Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

INFORMATION BIAS IN THE GRAPHICS ACCOMPANYING NEWS ARTICLES

Cian Flynn

A dissertation submitted in partial fulfilment of the degree of

MAI Computer Engineering

Supervisor: Professor Séamus Lawless

Submitted to the University of Dublin, Trinity College, May 2018

Declaration

I, Cian Flynn, declare that the following dissertation, except where otherwise stated, is entirely my own work; that it has not previously been submitted as an exercise for a degree, either in Trinity College Dublin, or in any other University; and that the library may lend or copy it or any part thereof on request.

Signature:

Date: 10th May, 2018

Summary

Bias in the mainstream news media has been studied for many years. In recent years, traditional mediums have given way to online and digital mediums, and with them new features are being presented to readers which could influence bias. This research aimed to determine if the level of bias perceived to be in a news article online could be impacted by an information graphic accompanying that article. The experiment involved participants reporting how biased they considered an article to be for three news stories, from three websites. Each story from each website was studied at three levels of distortion: with no graphic, with the original graphic, and with a tailored graphic.

The research found that an information graphic accompanying a news article will affect the level of bias perceived for the article as a whole, but that this effect was not found to be statistically significant, and no trend was found regarding what causes the bias level to increase or decrease. With a sample size of 124 participants, no statistically significant effect was detected. Closer examination of the data collected reveals findings which suggest further work would be worthwhile in this area.

The data collected also indicates strong tendencies among participants to avoid cognitive dissonance, and the presence of confirmation bias on the part of the participants. When participants were presented with a website they recognised, and which they previously had considered to be biased, they gave a significantly higher rating for bias in that article than for those who did not recognise the website. Additionally, those who recognised the website but did not previously consider it to be particularly biased, reported far lower levels of bias for that article than those who had not recognised it.

This research adds to an existing body of work in the area. Possible refinements to the study are proposed.

Acknowledgements

I would like to acknowledge the work of Professor Séamus Lawless, without whose initial guidance I would not have undertaken this research, and who has provided constant support and guidance throughout the project.

I would also like to acknowledge the extraordinary amount of advice and support given to me by Mr. Brendan Spillane. The motivation and guidance he provided throughout the research ensured that I could complete this research with the highest degree of academic rigour and integrity, which he promotes constantly.

Finally, I must acknowledge the support and help received from my family and friends over the course of this research project.

I thank them all for everything.

Cian Flynn

May 2018

Table of Contents

Table of Figures

Table of Tables

1. Introduction

With the ever-increasing availability and consumption of news media online, it is increasingly important that we understand the factors which affect our interpretation of news online. Bias in the online news media industry has, many times in recent years, been used as an explanation for a rise in support for political extremes [1]. Recently it has been credited with influencing the outcome of US Presidential and local elections [2], and for driving public support for a referendum decision which will result in the United Kingdom leaving the European Union [3]. It is evident that there is widespread belief that bias in news media, and specifically online news media, can be used to drive major social, economic, and political changes [4]. Bias has, and will continue to be an issue with news media, and has received significant attention from researchers for at least the last half century [5], [6].

Due to increases in the ability of modern printing techniques and the desire to attract attention to a news article dealing with a complex subject or series of events, newspapers regularly commission accompanying artwork for news articles in the form of information graphics. This method of displaying information is suitable for conveying large volumes of data quickly and accurately [7]. For example, the share price of a company can be presented as a graph over time, or the number of new cars being purchased could be presented as a bar chart per quarter. Traditionally, print news media was constituted almost entirely of text; the cost of printing images, be they photos or graphics, was prohibitive for printing on a frequent basis. With the falling cost of printing through technological advances, and the increased electronic consumption of news [8], images, including information graphics, have become more prevalent in news journalism. With the increasing presence of such images, comes increasing power to frame a narrative. Although the impact of bias in news, and especially print news, has been regularly investigated in areas such as headlines, photographs, coverage, rhetoric, and agenda setting among others, there is no research on whether it can be introduced in graphics and the extent of such influence. If bias can be introduced in graphics, then it is important that this effect is explored and its extent understood.

Information graphics are used in order to rapidly convey large amounts of information in easily interpretable ways. However, by changing the format of the information from raw data or other information into an information graphic, the designer of the graphic must make some design decisions; the graphic is inherently an abstraction of the original data, and is not a presentation of the original data itself [7]. Insofar as the information is being manipulated for presentation, this begs the question of whether bias can be introduced into these graphics or not, adding to or removing emphasis from a certain narrative construed from the original raw data.

Manipulating how facts, or which facts are presented to an uninformed viewer is central to the introduction of bias into news media. Bias in news media has been studied for decades, beginning with traditional news media formats, while online news has become an area of

research focus more recently. To date, some work, discussed in Chapter 2 of this dissertation, has explored how bias can be introduced through the text of news articles, and also through the design of the websites which contain them [9]. No significant work exists concerning whether bias can be introduced through the use of information graphics.

There are numerous definitions for the word "bias". The Oxford English Dictionary [10] defines bias as:

> *"[mass noun] Inclination or prejudice for or against one person or group, especially in a way considered to be unfair."*[1]

This definition is very broad and is untested in academic research. For this research, a more specific definition is required, pertaining to the field of study. Looking at existing literature shows a wide variety of definitions used.

Waldman and Devitt [11] stated, as part of their research into media bias:

> *"Bias can be defined as any systematic slant favoring one candidate or ideology over another."*

Gentzkow and Shapiro [12], discussing content bias stated:

> *"All the accounts are based on the same set of underlying facts. Yet by selective omission, choice of words, and varying credibility ascribed to the primary source, each conveys a radically different impression of what actually happened. The choice to slant information in this way is what we will mean in this paper by media bias."*

Andon and Free [13] suggest that media bias can be broken down into three categories: gatekeeping bias, where publishers decide what will be published and what won't be, coverage bias, where one side of a story gets more coverage than another, and statement bias, where bias is introduced through the text used in the coverage.

Bennet [14] also focusses on the significance of gatekeeping bias, but for this study only those things which are reported can be studied, and so this type of bias will not form a major part of this study.

Eberl, Boomgarden and Wagner [15] also suggest that there are a multitude of type of media bias, and that their effects may differ.

Across all of these definitions of bias however, it is clear that bias is not a result of untruth, but rather the selective framing of truth in favour of a particular point of view.

In the second and third definitions, which are more specifically tailored to the discussion of bias in the media, the authors conclude that the bias must be introduced by choice or systematically. While the systematic slant mentioned by Waldman and Devitt does not

[1] https://en.oxforddictionaries.com/definition/bias

necessarily mean that the slant is knowingly introduced, it is important to remember that the area of bias in information graphics, which is the focus of this research, has not previously been extensively studied and is not well understood. It is plausible, if not likely, that bias which has been introduced to articles through the use of these information graphics may have been introduced inadvertently or unknowingly. Therefore, for this study bias is defined as:

"*Deliberate or accidental slant by the journalist, editor or publication to distort reality*".

In studying this particular aspect of perceived bias in online news media, covering a little-researched area, this research should make a significant contribution to our understanding of that perceived bias in online news media.

1.1 Research Question

The purpose of this research project is to answer the question:

"To what extent do the information graphics accompanying a news article impact upon the perceived bias of the article?"

To this end, the following research objectives were formed:

- A ground-truth bias rating for each of the news articles
- Whether the information graphics accompanying those news articles can impact upon the perceived bias of the article
- If such graphics have an impact, the extent to which the design of the information graphics can impact upon the perceived bias of the article

A significant body of work already exists exploring bias in news media, and bias in graphics, but little work has been published about the perceived bias in the graphics accompanying news articles in online news media.

1.2 Hypothesis

This research aimed to determine whether bias can be introduced to an article through the use of information graphics. The research aimed to find evidence that bias could be introduced, and consequently the hypotheses are as follows.

The null hypothesis is:

(H_0) This research finds no evidence of bias being introduced to a news article through the use of an information graphic.

This is determined by finding the level of bias both with and without the information graphics and finding no statistically significant difference in the two levels.

The alternative hypothesis is:

(H_A) This research finds evidence of bias being introduced to a news article through the use of an information graphic.

This is determined by finding the level of bias both with and without the information graphics and finding a statistically significant difference in the two levels of bias.

1.3 Overview of this Dissertation

The remainder of this dissertation is structured as follows. The following chapter gives an overview of existing understanding related to bias in news media, both online and more generally, and bias in the creation and reproduction of information graphics.

Chapter 3 provides an explanation of the methodology employed in this research project, both in terms of the collection and the analysis of the data recorded.

Following this, Chapter 4 gives an overview of the experiment framework from a technical and practical perspective**, while Chapter 5** discusses the statistical methods used to make determinations on the data collected during the experiment.

Chapter 6 details the results of the statistical tests carried out on the data **and Chapter 7** provides a discussion on the results of the experiment. This includes discussion about the results presented in Chapter 6, and provides a reflection on the participant profile data also collected during the experiment.

Finally, Chapter 8 provides a conclusion to the dissertation, discussing both what has been learned and how this can contribute to future work in the area.

The full set of the data collected during experimentation, and the materials used in the collection of that data, can be found in the appendices at the end of this dissertation.

2. Existing Work

Bias in news media has been the subject of academic research for many decades, focussing both on specific aspects of the news media, for example the driving of a partisan agenda through bias [16]–[18], and on news media more generally [4], [17], [19].

This chapter will give an overview of existing work in the area of media bias, discussing the findings of that work, and why the research question is an important addition to the body of work. The findings of other researchers, discussed in this chapter, should also contextualise the design and implementation decisions, and results, of this experiment.

2.1 Bias

Bias in news media has been studied extensively since the 1970s, with research focussing mostly on the traditional mediums of print newspapers [11], [20] and television [6]. More recently research has begun to investigate the effects of bias in online news publications [8], [21]. The extent to which bias has been studied is no surprise given its apparent impact on news consumers [3], [22].

While most acknowledge the existence of bias, it can be difficult to describe. There is no doubt that while bias is only one dimension of credibility [23], there are many dimensions to bias, and by which bias could be measured [17].

Selection bias is the introduction of bias by choosing to cover some material and not to cover other material [24], [25]. For example, a newspaper editor could decide not to report at all on a story which an editor finds not to be of interest to their readers. Similarly, an editor could choose to omit certain aspects of a story for similar reasons. This could convey a significantly different narrative to an audience than if all aspects of the story were reported, while never actually diverging in any way from the truth, or having any inaccurate reporting. The bias in this case is introduced by what is omitted rather than by any manipulation of what is included.

Bias can also be introduced by the way in which content is presented or covered. This is called presentation bias. Research has found a link between the perceived bias of commentary depending on to whom that commentary is credited [16], [26], and also in how reported facts are contextualised [27]. The practice of selecting certain facts and presenting them as being more important or salient to a particular point in order to promote a particular point of view is known as framing [28], [29].

Partisan bias is the favouring of one party or person in news coverage of political stories. Often this presents itself in the form of selection bias, where a news agency is more likely to publish quotes by, or that are favourable to, a person or party which their readers support [30]. The causes for partisan bias are very often driven by a desire to please the audience to which the news agency is selling its output [24].

Agenda setting bias extends from this, where media outlets favour reporting viewpoints which agree with their underlying economic and political stance [31], [32].

Given that what constitutes bias is a matter of debate, there is also no generally accepted gold standard for the measurement of bias. Measurements of bias can only be obtained by people reporting bias which they experience. This is often in the form of a user survey, and it is clear that bias can be introduced both in the creation of content and also in the consumption of that content [33], [34]. That is to say that in the interaction between an article and consumer, the bias can be introduced by either the article or the consumer. As such, bias in a particular article could be attributed either to the article itself or its creator, or it could be attributed to the reader of that article, and must be regarded as, at best, an informed opinion rather than an empirical fact.

The level of bias perceived for a particular article is also an inherently subjective determination; each reader will have their own opinion. Measurements of bias can only be considered accurate when considered in the context that bias will have a relative definition for different people, and that the measurement can never be made in any absolute sense [15]. That is to say that the level of bias is intrinsically subjective, but this subjectivity can be accepted.

2.1.1 Definitions of Bias

There are numerous definitions of the word bias, including many which have been used specifically for the purposes of research into media bias.

As already discussed in Chapter 1, numerous researchers have used their own definitions for bias [11], [12], [17], each tailored to their specific areas of research. Related work in other areas which relate closely to bias, for example accuracy [35], have also presented their own definitions.

Across all of these definitions, it is clear that bias in media is the favouring of one particular side of a story, but not usually the intentional dissemination of false information. This is taken in the context of reputable news agencies, who uphold high standards of journalistic integrity. There are, of course, certain other media outlets who do in fact spread falsehoods, but these will not be considered in the scope of this research. This means that while an article may be perceived to be biased, and may favour one side of a story over the other, or drive a particular narrative, the facts reported in the article may still be exclusively true.

Some researchers contend that bias should only be considered so if it has been introduced intentionally, or by choice [12]. Others, meanwhile, have suggested that bias should be considered only if it is introduced systematically [11]; this could be interpreted to include unintentional bias which has been introduced as a result of an unrelated decision, for example an editorial decision on a newspaper's design.

Determining whether or not bias is present in the information graphics accompanying news articles presents a relatively new research area, it is not implausible that any bias which has been introduced to articles through the use of information graphics may have been introduced unintentionally. Therefore, for the purpose of this research, bias is defined as:

"*Deliberate or accidental slant by the journalist, editor or publication to distort reality*".

This definition was presented to all participants in the experiment before they undertook the experiment.

2.1.2 Bias in Mainstream News Media

While the majority of news articles published in the mainstream media are written to established journalistic standards, often an intrinsic bias can exist in some published news articles [18]. This can be perceived as being biased either in the way it is created, or by those who consume it. The bias can exist for many reasons, including commercial, economic, political and personal reasons.

Bias in the creation of news content can be introduced either in terms of how stories are covered, or in terms of what stories are selected to be covered by a particular media outlet [17], [24]. Even within a particular topic, the creator of the content can frame certain aspects of a story as being particularly important or salient, thus influencing a consumer's understanding of the facts, while never actually compromising the accuracy of the reporting of those facts [12], [27]–[29].

The perceived bias in the consumption of news media can be influenced significantly by a consumer's personal opinions about the topic or story being covered [33]. Furthermore, it has been found that consumers tend to favour news outlets whose editorial stance is aligned with their social, economic, and political views, and to avoid those with which they disagree, reducing cognitive dissonance [34].

Indeed, it has been found that news agencies play into this fact for commercial reasons. For news for which customers are unlikely to obtain an alternative, independent, third-party viewpoint, a news agency can actually bolster its reputation for accuracy by reporting news in a manner which its customers find agrees with their world-view [12]. News agencies may do this regardless of whether or not this is the fairest way to report the news. If consumers are likely to gain an alternative, independent account of the information from an impartial third-party, the same news agencies are less likely to distort the information they present [36]. As such, increased competition in the media marketplace tends to lead to lower levels of bias [12]. Furthermore, for stories on which there is a general consensus of public opinion, reporting tends to be relatively objective, whereas for stories which are contentious or for which there is divided public opinion, news agencies tend to segment the market, and promote more extreme editorial stances in their reporting [36].

The widespread availability of online news content has allowed for increased partisanship in the news industry [9], leading to the so-called "echo chamber" effect, whereby consumers can choose to expose themselves only to news stories which please them [4], [37].

Consumers will often do this subconsciously, as they often can be unaware of their own personal bias on a topic, while being very aware of someone else's with whom they disagree [38].

This in turn leads to consumer distrust in the media, as stories which displease consumers can be easily dismissed as biased or misleading, regardless of whether or not they actually are [39]. As a result, the vast majority of Americans, including 87% of Republicans [40], believe that the majority of mainstream news media is biased, one way or another [4], [41]. Although there is some evidence of measurable bias in the online publications of mainstream news media [19], there is strong research evidence to suggest that this is not as widespread as some may think [33], [42], [43].

It is important to note that research has also found that a journalist having a strong personal viewpoint on a particular subject will not necessarily cause their work to be biased or to convey bias [17], [44]. While it can be accepted that a person's own views will temper any decisions they make, including professional editorial decisions, professional journalistic standards will often help to mitigate any error arising from this judgement.

2.1.3 Bias in the Presentation of News Online

Bias in the news media has been extensively studied since the 1970s, and this work has typically focussed on highlighting differences between liberal and conservative news agencies or on biased coverage of a particular topic.

Compared to traditional mediums, relatively little research has been carried out into how bias may be present in the online presentation of news. Some existing research has looked at textual content and website design [9], [45]. It has previously been shown that bias exists with respect to vocabulary used in online news articles [21]. It has also been shown that the design of the website can have a significant impact on how biased its content is perceived to be, with certain features of website design affecting the perceived bias of the content more than others [46].

2.1.4 Information Graphics in News Media

Information graphics are used to convey large amounts of information in a format which can be interpreted quickly, and provide insights which the presentation of raw data alone could not achieve [7], [47], [48]. This should allow for increased understanding of a potentially large and complex set of information to be achieved by the reader, and relatively quickly. This

means that vast amounts of information can be efficiently conveyed through this method of communication.

Images are also attention-grabbing, and so they can be used to attract a reader to read the article that they accompany [49].

Consequently, their use in media publications is frequent, indeed increasingly so [8], [50]. It follows that as their use increases, so too does their influence on communicating information from journalists to readers. This makes understanding the effects of this bias increasingly important.

2.1.5 Bias in the Presentation of Information Graphics

It has been noted by Munzner that: *"no picture can communicate the truth, the whole truth, and nothing but the truth"* [7]. It is clear that any representation of data in an information-graphic is inherently subject to design decisions by its creator, and the resulting graphic is necessarily an abstraction of the data being represented and not just the data itself. Many of the factors which affect other forms of bias also affect bias in information graphics; bias can be introduced by consideration of what information is being communicated (selection bias), and also how it is being communicated (salience bias) [51].

It has been noted that even as information graphics in news media become more prevalent, little is understood about the balance between author-created elements of those graphics, and the data itself [52].

The processes for the creation of graphics also varies. The New York Times, for example, has a reasonably large, and multiple award-winning graphics department tasked with making these information graphics. Other publications such as The Economist and The Washington Post also spend significantly on graphic design. In many other publications less emphasis is put on graphic design, and so it is likely that information graphics which are presented are created on a more ad hoc basis. Given the standards of journalistic integrity which those who write the text of articles are held to, it should stand that the designers of graphics are held to the same standards, but as relatively little is known about the effects of the design process on readers' interpretation, this may not be the case.

Relatively little research has been carried out about how users extract information from information graphics. It has been shown that the design of the information graphics can affect how accurately and quickly readers can understand the information being conveyed [51], and also that the addition or removal of certain design elements can affect whether the information is perceived to be biased [53].

As information graphics accompany news articles with increasing frequency, it is increasingly important to understand how the use of these graphics can impact on the level of perceived bias in the article as a whole.

2.2 Example of Driving a Narrative with Visualisation

Figure 2.1 shows an example of an information graphic which presents the same information in two very different ways. The graphic visualises the population of the world, and also the growth rate of the population over the same period.

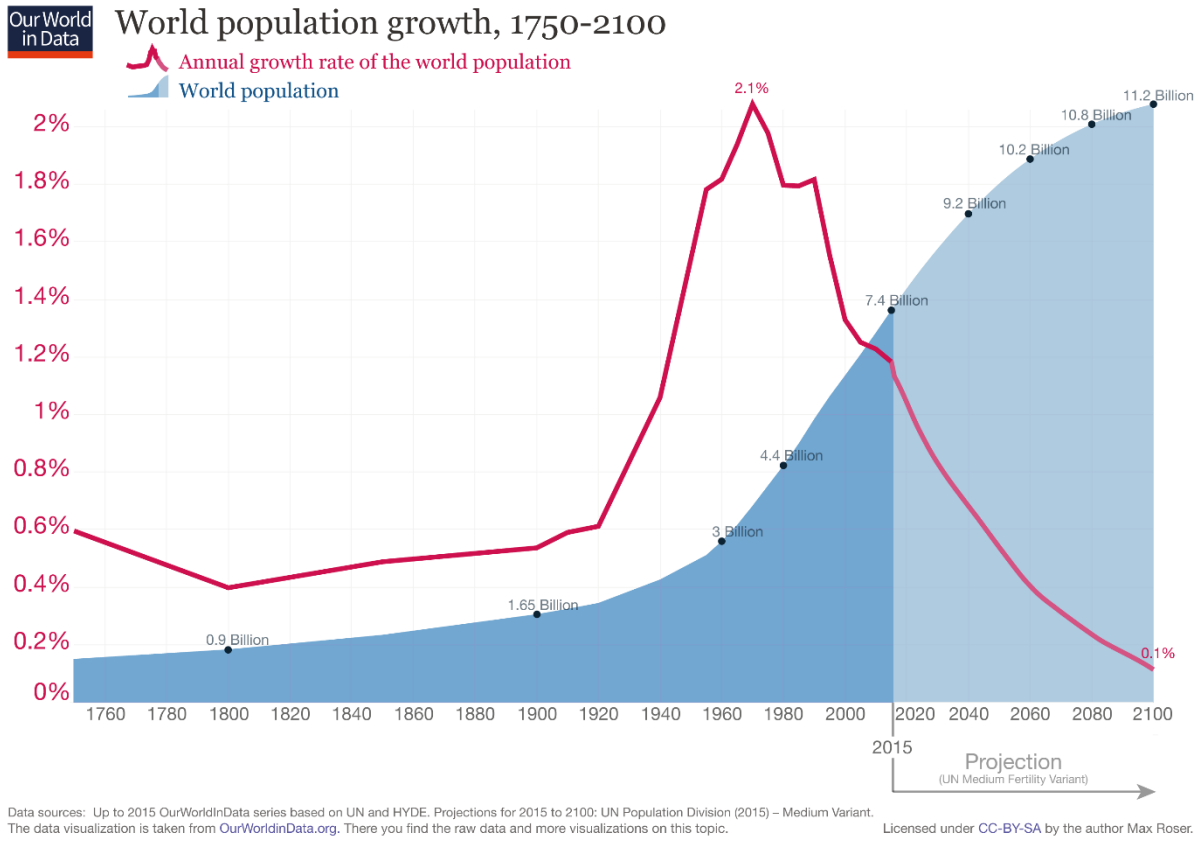


Figure 2.1 – Visualisation of population growth vs. population. Image source: Our World in Data[2]

Presenting both of these pieces of information related to the same thing on the same graphic is an eminently sensible design decision. However, if only one or the other of these pieces of information was presented, it would paint a very different picture.

A graphic with just the blue area visualising population growth could accompany an article about world population, and would signify a rapidly growing population. With this based in fact, and visually impressed on the reader, the article could make a claim about how this could be a huge problem for world resources, and seem very grounded in fact.

On the other hand, a graphic with just the line signifying the rate of population growth could accompany an article about world population, and would signify a rapidly slowing population growth. With this based in fact, and visually impressed on the reader, the article could make

[2] https://ourworldindata.org/world-population-growth

a claim about how the slowing population growth poses an existential threat to humankind, and this would seem very grounded in fact.

Considering either of those articles with the alternative graphic would expose a weakness in the case presented by either article, and shows the power of graphics to give credibility to the narrative in the text which they accompany.

In fact, for either case, the intentional selection of only certain elements of the graphic in order to bolster the claims made by the article shows a bias, which could massively influence the interpretation of the article by the reader.

However, it must also be considered that in Figure 2.1, the population is given as an absolute figure, whereas the population growth is given as a percentage of the population. This means that population is presented on a constant scale across the graphic, whereas population growth is presented on a varying scale. This shows how the scale can also be used to visually trick a reader into interpreting trends in data differently from how they actually are. The two elements of the graphic in Figure 2.1, are not directly comparable even though they are presented with each other.

2.3 Conclusion

Bias, and more specifically bias in the mainstream media has been studied extensively for decades. However, despite this, there has been almost no research carried out on bias introduced to media publications through the use of information graphics, and what effect this has on a reader's perception of the articles which the graphics accompany.

As graphics become ever more prevalent, particularly with the rise in online news readership, where their publication is no more expensive than text-based content, understanding how they affect our judgement of the articles they accompany, and whether they could be manipulated to favour one side of a story, or drive a particular narrative within that story, is more important than ever before. In a time when media bias is very much in the public spotlight, having been credited with driving major social, political, economic changes right around the world, understanding how bias can be introduced to news media online is crucial to understanding how this bias affects readers of these news publications.

This study will investigate whether bias is communicated by the graphical elements of news content which accompany articles in news websites, and attempt to determine what effect these information graphics may have on increasing or decreasing the level of perceived bias in the news article.

3. Methodology

Answering the questions posed by this research requires the collection and analysis of data related to how people perceive bias in online news media, specifically when they are viewing news articles accompanied by information graphics.

To do this, the experiment involved three stages:

1. Presenting participants with a survey to gather sample profile information
2. Then presenting participants with a series of images of webpages and asking them to rate how biased they considered the article on each of the webpages to be
3. The participants were then required to answer some follow up questions

The experiment was set up as a 3x3x3 design, Websites x Article x Distortions (WAD), using a Latin Cube in reduced form. This is a very simple form of Latin Hypercube Sampling, which is a statistical method for generating near random samples from a multidimensional set of parameters [54]. Participants were randomly assigned to one of nine paths through the 3x3x3 cube.

Participants were recruited to take part in the experiment through Prolific Academic [55]. The number of participants was determined using G*Power [56], in order to create a sufficient statistical power for the results to be meaningful.

Approval for this experiment was sought from, and granted by, the SCSS Research Ethics Committee, at the School of Computer Science and Statistic, Trinity College, Dublin.

3.1 Websites

The three websites selected were:

W0. The Daily Mail [57]
W1. The BBC [58]
W2. The Guardian [59].

They were chosen to provide a cross-section of British news media. The Daily Mail is traditionally aligned with conservative and right-wing viewpoints, whereas The Guardian is traditionally aligned with liberal and left-wing viewpoints. As a public service broadcaster, the BBC is traditionally seen as an impartial reporter [60]. The study therefore uses the UK's mainstream media perceived as among the most right-wing, left-wing, and from the centre.

3.2 Articles

Articles were chosen from the Daily Mail, The Guardian, and the BBC, covering stories reported by all three news agencies on the same day, and which contained graphical

representations of data relating to the story. As such, any bias perceived to be present in the articles was not related to story selection to fit the experiment.

The three articles selected were on the following stories:

A0. Consumer Price Index inflation, published on December 12th, 2017
A1. The price of bitcoin, published on February 2nd, 2018
A2. The rise in life-expectancy, published on September 27th, 2017

These three articles were chosen as they satisfied the criteria for inclusion. Importantly, they were not of excessive length which could have resulted in fatigue effects tempering the responses from participants. All three websites also reported very similarly in terms of data and sources, making them suitable for comparison.

3.3 Distortions

There are three levels of distortion for each website and story:

D0. The article presented without any accompanying information graphics. This is to determine a ground truth bias rating for the text of the article. The articles were presented with all other features of their website design included, but with branding removed.
D1. The article presented in its original form, including its original information graphic, but with branding removed. This is to determine the bias rating for the article as it was originally published.
D2. The article presented with the original graphic replaced by a new graphic, specially designed for the purposes of this experiment.

3.3.1 Creating D2 Graphics

The D2 level of distortion required graphics to be created specifically for the purposes of this experiment. For example, Figure 3.1 shows two graphics, the original graphic (D1) from the BBC article about inflation (W1A0), and the newly introduced graphic (D2). The D2 graphic has been designed to suggest an exaggerated gap in the inflation of wages and the consumer price index, discussed in the article, while making this distortion of the figure not immediately obvious. The figures were sourced from the same source as the BBC graphic.

