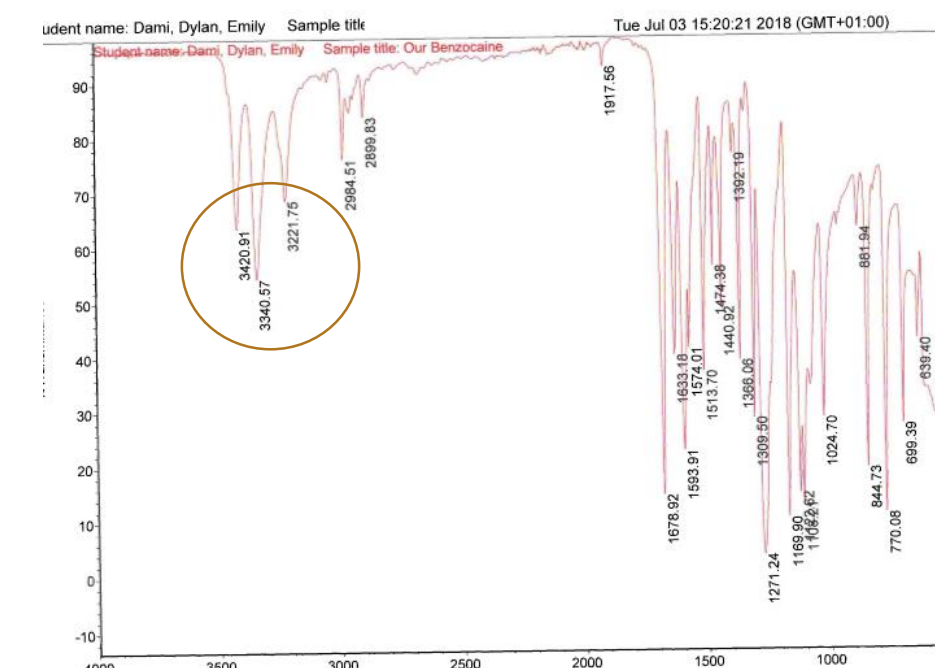
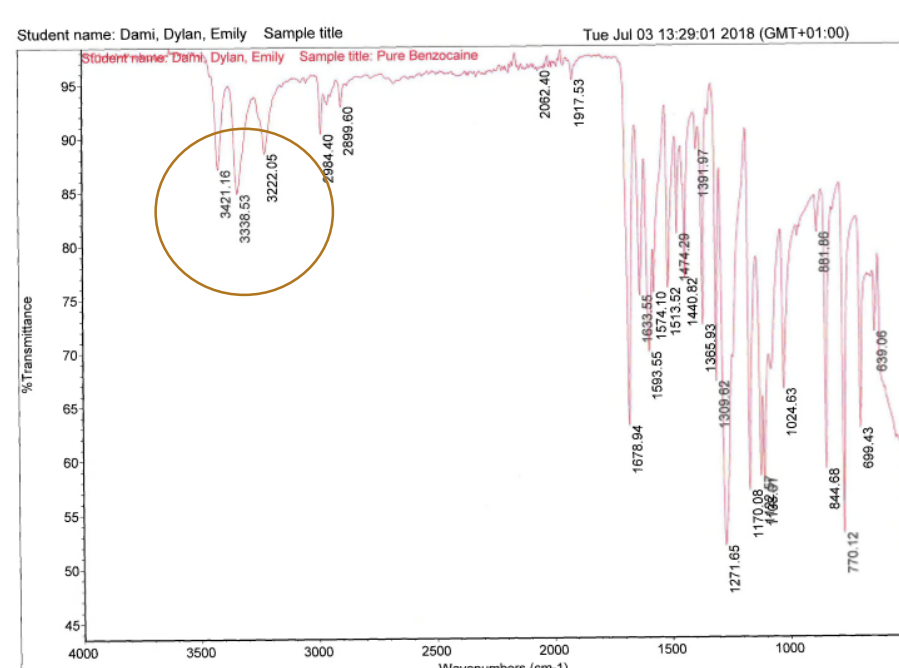


## Method:

1. 4-aminobenzoic acid (1.35g) was added to a mixture of ethanol and sulphuric acid (10cm<sup>3</sup>) in a round bottom flask before adding bumping granules and swirling the mixture to form a suspension.
2. The apparatus for reflux was set up, the water flow was started, and the heater switched on until a gentle boil was maintained.
3. The solution was left to boil for three hours.
4. Meanwhile, the melting point and an infrared spectra of both 4-aminobenzoic acid and pure benzocaine was measured.
5. After the 3 hours the heater was switched off and the solution was allowed to cool.
6. Aqueous sodium carbonate (40cm<sup>3</sup> 0.5moldm<sup>-3</sup>) was added into a round bottom flask and using a pipette, small portions of the reaction mixture was added to this.
7. The white precipitate formed was collected using filter paper and a Buchner Funnel, before rinsing the solid with ice cold water.
8. The product was vacuum dried, transferred into a watch glass, and allowed to dry in an oven for 30 minutes.
9. After this, the watch glass containing our product was weighed, and the percentage yield was calculated.
10. The melting point and infrared spectra of the product was recorded.
11. The benzocaine was analysed further using a Nuclear Magnetic Resonance and High Performance Liquid Chromatography.

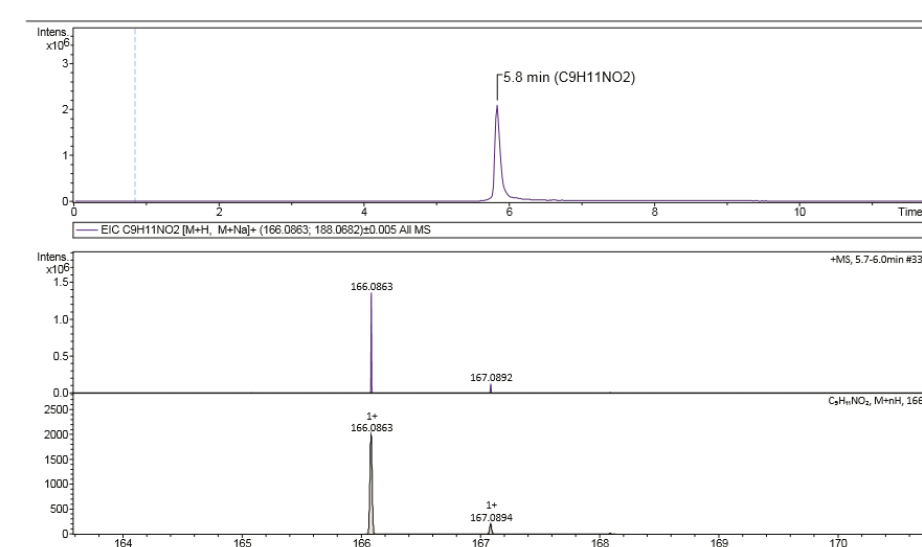
## IR Spectroscopy

Infrared Spectroscopy is used to identify the presence of the functional groups present in the molecule. The spectrum is unable to display the molecular mass of each molecule, but it produces an image that is unique to a particular molecule. If the spectrum is the same as the pure product's, it is pure.



## Mass Spectrometry/ High Performance Liquid Chromatography

Mass Spectrometry relies on the difference in molecular mass between different organic molecules to identify a sample. If the product matched the mass spectrum of the pure benzocaine, then a pure product was created.



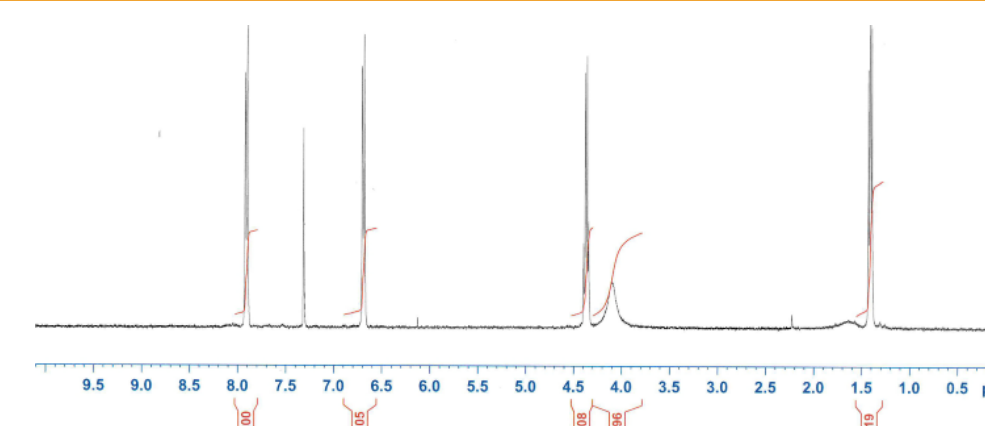
## Melting point

Knowing what the substance is, the melting point can be used to determine the purity. Comparing the expected melting point<sup>1</sup> with the product's melting point can indicate the purity of the synthesised product.

Melting point of pure 4-amino benzoic acid/ °C	189
Melting point of pure benzocaine/ °C	92
Melting point of product/ °C	91

## NMR

Nuclear Magnetic Resonance (NMR) determines both the amount and placement of protons present in a molecule, which can then be used to determine the bonds present. Results similar to the pure sample show that the product produced is correct and pure.



## Evaluation

All the results obtained are significantly similar to the results from the pure benzocaine sample. This shows that the product we have synthesised is very pure and the aims have been completed to a high standard.



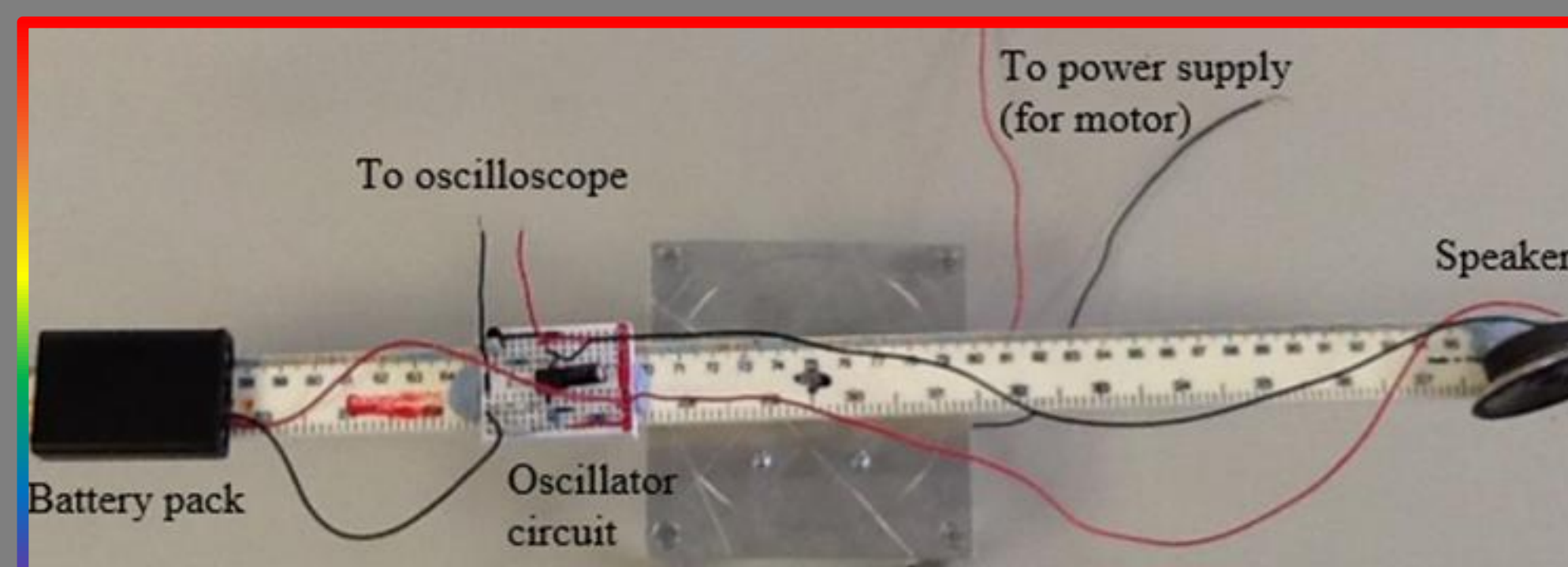
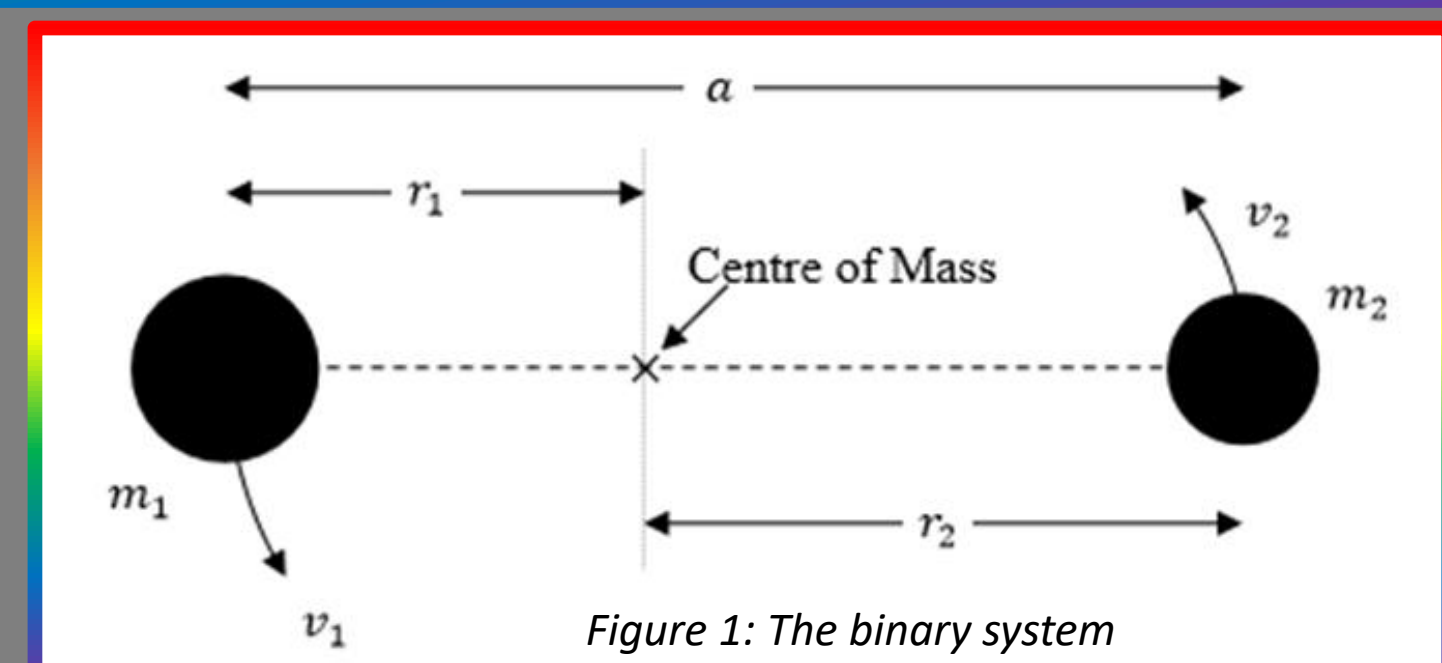


## Introduction

"Binary stars are two stars that share a gravitational link and simultaneously orbit their common centre of mass" (1). One of the ways that scientists work out the mass of stars is by "measuring their gravitational interaction with other objects" (2). "Information about the two stars can be deduced from study of spectral lines emitted by the stars that are Doppler-shifted as a result of their orbital motion" (2). It's useful to use a binary system to find individual stars' mass is because "when two objects orbit one another, their mass can be calculated very precisely by using Newton's calculations for gravity. The data collected from binary stars allows astrophysicists to extrapolate the relative mass of similar single stars" (3). We did an experiment which imitated two stars rotating about a centre of mass.

## Method

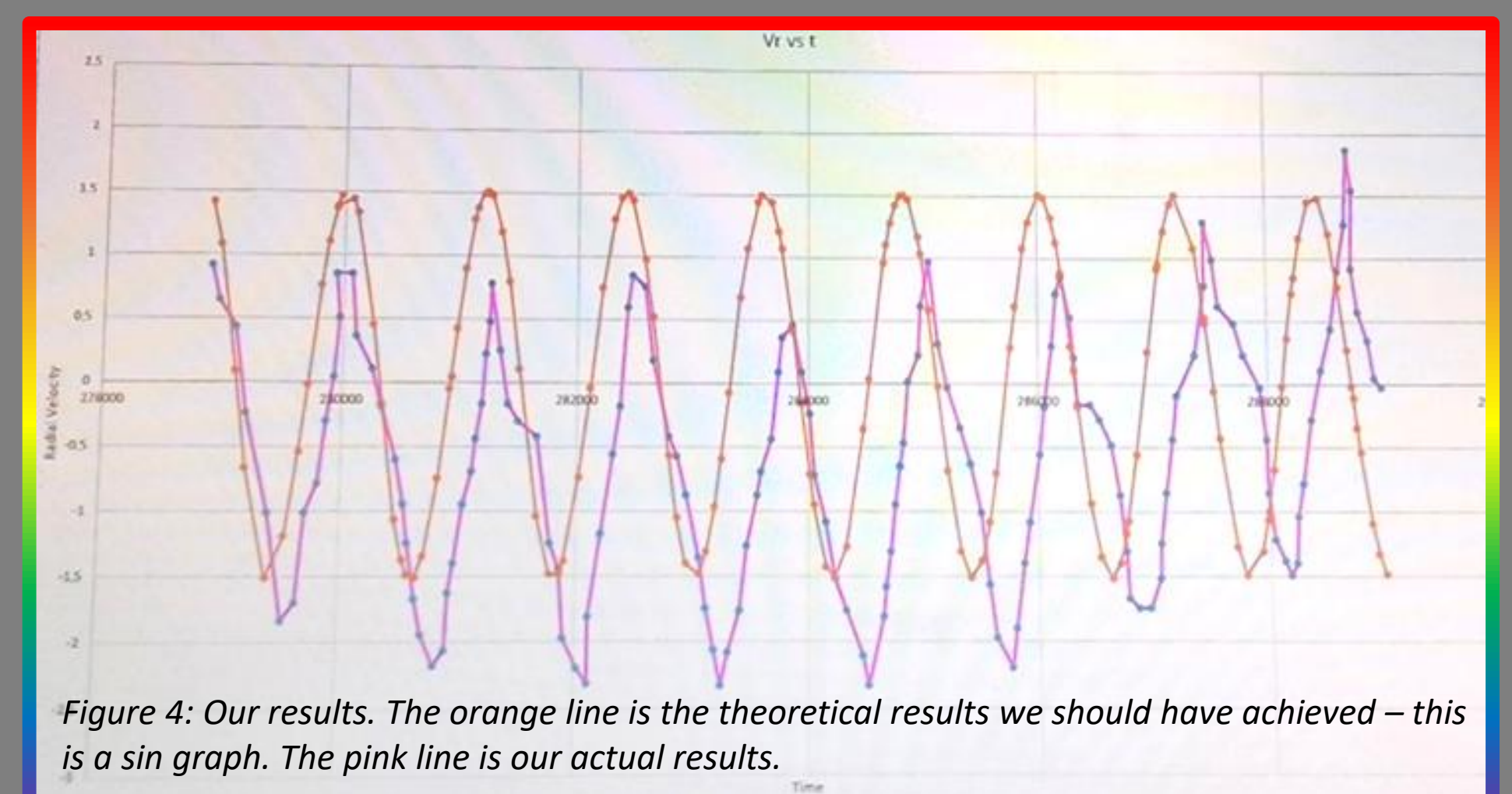
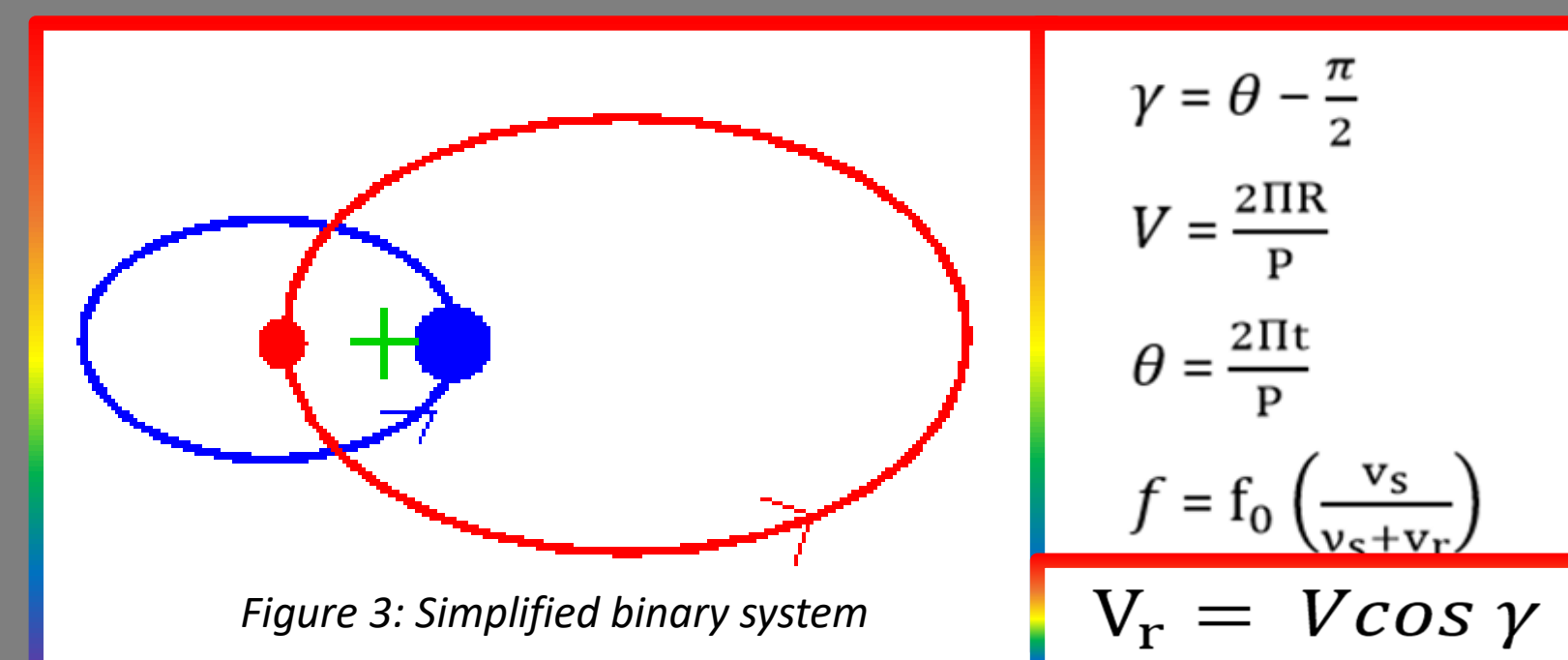
- 1) Equipment should already be set up as shown on the side, about a meter away from a microscope, with bubble wrap in between to avoid reflection of sound. This microscope should be connected to a computer with spectrogram 16 open.
- 2) First of all, connect the system to the oscilloscope and measured the frequency of the speaker.
- 3) Disconnect the circuit from the oscilloscope and connect it to the power pack which makes the ruler stick spin so the Doppler Effect can be measured.
- 4) Measure how many times the speaker completes a full cycle by using a stop watch to measure 10 cycles and divide it by 10.
- 5) Turn the power pack and the speaker on and the programme will pick up the signal.
- 6) Record the frequency of the signal by hovering the cursor over the maximum and minimum points, and finding the mean.
- 7) Save it, and log the values. Click points along the line making sure to be accurate. Copy and paste the results into excel and work out other values for the equation by using the formulae.
- 8) Make a graph out of the results and do the same thing using the frequency reading from the oscilloscope at the beginning and add to the graph.