For each D2 graphic created, the figures have been sourced from the same sources as the original figures used, or else sources cited in the article. Some D2 graphics were entirely original creations, while others were modified version of D1 graphics, with significant design changes, in ways which are known to alter perception of information graphics.

All the distortions presented to participants are shown in Appendix A4. All the original D1 graphics, and the newly created D2 graphics are presented side-by-side in Appendix A8.

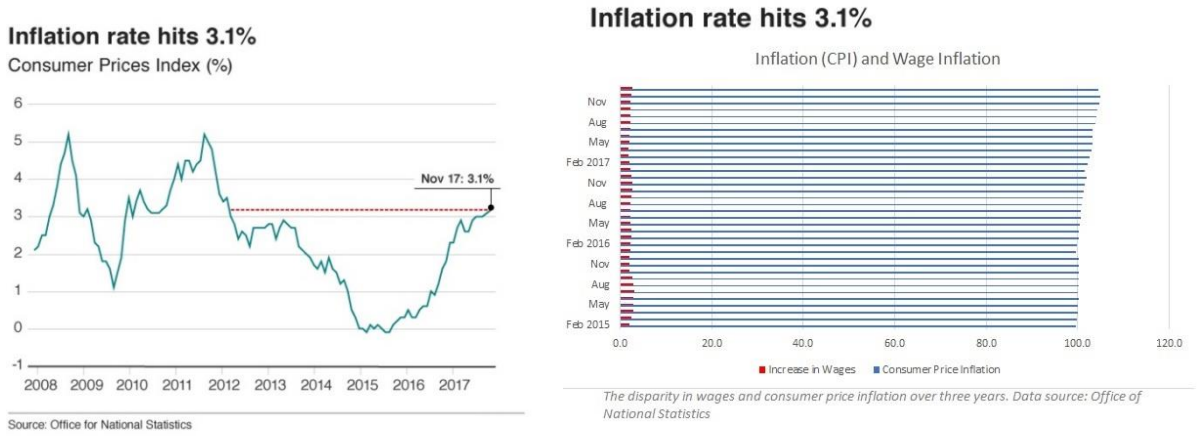


Figure 3.1 - Original graphic (D1), left. Especially created graphic (D2), right.

3.3.2 Website Branding

In the case of all three distortions, all branding, or anything which could identify the name of the website being used, was removed from the distorted versions of the websites. It is known that preconceptions about a newspaper's brand can influence a reader's trust in the content of that paper [45], and thus may impact their perception of bias. The branding was removed, as shown in Figure 3.2, in order to reduce the possibility of participants in the survey having preconceptions about the websites in question. This likelihood of this occurring was further reduced by limiting participation to US citizens living in the USA, and only using UK news websites. This was intended to increase the trust we can place in their responses being a considered and fair reflection of the content being shown. It is impossible to completely remove the possibility of participants recognising the websites, but by removing the branding, this concern is minimised as much as is possible, while without fundamentally altering the presentation of the website. It is important to avoid altering the presentation significantly, as this would unnecessarily introduce another variable to the experiment, which could not be independently measured; namely perceived bias possibly owing to the websites' design [46].

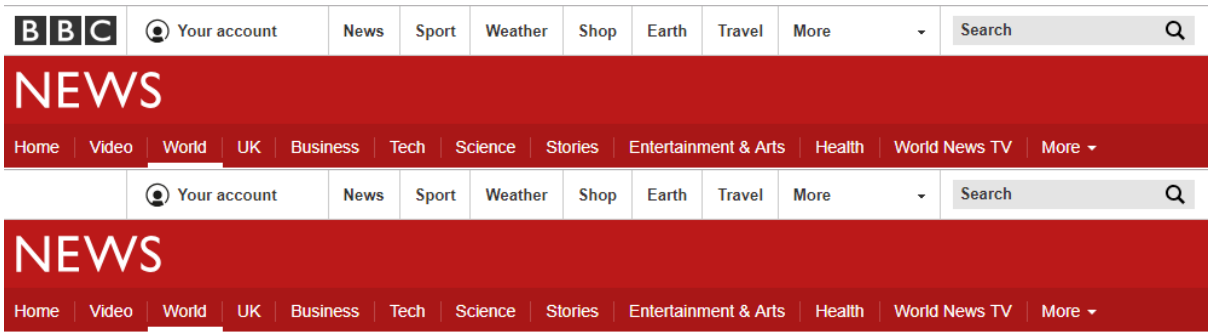


Figure 3.2 – Example of BBC website banner with explicit branding removed

3.4 The Experiment

As outlined in the opening section of this chapter, the experiment was split into three stages:

1. Participant Profile Questions
2. Bias Rating Experiment
3. Reflective Questions

The experiment was designed in this way so as to gather as much information as possible from each participant, not just about how biased they determined the articles with which they were presented to be, but also information which may give insight to how they reached that determination.

The three phases of the experiment are outlined in more detail below.

3.4.1 Phase 1: Participant Profile Questions

Rather than just collecting bias ratings from the participants, it was important to gain some context surrounding the responses provided by participants to the survey.

Prior to being presented with the websites for evaluation, participants were asked to provide the following information:

- Date of birth
- Gender
- Amount of time spent on the internet each day
- Highest level of education completed
- Expected income for 2018
- Occupation
- Political leaning
- Media accessed most often
- How many times do they check the news online each day

The data gathered from the responses to these questions is useful in contextualising the answers from the participants. If trends exist among socio-economic factors and the level of bias reported for a story, it would indicate an underlying effect which would require further attention and explanation. This can greatly add to the specificity of the findings.

3.4.2 Phase 2: Bias Rating Experiment

The bias rating part of the experiment involved presenting participants with an article from a website and asking the participant to report how biased they considered that article to be.

The participants rated bias on a slider scale from 0 to 100; 0 being not biased, and 100 being extremely biased.

The specific articles with which the participants were presented depended on to which path the participant had been assigned when they began the experiment. This system is outlined in the next section.

3.4.3 Experiment Paths

As outlined above, each participant was assigned to a path through the 3x3x3 cube. Each path ensured that each participant experienced each website, article, and distortion exactly once as they traversed the cube. The participants scored each website x article x distortion (WAD) combination presented to them on a slider scale from 0 to 100. The scale was anchored with the terms “unbiased” and “extremely biased”.

The assignment of participants to paths through the experiment cube was random. In order to ensure that each WAD combination was considered by the same number of participants, and thus the responses recorded for each path would be of equal statistical merit, the same number of participants was assigned to each path. This is important, as many statistical methods, including ANOVA which is suitable for this type of experiment, require balance in the distribution of participants to groups.

This was achieved by setting a maximum number of participants for each path, and closing that path when the required number of participants had been assigned to it. Therefore, the requirement to have the same number of participants on each path did not affect the randomness of the allocation of paths.

There are twenty-seven possible WAD combinations in the 3x3x3 cube. By having nine separate paths through the cube, each participant was presented with just three combinations of article, website and distortion. The combinations shown to participants on each path are shown in Figure 3.1 and Tables 3.1– 3.3 below.

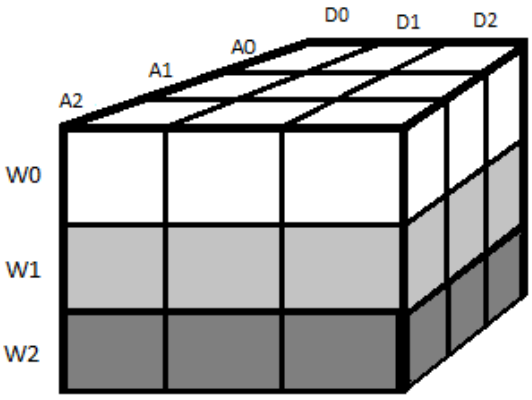


Figure 3.3 - An illustration of the 3x3x3 experiment cube, showing the three levels of websites, articles, and distortions. Each shaded layer of the cube corresponds to a table below (Tables 3.1 – 3.3), which detail how each path traverses the cube.

Table 3.1 - A top-down view of the top (white) row in the 3x3x3 cube in Figure 3.1 above. The intersecting A0 / D0 cell is the same as the A0 / D0 cell in Figure 3.1 above. Participants who were assigned to path one would therefore experience Website 0 x Article 0 x Distortion 0.

	Article (D0)	Article & Original Graphic (D1)	Article & Graphic-- (D2)
Story 1 (A0)	Path 1	Path 2	Path 3
Story 2 (A1)	Path 4	Path 5	Path 6
Story 3 (A2)	Path 7	Path 8	Path 9

Table 3.2 - A top-down view of the middle (light grey) row in the 3x3x3 cube in Figure 3.1 above. The intersecting A0 / D0 cell is the same as the A0 / D0 cell in Figure 3.1 above. Participants who were assigned to path one would therefore experience Website 1 x Article 1 x Distortion 1

	Article (D0)	Article & Original Graphic (D1)	Article & Graphic-- (D2)
Story 1 (A0)	Path 9	Path 7	Path 8
Story 2 (A1)	Path 3	Path 1	Path 2
Story 3 (A2)	Path 6	Path 4	Path 5

Table 3.3 - A top-down view of the top (dark grey) row in the 3x3x3 cube in Figure 3.1 above. The intersecting A0 / D0 cell is the same as the A0 / D0 cell in Figure 3.1 above. Participants who were assigned to path one would therefore experience Website 2 x Article 2 x Distortion 2

	Article (D0)	Article & Original Graphic (D1)	Article & Graphic-- (D2)
Story 1 (A0)	Path 5	Path 6	Path 4
Story 2 (A1)	Path 8	Path 9	Path 7
Story 3 (A2)	Path 2	Path 3	Path 1

For example, a participant who was randomly assigned to Path 1 through the experiment, was presented with [W0, D0, A0], [W1, D1, A1] and [W2, D2, A2], and was asked to evaluate each of those three combinations.

Likewise, a participant who was randomly assigned to Path 2 through the experiment, was presented with [W0, D1, A0], [W1, D2, A1] and [W2 D0, A2], and was asked to evaluate each of those three combinations.

By having each participant evaluating just three of the twenty-seven possible permutations of WAD, the effects of fatigue are reduced. Also, the participant did not rate more than one distortion of a particular article or website, which makes any crossover effects impossible.

3.4.4 Phase 3: Reflective Questions

Having rated all three websites, the participants were asked the following:

- If they recognised any of the websites used in the experiment, from a provided list of news websites
- If they considered any of the websites to be particularly biased in general, from a provided list of news websites
- Which elements, from a multiple-choice list of supplied elements, they consider contribute to bias

This additional information was stored along with their other responses, and was completely anonymous.

In addition to this, participants were asked one ‘spike’ question. An image of an article about dogs was presented to each participant before the first article as part of this experiment. The participants were required to answer if the article was about dogs or cats, on the same slider scale as during the experiment, thus ensuring that the participants were paying attention to

the content being presented to them, and not just responding to the survey at random. This increases confidence that the responses to the survey were genuine and considered, and therefore that the conclusions drawn can be considered to reflect reality.

3.5 Bias Rating Scale

Bias was rated by participants on a visual analogue scale, which ranged from 0 to 100. This is shown in Figure 3.4. This type of scale was chosen as it allows participants to report precisely the level of bias they determine to be present in the article which they are rating.

An alternative type of scale, which has been used extensively in research in the past, is the Likert scale. On a Likert scale, the participants report their answer as an approximation which falls within a grouping of scores. This makes sense when evaluation of results is being carried out manually, as it makes for more simplified analysis. However, with automatic methods for data collection and analysis, the greater granularity of the responses made possible on a continuous scale was possible to utilise. It is for this reason that a continuous scale was utilised.

Figure 3.4 - The Visual Analogue Scale on which participants rated the perceived level of bias for each article

3.6 Participants

The participants for the experiment were sourced through the crowd sourcing marketplace Prolific Academic[3][49].

Participation was limited to the United States of America. This was to help prevent the participants' personal opinion of articles presented to them affecting their perception of the articles' bias, as each of the news articles used for the experiment was sourced in media publications from the United Kingdom. With the branding removed from the UK websites, the likelihood of the American participants recognising the website, or having an opinion as to its bias, should be reduced [45]. If the participants did have their own strong opinion on the websites in question, it is likely that this could skew their interpretation of whether or not the article was biased [38].

The requisite number of participants was determined, using G*Power[56], in order to create a sufficient statistical power for the results to be meaningful. ANOVA analysis, discussed in

[3] www.prolific.ac

Chapter 5, is generally suitable for this type of experiment, and so calculations were based on creating a statistical power for ANOVA. A statistical power of .45 or better is sufficient to draw meaningful conclusions from the research. In order to attain this statistical power, 121 participants would be required. However, in order to have an equal number of participants per path through the Latin Cube, 126 participants were required; 14 participants per path.

Having an α error probability of <0.05 means that we have a 95% chance of not making a Type 1 error.

Also, with a sample size of 126, there is a >0.95 Statistical Power, or a >95% probability, that we will detect an effect size of 0.45 when there is an effect to be detected, and not making a Type 2 error.

With 126 participants, the calculations are as shown in Table 3.4. The effect size, f, shows the effect size which is being sought. The power shows the probability of not making a Type 2 error for this effect size.

*Table 3.4 - Table showing calculations of statistical power for this experiment, from G*Power.*

Input	**Output**
F Test	
ANOVA: Fixed effects, special, main effects and interactions Post hoc: Compute achieved power - given a sample size, and effect size	
• Effect size f = 0.45 • β / α ratio = 1 • Total Sample Size = 126 • Numerator df = 8 (levels minus 1) • Number of groups = 9	• Noncentrality Parameter = 25.515 • Critical F = 2.0674719 • Denominator df = 117 • α err prob = 0.0444294 • β err prob = 0.0444294 • Power = 0.9555706

3.7 Conclusion

The measurement of bias requires participants in the experiment to report their determination on the perceived level of bias in the article with which they are presented. As will be discussed in Chapter 5, in order to perform ANOVA analysis on the responses from the participants it is desirable to record a single continuous dependant variable, and one categorical independent variable. It was intended when designing the experiment that it should be suitable for this type of statistical analysis. Therefore, any other variables should be eliminated, and each participant should be asked to provide just a single piece of data; in this case, the level of bias in an article.

Participants are only asked to rate three different images of websites, thus reducing the possible effects of fatigue. Participants are also asked a spike question to ensure that they are paying attention before the experiment begins.

Use of Latin Hypercube Sampling provides a method of ensuring that participants are shown random images from the available selection, and also provides independence of observations between groups, another requirement for statistical analysis of the data collected.

The use of articles from UK websites, and American participants, along with removed branding, reduces the possible effects of bias arising from cognitive dissonance, by reducing the chances of the participants having a strong opinion on the material that they are rating. The presentation of the websites being kept as close as possible to their original format reduces the possible effects of bias being affected by the website design. It is important to mitigate these potential sources of error as much as is possible.

As statistical power of 0.45 is deemed sufficient to draw meaningful conclusions from this first research into the area; working with a higher statistical power would be economically prohibitive due to the number of participants required, while this should work to determine if there are useful results to be found from this experiment. According to Cohen [61], a power of 0.5 should detect an effect of medium magnitude. By using 0.45, the size which can be detected is even smaller. The calculations were based on the premise that ANOVA would be a suitable type of statistical analysis for the data collected in this experiment.

4. Experiment Apparatus

The survey for this experiment was deployed online, using a custom-built apparatus, on an Apache virtual machine (VM) in the School of Computer Science and Statistics at Trinity College, Dublin.

The apparatus is based on that built and used by Brendan Spillane for his web design experiments at the ADAPT Centre[4], but used here with significant modification. The existing apparatus was designed to accommodate two-dimensional experiments up to a maximum size of a 9x9 two-dimensional Latin square. While significantly smaller than that size, this experiment required a framework capable of handling a three-dimensional cube. The apparatus' code, therefore, required heavy modification in order to be suitable for this experiment. This coding was completed and tested locally before being deployed to the VM for public use.

The apparatus is written primarily in the Python 2.7 programming language using the Django Framework. The HTML elements of the apparatus are styled using Twitter Bootstrap, and interactive elements of the design are controlled with JavaScript.

Responses by participants were stored on a MySQL database, running on the same VM as the front-end website. This was linked to the front-end using python-mysql.

The articles were modified for each required level of distortion with branding removed, using photo editing software. Each of these samples presented to the participants is shown in Appendix A4.

Each participant partaking in the survey progressed through the steps detailed in Sections 4.1 to 4.10.

4.1 Prolific Academic

The participants were sourced through the crowdsourcing marketplace Prolific Academic[5].

Participation was limited to US citizens, living in the USA, and who were at least 18 years old.

Eligible participants saw this experiment advertised on Prolific Academic, chose to partake, and were brought to the start page of the experiment.

The experiment was advertised on Prolific Academic for four days, from April 27th to April 30th, 2018. Prolific Academic requires that participants are compensated at least £5 for an hour of participation in surveys. This experiment took approximately 10 minutes, and so each participant received compensation of £0.85 for their time.

[4] https://www.adaptcentre.ie/
[5] www.prolific.ac

4.2 Begin Survey

Participants who chose to partake were first brought to an introduction page where they were provided with detailed information about the experiment. They were then given the option to partake in the experiment or return to Prolific Academic. This page, and all subsequent pages were part of the website running on the VM at Trinity College, Dublin. At this point, participants clicked to begin their participation in the experiment.

4.3 Participant Information

As per Trinity Research Ethics, participants were presented with information about the experiment, and were then asked to provide their consent that their responses could be recorded and used in the analysis of this experiment. This was a prerequisite for participation in the experiment.

The full content of the participant information and consent pages are show in Appendix A3.

4.4 Instruction Tasks

Having provided their consent in the previous section, participants clicked the button to begin their participation in the experiment, and in so doing, were randomly assigned to one of the nine paths through the experiment, as described in Chapter 3, Figure 3.1.

They were then presented with instruction tasks; they were presented with pages which looked identical to the experiment proper, but were simply used to allow the participants to familiarise themselves with the experiment apparatus and the interface. Popup windows provided information to the user on how to partake in the experiment, and the users were requested to rate the bias of two sample images, as they would do later on in the experiment proper. These instruction pages are shown in Appendix A7.

4.5 Survey Questions

Before rating any articles as part of the experiment, participants were required to fill in a short survey. The results of this survey provided background information on the participants, allowing for contextualisation and greater understanding of their bias ratings.

The users were asked to provide the information detailed in Section 3.4.1.

This information provides information about the participants' socio-economic and political background. Though not directly contributing to the findings of the experiment, this information could be used to explain or contextualise the responses recorded.

4.6 Spike Question

Having completed the background survey, users were presented with a spike question to ensure diligence to the task and make sure they were not simply clicking though the experiment. This article is not part of the experiment data that was assessed and is simply designed to measure participants' attention to the task. To this end, participants were shown an article about dogs. The slider bar at the bottom of the page then asked them to indicate whether the article was about dogs or cats. Asking this simple and, more importantly, objective question for which there is a right and a wrong answer goes some way to ensuring that the participants were in fact paying attention to the experiment, and were giving considered responses. Any participant who answered the question incorrectly could be considered to have provided generally erroneous results, and their responses could be removed from consideration.

4.7 Bias Ratings

Participants then partook in the main part of the experiment, namely rating the bias they perceived to be present in each WAD combination. Each participant rated three WAD combinations, on a slider scale from 0 to 100, 0 being unbiased and 100 being extremely biased, as shown in Figure 3.4. The specific articles which were presented to the participants depended on which path they had been assigned through the experiment (see Figure 3.1).

After rating all three articles, the participants were then presented with all three again, with the opportunity to re-evaluate their ratings by comparing all three simultaneously.

Once satisfied with the rating which they had given for each, the participants were then once again presented with all three articles side-by-side, without seeing their previous rating, and asked to select the article they considered to be the most biased.

Asking for repeated affirmation of their decisions regarding the bias levels they perceived to be present in the articles increases confidence that the responses provided by the participants had been fully considered, and can provide meaningful information from which to draw conclusions.

4.8 Reflective Survey Questions

Having rated, and re-rated, the articles for their perceived level of bias, the participants were again asked a number of survey questions, reflecting on the experiment. Each participant was asked:

- If they recognised any of the websites used in the experiment, from a provided list of news websites
- If they considered any of the websites to be particularly biased in general, from a provided list of news websites

- Which elements, from a multiple-choice list of supplied elements, they consider contribute to bias

This information is used to provide context to the answers provided. For example, if a user said that they had recognised some of the websites used, we can no longer assume that their responses are entirely free of their own bias, from opinions they already had about the publication. Like the pre-experiment survey, described in Section 4.4, the answers to these questions do not directly contribute to the outcome of the experiment, but can be used to contextualise the responses recorded.

4.9 Debrief

Having completed the entire experiment, participants were presented with a debrief page, thanking them for their participation and providing them with contact information for the researchers, whom they could contact with any questions arising from the experiment. The full content of this page is presented in Appendix A6.

4.10 Submission and Payment

Having read the debrief page, participants were prompted to submit their responses to be included in the research. Upon clicking the button to do this, their answers were recorded on a MySQL database, which was hosted on the same Apache VM as the rest of the experiment apparatus.

The participants were then redirected to the Prolific Academic website, where they received payment as compensation for their time in completing the experiment.

4.11 Conclusion

The apparatus used in this experiment had previously been employed in two-dimensional experiments at the ADAPT Centre, but required heavy adaptation for use in this three-dimensional experiment.

The number of participants required to participate in the experiment was calculated using G*Power, as discussed in Chapter 3. The design of this experiment ensured that participants were always fully aware of what information they were expected to provide, and how to provide it. The design also ensured that responses were well considered, and provided context to a user's response decisions.

5. Data Analysis

Determining whether or not any bias exists in the data collected requires statistical analysis of the data. Originally, it was envisaged that analysis for this experiment would be achieved using one-way ANOVA, or Analysis of Variance tests, and the experiment was designed accordingly. On examination, it transpired that the data collected did not satisfy the assumptions for ANOVA as there were a number of significant outliers in the bias ratings, and so the Kruskel-Wallis H Test was performed instead. All tests were run using SPSS 25.

5.1 ANOVA Assumptions

There are six assumptions which an experiment and its resulting dataset must satisfy for ANOVA to be considered an appropriate test for that data:

1. There must be just one dependent variable, which must be continuous. In this case, that variable is the reported bias, which was reported on a continuous slider scale from 0 to 100 by the participants.
2. There must be one independent variable, which is categorical. In this case, that independent variable is one of either the Website, the Article, or the Distortion, depending on which dimension of the experiment is being examined at a particular time. Only one is examined at a time, which means that this assumption is satisfied.
3. There must be independence of observations. This is achieved by the Latin Hypercube Sampling experiment design, discussed in Chapter 3. This design ensures that the way that participants traverse the Latin Cube design guarantees independence of observations, by maintaining each randomly assigned group on separate paths through the cube.
4. There should be no significant outliers in the groups.
5. The dependent variable should be approximately normally distributed.
6. The variances of each variable should be approximately equal.

Assumptions 1, 2 and 3 are satisfied by the experiment design.

Assumptions 4, 5 and 6 depend entirely on the responses provided to the experiment by the participants. While it can often be expected that the responses will satisfy these assumptions, the data set must be tested to confirm that this is the case before an ANOVA analysis can be considered appropriate for the dataset.

Having collected all of the data for this experiment, the data failed Assumption 4; there were a small number of significant outliers, see Figure 5.1.

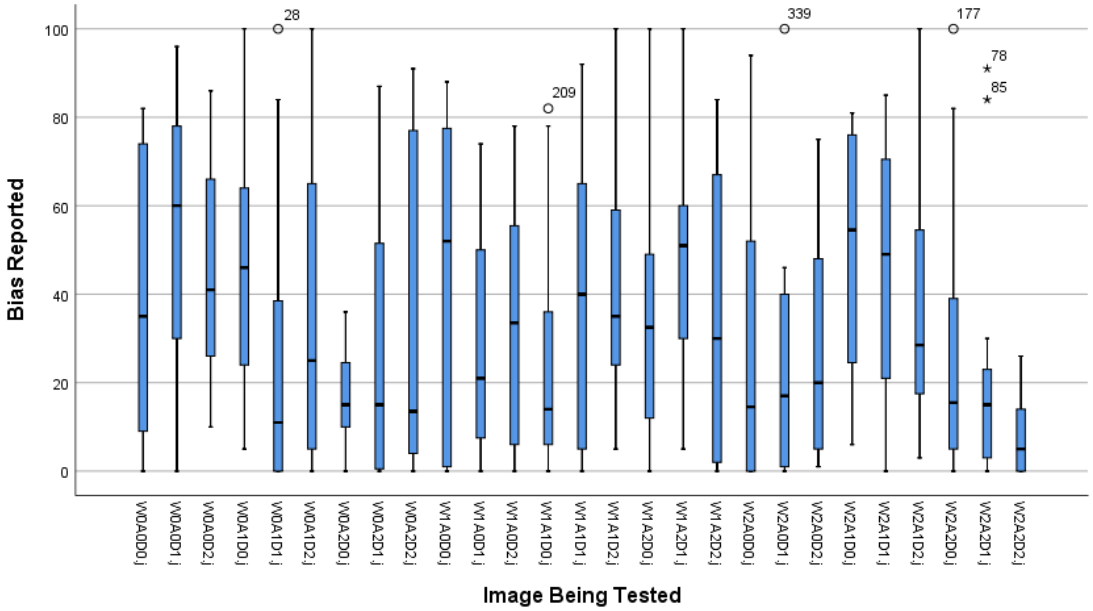


Figure 5.1 - Boxplot showing data collected for all twenty-seven combinations of WAD presented to participants. Significant outliers are seen represented by circles (more than one box-length), and asterisks (more than three box-lengths). Note that the numbers associated with the outliers are the unique identification numbers for those points in the dataset, and not the values of those points.

As there was no reason to reject these outlying data-points as being erroneous, it was necessary to include these in the statistical analysis. Consequently, ANOVA was unsuitable for analysis in this experiment, and an alternative, the Kruskel-Wallis H Test was used instead.

5.2 Kruskel-Wallis H Test Assumptions

Having rejected ANOVA as a suitable statistical test for use on this dataset, the Kruskel-Wallis H Test was chosen as a suitable alternative. This test, like ANOVA, is suitable for determining the relative differences between groups on a scale, which for this experiment is the bias rating. Importantly, the Kruskel-Wallis H Test is suitable for analysis on datasets with outliers, which is a necessity for the data collected in this experiment, as significant outliers exist.

For the Kruskel-Wallis H Test, the data must satisfy four assumptions, which are similar to the ANOVA assumptions, in order for this test to be suitable:

1. There must be just one dependent variable, which can be either continuous ordinal. In this case, that variable is the reported bias, which was reported on a continuous slider scale from 0 to 100 by the participants.
2. There must be one independent variable, which is categorical. In this case, that independent variable is one of either the Website, the Article, or the Distortion, depending on which dimension of the experiment is being examined at a particular time. Only one is examined at a time, which means that this assumption is satisfied.

3. There must be independence of observations. This is satisfied by the experiment design as discussed in section 5.1.
4. A determination must be made of whether the distribution of scores of the dependent variable has the same or different shape for each of the independent variables, as shown in Figure 5.2. The test is suitable whether or not the shape is the same, but the alternative hypothesis is different depending on this determination. This determination is made for the data each time the test is run, which for this experiment is twenty-seven times over the three dimensions of the experiment cube.

As the data collected from the participants in this experiment satisfies these assumptions, the Kruskel-Wallis H Test is a suitable statistical method.

5.3 Kruskel-Wallis H Test Hypotheses

The research question which this experiment aims to answer is, "To what extent do the information graphics accompanying a news article impact upon the perceived bias of the article?". This requires determining if the perceived level of bias changes when a graphic is introduced, and if so what the nature of that change is. This is achieved by comparing the bias ratings at the three levels of distortion and for the three websites and news stories as discussed in Chapter 3.