14.9kHz

Mean: 1.2005 seconds. This is the value we used for P

Highest: 15026Hz  
Lowest: 14862Hz  
Mean: 14944Hz



## Evaluation

The results broadly followed the trend of the theoretical results, however there was deviation. This could be because of the background noise in the lab. To improve the experiment, it would be ideal to be in a quiet or silent room so that only the sound emitted from the speaker would be picked up by the microphone. Furthermore, there is a possibility that some sound waves reflected off of the computer screen or another surface would interfere destructively with the sound travelling towards the microphone, which would have a huge impact on the results. Soft panelling could be used to avoid reflection, destructive interference and echoes.

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- Abramson, J, 2016, *What is a Binary Star System?* [Online] Study.com. Available from: <https://study.com/academy/lesson/what-is-the-binary-star-system.html> [Accessed 5<sup>th</sup> of July 2018]
- Cain, F, 2015, *What is a Binary Star?* [Online]. Universe Today. Available from: <https://www.universetoday.com/24203/what-is-a-binary-star/> [Accessed 5<sup>th</sup> of July 2018]

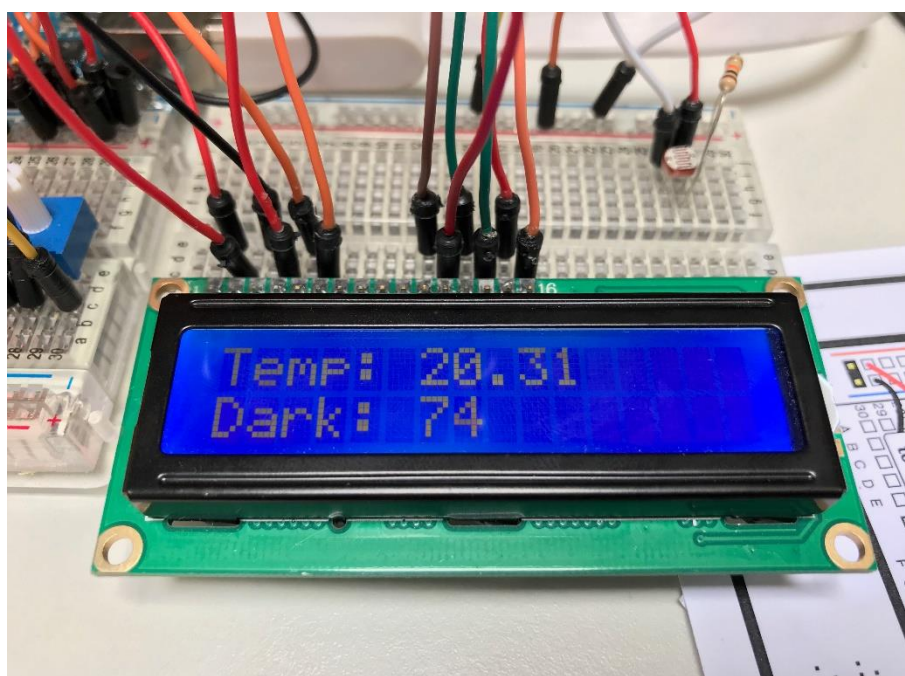


# The Sensuino

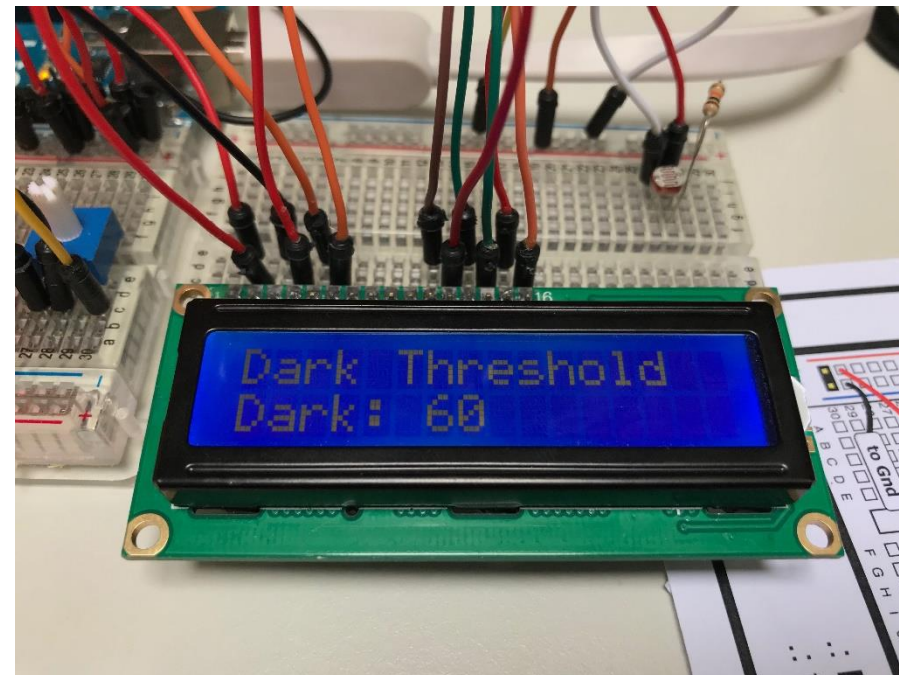
A prototype for home automation with the aim of improving quality of life.

## What does it do?

It collects data on the surroundings, such as temperature and light intensity, which it then uses to provide a useful output such as turning the fan on when it gets above a certain temperature to make the home owner feel comfortable. It also has other useful functions such as turning on the lights when it gets too dark. In addition, the Sensuino displays the collected data on a LCD (Liquid Crystal Display) which can provide useful information for any homeowner.



Default screen which shows the data being collected, measured and updated every 750ms



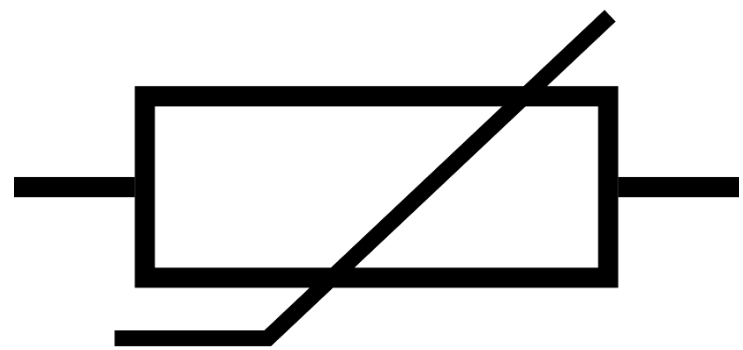
Darkness threshold screen which allows the user to change at what level of darkness which they want the lights to turn on.