The Kruskel-Wallis H Test can be used to determine if any differences observed in the collected data are statistically significant. The hypotheses which the Kruskel-Wallis H Test tests for are very similar to the hypotheses for ANOVA, and so it provides a suitable alternative test for this experiment. As this is a parametric test, unlike ANOVA, this test is suitable for datasets with significant outliers, which is a necessity for analysis of the data collected in this experiment.

The responses are grouped by their WAD combinations from the Latin Cube outlined in Chapter 3. The Kruskel-Wallis H Test is performed on each level of WAD, for each dimension of the cube. This means that twenty-seven tests are carried out on the experiment cube in total. The outcome of each test is either the rejection or retention of the null hypothesis, and in the case of rejection, the acceptance of the alternative hypothesis.

5.3.1 The Null Hypothesis

The null hypothesis (H_0), which is assumed, in a Kruskel-Wallis H Test is:

H_0: The distribution of scores for the groups are equal.

For this experiment, the scores are the bias ratings by participants, and the groups are the combinations of WAD.

As it is highly improbable that a set of data will contain identical data in different independent groups, a determination must be made for what is a statistically significant difference in order

to reject the null hypothesis. For Kruskel-Wallis H Tests, this is determined by p-values. As is standard practice, a p-value of 0.05 was used to test for significance in this experiment.

5.3.2 Alternative Hypothesis

Alternatively, if the relative levels of bias between groups is found to be statistically significant, the null hypothesis must be rejected. This implies that the alternative hypothesis (H_1) may be accepted. Consequently, we determine that the averages of the populations are, in fact, different, and we can say with 95% certainty that the levels of bias are different in at least one of the three groups.

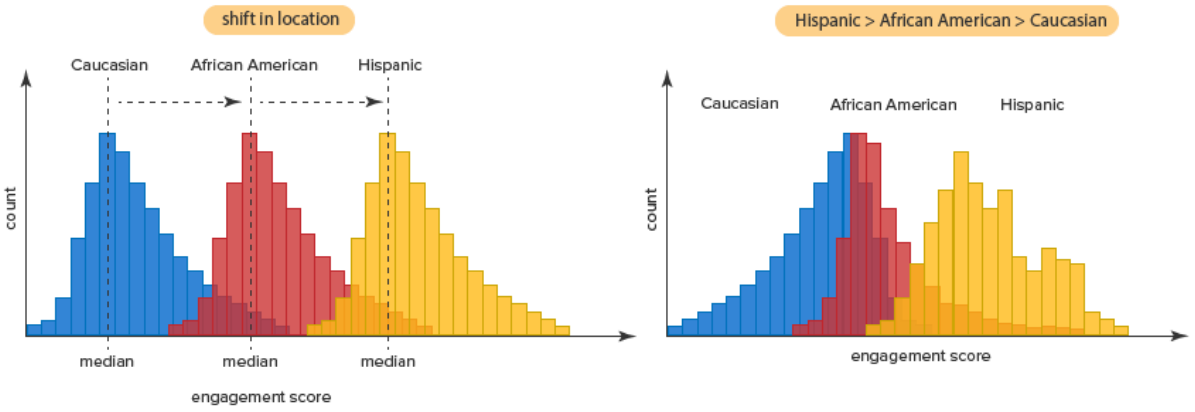


Figure 5.2 - Example illustration showing three different groups whose distribution is different, with distributions of the same shape (left), and different shape (right). Image source: Laerd Statistics[6]

Depending on whether the shapes of the distributions are equal, as per the example in Figure 5.2, determined in Assumption 4, the alternative hypothesis can be described in different ways. There is no generally accepted numerically rigorous approach to determining whether the shapes of the distributions are equal or not, and so this determination is made visually. For this experiment, that determination was made using box-plots of the data for each group. This is a standard approach.

If Assumption 4 is violated, and the shapes of the distributions are not similar then the alternative hypothesis states:

H_1: The mean ranks for the groups are not equal.

This means that there is evidence that the level of bias reported at least one of the groups is statistically significantly different from the others. This means that bias has been found to exist. The precise extent to which the groups differ is found by comparing the mean ranks of the groups.

[6] https://statistics.laerd.com/

Rejecting the null hypothesis, and consequently accepting the alternative hypothesis in all cases means that a statistically significant change in the levels of perceived bias has been detected in this experiment.

5.4 Kruskal-Wallis H Test Results

As mentioned in the previous section, whether or not to accept the null hypothesis is based on *p*-values. P-values become more accurate the larger the population size, but are considered appropriate for use once the population sample size is greater than five. The increase in accuracy is asymptotic, meaning that as the sample size increases, the rate of increase in the accuracy of the results reduces.

For this experiment, a *p*-value of <0.05 is considered to be statistically significant, as is standard practice. That is to say, a test result with a p-value of <0.05 will be sufficient to reject the null-hypothesis.

The p-value is calculated from the H-Statistic, which is the result of the experiment, and the number of degrees of freedom, which is the number of groups minus one. The H-Statistic approximately follows an x^2 distribution for the relevant number of degrees of freedom. For all tests of bias in this experiment, the number of degrees of freedom is two, as there are three groups in each of the three dimensions of the experiment cube.

5.5 Conclusion

In order to answer the research question proposed for this research, first a determination must be made as to whether or not the levels of bias are changed significantly by the introduction of graphics to news articles. The experiment was set up so that it would pass the first three assumptions necessary to undertake an ANOVA. However, the resulting data provided by the participants meant that there were too many outliers in the data and as a result it failed Assumption 4, rendering the dataset unsuitable for ANOVA analysis.

The Kruskel-Wallis H Test provides a suitable alternative to ANOVA. The test is suitable for determining a difference between the results reported by each group, but can do so regardless of whether or not there are outliers in the groups, or the distributions of responses are balanced. It was therefore used for analysis in this experiment.

The nature of any change found between the perceived levels of bias for each group, is determined by comparing either the mean rank or the median of the groups, depending on whether or not the distributions for each group had the same shape.

Accepting or rejecting the Kruskal-Wallis H Test's null hypothesis for these tests determined whether the level of bias perceived in articles was found to be affected by the use of information graphics accompanying those articles, answering the research question.

6. Results

This chapter details the results, following statistical analysis, of the bias ratings provided by participants in the experiment. The full data collected and used in this analysis is presented in Appendix A1.

The results shown below for each Kruskal-Wallis H Test carried out, comprise:

- A box plot, showing the reported levels of bias for each independent group being tested. The horizontal black line through the boxes shows the mean rank for each group.
- A table showing the mean value, and standard deviation for each independent group being tested. The mean value is on a scale from 0 to 100, as this is the range of responses allowed by the experiment apparatus.
- The decision on whether to accept or reject the null hypothesis, and the following key statistics drawn from the results
    - The H Test Statistic, presented as Chi-squared, and represented by $X^2(N-1)$, where N is the number of groups being tested.
    - The p-value of the results, used to accept or reject the null hypothesis. A p-value of <0.05 is considered sufficient to reject the null hypothesis.

A full summary of these results is provided in Section 6.6. These results, including the visualisations, were generated using SPSS 25, as noted in Chapter 5.

6.1 Experiment Participants

The experiment was run, and all data collected over four days from April 27th to April 30th, 2018. 124 complete responses were gathered and considered for statistical analysis. A breakdown of the participants' demographics is shown in Figure 6.1 and 6.2. The vast majority of participants were aged between 18 and 40 years old. 70 of the participants, or 56%, identified themselves as being male. 52 of the participants, or 42%, identified as female.

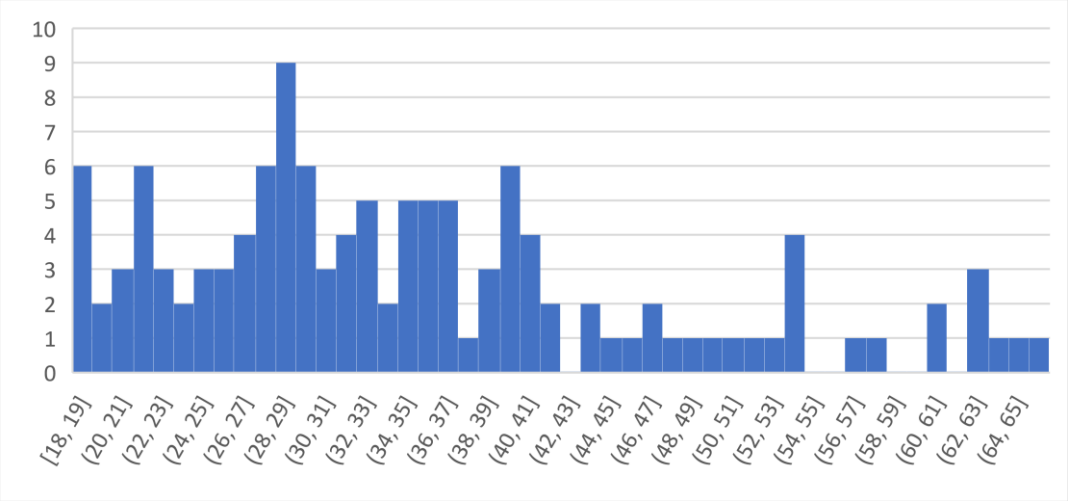


Figure 6.1 - The age distribution of participants

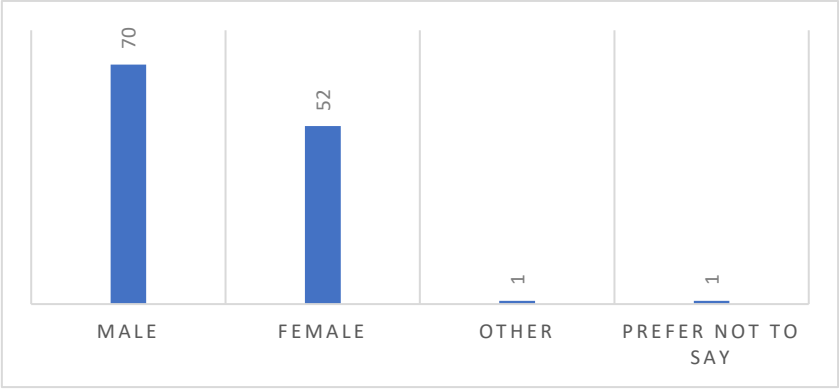


Figure 6.2 - Number of participants by gender

A full breakdown of all responses to the experiment are shown in Appendix A1 and Appendix A2.

6.2 How to Read the Kruskel-Wallis H Test Results

This section is designed to show how the results presented in this chapter should be interpreted.

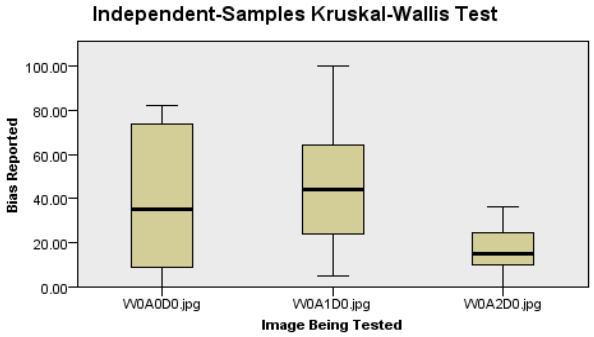
The determination on if the groups had a distribution of equal shape was made on the shape of the box plots for those groups. This decision is not dependent on how high or low the distribution is grouped on the vertical axis, but only on its height and the location of the mean rank within it, represented by the horizontal black line.

Regardless of whether or not the distributions were of equal shape, the Kruskel-Wallis H Test tests for the relative locations of the distribution on the vertical axis. The resulting score, the

H-statistic, is in fact a Chi-squared score for the test. As such, it is presented as $X^2(N-1)$, for N groups, as this is a more familiar statistic to many.

One of the results for this experiment is explained in detail in Section 6.2.1. All other results may be interpreted similarly.

6.2.1 Sample breakdown of results for a Kruskel-Wallis H Test interpretation



Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A0D0.jpg	38.92	13	30.404
W0A1D0.jpg	45.88	17	28.295
W0A2D0.jpg	16.50	12	10.775
Total	35.33	42	27.716

Figure 6.12 - Results of the Kruskal-Wallis H Test for W0D0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each article differed significantly from one another, $X^2(2) = 7.393$, $p = 0.025$. The null hypothesis is **rejected.**

6.2.1.1 Boxplots

The boxplot in the top left of figure 6.12 shows the distributions for the three groups being tested. In this case they are the groups of users who experienced W0A0D0, W0A1D0, and W0A2D0. It can be seen that the shapes of the three distributions of bias rating results are different from each other. The leftmost box has the largest distribution, and the rightmost box has the smallest distribution. This can also be confirmed with reference to the standard deviation, shown in the table on the right. It can also be seen that the median, the horizontal black line through each box plot, cuts the three boxes into different proportions. This is another indication that the distributions are not equal.

6.2.1.2 H-Statistic

To make a determination on whether or not to reject the null hypothesis for each test, the H statistic is calculated by running the Kruskal-Wallis H Test in SPSS 25. This is calculated by assigning a “rank” to each data point (bias rating), from 1 to n, beginning with the lowest bias rating, and working upward from there. A mean value is then found for the ranks which have been assigned to each group. This is called the mean rank for that group.

For example, the mean rank for the sample data set shown in Table 6.1 would be calculated as follows. Note, the data in Table 6.1 has been generated purely for explanation purposes, and is not real data from the experiment.

Table 6.1 - Sample dataset with three groups of bias ratings.

W0A0D0 Bias Ratings	W0A0D1 Bias Ratings	W0A0D2 Bias Ratings
15	45	18
32	63	22
43	42	46
17	19	82
14	32	53
28	61	37
53	25	46
26	36	57

1. The bias ratings are put in an ordered list and ranked from smallest to highest.

Table 6.2- Sample dataset with three groups of bias ratings with ranks

W0A0D0		W0A0D1		W0A0D2	
Bias Rating	Rank	Bias Rating	Rank	Bias Rating	Rank
15	2	45	15	18	4
32	9	63	23	22	6
43	13	42	12	46	16
17	3	19	5	82	24
14	1	56	20	54	19
28	8	61	22	37	11
53	18	48	17	44	14
26	7	36	10	57	21

2. The mean rank of each group is calculated. This is the arithmetic mean of the ranks assigned to that group.

Mean Rank for Group 1: (2 + 9 + 13 + 3 + 1 + 8 + 18 + 7)/8 = 61/8 = 7.625
Mean Rank for Group 2: (15 + 23 + 12 + 5 + 20 + 22 + 17 + 10)/8 = 124/8 = 15.5
Mean Rank for Group 3: (4 + 6 + 16 + 24 + 19 + 11 + 14 + 21)/8 = 115/8 = 14.375

3. The Kruskal-Wallis H Test then makes a comparison based on these mean ranks, rather than a comparison of the bias rating values themselves. This is the most suitable comparison of the distributions, as it takes into account the different distributions for each group.

The H-statistic is calculated using equation 1.

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j}\right] - 3(n+1) \qquad (1)$$

where, n = sum of sample sizes for all samples, c = number of samples, T_j = sum of ranks of the j^{th} sample, and n_j = size of the j^{th} sample.

For the sample data in Table 6.1, this would be calculated, using Equation 1 as follows.

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j}\right] - 3(n+1)$$

$$H = \left[\frac{12}{24(24+1)} \left(\frac{61^2}{8} + \frac{124^2}{8} + \frac{115^2}{8}\right)\right] - 3(24+1)$$

$$H = \left[\frac{12}{600} \times \frac{16161}{4}\right] - 75$$

$$H = 5.805$$

The H-statistic, which is the result of the Kruskal-Wallis H Test, is often reported in the more familiar form of a chi-squared score. For this sample breakdown, the H-statistic is $H = X^2(2) = 5.805$, indicating that the experiment has two degrees of freedom. Higher H-statistics indicate a greater variance between the bias levels reported for each group. Similarly, lower H-statistics indicate a smaller variance between the bias levels reported for each group.

6.2.1.3 Hypothesis Testing and p-values

Using this H-statistic, and knowing the number of degrees of freedom, the *p*-value can be found, either by calculation or using tables for the Chi-squared distribution.

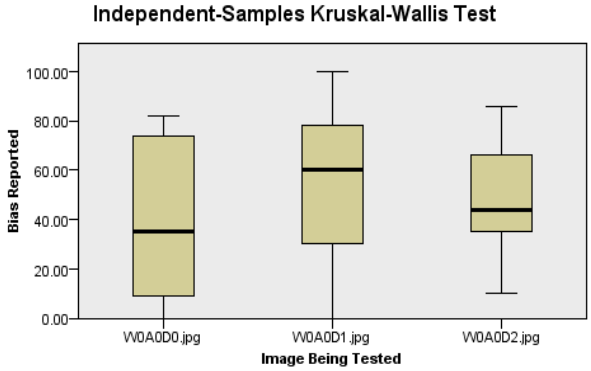
Using the Chi-square tables, as shown in Appendix A9, it can be seen that for a H-statistic/Chi-squared score of 5.805, with two degrees of freedom, the *p*-value is in the range $0.10 > p > 0.05$. As is standard practice, a *p*-value of <0.05 has been used in this experiment to determine significance. Having a *p*-value below 0.05 indicates that the null hypothesis can be rejected. For this example, $p > 0.05$, and therefore the null hypothesis is retained. This indicates that the difference between the bias reported for the groups is not statistically significant.

6.3 Bias Levels by Distortion

This section focusses on the outcome of the Kruskal-Wallis H Test for each combination of website and article. This directly compares the effects of distorting the graphic presented to users, without consideration of the website or article chosen.

For brevity, only the significant results are explored in detail.

6.3.1 W0A0 (D0/D1/D2) – The Daily Mail, CPI Inflation



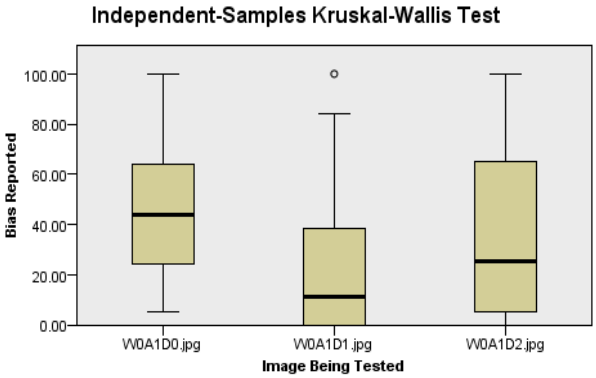
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A0D0.jpg	38.92	13	30.404
W0A0D1.jpg	53.07	14	34.582
W0A0D2.jpg	47.00	14	22.185
Total	46.51	41	29.322

Figure 6.3 – Results of the Kruskal-Wallis Test for W0A0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 1.451$, $p = 0.484$. The null hypothesis is retained.

6.3.2 W0A1 (D0/D1/D2) – The Daily Mail, Bitcoin Prices



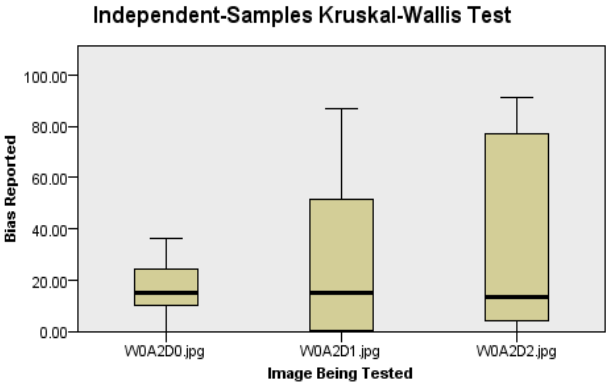
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A1D0.jpg	45.88	17	28.295
W0A1D1.jpg	26.44	16	32.737
W0A1D2.jpg	32.50	14	32.938
Total	35.28	47	31.712

Figure 6.4 - Results of the Kruskal-Wallis H Test for W0A1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 4.382$, $p = 0.112$. The null hypothesis is retained.

6.3.3 W0A2 (D0/D1/D2) – The Daily Mail, Life Expectancy



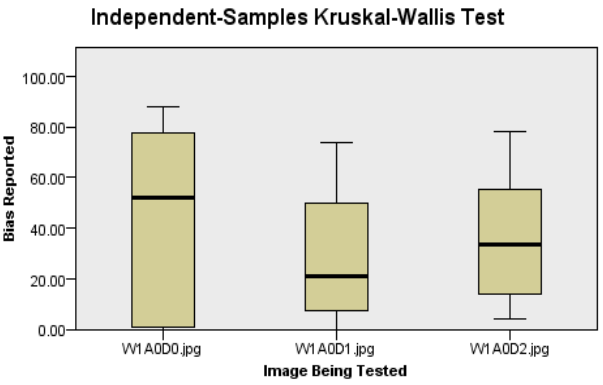
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A2D0.jpg	16.5000	12	10.77455
W0A2D1.jpg	27.6667	12	31.93839
W0A2D2.jpg	36.1667	12	38.36389
Total	26.7778	36	29.77162

Figure 6.5 - Results of the Kruskal-Wallis H Test for W0A1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 0.164$, $p = 0.921$. The null hypothesis is retained.

6.3.4 W1A0 (D0/D1/D2) – The BBC, CPI Inflation



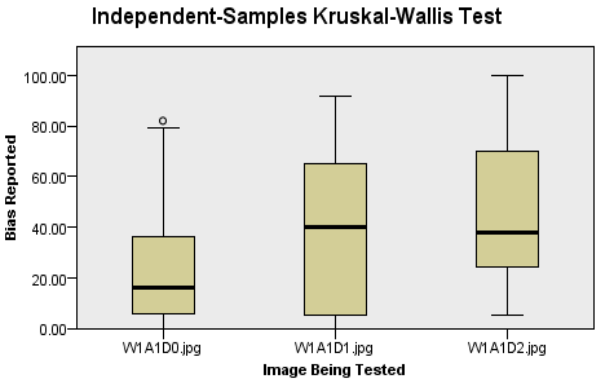
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W1A0D0.jpg	43.58	12	38.242
W1A0D1.jpg	28.08	12	25.040
W1A0D2.jpg	36.17	12	25.665
Total	35.94	36	30.082

Figure 6.6 - Results of the Kruskal-Wallis H Test for W1A0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 1.180$, $p = 0.554$. The null hypothesis is retained.

6.3.5 W1A1 (D0/D1/D2) – The BBC, Bitcoin Prices



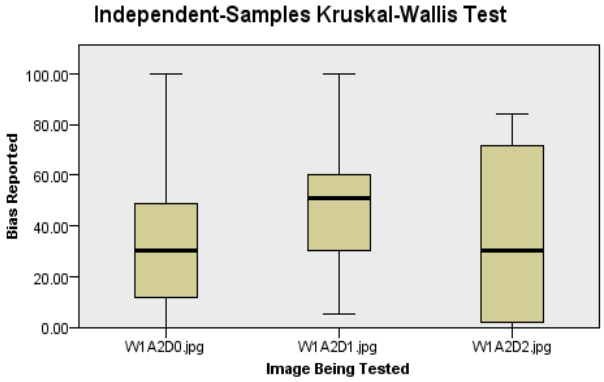
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W1A1D0.jpg	27.29	14	30.040
W1A1D1.jpg	37.69	13	34.565
W1A1D2.jpg	43.93	14	29.531
Total	36.27	41	31.378

Figure 6.7 - Results of the Kruskal-Wallis H Test for W1A1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 2.593$, $p = 0.274$. The null hypothesis is retained.

6.3.6 W1A2 (D0/D1/D2) – The BBC, Life Expectancy



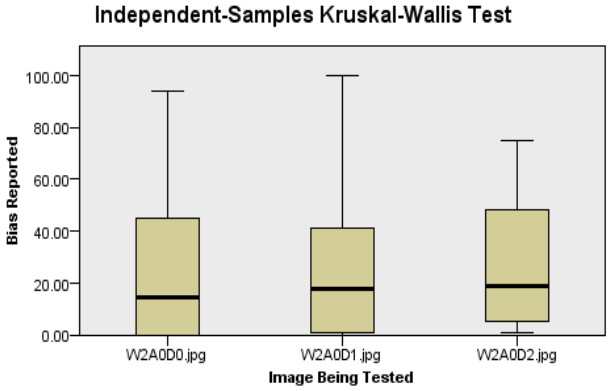
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W1A2D0.jpg	36.86	14	29.294
W1A2D1.jpg	49.12	17	29.801
W1A2D2.jpg	37.69	16	33.738
Total	41.57	47	30.913

Figure 6.8 - Results of the Kruskal-Wallis H Test for W1A2

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 1.983$, $p = 0.371$. The null hypothesis is retained.

6.3.7 W2A0 (D0/D1/D2) – The Guardian, CPI Inflation



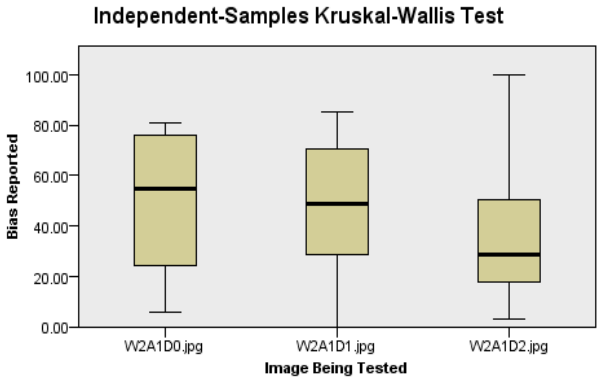
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W2A0D0.jpg	26.25	16	31.118
W2A0D1.jpg	26.21	14	28.631
W2A0D2.jpg	27.94	17	25.445
Total	26.85	47	27.808

Figure 6.9 - Results of the Kruskal-Wallis H Test for W2A0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 1.036$, $p = 0.596$. The null hypothesis is retained.

6.3.8 W2A1 (D0/D1/D2) – The Guardian, Bitcoin Prices



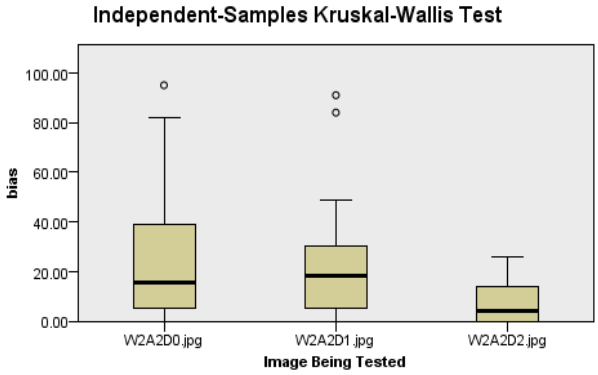
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W2A1D0.jpg	50.08	12	27.639
W2A1D1.jpg	47.83	12	28.064
W2A1D2.jpg	38.25	12	31.329
Total	45.39	36	28.691

Figure 6.10 - Results of the Kruskal-Wallis H Test for W2A1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 1.224$, $p = 0.542$. The null hypothesis is retained.

6.3.9 W2A2 (D0/D1/D2) – The Guardian, Life Expectancy



bias

Image Being Tested	Mean	N	Std. Deviation
W2A2D0.jpg	26.64	14	30.851
W2A2D1.jpg	26.64	14	28.830
W2A2D2.jpg	7.54	13	8.978
Total	20.59	41	26.166

Figure 6.11 - Results of the Kruskal-Wallis H Test for W2A2

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, $H = X^2(2) = 5.638$, $p = 0.060$. The null hypothesis is retained.

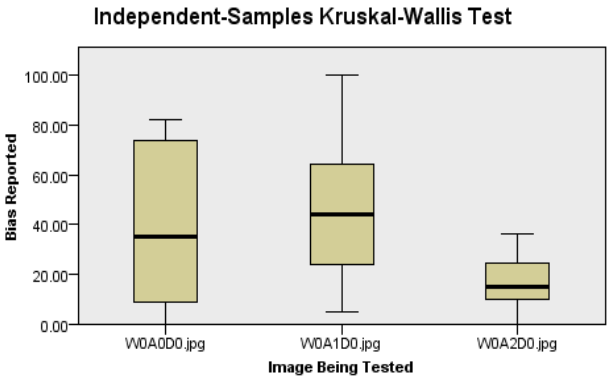
6.3.10 Overview of Results

There was no statistically significant difference found between the levels of bias reported for articles presented with or without graphics. In all nine cases, the null hypothesis, that the bias for each distortion was not statistically different from the other distortions, was retained. These results are discussed more fully in Section 7.1.

6.4 Bias Levels by News Story

This section details the outcome of the Kruskal-Wallis H Test for each combination of website and distortion. This directly compares the bias reported for each story, on the same website and for the same level of distortion.

6.4.1 W0D0 (A0/A1/A2) – The Daily Mail, no graphic



Bias Reported

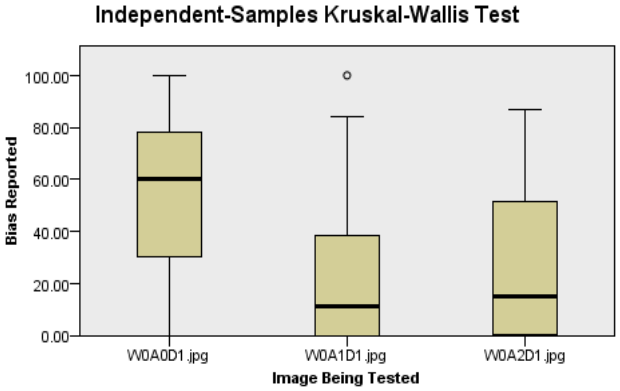
Image Being Tested	Mean	N	Std. Deviation
W0A0D0.jpg	38.92	13	30.404
W0A1D0.jpg	45.88	17	28.295
W0A2D0.jpg	16.50	12	10.775
Total	35.33	42	27.716

Figure 6.12 - Results of the Kruskal-Wallis H Test for W0D0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each article differed significantly from one another, $H = X^2(2) = 7.393$, $p = 0.025$. The null hypothesis is **rejected.**

This indicates that a statistically significant difference has been detected between the levels of bias reported for the each of the Daily Mail articles. It can be seen that the article about life expectancy (A2) was considered the least biased. This result is particularly important when compared to the other results for other distortions of the Daily Mail.

6.4.2 W0D1 (A0/A1/A2) – The Daily Mail, original graphic



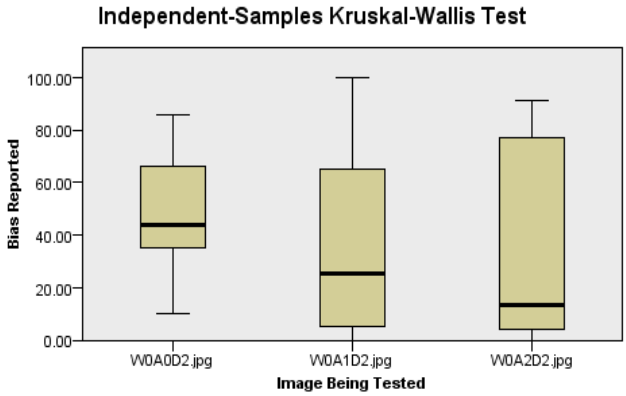
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A0D1.jpg	53.07	14	34.582
W0A1D1.jpg	26.44	16	32.737
W0A2D1.jpg	27.67	12	31.938
Total	35.67	42	34.646

Figure 6.13 - Results of the Kruskal-Wallis H Test for W0D1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, $H = X^2(2) = 4.913$, $p = 0.086$. The null hypothesis is retained.

6.4.3 W0D2 (A0/A1/A2) – The Daily Mail, experiment graphic



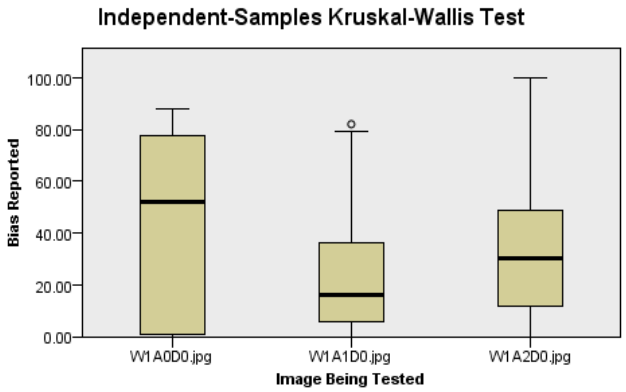
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A0D2.jpg	47.00	14	22.185
W0A1D2.jpg	32.50	14	32.938
W0A2D2.jpg	36.17	12	38.364
Total	38.68	40	31.326

Figure 6.14 - Results of the Kruskal-Wallis H Test for W0D2

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 2.832$, $p = 0.243$. The null hypothesis is retained.

6.4.4 W1D0 (A0/A1/A2) – The BBC, no graphic



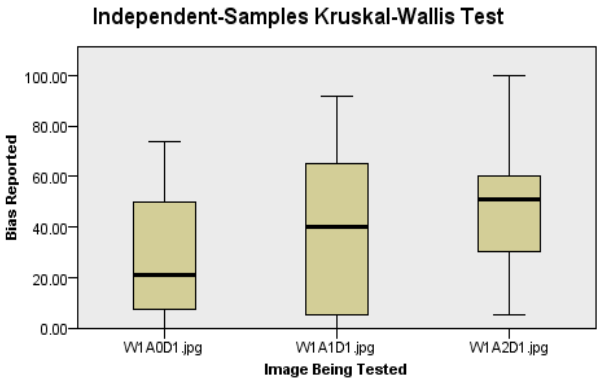
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W1A0D0.jpg	43.58	12	38.242
W1A1D0.jpg	27.29	14	30.040
W1A2D0.jpg	36.86	14	29.294
Total	35.53	40	32.316

Figure 6.15 - Results of the Kruskal-Wallis H Test for W1D0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 1.175$, $p = 0.556$. The null hypothesis is retained.

6.4.5 W1D1 (A0/A1/A2) – The BBC, original graphic



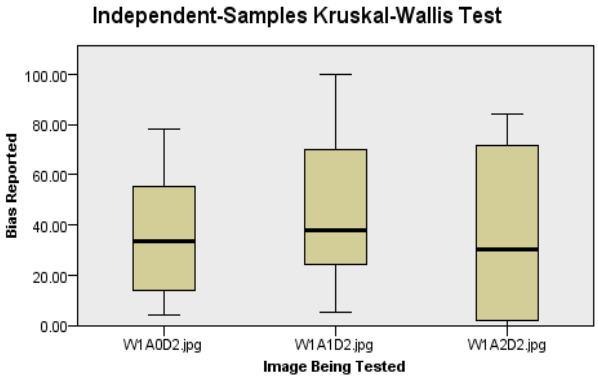
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W1A0D1.jpg	28.08	12	25.040
W1A1D1.jpg	37.69	13	34.565
W1A2D1.jpg	49.12	17	29.801
Total	39.57	42	30.692

Figure 6.16 - Results of the Kruskal-Wallis H Test for W1D1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 3.726$, $p = 0.155$. The null hypothesis is retained.

6.4.6 W1D2 (A0/A1/A2) – The BBC, experiment graphic



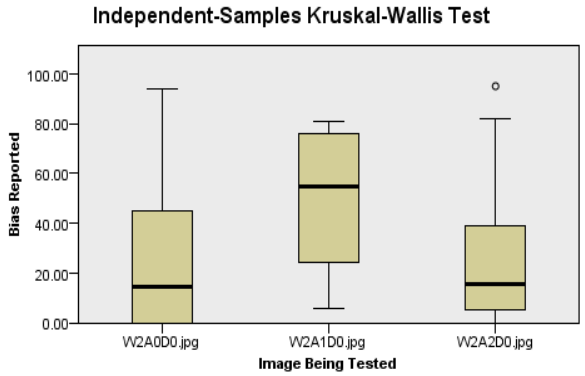
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W1A0D2.jpg	36.17	12	25.665
W1A1D2.jpg	43.93	14	29.531
W1A2D2.jpg	37.69	16	33.738
Total	39.33	42	29.679

Figure 6.17 - Results of the Kruskal-Wallis H Test for W1D2

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 0.79$, $p = 0.688$. The null hypothesis is retained.

6.4.7 W2D0 (A0/A1/A2) – The Guardian, no graphic



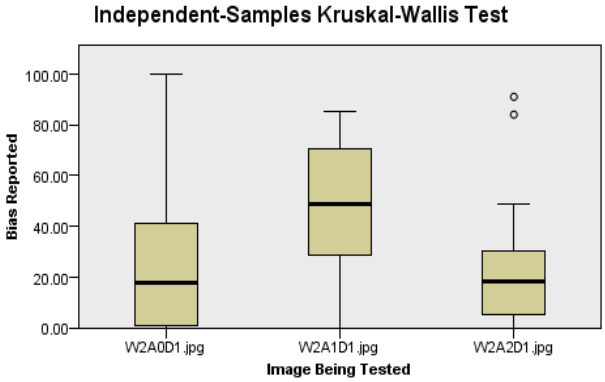
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W2A0D0.jpg	26.25	16	31.118
W2A1D0.jpg	50.08	12	27.639
W2A2D0.jpg	26.64	14	30.851
Total	33.19	42	31.272

Figure 6.18 - Results of the Kruskal-Wallis H Test for W2D0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 5.343$, $p = 0.069$. The null hypothesis is retained.

6.4.8 W2D1 (A0/A1/A2) – The Guardian, original graphic



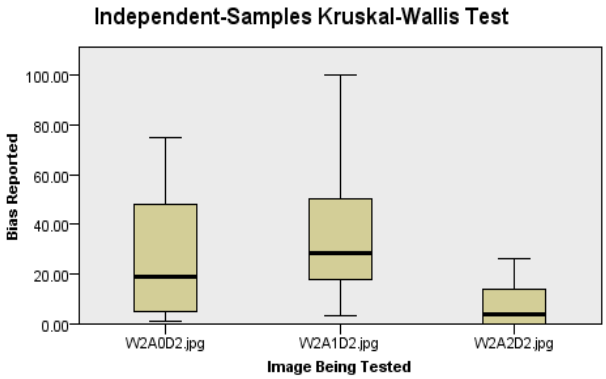
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W2A0D1.jpg	26.21	14	28.631
W2A1D1.jpg	47.83	12	28.064
W2A2D1.jpg	26.64	14	28.830
Total	32.85	40	29.515

Figure 6.19 - Results of the Kruskal-Wallis H Test for W2D1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 4.788$, $p = 0.091$. The null hypothesis is retained.

6.4.9 W2D2 (A0/A1/A2) – The Guardian, experiment graphic



Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W2A0D2.jpg	27.94	17	25.445
W2A1D2.jpg	38.25	12	31.329
W2A2D2.jpg	7.54	13	8.978
Total	24.57	42	26.287

Figure 6.20 - Results of the Kruskal-Wallis H Test for W2D2

The distributions of bias for each distortion were not similar for all groups. However, the values of bias reported for each article differed significantly from one another, H = $X^2(2)$ = 12.378, p = 0.002. The null hypothesis is **rejected.**

This indicates that a statistically significant difference was detected in the reported levels of bias for each article in The Guardian at the D2 level of distortion. The level of bias reported for the article about life expectancy (A2), was significantly lower than for the other two articles. This result is particularly important when compared to the results in Sections 6.4.7 and 6.4.8, where the differences were not statistically significant for the other levels of distortion of The Guardian website.

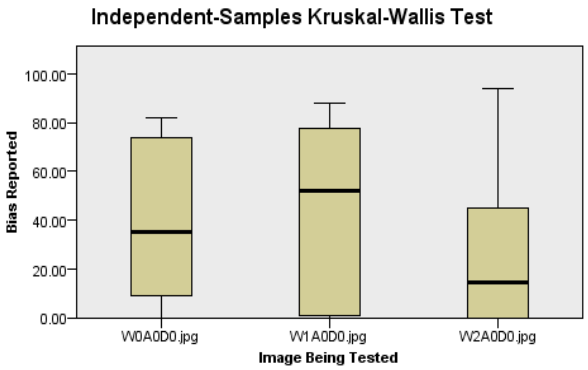
6.4.10 Overview of Results

There was a statistically significant difference detected between the bias reported for the Daily Mail at the D0 level of distortion, and for The Guardian at the D2 level of distortion. There was no significantly significant difference detected between the bias ratings of articles for any other website or level of distortion. Although this test was specifically a comparison of different articles for each website, at each level of distortion, a further inference can be made. Given that the only difference between the presentations within the group of sections 6.4.1 – 6.4.3, within the group of sections 6.4.4 – 6.4.6 and also within the group of sections 6.4.7 – 6.4.9, is the level of distortion, and the H-statistic for each of these tests is different (sometimes notably different), this tells us that the level of distortion (D0 / D1 / D2) is having an effect on the level of bias perceived. This indicates that the graphics accompanying the news articles have an effect on the level of bias perceived for the article as a whole.

6.5 Bias Levels by Website

This section details the outcome of the Kruskal-Wallis H Test for each combination of article and distortion. This directly compares the bias reported for each website's reporting of the same story, and at the same level of distortion.

6.5.1 A0D0 (W0/W1/W2) – CPI Inflation, no graphics



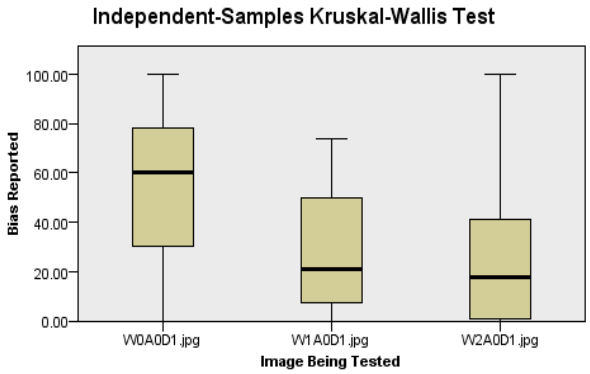
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A0D0.jpg	38.92	13	30.404
W1A0D0.jpg	43.58	12	38.242
W2A0D0.jpg	26.25	16	31.118
Total	35.34	41	33.170

Figure 6.21 - Results of the Kruskal-Wallis H Test for A0D0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, $H = X^2(2) = 1.781$, $p = 0.411$. The null hypothesis is retained.

6.5.2 A0D1 (W0/W1/W2) – CPI Inflation, original graphics



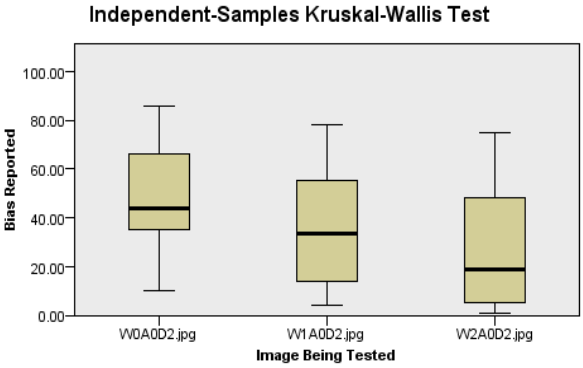
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A0D1.jpg	53.07	14	34.582
W1A0D1.jpg	28.08	12	25.040
W2A0D1.jpg	26.21	14	28.631
Total	36.18	40	31.733

Figure 6.22 - Results of the Kruskal-Wallis H Test for A0D1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, $H = X^2(2) = 4.722$, $p = 0.094$. The null hypothesis is retained.

6.5.3 A0D2 (W0/W1/W2) – CPI Inflation, experiment graphics



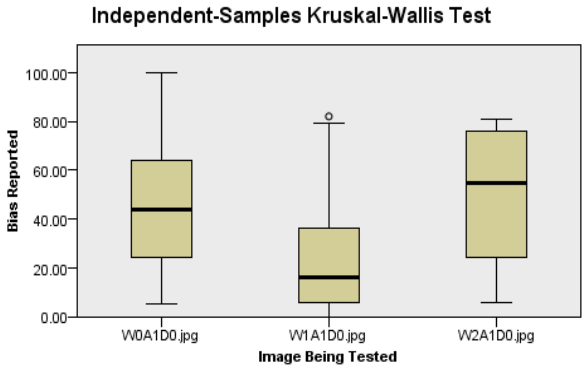
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A0D2.jpg	47.00	14	22.185
W1A0D2.jpg	36.17	12	25.665
W2A0D2.jpg	27.94	17	25.445
Total	36.44	43	25.257

Figure 6.23 - Results of the Kruskal-Wallis H Test for A0D2

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 4.730$, $p = 0.094$. The null hypothesis is retained.

6.5.4 A1D0 (W0/W1/W2) – Bitcoin Prices, no graphics



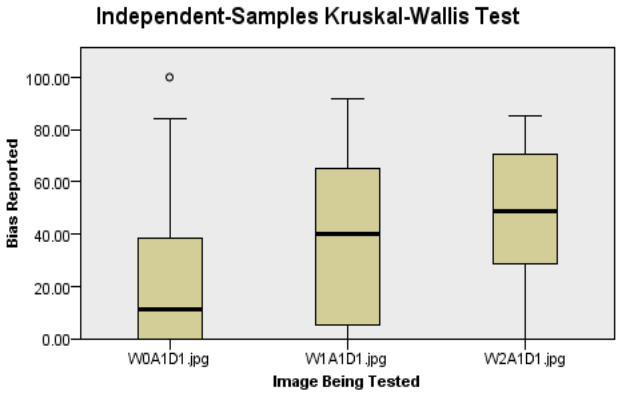
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A1D0.jpg	45.88	17	28.295
W1A1D0.jpg	27.29	14	30.040
W2A1D0.jpg	50.08	12	27.639
Total	41.00	43	29.670

Figure 6.24 - Results of the Kruskal-Wallis H Test for A1D0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 4.763$, $p = 0.092$. The null hypothesis is retained.

6.5.5 A1D1 (W0/W1/W2) – Bitcoin Prices, original graphics



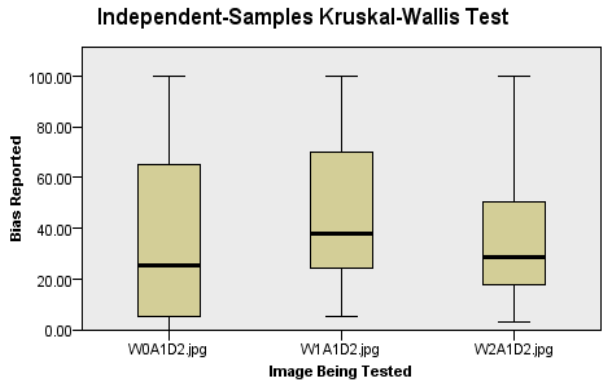
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A1D1.jpg	26.44	16	32.737
W1A1D1.jpg	37.69	13	34.565
W2A1D1.jpg	47.83	12	28.064
Total	36.27	41	32.502

Figure 6.25 - Results of the Kruskal-Wallis H Test for A1D1

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 3.635$, $p = 0.162$. The null hypothesis is retained.

6.5.6 A1D2 (W0/W1/W2) – Bitcoin Prices, experiment graphics



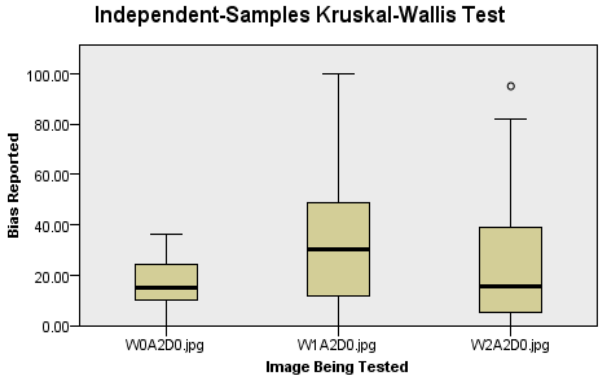
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A1D2.jpg	32.50	14	32.938
W1A1D2.jpg	43.93	14	29.531
W2A1D2.jpg	38.25	12	31.329
Total	38.23	40	30.864

Figure 6.26 - Results of the Kruskal-Wallis H Test for A1D2

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 1.365$, $p = 0.505$. The null hypothesis is retained.

6.5.7 A2D0 (W0/W1/W2) – Life Expectancy, no graphics



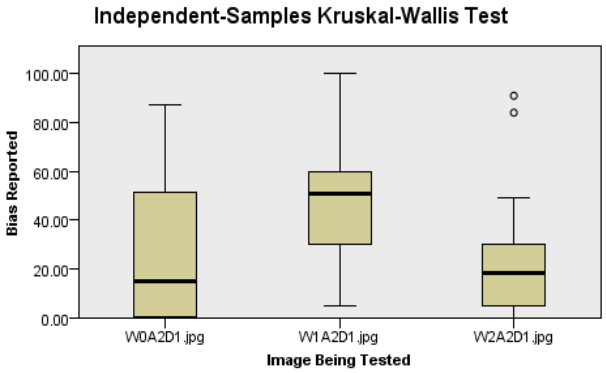
Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A2D0.jpg	16.50	12	10.775
W1A2D0.jpg	36.86	14	29.294
W2A2D0.jpg	26.64	14	30.851
Total	27.17	40	26.549

Figure 6.27 - Results of the Kruskal-Wallis H Test for A2D0

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, H = $X^2(2) = 3.730$, $p = 0.155$. The null hypothesis is retained.

6.5.8 A2D1 (W0/W1/W2) – Life Expectancy, original graphics



Bias Reported

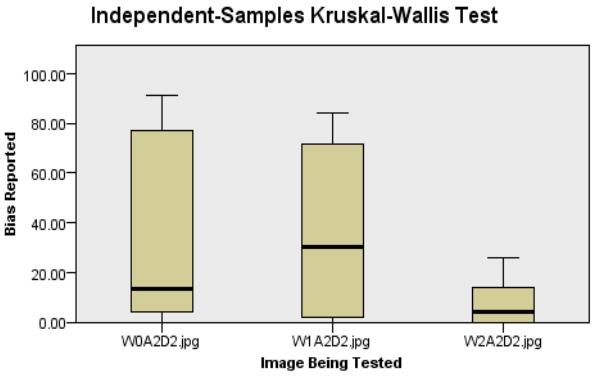
Image Being Tested	Mean	N	Std. Deviation
W0A2D1.jpg	27.67	12	31.938
W1A2D1.jpg	49.12	17	29.801
W2A2D1.jpg	26.64	14	28.830
Total	35.81	43	31.327

Figure 6.28 - Results of the Kruskal-Wallis H Test for A2D1

The distributions of bias for each distortion were not similar for all groups. However, the values of bias reported for each article differed significantly from one another, H = $X^2(2) = 7.847$, $p = 0.020$. The null hypothesis is **rejected**.

This means that a statistically significant difference was detected between the levels of bias reported for the different website's reporting on life expectancy, with the articles presented in their original format with the original graphic. The BBC had a significantly higher level of perceived bias than the Guardian in their article. This result is particularly important when taken in comparison to the results detailed in Sections 6.5.7 and 6.5.9. For those other results, no difference of statistical significance was detected, suggesting that the level of distortion had an effect on the level of bias perceived for the article.

6.5.9 A2D2 (W0/W1/W2) – Life Expectancy, experiment graphics



Bias Reported

Image Being Tested	Mean	N	Std. Deviation
W0A2D2.jpg	36.17	12	38.364
W1A2D2.jpg	37.69	16	33.738
W2A2D2.jpg	7.54	13	8.978
Total	27.68	41	32.392

Figure 6.29 - Results of the Kruskal-Wallis H Test for A2D2

The distributions of bias for each distortion were not similar for all groups. The values of bias reported for each distortion differed from one another, but the differences were not statistically significant, $H = X^2(2) = 5.191$, $p = 0.075$. The null hypothesis is retained.

6.5.10 Overview of Results

There was a statistically significant difference detected between the three websites' reporting the A2 article, at the D1 level of distortion. No other combinations of article and distortion produced any significantly different results between websites.

Although this test was specifically a comparison of different websites for each article, at each level of distortion, a further inference can be made. Given that the only difference between the presentations within the group of sections 6.5.1 – 6.5.3, within the group of sections 6.5.4 – 6.5.6 and also within the group of sections 6.5.7 – 6.5.9, is the level of distortion, and the H-statistic for each of these tests is different (sometimes notably different), this tells us that the level of distortion (D0 / D1 / D2) is having an effect on the level of bias perceived. This indicates that the graphics accompanying the news articles have an effect on the level of bias perceived for the article as a whole.

6.6 Summary of Results

Table 6.3 – A summary of the key statistics generated by the results for this experiment, and the decision to retain or reject the null hypothesis

Independent Variable Being Tested	Sample	H Test Result	*p*-value	Null Hypothesis (REJECT if *p*-value < 0.05)
D0, D1, D2	W0A0	1.451	0.484	Retain
	W0A1	4.832	0.112	Retain
	W0A2	0.164	0.921	Retain
	W1A0	1.180	0.554	Retain
	W1A1	2.593	0.274	Retain
	W1A2	1.983	0.371	Retain
	W2A0	1.036	0.596	Retain
	W2A1	1.224	0.542	Retain
	W2A2	5.638	0.060	Retain
A0, A1, A2	W0D0	7.393	0.025	REJECT
	W0D1	4.913	0.086	Retain
	W0D2	2.832	0.243	Retain
	W1D0	1.175	0.556	Retain
	W1D1	3.726	0.155	Retain
	W1D2	0.79	0.688	Retain
	W2D0	5.343	0.069	Retain
	W2D1	4.788	0.091	Retain
	W2D2	12.378	0.002	REJECT
W0, W1, W2	A0D0	1.781	0.411	Retain
	A0D1	4.722	0.094	Retain
	A0D2	4.370	0.094	Retain
	A1D0	4.763	0.092	Retain
	A1D1	3.635	0.162	Retain
	A1D2	1.365	0.505	Retain
	A2D0	3.370	0.155	Retain
	A2D1	7.847	0.020	REJECT
	A2D2	5.191	0.075	Retain

6.7 Conclusions

6.7.1 Bias Rating Results

Although differences were found in the levels of bias reported between different groups, for only three of the twenty-seven permutations of this experiment was that difference considered statistically significant. There is no obvious trend in the rejection of the null hypothesis for these samples.

Crucially, for answering the research question, none of the differences found in relation to the different levels of graphical distortion (D0, D1, D2) was found to be statistically significant.

Therefore, no statistically significant evidence has been found to support the proposition that the level of perceived bias can be affected by the graphics accompanying a news article.

6.7.2 Level of Significance

While the differences were determined not to be statistically significant, there were small differences between each group tested. There were some which were close to achieving statistical significance; eleven of the twenty-seven tests had *p*-values of <0.1, as seen in Figure 6.30.