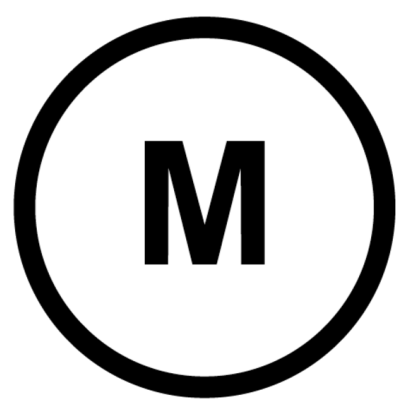
Fan speed screen which allows the user to adjust the fan speed regardless of the temperature

## How it works

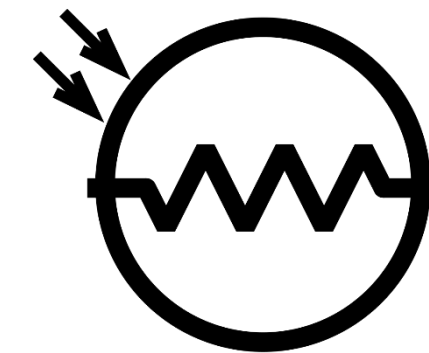
The Sensuino prototype is built using an Arduino, a microcomputer that is commonly used in embedded systems, as its foundation and allows us through the use of programming to interact directly with hardware such as LEDs, LCDs, motors and sensors. Our current prototype utilises a thermistor to measure temperature, a photoresistor to measure the intensity of light and a LCD to output the data and allow the user to change the settings such as the intensity of light at which the user wants the lights to turn on and also the speed of the fan.



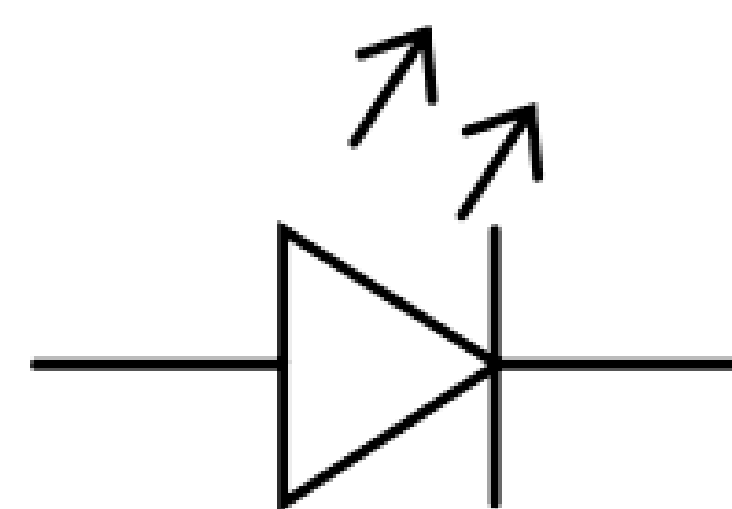
The thermistor is a sensor used to measure the temperature and it works by resisting the current based on the temperature of the environment, the higher the temperature, the greater the resistance. Our software that is uploaded on the Arduino will measure the current and then convert this through the use of a formula to degrees Celsius. Depending on this temperature the motor, controlling the fan, spins faster or slower to lower the temperature.



The current version of the prototype currently uses a motor as the fan, the speed of the motor is dependent on the flow of the current and we can adjust this through the use of our software which increases the current if the temperature is higher which in turns spins the motor faster.



The photoresistor is used to measure the intensity of light and will also like the thermistor resist the current based on the light intensity, the darker it is the lower the resistance. The software in this case based on the custom threshold set by the user will turn on the LEDs based on the intensity of light.



A light-emitting diode is a two-lead semiconductor light source, that emits light when current is supplied. Our prototype uses four LEDs, which turns on based on the threshold value of the intensity of light set by the user and measured by the photoresistor.

## Real Life Applications

Home automation is the future and the industry is rapidly growing, with IoT (Internet of Things) becoming cheaper and more accessible, the Sensuino is the basis of any home automation system. It automatically adapts based on the environment without any input from the user. It is very easy to think of our prototype in a limited sense, but it can be applied to a variety of situations. For example instead of a motor, the system could be hooked up to an air conditioning unit, in place of the LEDs we can have an expensive chandelier in the lounge.







# Solving Connect Four with Game Theory

## How is Game Theory related to Maths?

Game theory is a branch of applied maths that allows us to model and analyse zero-sum games between intelligent rational decision makers. Connect 4 is an example of a game that can be modelled and “solved” using game theory.

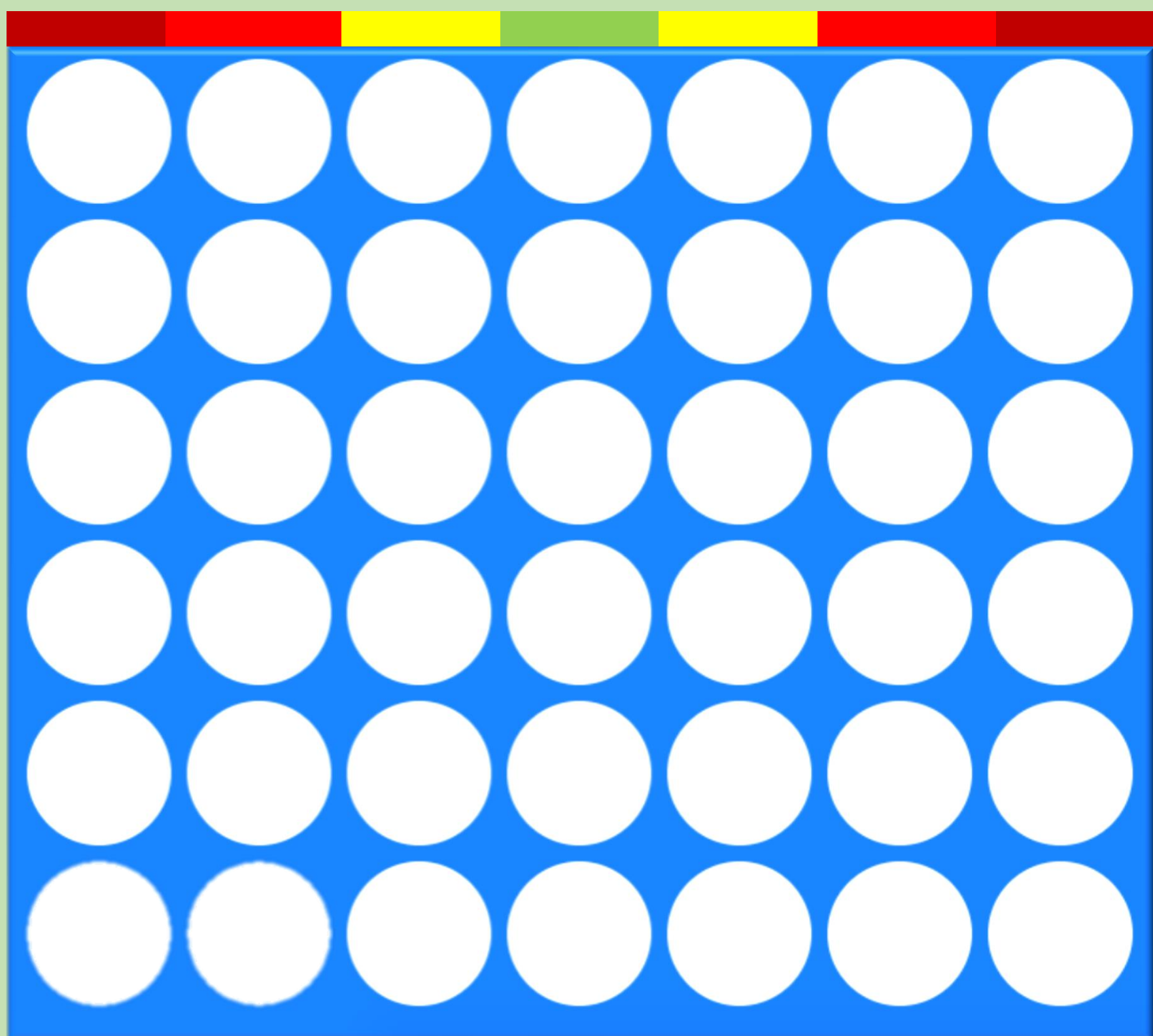


Figure 1

## The perfect strategy to Connect 4

Connect 4 was “solved” in 1988 by Victor Allis and James D. Allen, they proved that Player 1 will always win if playing perfectly in 41 moves or less, they also proved that the only way to win when against someone who also knows the perfect strategy is to go in the middle. Anywhere else will result in a draw or loss. The only problem is that the perfect strategy is extremely complicated and humans cannot possibly compute every position.

### Did you know?

Chess is another zero-sum game with two players. However the computational power to “solve” chess is too high for current computers!