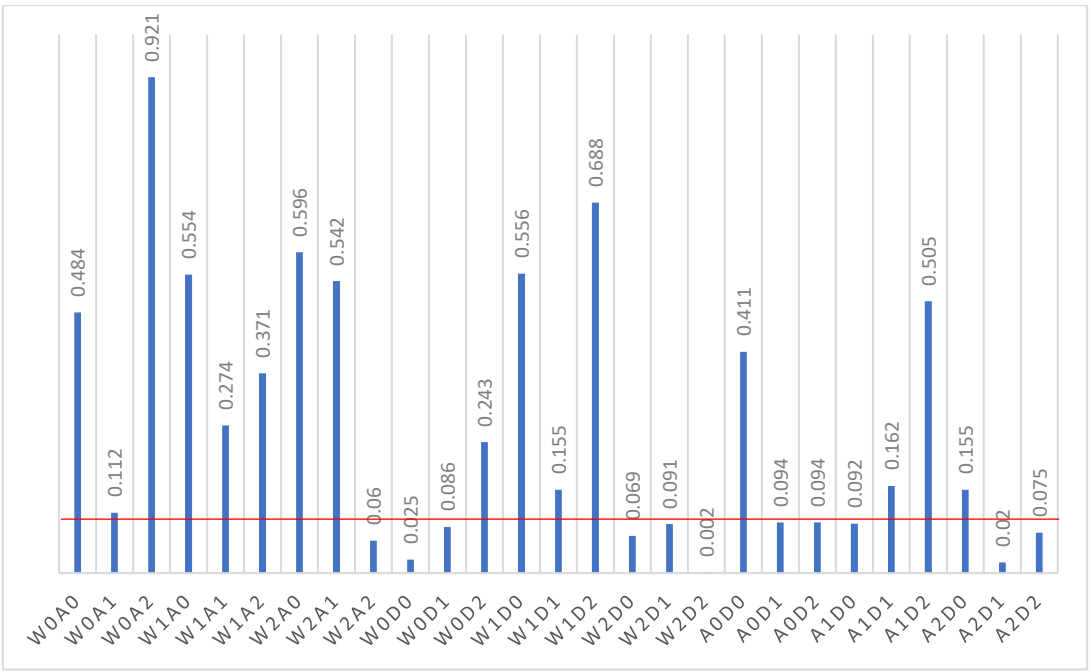


Figure 6.30 – The p-values for each of the tests carried out on the bias ratings. The horizontal red line signifies p=0.1

The limit of *p*=0.05, which was used in this experiment as the determining factor for significance, is the standard used for such tests. However, this value is somewhat arbitrary, and while rejection of the null hypothesis would have given a clear result, the retention of the null hypothesis in most of these cases does not tell the whole story. Differences do exist

between the different groups, and these are discussed in Chapter 7. Also, a wealth of other data was also collected during the experiment on the participants' backgrounds, which is also discussed in Chapter 7.

7. Discussion of Results

This chapter will focus on analysis of the results detailed in Chapter 6, and will also contain discussion about the other data obtained in the survey section of the experiment.

The full set of responses recorded from the participants is given in Appendix A1 and Appendix A2.

7.1 Bias Rating Results

The results obtained from this experiment, as detailed in Chapter 6, show that graphics accompanying news articles can have some impact on the level of bias perceived in the articles. However, the tests in this experiment found many of these effects to be very small, and very little evidence of these effects being statistically significant.

The tests which directly examine the difference between bias levels for different distortions of the same website and articles found no statistically significant difference across any of the distortion levels. There were differences observed in seven of the nine such tests, but these were too small to be deemed statistically significant.

7.1.1 The Daily Mail

For each article taken from the Daily Mail (W0), the addition of a graphic had a different effect, one increasing the perceived bias (A0), one reducing the perceived bias (A1), and one making no discernible difference (A2), as can be seen in Figures 6.1 – 6.3. In both cases where the addition of a graphic caused a large change in the level of bias, the second distortion (D2) actually served to moderate this effect; the second distortion was never considered the most or least biased, but was actually roughly half way between. Although the different distortions did not much affect the mean-rank for the third article (A2), there were very different distributions for the results of each, with the responses becoming more distributed with each distortion.

It is clear, therefore that while the graphic had some effect on the perceived bias of the articles, what that effect was depended on the articles and graphics.

7.1.2 The BBC

Similar results were seen across the samples taken from the BBC (W1), as seen in Figures 6.4 – 6.6. Here, again, the addition of a graphic changed the bias level where compared to when the article was presented without a graphic. Once again, the second level of distortion was never perceived as being the most biased. Also, similar to the results for the Daily Mail was

the result that for the third article (A2), the most significant change in bias levels was that the responses became more widely distributed as the distortion level increased.

Again, it is clear that the graphic accompanying the articles had an effect on the perceived level of bias for that article. It is notable that, like for the Daily Mail, the graphic for the D2 level of distortion served to divide opinion among participants rather than to change the overall average of their responses.

7.1.3 The Guardian

Finally, for the Guardian (W2), bias levels appear to have been affected to a much smaller extent by the distortions, as seen in Figure 6.7 – 6.9. Overall, the responses to these samples had a much smaller distribution, indicating larger consensus among participants on the presence of bias in the samples.

It is particularly notable that the difference between the D0 level of distortion, with no graphic, and the D1 level of distortion, with original graphic, was negligible across all three articles. This indicates that just the addition of the graphic alone did not serve to alter the level of bias perceived to be present in the article it accompanied.

7.1.4 Website and Article Dimensions

Tests across the other dimensions of the experiment cube further underline that the graphics accompanying news articles do have some effect on the perceived bias of the article, as the relative differences between articles and websites changes, sometimes significantly, between tests on different levels of distortion.

For example, as seen in Figure 6.10, there is a statistically significant difference between the levels of bias reported for each article. As seen in Figure 6.11 and Figure 6.12, for the other levels of distortion, the difference between the groups is not statistically significant. This is possible only by the relative change in bias owing to the changes in the distortion, as the articles and websites remain the same.

Similar conclusions can be drawn for both other cases where the null hypothesis was rejected (W2D2 and (A2D1).

7.1.5 Impact of Distortions

The differences observed between the distortions with no graphic present (D0), and the distortions with graphics added (D1 and D2), were not statistically significant, but still warrant explanation.

The difference is unlikely to be simply a matter of the website design changing, as it can be seen in Figures 6.3, 6.7, 6.8, and 6.9, that there is no considerable change in the bias rating

with the addition of a graphic (D1), compared to when there was none (D0). In three of these cases (Figure 6.3, 6.8, and 6.9), however, there is a discernible change in the level of perceived bias between the D1 and D2 levels of distortion. This could be an indication that the level of perceived bias has been affected by the graphic itself, and as such that information bias within the graphic itself has affected the overall perceived level of bias for the article.

7.1.6 Impact of Graphics

The differences evident in the box-plots of results for the Kruskel-Wallis H Test, shown in Figure 6.3 – 6.29, show that the perceived level of bias does change depending on the graphic present. The failure to reject the null-hypothesis in most cases in this experiment may be put down to the sample size being too small to detect this effect size; as the sample size increases, so too does the proximity of a *p*-value to its true value. It is fully possible that the differences observed in this experiment were too small to detect statistically with the sample sizes used. This does not make the evidence of differences irrelevant; they just can't be deemed statistically significant at a 95% confidence level for this particular sample size.

7.2 Hypothesis Results

The null hypothesis for this experiment stated:

(H_0) This research finds no evidence of bias being introduced to a news article through the use of an information graphic.

The alternative hypothesis stated:

(H_A) This research finds evidence of bias being introduced to a news article through the use of an information graphic.

This experiment found no statistically significant evidence to support the proposition that information bias in the graphics accompanying news articles online can affect the level of perceived bias for the article as a whole. Therefore, the null hypothesis is retained.

7.3 Bias Attributed to Publication

It was clear at the design stage of the experiment, that recognition, and opinions, among participants of the websites used in the experiment, could affect the participants' judgement of a website. It was for this reason that participants were asked to report any websites they recognised, and any websites they considered particularly biased. This section analyses those responses.

Every effort was made in the design of this experiment to minimise the effects of participants having pre-conceived notions of how biased they expect a particular news website to be, and

rating the bias accordingly. This is a known effect, as discussed in Chapter 2, and was to be avoided, insofar as possible, in order to obtain accurate ratings for the specific samples used in this experiment. Therefore, every precaution was taken to avoid it.

For this experiment all of the news websites were from the UK, and all of the participants were US citizens living in the USA. Additionally, all names and branding were removed from the images of websites shown to the participants. They could not determine the website without prior knowledge of it. That said, owing to the universal nature of publications on the internet, it is impossible to categorically find a demographic who will not know a certain news agency.

7.3.1 Participant Recognition of Websites

Recognising this fact, and in an attempt to quantify any effect arising from it, at the end of the experiment, participants were asked to select any publications they had recognised during the experiment, from a multiple-choice list. The numbers recognising publications is shown in Table 7.1.

There were three websites used in the experiment, but nine on the multiple-choice list for participants. This was to ensure that participants truly did recognise the websites used and could differentiate them from websites not used. By only having the three used in the experiment on the list, participants could have convinced themselves that they had recognised each, in a sort of confirmation bias of itself. By having to differentiate between websites, a participant is required to have genuinely recognised the website, or thought they had.

Table 7.1 – News-websites reportedly recognised by participants. The actual websites used are highlighted in grey and with an asterisk.

Website	Number of Participants	Percentage of Participants
None	54	43.55%
The Guardian*	43	34.68%
The Telegraph	25	20.16%
The Independent	22	17.74%
The Daily Mail*	48	38.71%
The Spectator	7	5.56%
New Statesman	6	4.84%
Al Jazeera	23	18.55%
BBC*	47	37.90%
Reuters	25	20.16%

It is evident, from the data collected, that a small number of these responses could be disregarded. Specifically, five respondents claimed to have recognised all nine websites

during the course of the experiment, which would have been impossible as each participant was only presented with six (two instruction tasks, one spike question, and three in the experiment proper). In these cases, it is likely that they just selected all of the boxes on the multiple-choice survey question without regard to the question being asked or the responses being selected.

There are many cases evident in Table 7.1 where participants incorrectly identified websites which were not a part of the experiment. This could be attributed to mistakenly misattributing certain design features from a website not in the experiment, to one on the list. It could also simply be a case of mistaking a websites name for another.

Even taking this into account, it is noticeable that the most recognised websites by far were in fact the ones used in the experiment, as seen in Figure 7.1. These are The Guardian (W2), The Daily Mail (W0) and the BBC (W1), with well over one-third of participants recognising each of those websites.

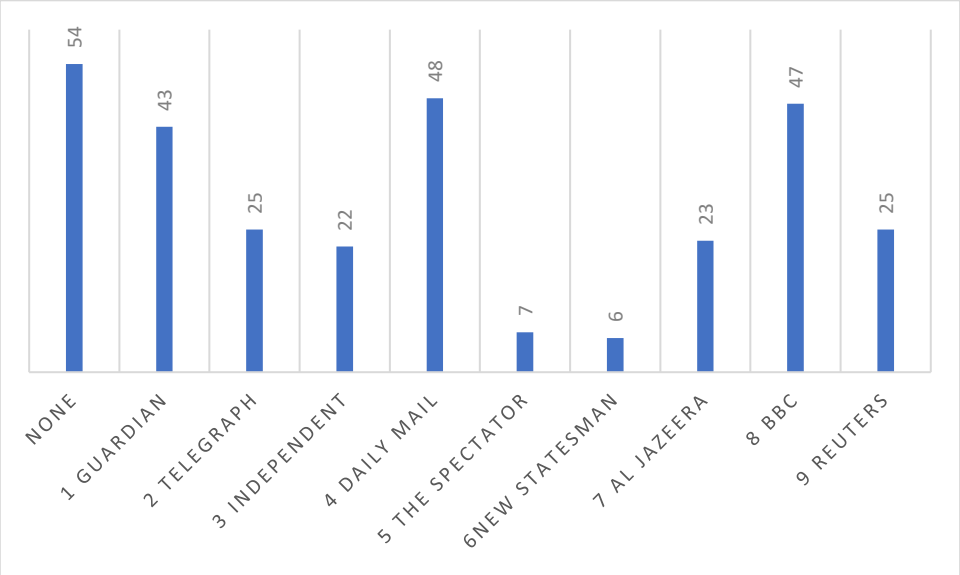


Figure 7.1 – Number of participants claiming to recognise each website during the experiment, chosen from a multiple-choice list.

While the greatest number of responses, almost 44%, claimed to recognise none of the websites, the majority claimed to have recognised one or more. This shows that the efforts made to reduce this effect were not entirely successful.

Furthermore, it can be seen in Figure 7.2 that over one-fifth, of the 124 respondents, correctly identified all three websites.

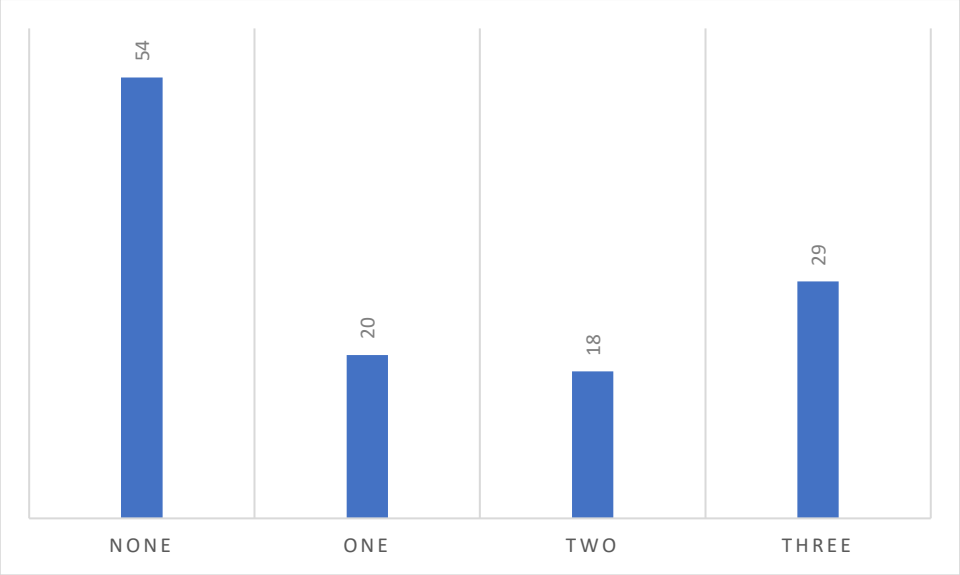


Figure 7.2 – Number of participants correctly identifying a number of websites.

With this level of recognition for the websites used, quantification of any effect this may have had on the experiment was important. This was made possible by using the responses to another of the reflective questions posed to participants.

7.3.2 Participants' Opinions of the Websites' Bias

Participants were also asked if they considered any of the news websites on the list to be particularly biased in general. The results can be seen in Table 7.2.

Table 7.2 – The number of participants who consider each news website to be particularly biased. The websites used in this experiment are highlighted in grey and with an asterisk.

Website	Number of Participants	Percentage of Participants
None	61	49.19%
The Guardian *	20	16.13%
The Telegraph	14	11.29%
The Independent	9	7.26%
The Daily Mail *	51	41.13%
The Spectator	7	5.56%
New Statesman	6	4.84%
Al Jazeera	18	14.52%
BBC *	12	9.68%
Reuters	8	6.45%

Particularly of note from these results is that over two-fifths of participants considered the Daily Mail to be particularly biased. As this is one of the news websites used in this experiment, and almost two-fifths claimed to recognise it when they saw it in the experiment,

it raises the possibility that participants' opinions of the websites, external to this experiment, may have influenced the results. Participants could only respond in this way if they had some prior knowledge or opinions on the website.

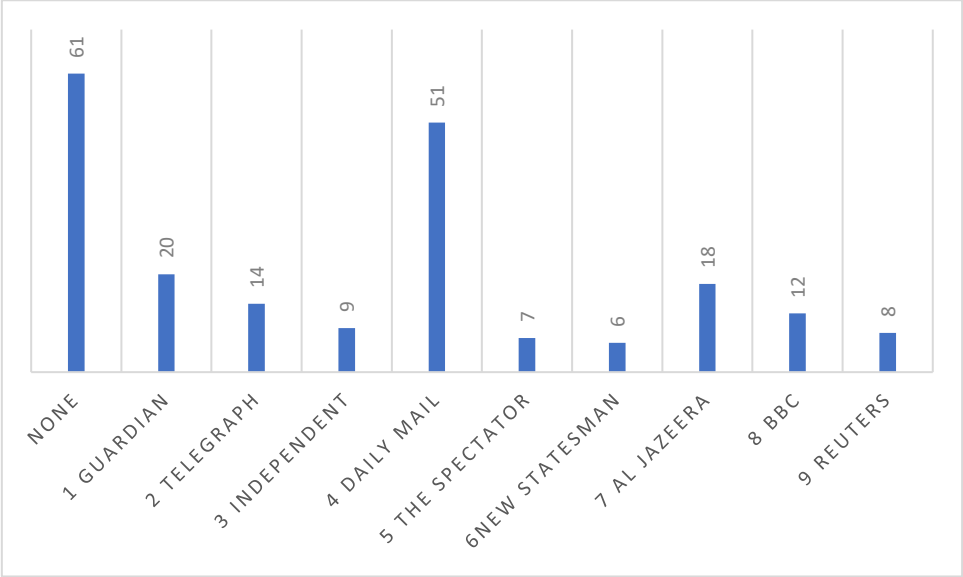


Figure 7.3 – The number of participants who consider each news website to be particularly biased.

7.3.3 Effect on Bias Ratings

In order to investigate if this may have been the case, further analysis was required. For this, participants were split into three separate groups for each website:

1. Those who did not recognise the website being tested.
2. Those who recognised the website being tested, but do not consider that website to be particularly biased.
3. Those who recognised the website being tested, and who consider that website to be particularly biased.

The bias rating that each participant gave for each website, regardless of distortion or story, was considered. To determine if there was an effect from websites being recognised, the relative levels of bias reported was compared across the three groups for each website, and a determination was made as to the significance of this.

As with the bias results for the main part of the experiment, the data involved does not satisfy the assumptions required for ANOVA, as significant outliers exist in the bias ratings. The data does satisfy the assumptions for the Kruskel-Wallis H Test, and so this test was used once again.

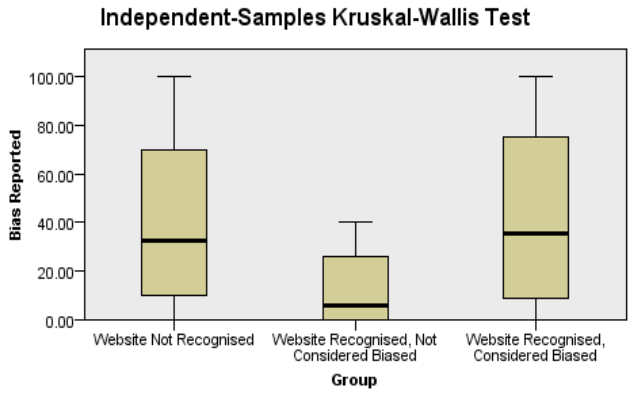
The null hypothesis for these tests assumed that the distributions for each group would be equal, indicating that recognition and prior expectation of the website had no impact on the bias reported by the participant.

Rejection of the null hypothesis would indicate that recognition of the websites, and an expectation of that website's bias, had influenced the level of bias reported by the participants.

7.3.4 Results of Bias Testing

The groups were analysed for each website, and the results are as follows.

7.3.4.1 Daily Mail (W0)



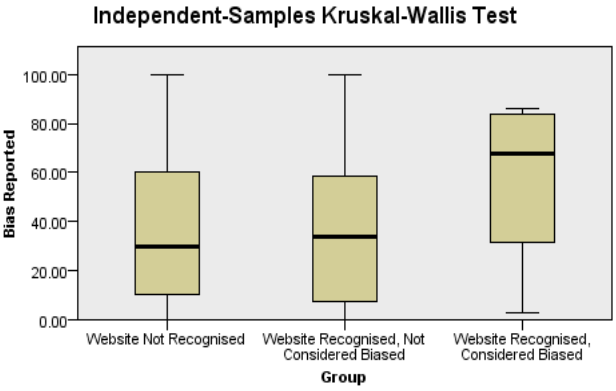
Bias Reported

Group	Mean	N	Std. Deviation
Website Not Recognised	39.01	78	31.121
Website Recognised, Not Considered Biased	13.31	16	13.817
Website Recognised, Considered Biased	41.40	30	32.405
Total	36.27	124	30.934

Figure 7.4 - Results of the Kruskal-Wallis H Test for the Daily Mail (W0)

The distributions of bias for each group were not similar for all groups. The values of bias reported by each group differed significantly from one another, $X^2(2) = 10.373$, $p = 0.006$. The null hypothesis is **rejected**, indicating that existing opinions of the website's bias significantly affected the results of this experiment.

7.3.4.1 BBC (W1)



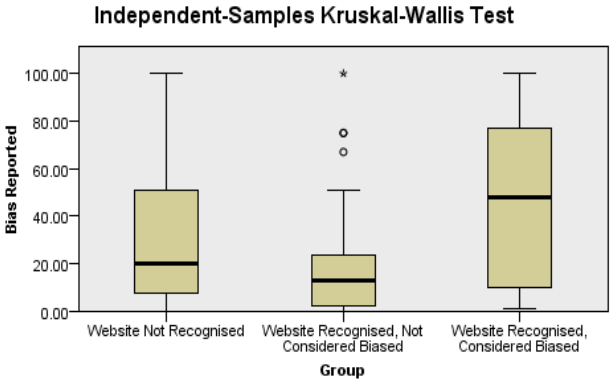
Bias Reported

Group	Mean	N	Std. Deviation
Website Not Recognised	36.10	77	30.144
Website Recognised, Not Considered Biased	36.97	39	29.534
Website Recognised, Considered Biased	56.75	8	32.766
Total	37.71	124	30.289

Figure 7.5 - Results of the Kruskal-Wallis H Test for the BBC (W1)

The distributions of bias for each group were not similar for all groups. The values of bias reported by each group differed, but not significantly, $X^2(2) = 3.290$, $p = 0.193$. The null hypothesis is retained, indicating that existing opinions of the website's bias did not significantly affect the results of this experiment.

7.3.4.2 The Guardian (W2)



Bias Reported

Group	Mean	N	Std. Deviation
Website Not Recognised	31.29	80	28.798
Website Recognised, Not Considered Biased	20.65	31	26.649
Website Recognised, Considered Biased	44.23	13	33.917
Total	29.98	124	29.371

Figure 7.6 - Results of the Kruskal-Wallis H Test for The Guardian (W2)

The distributions of bias for each distortion were not similar for all groups. The values of bias reported by each group differed significantly from one another, $X^2(2) = 6.202$, $p = 0.045$. The null hypothesis is **rejected**, indicating that existing opinions of the website's bias significantly affected the results of this experiment.

7.3.5 Analysis of Results for bias attributed to publications

It can be seen from these results that participants' existing opinions pertaining to the perceived bias of each website has had a statistically significant impact on the results. While there is no significant impact of this evident for responses to the BBC's articles, it is worth noting that the number of participants who considered that website to be biased was relatively low anyway, thus increasing the *p*-value and making rejection of the null hypothesis less likely, regardless of the responses.

Similarly, the difference between groups is most significant for the Daily Mail, which was considered biased by the largest number of participants of any website. While this increases the significance in itself, the simple fact that knowledge of the website has had an effect on results, and that approximately two-fifths of respondents recognised it and considered it biased, shows that this did in some way affect the results obtained for bias ratings.

This additional bias, introduced by the participant, is a confounding variable. The effect was known and acknowledged by the experiment design; it was for this reason that participants were asked the reflective questions. This does pose a challenge to carrying out experiments of this type, and perhaps other experiment designs could be considered to reduce the effect further. For example, participants could be asked to identify websites they would recognise before they start rating them, and then only be presented with those websites which they would not recognise.

The results also provide further evidence that consumers tend to favour news media which they find agreeable. By far the lowest levels of bias were reported for websites which were recognised by participants, but which those participants did not consider to be biased.

7.4 Other External Factors

Consideration was also given to other information supplied by the participants, and how that might have affected their responses. No correlation was found between the level of bias reported and the age, level of education, occupation, or expected yearly salary reported by the participants. These social and economic factors therefore likely played no role in altering the levels of bias reported by the participants. Visualisation of these results are shown in Appendix A6.

There is no apparent correlation between political leaning and the level of bias reported by the participants. With almost three-quarters of participants reporting that they hold a centre or left-of-centre political view, any effect which is caused by political leaning will be somewhat reduced by the homogeneity of the participant's viewpoints anyway.

There is also no apparent correlation between the amount of time participants spend online each day or the amount of time the participants spend reading the news online each day and the level of bias reported by participants in the experiment. This indicates that familiarity with accessing news online played no significant part in altering participants' perception of bias.

The vast majority of participants reported, in a multiple-choice survey question, regularly consuming news online, either using websites or social media the results of which are shown in Figure 7.7.

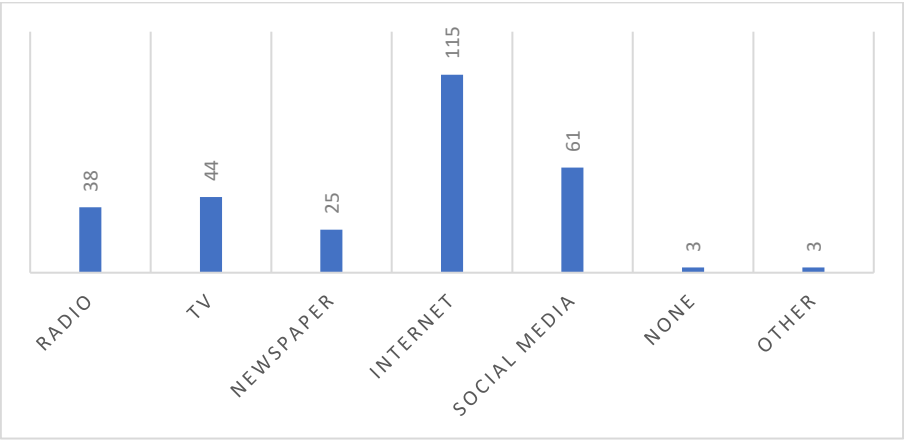


Figure 7.7 – Media regularly used by participants to consume news.

7.5 Factors Contributing to Bias

The final question asked of participants in this experiment was, *"When judging bias in news articles online, which of the following do you consider to be significant elements of bias?"*

This question was designed to elicit what they believe constitutes bias in news media. There is very little information in existing literature which ascertains exactly how people understand bias. This likely contributes to confusion in the domain.

It should be noted that the participants had already been presented with the definition of bias for this experiment before answering this question, that is:

"*Deliberate or accidental slant by the journalist, editor or publication to distort reality*".

7.5.1 Responses

Figure 7.8 shows the responses received to this multiple-choice question.

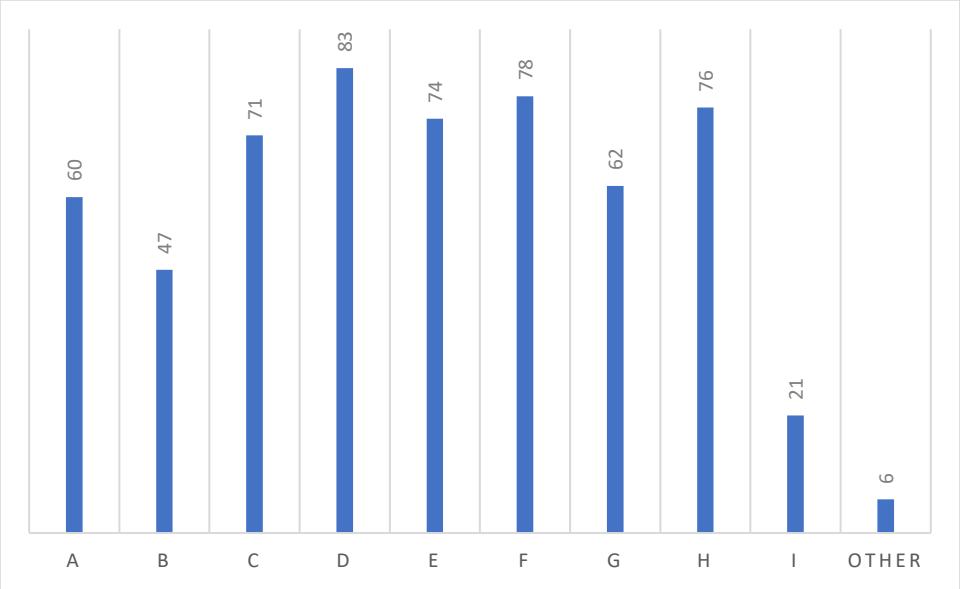


Figure 7.8 – Responses to the question, "When judging bias in news articles online, which of the following do you consider to be significant elements of bias?"