## History of Connect 4



Howard Wexler

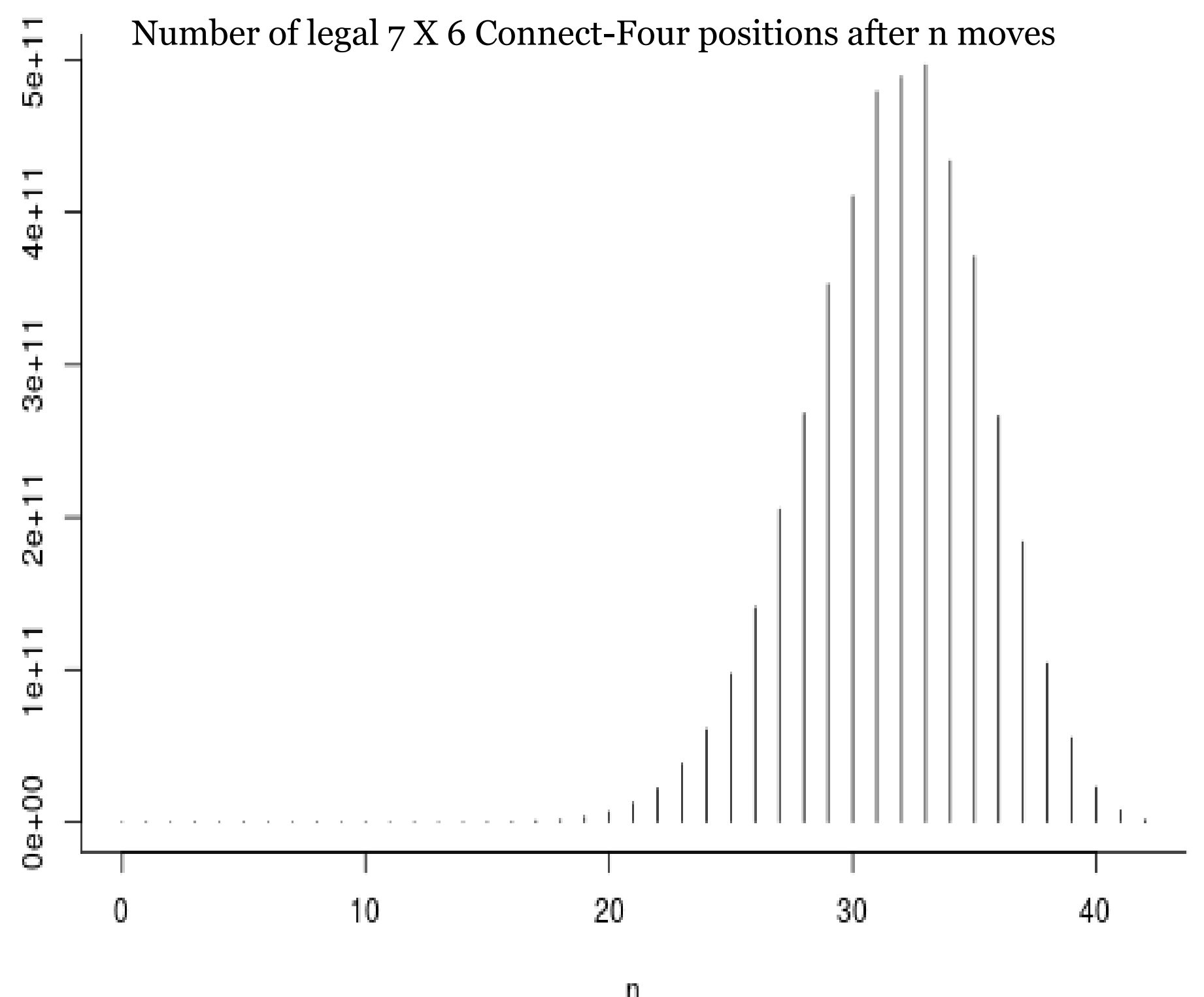


Victor Allis

Connect 4 was made in February 1974 by Howard Wexler, but was only perfectly “solved” in 1988 by Victor Allis and James D. Allen. The game involved two players playing on a 7x6 board trying to make a row of 4. The objective of the game and the rules sound simple but the proof for such a winning strategy is extremely complicated and can only be derived by a computer.

### Fact

There are over **4,531,985,219,092** different ways to fill a Connect 4 grid!



References:  
Banner: <https://leludimag.wordpress.com/2017/04/19/pourquoi-se-remettre-aux-jeux-de-societe-est-il-si-complique/>  
Howard Wexler: <https://www.newsmax.com/tommessner/howard-wexler-connect-four-games-inventor/2018/01/29/id/840078/>  
Victor Allis: <https://chessprogramming.wikispaces.com/Victor+Allis>



# From Barbie To Grand Theft Auto

Everyone plays video games, right? But how many times have you stopped to think of the things wrong with video games such as gender difference? We decided to conduct research into the gender differences and the way that certain characters are made to appear within the gaming industry.

## Our experiment:

We watched 50 of the most popular video game trailers. From each trailer we analysed several aspect but we had particular focus on:

- Whether the character were primary or secondary with respect to gender
- How sexualised the male and female characters were

Before we started analysing, we created a hypothesis that women are a lot more sexualised in video games than men and generally men take primary roles in video games.

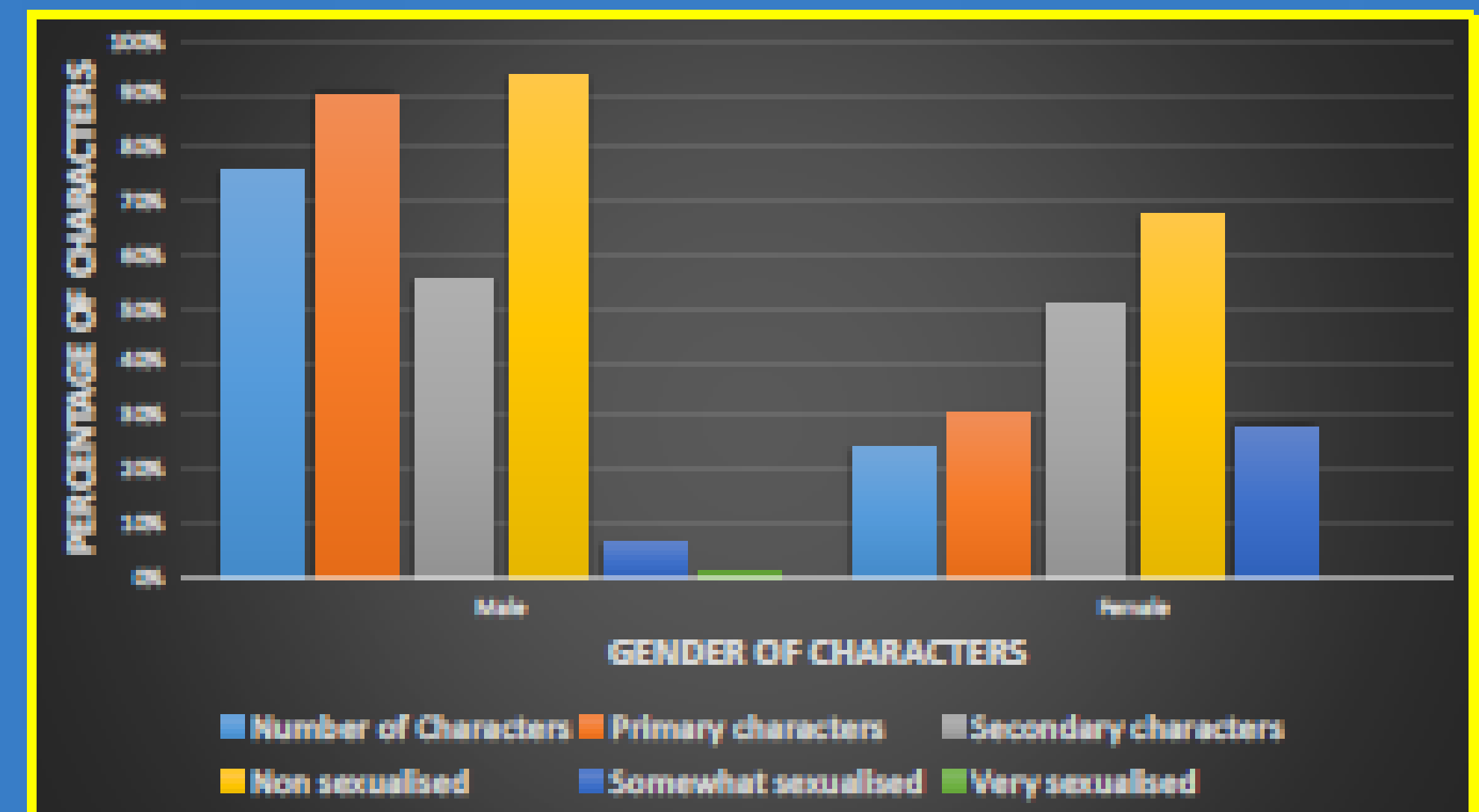
The results of our experiment were the following:

- Females were seen to be more sexualised than males.
- There were more male characters than female characters.

## Breakdown of analysis:



Here is one of the many characters we analysed. The first characteristic we looked at was the overall body composition. Here you can see the character has a slim, hourglass, body shape. From just this, it can be evoked that this character is most likely to be sexualised. Next, it is quiet clear to see that the character has a lot of exposed skin, strengthening the perception the gamer has on the character, perhaps even women. For characters such as these, it is obvious not much analysing is needed to conclude that this protagonist is moderately sexualised. To add on, some people may argue that this is a misconception of females as, in many of the clips they were idealised very heavily.



## Supporting Evidence (Miller & Summers, 2007):

As shown by the findings of our experiment it is evident that more characters are male in comparison to female characters. It is also visible that female characters are more sexualised than male characters. We believe that this stereotypical gender split should be broken. Why can't females play video games using characters of their own gender without them being sexualised? This may be the cause of females not playing video games as much as males. We also conducted further research to support this. We done this by asking 5 females and 5 males if they play video games. The results were the following:

- 80% of males played video games
- 20% of females played video games

As you can see there is a huge gender split when looking at gamers and we believe that this can be broken if there were an increase of female characters and a reduction of sexualised female characters.



## Conclusion:

What we found from our experiment is supportive of our hypothesis – women are more sexualised in video games but to an extent. Women were sexualised more than men but the results did not show as much significance as we predicted. Additionally we later realised that there were many limitations to the experiment we did not consider. Some of these being the extent people consider sexualised and whether the sexualisation was relevant to the game/game genre. Moreover, in our further research our sample size could have been larger resulting in more valid results that show more accuracy.



## References

<https://link.springer.com/article/10.1007/s11199-007-9307-0>



# Why has there been an increase in the prison population in England and Wales, and what problems does this create? Lee et. al

The management of crime prior to the 20th century hugely contrasts to its management in recent years. Between 1500-1899, policing was based on the aim to deter people from committing crime, with punishments for various crimes differing between capital and corporal punishment. However, since early 20th century it was evident that the criminal justice system was no longer achieving its aim of being a deterrent to crime. As a result, a state funded full time police force was introduced in 1900, in which more criminals could be caught and sent to prison as an alternative form of punishment.