The letters A-I in the bar chart in Figure 7.8 correspond to the following options:

- A = "Lack of balance"
- B = "Unfairness"
- C = "Subjectivity"
- D = "Distortion affecting one side of a story"
- E = "Not giving one side of a story as much coverage as the other"
- F = "Expression of personal opinions by a journalist"
- G = "Providing sources for one side of a story and not the other"
- H = "Providing data to support one side of a story and not the other"
- I = "Order in which sides of a story are reported"

All of the possible responses to this survey question were intentionally unqualified, requiring a level of interpretation on the part of the participant. The responses provide insight to what the participants in this experiment were judging their perception of bias.

7.5.2 Analysis of Responses

Of particular note are the number of participants who chose options G and H. Over 22% more participants chose option H, when compared to option G. This suggests that they consider it more important to provide data for both sides of a story than to provide sources. This perhaps highlights a distrust in the media generally, where readers would apparently rather make sense of the raw information themselves, than to have it interpreted by a journalist or other person who is cited as being the source.

Also interesting is that option B, “Unfairness”, was selected by far fewer participants than most of the other responses. Just over one-third of the 124 of participants chose this option compared to over one-half selecting many of the other options. “Unfairness” is an English-language synonym for “bias”, making the lack of participants choosing it somewhat peculiar. Many of the options which were most-selected were more specifically tailored to news media, and being less vague may have seemed more relevant to the question.

Most specifically, it is interesting to note how significantly participants’ opinions of what constituted bias differed from participant to participant, despite each participant taking the same survey during which they were each presented with the same definition of bias. This highlights a challenge in accurately carrying out this sort of experiment, where participant subjectivity, and participant interpretation of the questions, can play a large role in forming the participants’ answers. Even by presenting participants with a common definition for bias, their subjectivity can play a part in how they apply that definition.

7.6 Summary of Results

The null hypothesis for this experiment was retained, as there was no statistically significant evidence to support the proposition that information bias in the graphics accompanying news articles affected the level of bias perceived for the article as a whole. Despite this, there was a small effect evident in the results, which was too small to confirm statistically in this experiment.

More importantly, it was found that, despite efforts made to minimise the chances of this happening, participants’ pre-determined opinions of the news websites presented in the experiment significantly affected how they responded to the survey. Those who expected a website to be particularly biased reported a significantly higher bias rating for that website than other participants for the same website. This undermines the confidence we can have that the results to the bias ratings are a fair and considered response to what was presented

to participants, and that the research into the different levels of graphical distortion has been compromised by bias on the part of a significant number of the participants.

No other external factors seem to have influenced the results to any considerable degree, and participants were almost all quite familiar with the online news medium.

The final finding shows a lack of consensus among participants of what constituted bias. This is in spite of the participants all working from the same definition of bias, and suggests that participants reported bias ratings for the articles based on different criteria.

8. Conclusions

This research builds on a significant body of existing research into media bias, asking specifically the question:

"To what extent do the information graphics accompanying a news article impact upon the perceived bias of the article?"

The research indicates that the information graphics accompanying a news article can have a material impact on the perceived bias of that article. The effect size observed in this particular experiment was deemed statistically insignificant however. There was also no clear trend in the results of this experiment, in terms of whether the bias level increased or decreased for different levels of distortion. Despite this, visualisations of the data show that graphics do impact on the perceived bias, suggesting that the research topic may be worthy of further investigation.

A more significant finding arising from the user survey carried out, was that despite efforts to minimise the chances of participants recognising the news websites used in the experiment, and bringing their own opinions of those websites to bear on the results of the experiment, there is significant evidence to suggest that this was the case. This is a result of crowdsourcing participants, where the researchers have no control over what information participants do or do not have, external to that which is presented to them in the experiment. This is unavoidable, but must be noted.

Importantly, where participants recognised a website which they considered to be particularly biased, they affirmed their own opinion by rating the bias level for that website significantly higher than others who had no such opinion. Similarly, where participants recognised a website but did not expect it to be biased, the participants reported significantly lower levels of bias than those who had no such opinion. This is strong evidence of confirmation bias, where the participant actively looks for reasons to give a high bias rating to a website they consider to be biased. There are two important considerations resulting from this:

1. The results agree with existing research in the area, further adding to the evidence of the effects of confirmation bias.
2. Despite intentional efforts to minimise the effects, the confounding variable of participants having an opinion of the bias associated with certain websites, played a part in results. This presents a learning opportunity; a different experiment design should be considered for future similar work.

It was also interesting to find the lack of consensus among participants on what constitutes bias in news media. This lack of consensus came despite all participants having been presented with the same definition of bias for the experiment. Their responses serve to illustrate the multitude of factors which may affect a participant's determination on the

presence of bias, and the difficulties which this presents to researchers in the area. This is an area which will require significant future work in order for a comprehensive understanding to be attained.

Although the null hypothesis was retained for this experiment, some evidence was found of an effect graphics had on the level of bias perceived for the article they accompany. Future work would be required to detect the precise significance of that effect.

8.1 Future Work and Refinements

The results of this experiment provide some interesting insights into the perceptions of bias in news media. Arising from this research are learning opportunities, and also areas which could benefit from further study. The lessons learned from this research should be taken into account in the formulation of the design of future experiments in order to avoid some of the confounding effects found in this research.

Every effort was made in the preparation of news website samples, to be rated by participants in the experiment, to ensure that the design of the website which was presented to participants was not significantly altered from its original design. While branding was removed, the rest of the website design and layout was left unaltered, in an attempt to avoid the known effects of website design on the perception of bias. Efforts were also made to minimise the possibilities of participants recognising the websites by having the source material and participants coming from different countries. In spite of this, a significant proportion of participants recognised the websites used, and with their own preconception of whether or not that website should be bias, skewed the results significantly in favour of their own opinions. This is not helpful to the research, as it does not compare like with like.

For future studies in this area, it should be considered, therefore, to present the articles alone without the rest of their website, or else in a common template which is not website specific. Another alternative, which would likely remove the effect altogether without removing design effects, would be to ask participants which websites they would recognise in advance of rating the images, and presenting them only with websites which they would not recognise. Whatever method is employed, it is clear that there is a need to remove the introduction of bias by the participants in this way.

Another possible refinement to the experiment relates to the samples used. The effect of the graphics on the articles tended to differ depending on the particular article and graphic. Presenting multiple graphics with the same article, or multiple articles on the same topic with and without the same graphic may provide further insight into what effect the graphics have. Varying the graphic, article and website may have been useful for providing an answer if the effect had been very large in this experiment, but as it was not, a more nuanced approach may be required which focusses on one specific aspect of this research.

In terms of effect size, it was seen in this research that the effect size was relatively small. In order to make a statistically significant finding for this using *p*-values, it would be necessary to use a much larger sample size. As the size increases the increasing accuracy of the *p*-value slows, meaning that it would possibly have to be much larger sample size than was used in this experiment.

Finally, further research could also be carried out into how users perceive bias based on what they consider to constitute bias. The findings of this research, as shown in Figure 7.8, suggest that there is far from consensus on the matter. Asking for bias ratings based on specific aspects of bias, rather than just from a general high-level definition, and examining the relative effect of these aspects could add significant understanding to how we determine that bias exists in a piece of news media.

8.2 Final Thoughts

Although the null hypothesis for this experiment was not rejected, the research has highlighted some important factors which can affect this sort of experiment which will be useful for future work. Effects including the introduction of bias through participants' existing experience of certain newspapers, despite significant efforts made to minimise this effect in the experiment design, serve to highlight the importance of ongoing consideration of experiment design for similar experiments. This was only detectable by collection of the appropriate data from participants, and regardless of the experiment design, these results have shown the importance of collecting this sort of background information to contextualise participants' responses.

While there was no statistically significant evidence found to support the supposition that information bias in the graphics accompanying news articles can affect the level of bias perceived for that article, finding exactly the extent to which the external factors influenced the results is an important finding in itself. Determining also that the effect of graphics on the bias in articles they accompany is likely quite small should provide important information for the design of future experiments researching this topic.

From these results it is evident that there is a strong likelihood that the graphics accompanying news articles affect the perception of bias in that article as a whole, but that this effect is relatively small, and requires further research to adequately confirm. This further research should explore the effects of different graphics, and the coverage of different topics, including those which may be emotive. Future work is also required to establish the effects of using different types of graphics.

References

[1] M. Higgins, 'Mediated populism, culture and media form', *Palgrave Communications*, vol. 3, no. 1, p. 3, Oct. 2017.

[2] E. C. Nisbet, P. Beck, and R. Gunther, 'Trump may owe his 2016 victory to "fake news," new study suggests', *The Conversation*. [Online]. Available: http://theconversation.com/trump-may-owe-his-2016-victory-to-fake-news-new-study-suggests-91538. [Accessed: 10-Apr-2018].

[3] 'Ethics in the News - Media Lies and Brexit - Ethical Journalism and the EU', *Ethical Journalism Network*. .

[4] T.-T. Lee, 'Why They Don't Trust the Media: An Examination of Factors Predicting Trust', *American Behavioral Scientist*, vol. 54, no. 1, pp. 8–21, Sep. 2010.

[5] D. S. Tull, 'Intentional Bias in Public Opinion Polls for Decisional Purposes', *Public Opinion Quarterly*, vol. 39, no. 4, p. 552, 1975.

[6] F. D. Russo, 'A Study of Bias in Tv Coverage of the Vietnam War: 1969 and 1970', *Public Opinion Quarterly*, vol. 35, no. 4, pp. 539–543, 1971.

[7] T. Munzner, *Visualization analysis and design*, 1st ed. Boca Raton: CRC Press, 2014.

[8] M. Tremayne, A. S. Weiss, and R. C. Alves, 'From product to service: the diffusion of dynamic content in online newspapers.', *Journalism & Mass Communication Quarterly*, vol. 84, no. 4, pp. 825–839, 2007.

[9] J. Bar-Ilan, K. Keenoy, M. Levene, and E. Yaari, 'Presentation bias is significant in determining user preference for search results—A user study', *J. Am. Soc. Inf. Sci.*, vol. 60, no. 1, pp. 135–149, Jan. 2009.

[10] J. A. Simpson and E. S. C. Weiner, Eds., *The Oxford English dictionary. Vol.2: B.B.C.-Chalypsography*, 2nd ed. Oxford: Clarendon P, 1989.

[11] P. Waldman and J. Devitt, 'Newspaper photographs and the 1996 presidential election: The question of bias', *Journalism & Mass Communication Quarterly*, vol. 75, no. 2, pp. 302–311, 1998.

[12] M. Gentzkow and J. M. Shapiro, 'Media Bias and Reputation', *journal of political economy*, p. 37.

[13] Paul Andon and Clinton Free, 'Media coverage of accounting: the NRL salary cap crisis', *Acc Auditing Accountability J*, vol. 27, no. 1, pp. 15–47, Jan. 2014.

[14] W. L. Bennett, *News: the politics of illusion*, 7th ed. Harlow: Longman, 2007.

[15] J.-M. Eberl, H. G. Boomgaarden, and M. Wagner, 'One Bias Fits All? Three Types of Media Bias and Their Effects on Party Preferences', *Communication Research*, vol. 44, no. 8, p. 1125, Dec. 2017.

[16] M. Kim, 'The Role of Partisan Sources and Audiences' Involvement in Bias Perceptions of Controversial News', *MEDIA PSYCHOLOGY*, vol. 19, no. 2, pp. 203–223, Apr. 2016.

[17] T. Groeling, 'Media Bias by the Numbers: Challenges and Opportunities in the Empirical Study of Partisan News', *Annual Review of Political Science*, vol. 16, no. 1, pp. 129–151, May 2013.

[18] T. E. Patterson and W. Donsbagh, 'News decisions: Journalists as partisan actors', *Political Communication*, vol. 13, no. 4, pp. 455–468, Oct. 1996.

[19] E. Elejalde, L. Ferres, and E. Herder, 'On the nature of real and perceived bias in the mainstream media', *PLoS ONE*, vol. 13, no. 3, pp. 1–28, Mar. 2018.

[20] A. W. Barrett and L. W. Barrington, 'Bias in newspaper photograph selection', *Political Research Quarterly*, vol. 58, no. 4, pp. 609–618, 2005.

[21] R. Krestel, A. Wall, and W. Nejdl, 'Treehugger or petrolhead?: identifying bias by comparing online news articles with political speeches', in *Proceedings of the 21st international conference companion on World Wide Web*, New York, NY, USA, 2012, pp. 547–548.

[22] M. Higgins, 'Mediated populism, culture and media form', *Palgrave Communications*, vol. 3, no. 1, p. 3, Oct. 2017.

[23] E. C. . Nisbet nisbet. 5@osu. ed., M. Saldaña magdalenasaldan@gmail. co., T. J. . Johnson tom. johnson@austin. utexas. ed., G. Golan gjgolan@usf. ed., and A. Day daydoc@gmail. co., 'Credibility Gaps and Public Opinion in a Competitive Media Environment: The Case of Arab Satellite TV News in Lebanon', *International Journal of Communication (19328036)*, vol. 11, pp. 3072–3095, Jan. 2017.
[24] T. GROELING, 'Who's the Fairest of them All? An Empirical Test for Partisan Bias on ABC, CBS, NBC, and Fox News', 2008.
[25] A. Westerwick, B. K. Johnson, and S. Knobloch-Westerwick, 'Confirmation biases in selective exposure to political online information: Source bias vs. content bias', *Communication Monographs*, vol. 84, no. 3, pp. 343–364, Jul. 2017.
[26] G. W. Yun, S.-Y. Park, S. Lee, and M. A. Flynn, 'Hostile Media or Hostile Source? Bias Perception of Shared News', *SOCIAL SCIENCE COMPUTER REVIEW*, vol. 36, no. 1, pp. 21–35, Feb. 2018.
[27] Q. Ma and M. Yoshikawa, 'Topic and Viewpoint Extraction for Diversity and Bias Analysis of News Contents', in *Advances in Data and Web Management*, Q. Li, L. Feng, J. Pei, S. X. Wang, X. Zhou, and Q.-M. Zhu, Eds. Springer Berlin Heidelberg, 2009, pp. 150–161.
[28] S. Park, M. Ko, J. Kim, H. Choi, and J. Song, 'NewsCube2. 0: An Exploratory Design of a Social News Website for Media Bias Mitigation', in *Workshop on Social Recommender Systems*, 2011.
[29] R. M. Entman, 'Framing: Toward Clarification of a Fractured Paradigm', *Journal of Communication*, vol. 43, no. 4, pp. 51–58, Dec. 1993.
[30] M. Haselmayer, M. Wagner, and T. M. Meyer, 'Partisan Bias in Message Selection: Media Gatekeeping of Party Press Releases', *Political Communication*, vol. 34, no. 3, pp. 367–384, Jul. 2017.
[31] V. Larcinese, R. Puglisi, and J. M. Snyder, *Partisan bias in economic news: evidence on the agenda- setting behavior of U.S. newspapers*. London: Suntory and Toyota International Centres for Economics and Related Disciplines, 2008.
[32] J. Cohen cohen@bc. ed., Y. Ding, C. Lesage, and H. Stolowy, 'Media Bias and the Persistence of the Expectation Gap: An Analysis of Press Articles on Corporate Fraud', *Journal of Business Ethics*, vol. 144, no. 3, pp. 637–659, Sep. 2017.
[33] A. C. Gunther, 'Biased Press or Biased Public? Attitudes Toward Media Coverage of Social Groups', *The Public Opinion Quarterly*, vol. 56, no. 2, pp. 147–167, Jul. 1992.
[34] S. Lyengar and K. S. Hahn, 'Red Media, Blue Media: Evidence of Ideological Selectivity in Media Use', *Journal of Communication*, vol. 59, no. 1, pp. 19–39, 2009.
[35] D. C. Funder and S. G. West, 'Concensus, Self-Other Agreement, and Accuracy in Personality Judgment: An Introduction', *Journal of Personality*, vol. 61, no. 4, pp. 457–476, Dec. 1993.
[36] Sendhil Mullainathan and Andrei Shleifer, 'The Market for News', *The American Economic Review*, vol. 95, no. 4, pp. 1031–1053, 2005.
[37] E. Pariser, *The Filter Bubble: What The Internet Is Hiding From You*. Penguin UK, 2011.
[38] J. Ehrlinger, T. Gilovich, and L. Ross, 'Peering Into the Bias Blind Spot: People's Assessments of Bias in Themselves and Others', *Pers Soc Psychol Bull*, vol. 31, no. 5, pp. 680–692, May 2005.
[39] N. Geidner, I. Pjesivac, I. Imre, I. Coman, and D. Yuran, 'The Role of Interactive Graphics in Reducing Misperceptions in the Electorate', *Visual Communication Quarterly*, vol. 22, no. 3, pp. 133–145, Jul. 2015.
[40] 1615 L. St NW, S. 800 Washington, and D. 20036 U.-419-4300 | M.-419-4349 | F.-419-4372 | M. Inquiries, 'Views of media bias', *Pew Research Center's Journalism Project*, 09-May-2017. .
[41] C. D. Urban, *Examining Our Credibility: Perspectives of the Public and the Press ; [report for the ASNE Journalism Credibility Project]*. American Soc. of Newspaper Ed., 1999.
[42] D. Niven, *Tilt?: The Search for Media Bias*. Greenwood Publishing Group, 2002.
[43] V. Larcinese, R. Puglisi, and J. M. Snyder Jr, 'Partisan bias in economic news: Evidence on the agenda-setting behavior of US newspapers', *Journal of Public Economics*, vol. 95, no. 9, pp. 1178–1189, 2011.

[44] T. Groseclose and J. Milyo, ‘A Measure of Media Bias’, *The Quarterly Journal of Economics*, vol. 120, no. 4, pp. 1191–1237, Nov. 2005.
[45] P. B. Lowry, D. W. Wilson, and W. L. Haig, ‘A Picture is Worth a Thousand Words: Source Credibility Theory Applied to Logo and Website Design for Heightened Credibility and Consumer Trust’, *International Journal of Human-Computer Interaction*, vol. 30, no. 1, pp. 63–93, Jan. 2014.
[46] B. Spillane, S. Lawless, and V. Wade, ‘Perception of bias: the impact of user characteristics, website design and technical features’, 2017, pp. 227–236.
[47] S. Zwinger, J. Langer, and M. Zeiller, ‘Acceptance and Usability of Interactive Infographics in Online Newspapers’, in *2017 21st International Conference Information Visualisation (IV)*, 2017, pp. 176–181.
[48] C. Chen and C. Chen, *Information visualization: beyond the horizon*, 2nd ed. London: Springer, 2004.
[49] B. I. U. Dur, ‘Analysis of Data Visualizations in Daily Newspapers in Terms of Graphic Design’, *Procedia - Social and Behavioral Sciences*, vol. 51, pp. 278–283, Jan. 2012.
[50] S. Pasternack and S. H. Utt, ‘Reader Use & Understanding of Newspaper Infographics’, *Newspaper Research Journal*, vol. 11, no. 2, pp. 28–41, Mar. 1990.
[51] S. Bateman, R. L. Mandryk, C. Gutwin, A. Genest, D. McDine, and C. Brooks, ‘Useful junk?’, *Conference on Human Factors in Computing Systems Proceedings*, p. 2573, Apr. 2010.
[52] E. Segel and J. Heer, ‘Narrative Visualization: Telling Stories with Data’, *IEEE Transactions on Visualization and Computer Graphics*, vol. 16, no. 6, pp. 1139–1148, Nov. 2010.
[53] J. Vila and Y. Gomez, ‘Extracting business information from graphs: An eye tracking experiment’, *Journal of Business Research*, vol. 69, pp. 1741–1746, May 2016.
[54] N. M. Urban and T. E. Fricker, ‘A comparison of Latin hypercube and grid ensemble designs for the multivariate emulation of an Earth system model’, *Computers & Geosciences*, vol. 36, no. 6, pp. 746–755, Jun. 2010.
[55] ‘https://prolific.ac/’. [Online]. Available: https://prolific.ac/. [Accessed: 22-Mar-2018].
[56] ‘http://www.gpower.hhu.de/’. [Online]. Available: http://www.gpower.hhu.de/. [Accessed: 22-Mar-2018].
[57] ‘dailymail.co.uk’, *Mail Online*. [Online]. Available: http://www.dailymail.co.uk/home/index.html. [Accessed: 22-Mar-2018].
[58] ‘bbc.co.uk/news’, *BBC News*. [Online]. Available: http://www.bbc.co.uk/news. [Accessed: 22-Mar-2018].
[59] ‘theguardian.com’, *the Guardian*. [Online]. Available: http://www.theguardian.com/international. [Accessed: 22-Mar-2018].
[60] ‘YouGov | How left or right-wing are the UK’s newspapers?’, *YouGov: What the world thinks*. [Online]. Available: //yougov.co.uk/news/2017/03/07/how-left-or-right-wing-are-uks-newspapers/. [Accessed: 30-Jan-2018].
[61] J. Cohen, *Statistical power analysis for the behavioral sciences*, 2nd ed. Hillsdale, N.J: L. Erlbaum Associates, 1988.

Appendix A1: Bias Ratings Data

The data in the tables in this Appendix shows the responses by participants in this survey when reporting the level of perceived bias in the images with which they were presented.

The data is presented in a number of columns, as follows:

	ID	The unique identification number of the participant.
	Path	The path through the experiment cube to which the participant was assigned.
Initial Evaluation of Samples	**Sample One**	The first sample presented to the participant.
	Bias One	The bias rating given by the participant when presented with Sample One. This rating is on a continuous slider scale from 0 to 100. The slider defaulted to 0. Where a participant did not move the slider from the 0 mark, the response was recorded as NULL. This can therefore be taken to mean 0.
	Sample Two	The second sample presented to the participant.
	Bias Two	The bias rating given by the participant when presented with Sample Two. This rating is on a continuous slider scale from 0 to 100. The slider defaulted to 0. Where a participant did not move the slider from the 0 mark, the response was recorded as NULL. This can therefore be taken to mean 0.
	Sample Three	The third sample presented to the participant
	Bias Three	The bias rating given by the participant when presented with Sample Three. This rating is on a continuous slider scale from 0 to 100. The slider defaulted to 0. Where a participant did not move the slider from the 0 mark, the response was recorded as NULL. A response of NULL can therefore be taken to mean 0.
	Bias One	The bias rating given by the participant when presented with Samples One, Two, and Three side-by-side. The

Comparative Re-Evaluations	**Bias Two**	slider value defaulted to the response the participant had given when originally presented with each sample. If the participant did not change their rating for the bias of an article, the response was recorded as NULL. A response of NULL can therefore be taken to indicate that the value of bias is the same as in the original bias column.
	Bias Three	
Most Biased		The sample, from the three presented simultaneously to the participant, which they consider to be most biased. The participants could not view their previous bias ratings for those samples at this time. If a participant did not select a sample as the most biased, this is recorded as blank cell. Note that the result of this test may indicate that the participant recorded a different result to that when the samples were presented individually at the start of the survey.