In recent years, the prison population in England and Wales has increased dramatically, it has risen by 90% between 1990 and 2016. For this reason our group has decided to research the factors that has caused such a drastic change in prison population, other than the improvements on policing. Here, we have highlighted that deprivation, changes in prison sentences and gender inequality have escalated to become the main factors that contribute to rising prison populations.

**RQ1** How does deprivation contribute to the increase in prison population?

**RQ2** How does gender equality contribute to the increase in prison population?

**RQ3** How does recent changes to sentencing contribute to the increase in prison population?

Deprivation can be seen as being a cause of the increase in prison populations in the UK. A significant minority of prisoners have lived in care, children's homes at some point during their childhood. A sample of female prisoners found that '15% of their sample had grown up in children's homes, and 20% overall had been taken into care'.

Official statistics from the Cabinet Office state '65% of boys with convicted fathers will go on to offend themselves'. This statistic from the Social Exclusion Task Force of 2006, highlights the potential ineffectiveness of the data, because it was collected 12 years ago. However, it is from a trusted website and thus could be used as supporting evidence.

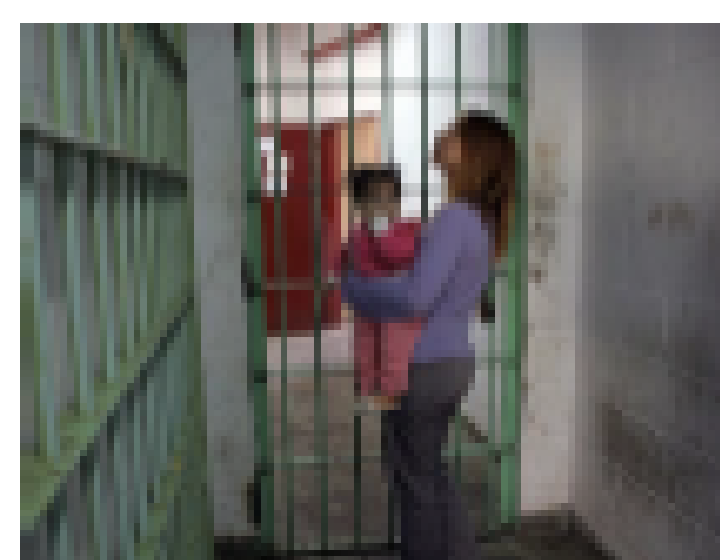
24% of prisoners stated they had been in care at some point during their childhood. Those who had been in care were younger when they were first arrested, and were more likely to be reconvicted in the year after release from custody, than those who had been in care.

Deprivation can link to the theory of conflict, particularly focusing on sociologist Karl Marx. Marxists believe the real criminals are the rich people who exploit the rest of the population.

There is a positive correlation between increasing prison populations and prison expenditure in the U.K. This is a controversial topic in terms of the economic implications that it has for tax payers and our government.

The useable operational capacity of U.K. prisons (2016-2017) was 87,072, however 84,746 of these spaces were filled, each costing £22,933, which is a 4.2% higher than the previous year. This is validated by figures provided by the Home Office which say that out of 73,560 releases between April and June 2016, 36,452 people reoffended with a total of 143,798 offences. From this, many infer that prison's aim of rehabilitation is not being achieved, and so it is argued that money is overspent on inadequate prisons that do not contribute to the prevention of crime. Furthermore, alternative punishments can be considered to use budgets more effectively in order to prevent conviction. For example, permitting offenders to license work would reduce the cost of imprisonment and also reduces the cost to fund reoffenders. This is because only 1 out of 10,000 of those released on temporary license commit further crimes.

One reason we identified for the rise in prison population is the increasing equality of women, which we believe has resulted in the chivalry effect being less prominent in women's sentencing. Women are only a very small percentage of the overall prison population, shown in the graph below (Prison population in the UK, 2017) however the Prison Reform Trust puts forward how during the past twelve months there has been a sudden rise in the female population; which may be a result of the community service falling by 44% in the last decade (Prisonreformtrust.org.uk, 2018), meaning more women are going straight to prison than completing community service. Recent statistics also show that twice as many women than men are jailed for a first time offence (Thetimes.com/prisonstats), meaning the female population is likely to continue to rise.



With a greater number of women being presented with prison sentences; this impacts the next generation. The breaking up of families, especially children from their mothers, cause children to be placed into care or foster homes. Only 28% of mothers in prison stated that their children's father was a primary caregiver, which suggests that their mothers being separated from them will have more detrimental effects than if it was the father going to prison. Further to these issues, more women going to prison increases prison population: with 61% of girls who are in care going to prison at some point in their life. This proves how children affected by separation from mothers in prison can lead to them committing crime when they are older also.

Recent changes to sentencing has resulted in ..

- More people being sentenced to immediate custody- there were around 40,000 more prisoners serving custodial sentences in 2016, compared to 1993.
- Recalled offenders are increasing - In 1995, only around 150 in the prison population were recalled for offences. This has increased to 6,600 in 2016.
- People are being sentenced to longer periods of imprisonment as shown by the graph below:

The average time spent in prison (including time spent on remand) for determinate sentenced prisoners (those with a fixed length sentencing) has increased



This may be due to the offence make-up of the prison population changing towards offences that carry longer sentences e.g. violence against the person.

Overall, the issue with longer and harsher sentencing is that prisons will reach their maximum points of capacity a lot sooner. With the addition of many more criminals of petty crimes along with longer sentences for crimes, such as sexual offences, in the next 10 or even 5 years prisons in England and Wales could be to the point of needing serious expansion.

## METHODOLOGY

We decided to use a combination of quantitative and qualitative methodology to collect information, using a variety of secondary sources ranging from media articles to government statistics. To further enhance our analysis we also employed three criminological theoretical positions within our positions; labelling, conflict and feminist theories.

## CONCLUSION

To conclude, we have established that changes to sentencing, family deprivation and gender inequality have all contributed to the increase in the prison population - which we have discussed previously in our three main research questions. Based on evidence, we believe the changes to sentencing have been the largest contributor to the increase in the prison population as there were around 40,000 more prisoners serving immediate custodial sentences in 2016, compared to 1993- which was stated on the Ministry of Justice published statistics.

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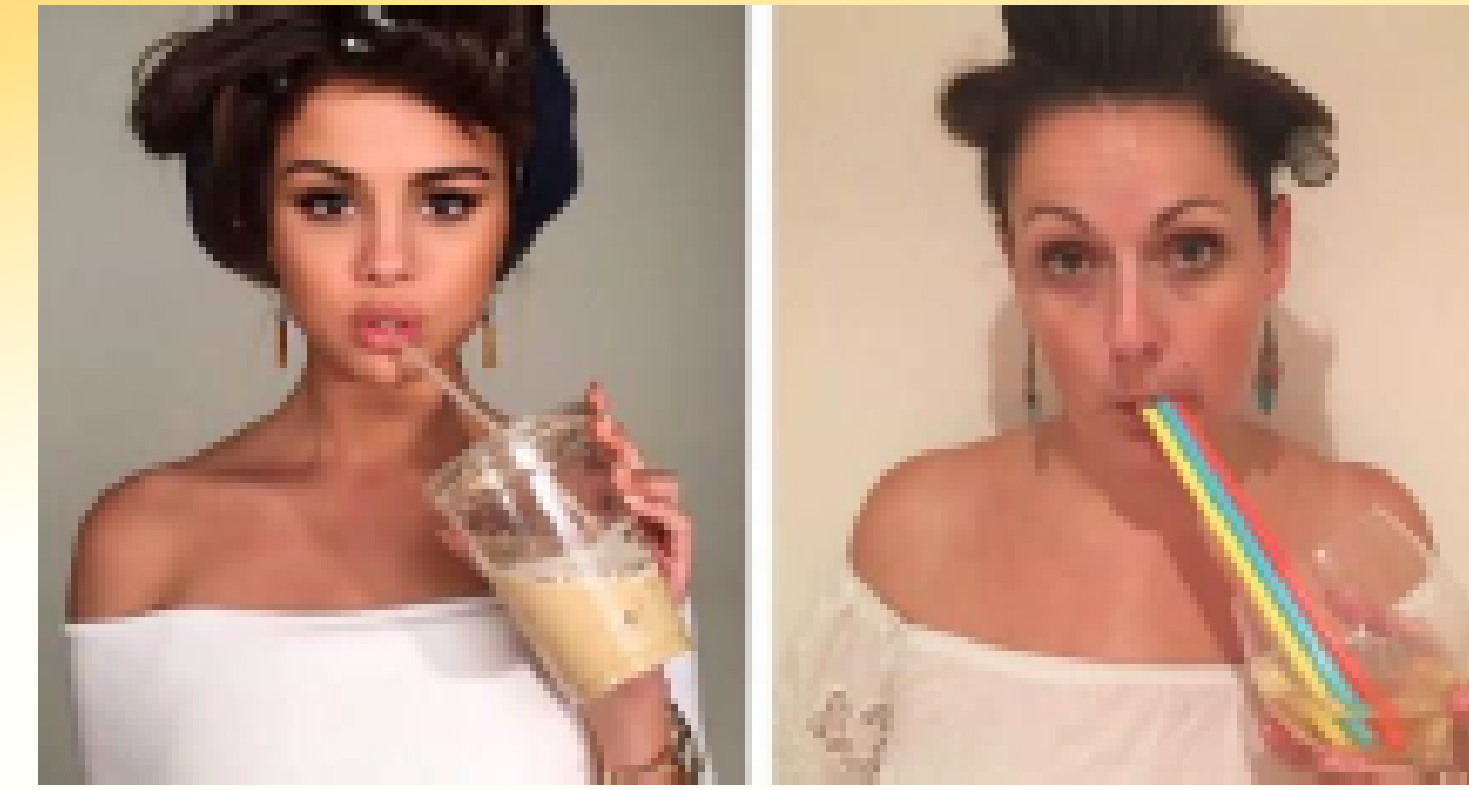
The Guardian. (2016). Why focus on our female prison population. (online). Available at: https://www.theguardian.com/society/2016/jun/06/women-prison-population/ (Accessed 20 Jan. 2018).

# How has the portrayal of women on Instagram had a negative effect on their health?



## Overview

We have decided to research how the portrayal of women on Instagram has an affect on health as we feel it is a current issue in which we ,as females Instagram users, are a victim of. One study which had especially surprising results and persuaded us into exploring the topic further was about how people felt about their body before and after using Instagram; <sup>1</sup>43% (the majority) of people surveyed before using Instagram, voted 3 on a body satisfaction scale from 1-5, 1 being the lowest for how they felt about their body. In contrast, after viewing photos on Instagram the highest percentage of votes, 40.8% was for a body satisfaction score of 2. Therefore alluding that people's satisfaction with their body decreased after looking on Instagram. In addition the number of people who scored their satisfaction as 1 increased by 9.5%. Furthermore, if we make people more knowledgeable about the subject we can prevent or reduce the negative impacts that Instagram has and hopefully reduce the number of women with mental and physical health related to social media.



## Instagram on Women's Health

Overall it became clear that Instagram has a negative impact on women's health when it was listed as the top most negatively impacting social media platform in areas such as self-identity, depression and anxiety from the <sup>2</sup> #StatusOfMind study. The author of the study, Matt Keracher, claimed that Instagram shows a "filtered and Photoshopped version of reality" and with the recent rise in trends like "#bonespiration" it's no surprise that young girls hold such an unhealthy view about what their body should look like. Instagram celebrity, <sup>3</sup> Essena O'Neill came forward to say that what she presented on Instagram was not "real life" and she would "suck in her stomach" and "make her body look skinnier" and this seems to have a knock on effect as shown in a questionnaire asking how people feel after looking at Instagram where <sup>1</sup> 40.8% rated feeling a 2/5, 5 being the best.



## The portrayal of women on Instagram

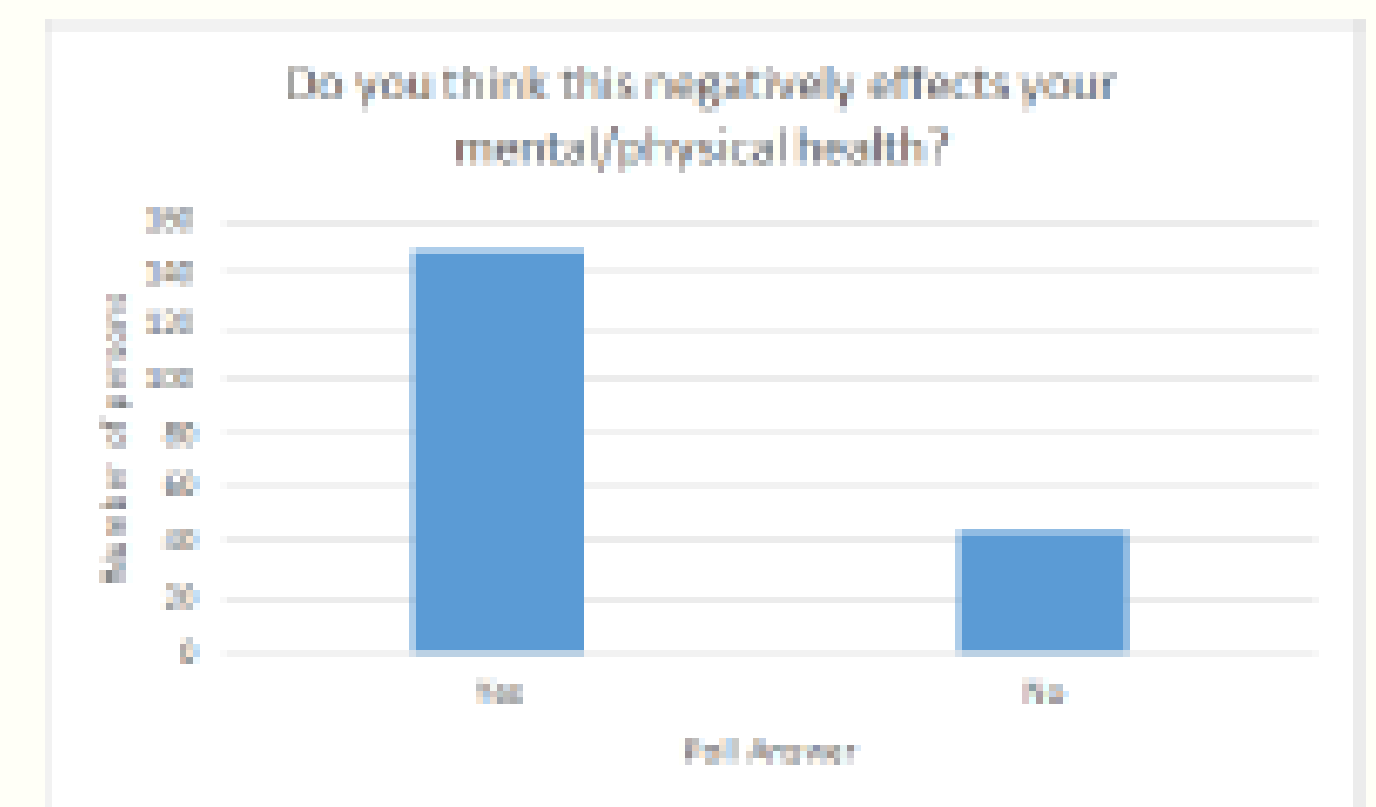
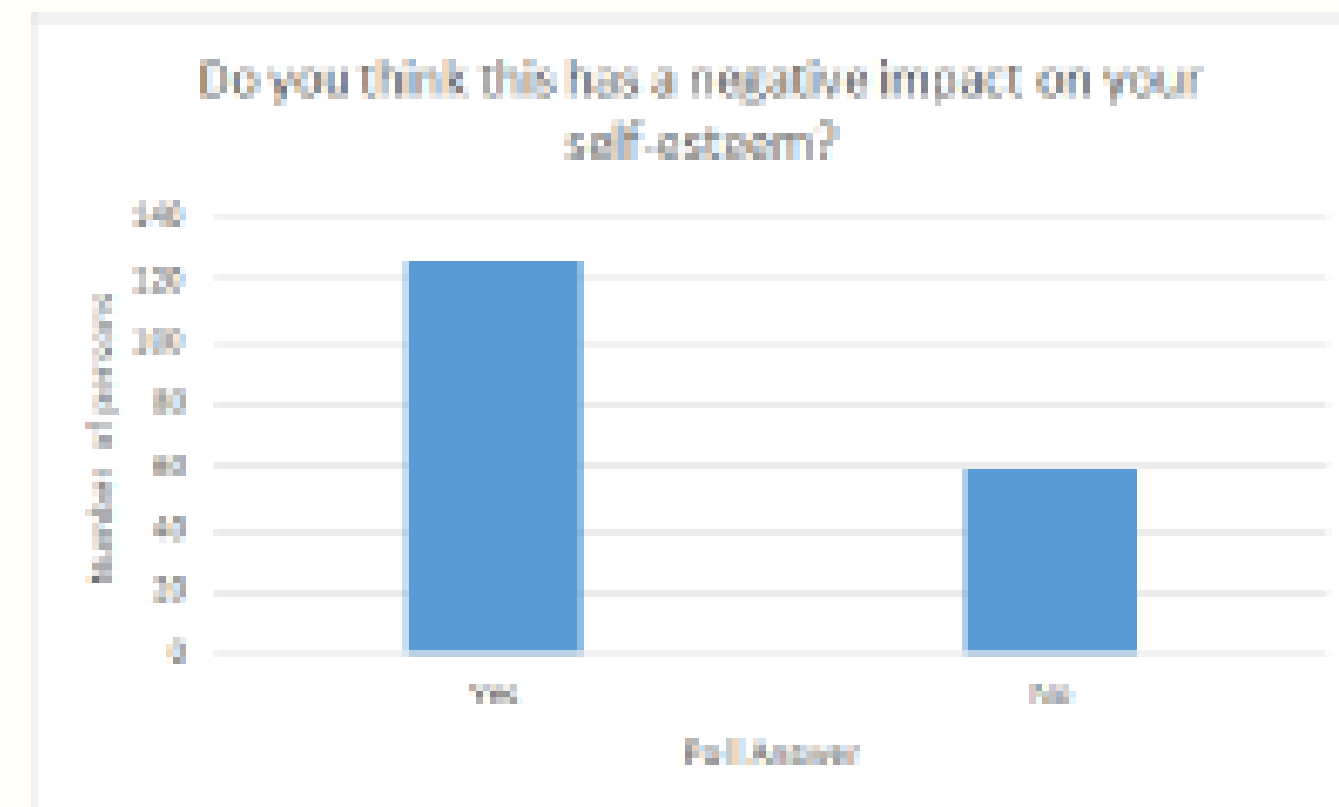
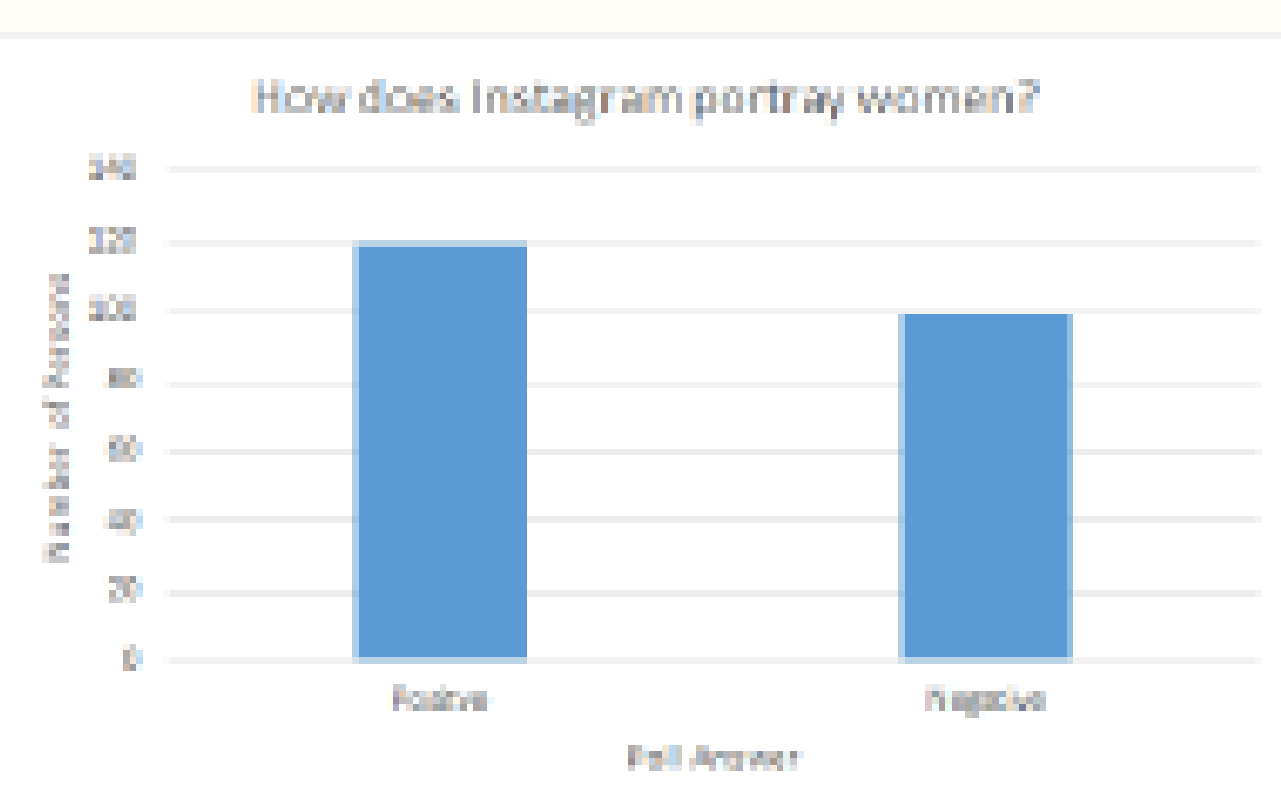
The portrayal of Women on the social networking site Instagram has been a point of discussion for some time. A recent 2014 survey by 'a picture of health' found that 41% of Women between 18-25 felt that the portrayal of women on Instagram was unrealistic. In recent years we see much more emphasis on celebrity culture where they only present an immaculate image. As a result this has increased the pressure on regular women to always strive for perfection and to appear without flaws on social networking sites like Instagram by using filters and Photoshop .According to Lindsey Mean, an associate professor of social and behavioural sciences "women on social media are portrayed in less powerful, and often highly sexualised roles - it's a very limited range of representation". Although, Women are sometimes portrayed in a natural and realistic forms, these examples are very much in the minority. Evidently, there is a clear distortion of women on social media and this arguably has a negative effect on female Instagram users.