		InitiaLEvaluation of Samples						Comparative Re-evaluation			Most Biased
ID	Path	Sample One	Bias One	Sample Two	Bias Two	Sample Three	Bias Three	Bias One	Bias Two	Bias Three	
1	8	W1A0D2	37	W0A2D1	55	W2A1D0	46	NULL	NULL	NULL	W1A0D2
2	4	W2A0D2	1	W1A2D1	51	W0A1D0	69	NULL	NULL	NULL	W0A1D0
3	5	W2A0D0	52	W1A2D2	NULL	W0A1D1	10	NULL	NULL	NULL	W1A2D2
4	9	W1A0D0	NULL	W2A1D1	10	W0A2D2	NULL	NULL	NULL	NULL	W2A1D1
5	6	W1A2D0	58	W2A0D1	20	W0A1D2	75	NULL	NULL	NULL	W0A1D2
6	8	W1A0D2	NULL	W0A2D1	11	W2A1D0	80	22	NULL	NULL	W2A1D0
7	2	W2A2D0	5	W1A1D2	59	W0A0D1	96	NULL	NULL	NULL	W0A0D1
8	4	W2A0D2	48	W1A2D1	55	W0A1D0	64	NULL	NULL	NULL	W0A1D0
9	1	W2A2D2	14	W1A1D1	40	W0A0D0	4	NULL	NULL	9	W1A1D1
10	5	W1A2D2	65	W0A1D1	26	W2A0D0	NULL	NULL	NULL	NULL	W1A2D2
11	2	W1A1D2	77	W0A0D1	78	W2A2D0	82	NULL	NULL	NULL	
12	2	W1A1D2	24	W0A0D1	40	W2A2D0	8	NULL	NULL	NULL	W0A0D1
13	4	W1A2D1	90	W0A1D0	100	W2A0D2	61	100	NULL	56	W1A2D1
14	2	W1A1D2	5	W2A2D0	NULL	W0A0D1	5	NULL	NULL	NULL	W2A2D0
15	3	W1A1D0	12	W0A0D2	66	W2A2D1	21	NULL	NULL	NULL	W0A0D2
16	8	W1A0D2	78	W2A1D0	77	W0A2D1	80	NULL	NULL	NULL	W1A0D2
17	2	W1A1D2	10	W2A2D0	25	W0A0D1	5	NULL	NULL	NULL	W0A0D1
18	1	W0A0D0	NULL	W1A1D1	0	W2A2D2	0	NULL	NULL	NULL	W2A2D2
19	2	W1A1D2	10	W2A2D0	NULL	W0A0D1	30	15	NULL	NULL	W0A0D1
20	2	W0A0D1	NULL	W2A2D0	NULL	W1A1D2	25	NULL	NULL	NULL	W1A1D2
21	1	W2A2D2	0	W1A1D1	10	W0A0D0	0	NULL	NULL	NULL	W1A1D1
22	4	W0A1D0	92	W1A2D1	30	W2A0D2	23	NULL	NULL	19	W0A1D0
23	7	W2A1D2	25	W0A2D0	1	W1A0D1	74	NULL	NULL	NULL	W1A0D1
24	1	W2A2D2	0	W1A1D1	65	W0A0D0	75	NULL	NULL	NULL	W0A0D0
25	2	W0A0D1	70	W2A2D0	15	W1A1D2	40	NULL	NULL	50	W0A0D1
26	1	W0A0D0	9	W2A2D2	26	W1A1D1	1	NULL	NULL	NULL	W0A0D0
27	1	W0A0D0	52	W2A2D2	5	W1A1D1	92	75	1	NULL	W1A1D1
28	5	W0A1D1	100	W2A0D0	52	W1A2D2	40	NULL	NULL	NULL	W0A1D1
29	9	W0A2D2	9	W1A0D0	12	W2A1D1	25	NULL	NULL	40	W2A1D1
30	1	W0A0D0	21	W2A2D2	12	W1A1D1	5	NULL	NULL	NULL	W0A0D0
31	5	W1A2D2	NULL	W0A1D1	NULL	W2A0D0	NULL	NULL	NULL	NULL	W1A2D2
32	9	W2A1D1	58	W0A2D2	8	W1A0D0	2	NULL	NULL	NULL	W2A1D1
33	2	W0A0D1	77	W2A2D0	39	W1A1D2	46	NULL	NULL	NULL	W0A0D1
34	2	W2A2D0	19	W1A1D2	30	W0A0D1	34	NULL	NULL	NULL	W0A0D1
35	4	W2A0D2	20	W1A2D1	60	W0A1D0	39	NULL	NULL	NULL	W1A2D1
36	5	W1A2D2	69	W0A1D1	46	W2A0D0	16	NULL	NULL	NULL	W1A2D2
37	1	W1A1D1	42	W0A0D0	35	W2A2D2	4	NULL	NULL	NULL	W0A0D0
38	8	W2A1D0	19	W0A2D1	19	W1A0D2	51	NULL	NULL	NULL	
39	8	W2A1D0	30	W1A0D2	74	W0A2D1	48	NULL	NULL	NULL	W0A2D1
40	6	W1A2D0	12	W0A1D2	10	W2A0D1	8	NULL	NULL	NULL	W1A2D0

		InitiaLEvaluation of Samples						Comparative Re-evaluation			Most Biased
ID	Path	Sample One	Bias One	Sample Two	Bias Two	Sample Three	Bias Three	Bias One	Bias Two	Bias Three	
41	2	W0A0D1	50	W1A1D2	100	W2A2D0	11	NULL	NULL	NULL	W1A1D2
42	7	W1A0D1	34	W0A2D0	23	W2A1D2	58	NULL	NULL	38	W2A1D2
43	7	W1A0D1	5	W0A2D0	36	W2A1D2	20	NULL	NULL	NULL	W0A2D0
44	1	W2A2D0	58	W1A1D2	24	W0A0D1	70	NULL	NULL	NULL	W0A0D1
45	6	W2A0D1	41	W1A2D0	9	W0A1D2	72	NULL	NULL	NULL	W0A1D2
46	6	W0A1D2	7	W2A0D1	1	W1A2D0	40	NULL	NULL	NULL	W1A2D0
47	4	W0A1D0	34	W1A2D1	58	W2A0D2	68	NULL	NULL	NULL	W2A0D2
48	2	W0A0D1	84	W2A2D0	16	W1A1D2	74	88	NULL	70	W0A0D1
49	3	W0A0D2	47	W1A1D0	NULL	W2A2D1	NULL	NULL	NULL	NULL	W0A0D2
50	1	W2A2D2	0	W0A0D0	30	W1A1D1	25	NULL	NULL	NULL	W0A0D0
51	6	W2A0D1	NULL	W0A1D2	25	W1A2D0	35	NULL	35	25	W0A1D2
52	4	W0A1D0	70	W2A0D2	5	W1A2D1	60	NULL	NULL	NULL	W0A1D0
53	2	W0A0D1	83	W2A2D0	100	W1A1D2	50	100	95	80	W2A2D0
54	2	W0A1D1	NULL	W1A2D2	NULL	W2A0D0	NULL	NULL	NULL	NULL	W1A2D2
55	7	W0A2D0	26	W1A0D1	50	W2A1D2	51	NULL	NULL	NULL	W1A0D1
56	6	W2A0D1	0	W1A2D0	0	W0A1D2	NULL	NULL	NULL	NULL	W1A2D0
57	5	W0A1D1	20	W1A2D2	20	W2A0D0	85	NULL	NULL	NULL	W2A0D0
58	6	W0A1D2	25	W2A0D1	15	W1A2D0	30	NULL	NULL	NULL	W1A2D0
59	9	W1A0D0	76	W0A2D2	9	W2A1D1	17	NULL	NULL	NULL	W1A0D0
60	4	W2A0D2	13	W1A2D1	11	W0A1D0	14	NULL	NULL	NULL	W1A2D1
61	3	W1A1D0	20	W2A2D1	20	W0A0D2	35	NULL	NULL	NULL	W0A0D2
62	7	W0A2D0	15	W2A1D2	95	W1A0D1	27	NULL	NULL	NULL	W2A1D2
63	3	W0A0D2	26	W1A1D0	78	W2A2D1	16	NULL	79	NULL	W1A1D0
64	1	W1A1D1	41	W0A0D0	74	W2A2D2	18	NULL	NULL	NULL	W2A2D2
65	1	W2A2D2	18	W0A0D0	49	W1A1D1	80	NULL	NULL	NULL	W1A1D1
66	5	W2A0D0	0	W0A1D1	31	W1A2D2	0	NULL	NULL	NULL	W0A1D1
67	1	W2A2D2	0	W0A0D0	82	W1A1D1	0	NULL	NULL	NULL	W0A0D0
68	8	W0A2D1	1	W1A0D2	6	W2A1D0	67	NULL	NULL	NULL	W2A1D0
69	5	W2A0D0	13	W0A1D1	NULL	W1A2D2	15	NULL	NULL	NULL	W1A2D2
70	8	W2A1D0	51	W0A2D1	0	W1A0D2	60	NULL	NULL	NULL	W2A1D0
71	6	W2A0D1	46	W1A2D0	30	W0A1D2	1	NULL	NULL	NULL	W2A0D1
72	8	W1A0D2	6	W0A2D1	NULL	W2A1D0	11	NULL	NULL	NULL	W2A1D0
73	9	W1A0D0	NULL	W2A1D1	50	W0A2D2	NULL	NULL	NULL	NULL	W2A1D1
74	3	W2A2D1	30	W0A0D2	10	W1A1D0	1	NULL	NULL	NULL	W0A0D2
75	9	W0A2D2	18	W1A0D0	NULL	W2A1D1	42	NULL	NULL	NULL	W2A1D1
76	7	W0A2D0	26	W1A0D1	50	W2A1D2	32	NULL	NULL	NULL	W1A0D1
77	3	W1A1D0	3	W2A2D1	3	W0A0D2	19	NULL	NULL	NULL	W0A0D2
78	3	W2A2D1	91	W0A0D2	86	W1A1D0	77	NULL	NULL	NULL	W0A0D2
79	5	W1A2D2	84	W0A1D1	9	W2A0D0	94	NULL	NULL	NULL	W1A2D2
80	4	W2A0D2	62	W1A2D1	24	W0A1D0	21	NULL	NULL	NULL	W0A1D0

		InitiaLEvaluation of Samples						Comparative Re-evaluation			Most Biased
ID	Path	Sample One	Bias One	Sample Two	Bias Two	Sample Three	Bias Three	Bias One	Bias Two	Bias Three	
81	4	W1A2D1	50	W0A1D0	46	W2A0D2	33	31	26	25	W1A2D1
82	5	W2A0D0	4	W1A2D2	4	W0A1D1	10	NULL	NULL	NULL	
83	9	W1A0D0	88	W0A2D2	0	W2A1D1	NULL	NULL	NULL	NULL	W1A0D0
84	4	W2A0D2	4	W1A2D1	5	W0A1D0	7	NULL	NULL	NULL	
85	3	W2A2D1	84	W1A1D0	82	W0A0D2	75	NULL	NULL	NULL	W1A1D0
86	7	W0A2D0	21	W1A0D1	59	W2A1D2	50	NULL	NULL	NULL	W1A0D1
87	7	W0A2D0	15	W1A0D1	10	W2A1D2	15	NULL	NULL	NULL	W0A2D0
88	1	W0A0D0	77	W1A1D1	85	W2A2D2	10	47	89	5	W1A1D1
89	9	W1A0D0	76	W2A1D1	83	W0A2D2	91	NULL	NULL	NULL	W2A1D1
90	3	W0A0D2	55	W2A2D1	10	W1A1D0	28	NULL	NULL	NULL	W0A0D2
91	6	W0A1D2	100	W1A2D0	100	W2A0D1	100	NULL	NULL	NULL	W0A1D2
92	3	W2A2D1	5	W0A0D2	57	W1A1D0	10	NULL	NULL	NULL	W0A0D2
93	3	W1A1D0	36	W2A2D1	14	W0A0D2	25	NULL	24	35	W1A1D0
94	9	W2A1D1	79	W1A0D0	86	W0A2D2	77	NULL	NULL	NULL	W1A0D0
95	6	W2A0D1	35	W0A1D2	65	W1A2D0	49	NULL	NULL	NULL	W0A1D2
96	9	W1A0D0	79	W2A1D1	62	W0A2D2	91	NULL	NULL	NULL	W0A2D2
97	6	W0A1D2	34	W1A2D0	45	W2A0D1	40	NULL	NULL	NULL	W1A2D0
98	6	W2A0D1	19	W1A2D0	70	W0A1D2	38	54	85	26	W1A2D0
99	4	W1A2D1	35	W2A0D2	18	W0A1D0	60	NULL	NULL	NULL	W0A1D0
100	4	W1A2D1	35	W2A0D2	45	W0A1D0	60	NULL	NULL	NULL	W0A1D0
101	4	W2A0D2	12	W0A1D0	44	W1A2D1	60	NULL	NULL	NULL	W1A2D1
102	3	W2A2D1	3	W0A0D2	26	W1A1D0	6	NULL	36	NULL	W0A0D2
103	4	W1A2D1	100	W2A0D2	75	W0A1D0	51	NULL	NULL	NULL	W1A2D1
104	4	W1A2D1	100	W2A0D2	2	W0A1D0	24	NULL	NULL	NULL	W1A2D1
105	5	W2A0D0	55	W1A2D2	65	W0A1D1	84	30	50	NULL	W0A1D1
106	7	W0A2D0	15	W2A1D2	20	W1A0D1	15	NULL	NULL	NULL	W0A2D0
107	4	W2A0D2	2	W1A2D1	20	W0A1D0	5	NULL	NULL	NULL	W1A2D1
108	9	W2A1D1	48	W1A0D0	38	W0A2D2	54	NULL	NULL	NULL	W0A2D2
109	8	W1A0D2	4	W2A1D0	6	W0A2D1	87	NULL	NULL	NULL	W0A2D1
110	7	W0A2D0	5	W2A1D2	100	W1A0D1	13	NULL	NULL	NULL	W2A1D2
111	5	W0A1D1	NULL	W1A2D2	20	W2A0D0	NULL	NULL	NULL	NULL	W1A2D2
112	7	W2A1D2	10	W1A0D1	NULL	W0A2D0	15	NULL	NULL	NULL	W0A2D0
113	6	W2A0D1	7	W0A1D2	5	W1A2D0	30	NULL	NULL	NULL	W1A2D0
114	5	W2A0D0	38	W1A2D2	64	W0A1D1	12	NULL	74	NULL	W1A2D2
115	5	W2A0D0	36	W0A1D1	73	W1A2D2	84	NULL	75	NULL	W1A2D2
116	8	W2A1D0	81	W1A0D2	30	W0A2D1	7	NULL	NULL	NULL	W2A1D0
117	3	W1A1D0	15	W0A0D2	29	W2A2D1	NULL	21	41	17	W0A0D2
118	7	W1A0D1	NULL	W2A1D2	3	W0A2D0	NULL	NULL	NULL	NULL	W2A1D2
119	5	W1A2D2	78	W2A0D0	0	W0A1D1	NULL	NULL	NULL	NULL	W1A2D2
120	8	W1A0D2	24	W0A2D1	0	W2A1D0	75	NULL	NULL	NULL	W2A1D0

		InitiaLEvaluation of Samples						Comparative Re-evaluation			Most Biased
ID	**Path**	**Sample One**	**Bias One**	**Sample Two**	**Bias Two**	**Sample Three**	**Bias Three**	**Bias One**	**Bias Two**	**Bias Three**	
121	3	W1A1D0	13	W2A2D1	23	W0A0D2	70	7	49	NULL	W0A0D2
122	8	W1A0D2	42	W2A1D0	58	W0A2D1	24	NULL	NULL	NULL	W2A1D0
123	9	W2A1D1	85	W1A0D0	66	W0A2D2	77	NULL	NULL	NULL	W2A1D1
124	6	W2A0D1	NULL	W1A2D0	3	W0A1D2	NULL	NULL	NULL	NULL	W1A2D0

Appendix A2: Survey Responses

The qualitative data collected for this survey, consisted primarily of responses to multiple choice questions. Some questions were posed before the survey; others were posed after the survey.

In addition to multiple choice questions, each participant also provided his or her date of birth (DOB).

A unique identifier (ID) was assigned to each participant.

Each question is assigned a letter (A to K). The following is the list of question and the permitted answers. Questions A to H were answered prior to the survey. Questions I to K were answered following the survey.

	Question	**Answer codes**
A	*"What gender are you?"*	0 = "Male" 1 = "Female" 2 = "Other" 3 = "I prefer not to say"
B	*"How long do you spend on the Internet each day?"*	0 = "Less than one hour a day" 1 = "1 – 2 hours a day" 2 = "2 – 4 hours a day" 3 = "4 – 6 hours a day" 4 = "6 – 8 hour a day" 5 = "8+ hours a day"
C	*"What is the highest level of education you have completed?"*	1 = "Elementary school only" 2 = "Some high school, but did not finish" 3 = "Completed high school" 4 = "Some college, but did not finish" 5 = "Two-year college degree / A.A / A.S." 6 = "Four-year college degree / B.A. / B.S." 7 = "Some graduate study" 8 = "Completed Masters or professional degree" 9 = "Advanced Graduate study or Ph.D." 10 = "Other"

	Question	Answer codes
D	*"What is your expected income range for 2018?"*	1 = "Under $10,000" 2 = "$10,000 - $19,999" 3 = "$20,000 - $29,999" 4 = "$30,000 - $39,999" 5 = "$40,000 - $49,999" 6 = "$50,000 - $59,999" 7 = "$60,000 - $69,999" 8 = "$70,000 - $79,999" 9 = "$80,000 - $89,999" 10 = "$90,000 - $99,999" 11 = "$100,000 - $109,999" 12 = "$110,000 - $119,999" 13 = "$120,000 - $129,999" 14 = "$130,000 - $139,999" 15 = "$140,000 - $149,999" 16 = "$150,000 - $159,999" 17 = "$160,000 - $169,999" 18 = "$170,000 - $179,999" 19 = "$180,000 - $189,999" 20 = "$190,000 - $199,999" 21 = "$200,000 - $209,999" 22 = "$210,000 - $219,999" 23 = "$220,000 - $229,999" 24 = "$230,000 - $239,999" 25 = "$240,000 - $249,999" 26 = "Over $250,000"

	Question	Answer codes
E	*"Which best describes your current occupation?"*	1 = "Stay at home Parent" 2 = "Student" 3 = "Unemployed" 4 = "Professional" 5 = "Semi-professional" 6 = "Skilled professional" 7 = "Skilled manual" 8 = "Semi-skilled manual" 9 = "Unskilled manual" 10 = "Other"
F	*"What most closely describes your political viewpoint?"*	0 = "Strong Liberal" 1 = "Not so strong Liberal" 2 = "Independent leaning Liberal" 3 = "Independent" 4 = "Independent leaning Conservative" 5 = "Not so strong Conservative" 6 = "Strong Conservative" 7 = "Other" 8 = "Don't know"
G	*"Which mediums do you access News from most often? Select all that apply."*	1 = "Radio" 2 = "TV" 3 = "Newspaper" 4 = "Internet" 5 = "Social Media" 6 = "None" 7 = "Other"

	Question	Answer codes
H	*"If the Internet is one of your primary sources of News, how many times do you check it each day?"*	0 = "Less than once per day" 1 = "1 - 2 times per day" 2 = "2 - 4 times per day" 3 = "4 - 6 times per day" 4 = "6 - 8 times per day" 5 = "8 - 10 times per day" 6 = "10 + times a day"
I	*"Did you recognize any of the below News websites used in this experiment? Select each that you recognized."*	0 = "None" 1 = "The Guardian" 2 = "The Telegraph" 3 = "The Independent" 4 = "The Daily Mail" 5 = "The Spectator" 6 = "New Statesman" 7 = "Al Jazeera" 8 = "BBC" 9 = "Reuters"
J	*"Do you consider any of these News websites used in this experiment to be especially biased? Select each that you consider biased."*	0 = "None" 1 = "The Guardian" 2 = "The Telegraph" 3 = "The Independent" 4 = "The Daily Mail" 5 = "The Spectator" 6 = "New Statesman" 7 = "Al Jazeera" 8 = "BBC" 9 = "Reuters"

	Question	Answer codes
K	*"When judging bias in news articles online, which of the following do you consider to be significant elements of bias? Please select all that apply."*	0 = "Lack of balance" 1 = "Unfairness" 2 = "Subjectivity" 3 = "Distortion affecting one side of a story" 4 = "Not giving one side of a story as much coverage as the other" 5 = "Expression of personal opinions by a journalist" 6 = "Providing sources for one side of a story and not the other" 7 = "Providing data to support one side of a story and not the other" 8 = "Order in which sides of a story are reported" 9 = "Other"

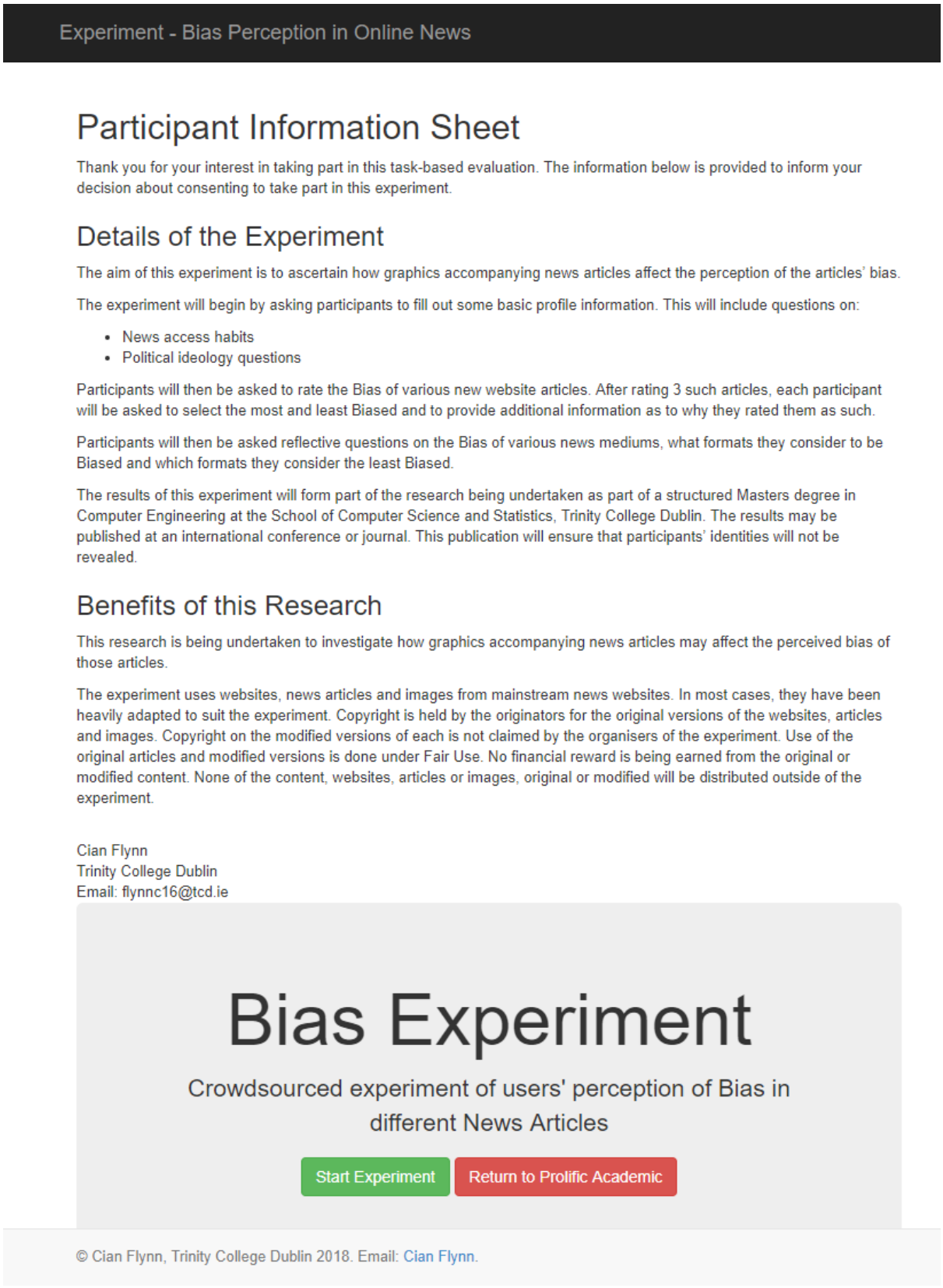
The data in the following table shows the responses by participants to survey questions before and after rating the bias of the articles with which they were presented, as detailed in Chapter 3.

	Responses to pre-bias rating survey questions									Responses to reflective questions		
ID	D.O.B.	A	B	C	D	E	F	G	H	I	J	K
1	25/05/1991	1	4	6	1	5	2	1,2,3,4,5	3	0	0	1,2,3,7,8
2	17/09/1953	0	2	6	7	3	1	3,4	6	1,2,3,4,7,8,9	4,7	0,3,5,6
3	08/03/1986	0	3	6	7	6	2	1,2,4,5	2	0	0	0,1,3,5,7
4	09/06/1999	1	3	3	1	2	2	2,4,5	1	0	0	2,4,5
5	01/04/1987	1	4	9	10	4	0	4,5	1	1,2,8	0	0,3,5,6,7
6	06/08/1992	1	1	6	6	6	1	4	2	1	1	4,7
7	04/09/1994	0	5	6	6	6	2	4,5	6	1,8	4	0,3,4
8	13/06/1988	1	1	5	3	1	0	2,4	1	0	0	3
9	01/04/1989	0	5	3	2	8	1	4,5	1	1,4	4	2,3,5
10	30/10/1991	0	1	5	4	2	5	4,5	4	8	4	0,2,4,5,7
11	15/10/1980	1	4	8	16	4	0	3,4,5	2	1,2,3,4,7,8	1,2,3,4,6,7	1,2,4
12	31/12/1988	1	3	4	2	2	3	2,4,5	5	4	0	0,1,2,3,4,5,6,7
13	17/11/1995	0	5	4	6	3	2	4,5	1	4	4	3,4,5,7
14	03/04/1989	1	4	6	6	5	1	1,4,5	3	2,4	0	1,3,4,7
15	15/02/1988	1	3	6	4	4	0	3,4,5	1	2	3,4,6,7,9	0,3,4,5,6,7
16	15/10/1980	0	4	8	16	4	0	3,4,5	2	1,2,3,4,5,6,7,8	1,2,3,4,5,7	1,2,3,4
17	01/02/1986	0	4	4	3	5	4	4,5	2	1,4	0	4
18	27/10/1964	1	3	6	4	4	2	2,3	2	1,2,3,4,7,8,9	0	0,1,3,5,6,7
19	24/12/1980	1	3	4	4	5	2	4,5	2	0	1,5,7	2,5,6,9
20	26/02/1998	0	3	3	1	2	3	1,4,5	4	0	4,7	0,1,2,3,4,5
21	19/01/1976	1	5	6	10	6	0	4,5	6	4	4	0,1,2,3,4,5,6,7,8,9
22	06/04/2000	0	2	2	1	2	2	4,5,7	1	1,3,8,9	3,9	1,2,3,6,7
23	18/11/1991	0	5	4	1	2	0	2,4	2	0	4	0,2,5
24	04/04/1981	0	3	8	8	4	5	1,4	6	0	0	0,3,4,6,7
25	18/01/1998	0	5	4	1	2	3	4	0	0	1	0,4
26	01/01/1999	0	3	5	1	2	3	3,4	1	4	4	0,1,2,4,6,7
27	25/04/1977	1	2	3	3	9	3	4	1	0	0	2,5,8
28	13/10/1984	0	5	6	8	4	5	1,2,3,4,5	3	0	0	0,5,6,7,8
29	24/11/1986	0	3	6	9	4	3	4	2	0	0	0,1,6,7
30	01/08/1973	0	4	3	10	5	0	4	6	8	0	0,3,4,6,7
31	05/05/1972	3	2	6	1	5	8	2,4	3	4	0	5,7
32	16/10/1998	0	5	4	2	1	8	4,5	6	0	0	3,5
33	11/11/1978	0	5	6	8	4	6	2,4,5	6	1	1,2,4,7,8,9	0,1,2,3,4,5,6,7,8
34	12/07/1970	0	5	6	11	6	4	2,5	1	0	0	7
35	10/06/1954	1	2	5	4	10	1	2,4,5	3	0	0	3
36	01/04/1977	1	2	4	2	9	0	1,4,5	1	0	4	0,1,3,7
37	24/08/1972	0	1	6	5	6	3	4	1	1,3,4,7,8,9	4,9	0,1,2,3,4,5,6,7
38	18/05/1952	0	2	8	5	10	6	1,4	1	1,2,4	5,6,7	3,4,6
39	18/02/1981	0	3	7	6	6	1	4	1	0	0	2,3,6,7
40	05/07/1986	0	3	6	7	4	0	4,5	2	0	4,7	0,1,2,3,4,5,6,7,8
41	22/03/1985	0	5	6	8	5	4	2,4,5	4	0	4,7	0,1,2,3,5,6,7
42	12/09/1975	0	3	8	18	4	5	2,3,4,5	2	1,2,3,4,8	1,3,4	4,5,7
43	11/11/1999	0	5	3	1	2	2	1,4	0	1,4,8	4	7

	Responses to pre-bias rating survey questions									Responses to reflective questions		
ID	**D.O.B.**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
44	03/03/1996	0	5	4	2	2	3	4	3	0	0	0,2,4,6
45	14/04/1983	0	4	4	5	8	3	2	1	8	0	0,2
46	28/09/1989	0	5	4	2	2	2	4	4	1,2,3,4,7,8,9	1	2,3,5,7
47	03/03/1996	0	5	4	2	2	3	4	3	0	0	0,1,2,4,6
48	03/04/1985	1	4	4	1	3	2	1	0	0	0	1,2,3,4,5,6,7,8
49	06/06/1984	1	5	7	4	6	0	2,4,5	1	1,7,8,9	2,4,5	2,3,4,5,6,7
50	22/10/1978	1	5	4	1	2	3	6	0	8	0	0,1,2,3,4,5,7
51	16/01/1970	0	3	6	18	4	0	1,4	4	0	0	0,2,3,4,7
52	23/04/1971	0	5	5	1	3	3	4	3	0	1,2,3,4,5,6, 7,8,9	1,2,3,5
53	19/03/1982	0	2	9	15	4	3	2,3,4,5	2	1,4,7,8	3,4,7,8	9
54	10/08/1983	1	5	6	9	6	0	4	6	0	0	1,2,3,5
55	27/05/1987	1	2	8	2	2	0	4,5	2	1,4,8	4	2,3,5,6,7
56	06/07/1977	1	2	3	1	1	6	6	4	0	0	9
57	14/05/1993	1	4	4	5	4	0	1,4,5	1	0	0	2,3,5,9
58	06/05/1956	1	1	5	2	10	1	2,3,4	0	0	1,2,4,9	0,3,4,5,6,7,8
59	02/05/1996	1	1	4	5	1	3	2,3,4,5	2	0	0	3,4,5
60	29/03/1983	0	5	6	3	4	5	1,2,3,4	3	0	7,9	2,3,5,7
61	07/10/1976	0	3	3	1	10	4	2,3,4,5	2	1,2,4	0	3,4
62	14/05/1993	1	4	4	5	4	0	1,4,5	1	0	4	2,3,5,9
63	26/02/1991	0	1	6	3	5	5	2,4	2	4	9	4,5
64	07/07/1988	1	3	5	3	5	0	2,4,5	6	8	0	5,7
65	25/12/1996	0	3	3	10	7	3	2,4	3	0	0	4
66	07/11/1988	0	2	6	2	4	3	4,5	1	0	4	0,2,5,6,7
67	09/05/1982	1	3	4	8	5	6	1,2,3,4	0	1,8,9	0	0,2,3,4,5,6,7
68	03/09/1982	0	5	3	2	8	2	4,5	6	1,2,4,7,8,9	4,7	0,3,4,8
69	16/02/1988	1	2	3	3	3	2	2,4,5	2	1,4,7,8	0	4,5,6,7
70	23/08/1981	1	3	4	2	6	0	4	1	1,2,3,4,7,8,9	1,4,7	0,1,2,3,4,5,6,7
71	25/07/1994	1	3	4	3	2	1	4,5	2	0	0	2,5
72	14/09/1984	1	5	5	5	1	4	1,4	0	0	0	0,1,2,4,5,6,7
73	12/12/1992	0	4	3	1	3	2	2,4,5	1	0	0	0,1,3,4,5,6,7
74	17/07/1981	0	2	8	8	4	2	4,5	2	4,8,9	1,4,7	2,3,4,5,6
75	27/04/1999	1	2	3	1	2	2	2,4	0	1,4,7,8,9	4	2,4,6,7
76	03/09/1985	1	5	6	6	6	0	4	1	1,2,3,4,7,8,9	0	0,2,3,4,5,6,7
77	04/03/1955	0	1	8	10	4	5	1,2,3,4	2	1,2,3,4,7,8,9	7,8	0,1,2,3,4,5,6,7,8
78	25/10/1977	0	4	8	26	4	6	1,5	4	2,4,6,8	2,4	5,7,8
79	12/04/1979	0	2	6	10	4	2	1,4	2	0	0	0,1,2,3,4,5,6,7
80	01/09/1963	0	3	5	2	2	3	1,4	2	0	0	4
81	08/07/1954	1	3	4	13	1	3	4	1	4,8	0	0,1,3,4,6,7,8
82	08/11/1963	0	5	6	6	4	0	4	1	1,9	0	1,3,5
83	11/11/1973	1	1	8	12	1	1	1,4	2	0	0	2,3,5
84	02/11/1956	0	2	8	8	4	5	2,3,4	2	2,3,4	0,4	3
85	25/10/1977	0	4	8	26	4	6	1,2,3,4,5	4	3,4,5,8	2,3,4,6,8	5,6,8