## Data Collection Method:

We created questions that related to our topic and original question.

All four of us used the Instagram poll sticker on our Instagram account stories to ask followers the following questions: 'How does Instagram portray women?' answering either 'Negatively' or 'Positively'; 'Do you think this negatively affects your mental/physical health?' and 'Do you think this has a negative impact on your self-esteem?', both answering either 'Yes' or 'No'.

We all allowed followers to vote on the above questions and gathered our data in a quantitative form to be able to use excel to create bar graphs that clearly represent people's' views and to make it easier to analyse.



## Analysis

Our method for collecting data is to support our question and used to compare to research as well as our personal opinions as well as others like professionals. We did our data collection through an Instagram poll, which is contemporary data collection and links directly to our topic. Above all, we got the relevant audience directly while they're engaging with and in the process of using the app, as it's at the forefront of their thinking. Additionally, the poll only has two answer options meaning when asking the question we could get a number per answer rather than many qualitative answers; this made it easier to create a graph from our data enabling us to read and analyse it. However, this data may not be representational of all Instagram users; we are all young females of similar class and nationality, meaning it's more likely that our followers are people with similar identities and we may not have got a widely diverse response.

Overall, just over 20 more people felt that Instagram portrayed women in a positive way, while the majority of people felt that the way in which women were portrayed (positive or negative) had a negative impact on their mental and physical health as well as their self-esteem. This suggests that it's true that Instagram can have a negative impact on females' mental and physical health however, that female representation may not be responsible.

## Conclusion

In conclusion each user's Instagram experience is personal and unique, therefore the content seen varies and so the portrayal of women on Instagram is subjective. Moreover, Instagram is a platform for prosumers to freely "self express and socially interact"; we are responsible for our own perceptions of women and the consequences of physical/mental health impacts. Instagram could do more to support and prevent these expectations however this may cause the Instagram community to retaliate and question their control of self expression. This is a continuous cycle of unrealistic representations of women, causing low self esteem, which in turn perpetuates the desire for perfection.

- [https://www.researchgate.net/figure/Body-Satisfaction-Scale-2\\_fig2\\_317579752](https://www.researchgate.net/figure/Body-Satisfaction-Scale-2_fig2_317579752)
- <https://edition.cnn.com/2017/05/18/health/instagram-worst-social-network-app-young-people-mental-health/index.html>
- <https://dailypress.com/blog/2015/11/19/op-ed-how-instagram-is-damaging-the-self-esteem-of-women/>
- <https://www.sciencedirect.com/science/article/pii/S0191886914304502>

# Design and Production of a Dolphin Prosthesis

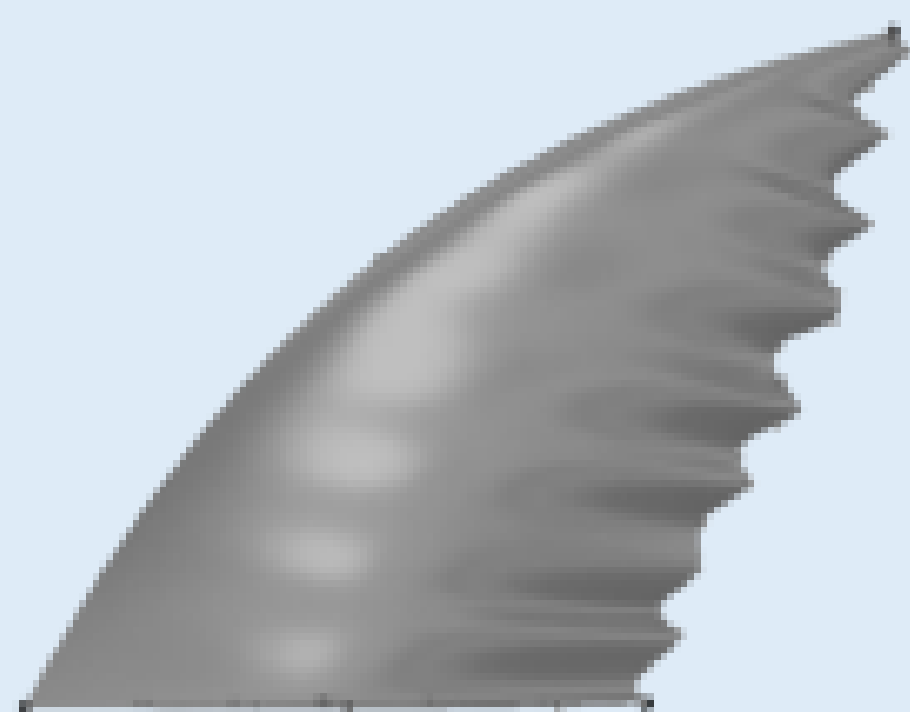
## Background and Aims

- Dolphins get attacked by predators and sadly their dorsal fin will be damaged.
- Dorsal fins function to provide stability against rolling and to assist with turning.
- To create a prosthesis as a replacement fin to aid these injured dolphins.
- The fin must be designed to reduce the drag that the dolphin will experience.
- The fin must act as the original dorsal fin would.

## Design

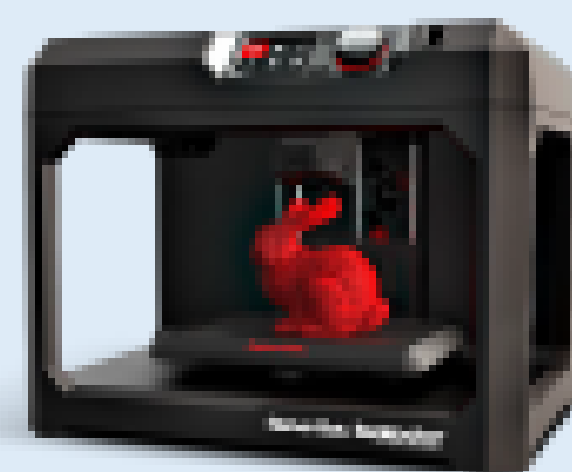
Our design minimises the drag coefficient through providing an aerodynamic shape that reduces drag and a larger frontal surface area.

- The front of the fin is curved and the base is wider in the centre and thin at the end to allow water to glide past.
- The spikes on the back are designed to repel future predators who may damage the prosthesis.



## Production

- The dolphin fin was produced using additive 3D printing.
- Thin layers of hot plastic were built on top of each other and cooled to form a solid structure.



## Testing

- We tested the base of the fin in a water tank in order to distinguish the drag force of the fin only.
- Then the fin was tested to calculate the voltage proportional to the drag force.
- The value was converted into Newtons and then used to find the coefficient of drag.

## Results

Drag force =  $0.5(\text{Drag coefficient} * \text{density} * \text{velocity}^2 * \text{Area})$

Using this equation we substitute in our results to find the drag coefficient.

We also needed to know the density of the water, the velocity of the fin and the area of the front facing part of the fin.

	Drag force (V)	Drag force (N)	Drag coefficient
Trial 1	1.42	0.08236	0.62
Trial 2	1.42	0.08236	0.62
Trial 3	1.42	0.08236	0.62
Average	1.42	0.08236	0.62

## Conclusion

We compared our results to those of three other groups and found that our dolphin fin had the lowest drag coefficient and therefore fulfilled the aims of the project best.