	Responses to pre-bias rating survey questions									Responses to reflective questions		
ID	D.O.B.	A	B	C	D	E	F	G	H	I	J	K
86	04/05/1988	0	2	5	5	4	3	4	3	8	8	4
87	11/12/1996	1	5	4	2	2	0	4,5	1	0	0	0,2,5,7
88	22/08/1977	0	3	7	5	6	2	1,4	2	1,2,3,4,6,7,8,9	1,2,4,8	0,2,3,5,6,7
89	25/10/1977	0	4	8	26	4	6	1,2,3,4,5	4	2,8	2,3,4,6,8	3,5,6,7
90	19/11/1981	1	5	4	2	1	0	4,5	3	1,4	1,4	0,1,2,3,4,5,6,7,8
91	16/07/1982	1	5	8	7	4	3	6	0	0	0	2
92	14/12/1989	0	5	6	8	4	0	2,4,5	6	4	4	0,2,4,5
93	27/08/1988	1	5	6	8	4	4	1,2,4,5	1	1	0	0,3,4,5,7
94	25/10/1977	0	4	8	26	4	6	1,2,3,5	4	2,3,4,8	2,4,8	3,6
95	11/03/1996	1	2	6	5	5	0	1,3,4	3	0	0	0,1,2,4,6,7
96	02/01/1964	1	5	8	8	6	3	4	6	8	4	3,4,5,6,7
97	01/10/1990	0	3	8	2	2	3	4	1	0	0	0,1,2,3,4,5,6,7,8
98	27/04/1966	0	2	5	3	10	6	1,2,4	2	8,9	1,2	0,1,2,3,5,6,8
99	14/08/1989	1	3	5	1	1	4	2,4	1	0	0	0,2,3,4,5,6,7,8
100	29/12/1987	0	4	8	1	3	2	4	3	0	2,4	3,6,7
101	01/10/1992	1	4	4	3	8	2	2,4,5	1	1	1,4	3,4,5
102	07/02/1995	0	4	6	2	2	0	2,4,5	3	1,3,4,8	0	0,1,2,3,5,7
103	20/12/1989	2	2	7	3	5	1	1,4	0	1,4,7,8,9	4	0,2,3,4,5,6,7
104	07/04/1960	1	4	8	3	6	5	4	1	1,3,4,7,8,9	4	0,2,3,4,5,6,7
105	01/10/1981	0	2	5	4	4	2	1,4,5	1	9	4	2,3,4,6,7
106	04/12/1963	0	2	4	8	6	0	1,4	3	0	1	0,1,2,3,4,5,6,7
107	18/02/1990	1	4	4	1	3	1	4,5	0	0	0	1,2,3,6,7
108	03/03/1968	0	3	5	8	6	1	4,5	4	1,4,7,8,9	1,4	1,2,4,6,7
109	07/01/1996	0	3	4	2	10	3	2,4,5	0	0	0	5,6,7
110	01/04/1988	0	5	4	2	4	6	1,4,5	1	1,2,3,4,7,8,9	1,2,3,4,8	0,1,2,3,4,5,6,7,8
111	22/05/1990	0	2	6	7	4	2	4,7	3	1,2,3,4,7,8,9	4	0,1,2,3,4,5
112	16/04/1986	0	2	4	4	7	1	4,5	1	0	0	2,4,5,7
113	01/06/1968	0	2	6	7	6	5	2,4,5	1	1,4,5,7,8,9	1,7	1,3,7
114	11/11/1990	1	1	6	6	4	1	1,4	1	0	0	2,4
115	15/03/1952	0	3	8	3	10	3	4,5	4	4	4	1,2,3,4,5,6,7
116	11/03/1989	0	3	4	1	1	2	1,4,5	6	8	0	0,1,2,3,4,5
117	01/03/1997	1	4	3	2	10	2	3,4,7	3	1,2,3,4,7,8,9	4,7	0,1,2,3,4,5,6,7,8
118	12/07/1988	1	2	5	1	1	3	1,3,4,5	1	1,2,3,4,8	0	3,4,5,7
119	19/07/1960	0	2	6	11	4	6	1,2,4	1	0	0	0,1,2,3,4,5,6,7,8
120	23/06/1976	0	3	4	6	4	0	4	1	1,4,8,9	0	2,3
121	25/07/1983	0	2	8	12	4	1	1,2,3,4,5	3	0	4	0,1,2,3,4,5,6,7
122	07/02/1990	1	5	5	2	5	0	4	1	0	4,5,8	0,3,4
123	08/08/1979	0	5	3	4	4	2	4	5	0	0	0,1,2,3,4,5,6,7,8
124	01/07/1966	0	5	6	10	4	5	1,2,3,4	1	1,2,3,4,7,8,9	0	0,1,3,4,6,7

Appendix A3: Participant Information



Experiment - Bias Perception in Online News

Participant Information Sheet

Thank you for your interest in taking part in this task-based evaluation. The information below is provided to inform your decision about consenting to take part in this experiment.

Details of the Experiment

The aim of this experiment is to ascertain how graphics accompanying news articles affect the perception of the articles' bias.

The experiment will begin by asking participants to fill out some basic profile information. This will include questions on:

- News access habits
- Political ideology questions

Participants will then be asked to rate the Bias of various new website articles. After rating 3 such articles, each participant will be asked to select the most and least Biased and to provide additional information as to why they rated them as such.

Participants will then be asked reflective questions on the Bias of various news mediums, what formats they consider to be Biased and which formats they consider the least Biased.

The results of this experiment will form part of the research being undertaken as part of a structured Masters degree in Computer Engineering at the School of Computer Science and Statistics, Trinity College Dublin. The results may be published at an international conference or journal. This publication will ensure that participants' identities will not be revealed.

Benefits of this Research

This research is being undertaken to investigate how graphics accompanying news articles may affect the perceived bias of those articles.

The experiment uses websites, news articles and images from mainstream news websites. In most cases, they have been heavily adapted to suit the experiment. Copyright is held by the originators for the original versions of the websites, articles and images. Copyright on the modified versions of each is not claimed by the organisers of the experiment. Use of the original articles and modified versions is done under Fair Use. No financial reward is being earned from the original or modified content. None of the content, websites, articles or images, original or modified will be distributed outside of the experiment.

Cian Flynn
Trinity College Dublin
Email: flynnc16@tcd.ie

Bias Experiment

Crowdsourced experiment of users' perception of Bias in different News Articles

Start Experiment | Return to Prolific Academic

© Cian Flynn, Trinity College Dublin 2018. Email: Cian Flynn.

Appendix A4: News Articles and Distortions Used in the Experiment

The following images show the websites presented to participants in the experiment for their evaluation of perceived level of bias.

The label associated with each website corresponds to the website (W), story (A), and level of distortion (D), as discussed in Chapter 3.

W0A0D0 W0A0D1 W0A0D2

Inflation rises AGAIN to a near-six year high of 3.1 per cent to intensify a squeeze on wages as food, air fares and culture drive up prices

- CPI inflation is running at 3.1 per cent in November, the highest since March 2012
- Rising prices were fuelled by increasing air fares and more expensive food
- Wages are now falling further behind, increasing at just 2.1 per cent

Inflation rises AGAIN to a near-six year high of 3.1 per cent to intensify a squeeze on wages as food, air fares and culture drive up prices

- CPI inflation is running at 3.1 per cent in November, the highest since March 2012
- Rising prices were fuelled by increasing air fares and more expensive food
- Wages are now falling further behind, increasing at just 2.1 per cent

Inflation rises AGAIN to a near-six year high of 3.1 per cent to intensify a squeeze on wages as food, air fares and culture drive up prices

- CPI inflation is running at 3.1 per cent in November, the highest since March 2012
- Rising prices were fuelled by increasing air fares and more expensive food
- Wages are now falling further behind, increasing at just 2.1 per cent

W0A1D0

Bitcoin loses HALF of its value in six weeks and is on course for its worse week since 2013 as price plummets to £5,730

- Bitcoin dropped by nine per cent to $8,155 (£5,733) on Friday morning
- The cryptocurrency is so far down more than 30 percent this week
- Bitcoin is headed for its worst weekly performance since April 2013

Low value: Bitcoin dropped to $8,155 (£5,733) on Friday morning, a nine per cent fall in value

W0A1D1

Bitcoin loses HALF of its value in six weeks and is on course for its worse week since 2013 as price plummets to £5,730

- Bitcoin dropped by nine per cent to $8,155 (£5,733) on Friday morning
- The cryptocurrency is so far down more than 30 percent this week
- Bitcoin is headed for its worst weekly performance since April 2013

Low value: Bitcoin dropped to $8,155 (£5,733) on Friday morning, a nine per cent fall in value

Going lower: Bitcoin is down more than 30 percent this week and headed for its worst weekly performance since April 2013

W0A1D2

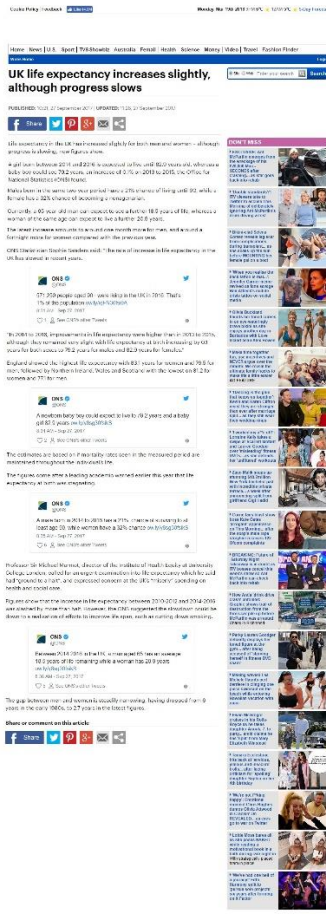
Bitcoin loses HALF of its value in six weeks and is on course for its worse week since 2013 as price plummets to £5,730

- Bitcoin dropped by nine per cent to $8,155 (£5,733) on Friday morning
- The cryptocurrency is so far down more than 30 percent this week
- Bitcoin is headed for its worst weekly performance since April 2013

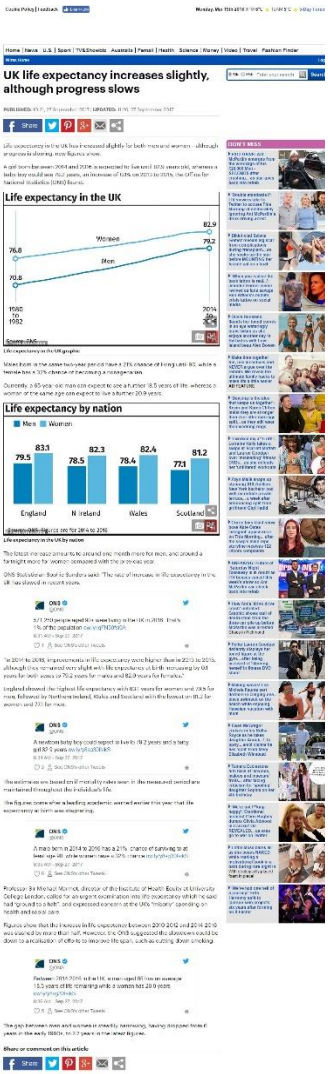
Low value: Bitcoin dropped to $8,155 (£5,733) on Friday morning, a nine per cent fall in value

Going lower: Bitcoin is down more than 30 percent this week and headed for its worst weekly performance since April 2013

W0A2D0

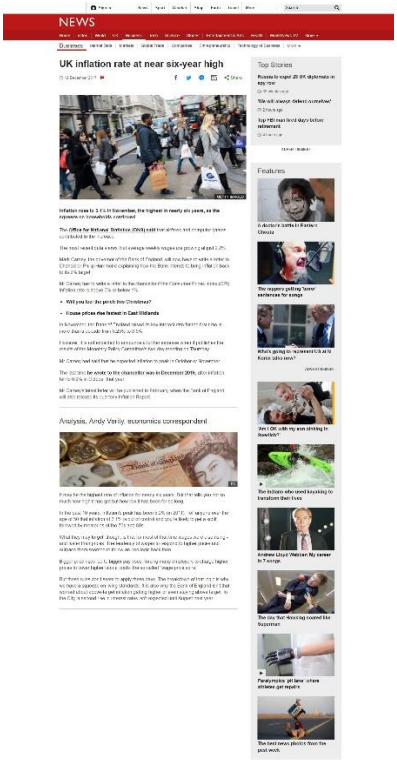


W0A2D1

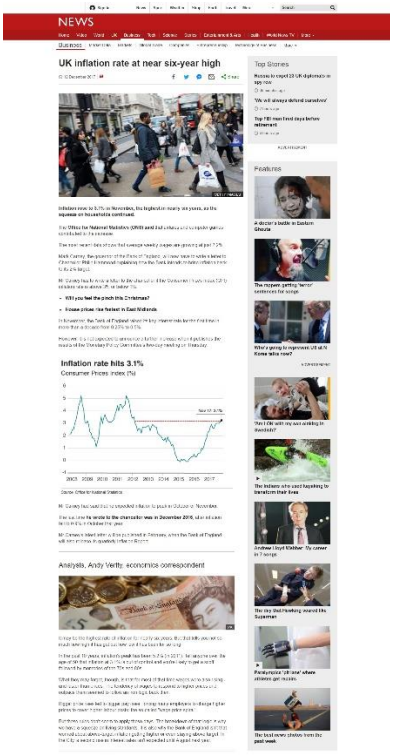


W0A2D2

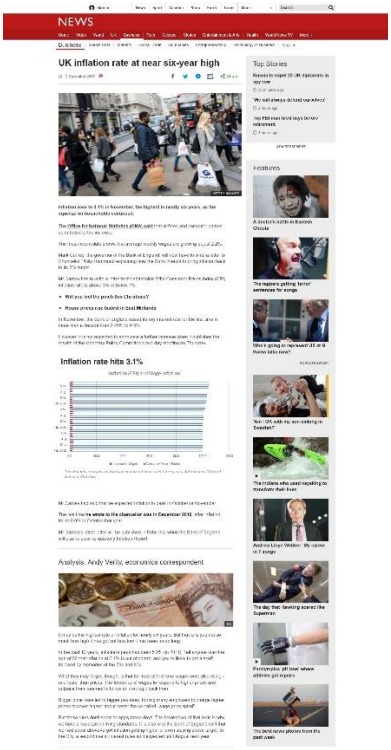
W1A0D0



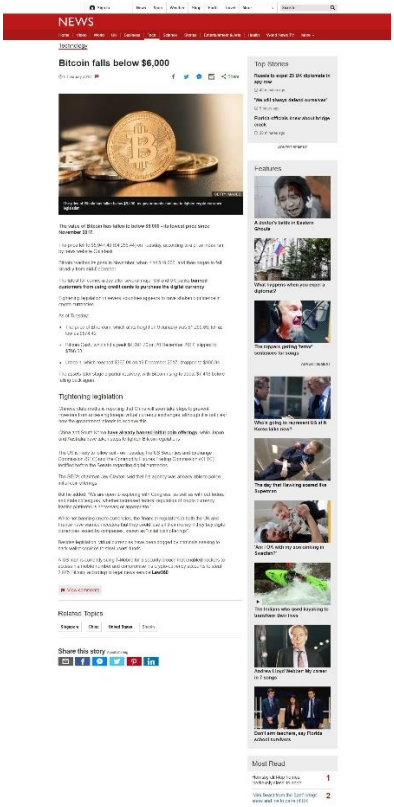
W1A0D1



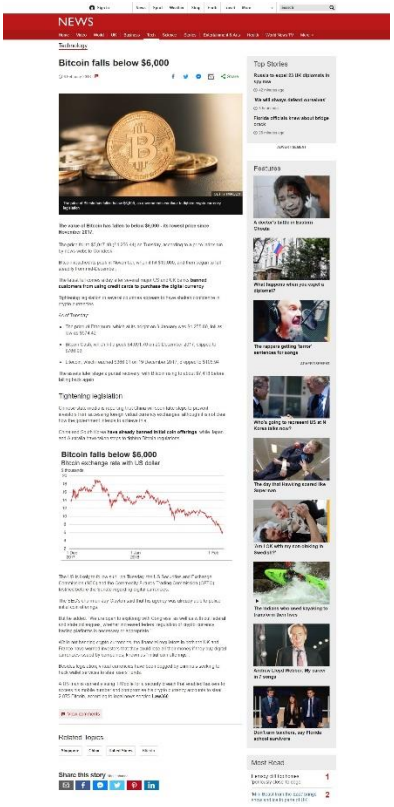
W1A0D2



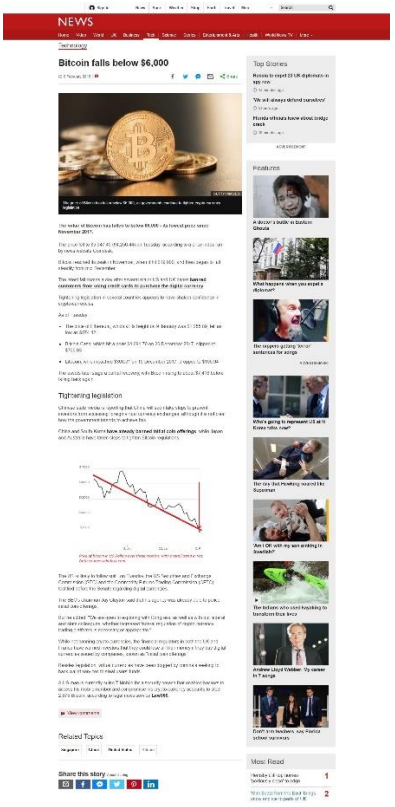
W1A1D0



W1A1D1



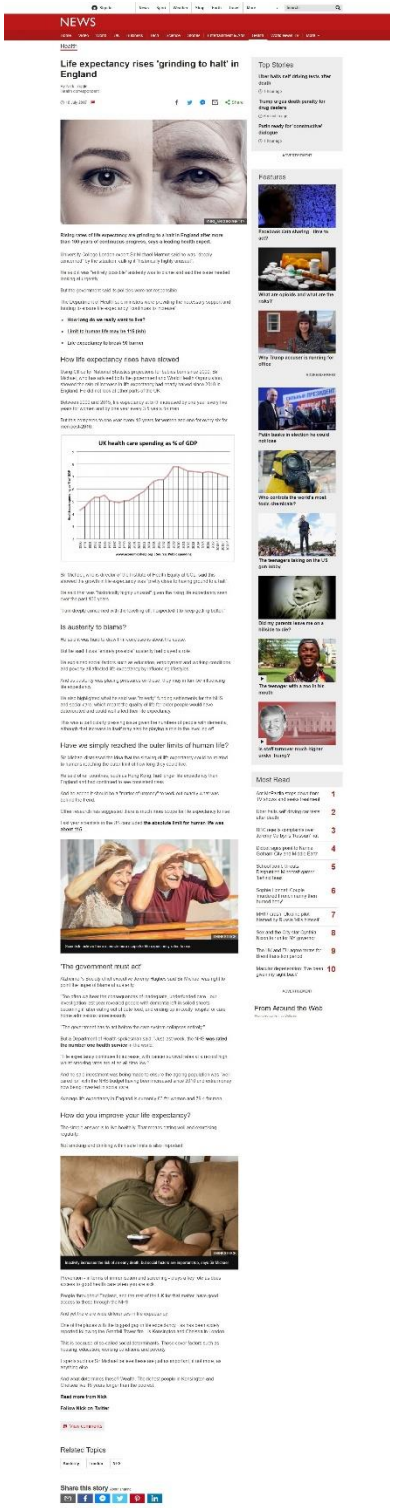
W1A1D2



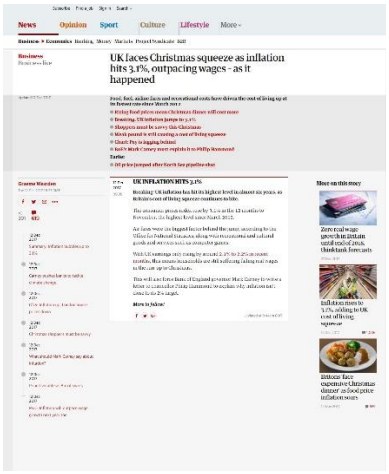
W1A2D0

W1A2D1

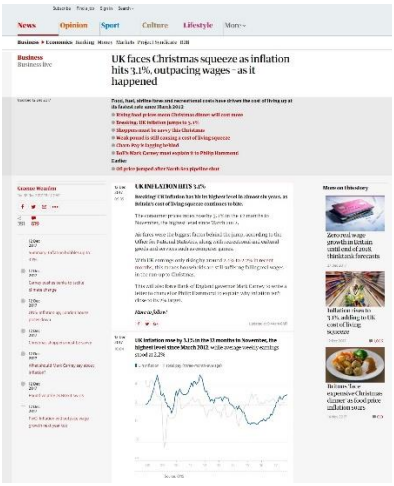
W1A2D2



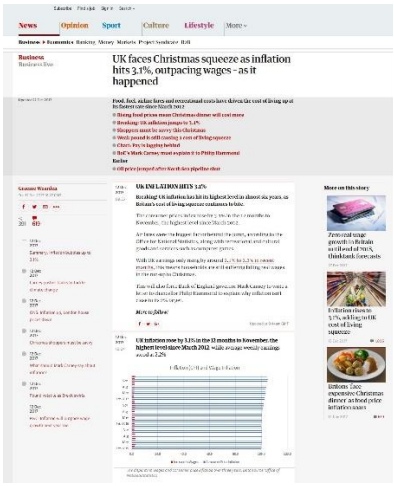
W2A0D0



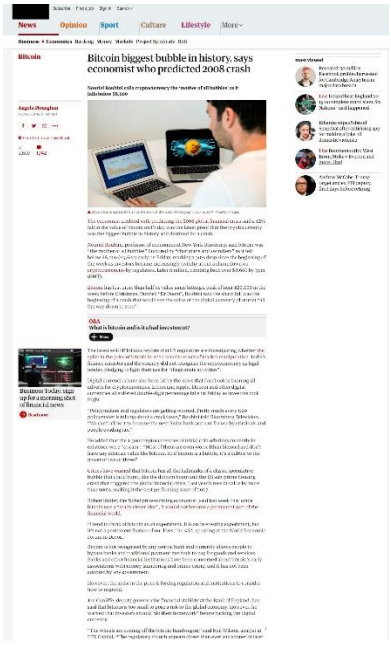
W2A0D1



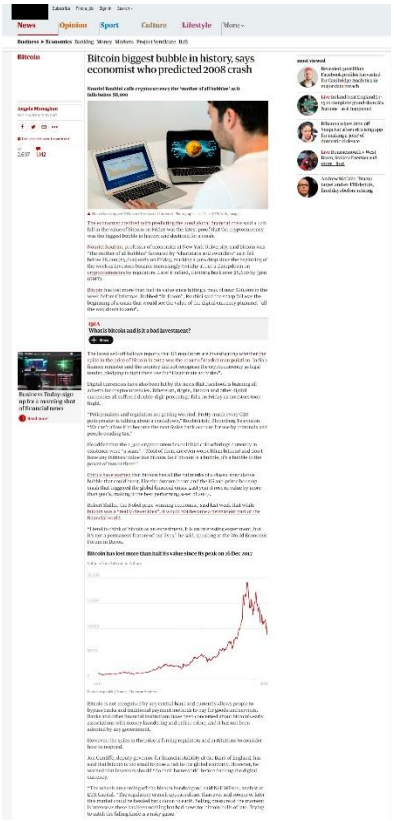
W2A0D2



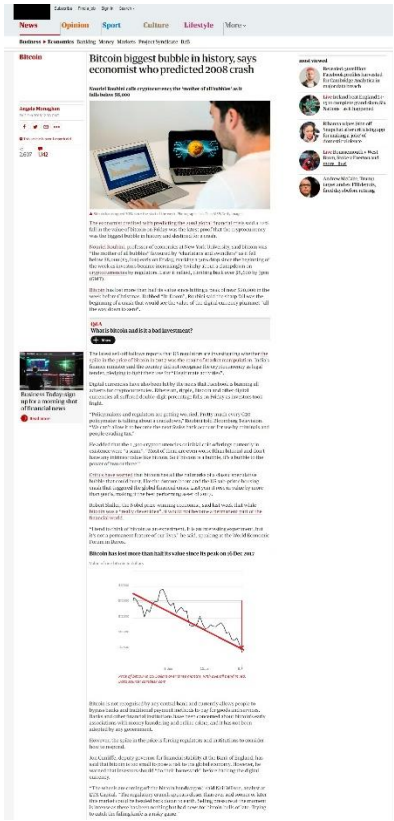
W2A1D0



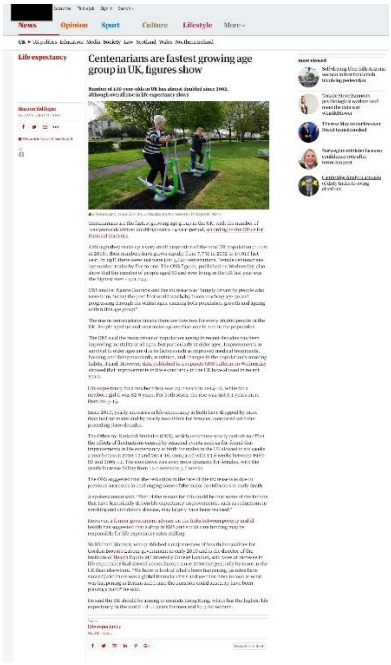
W2A1D1



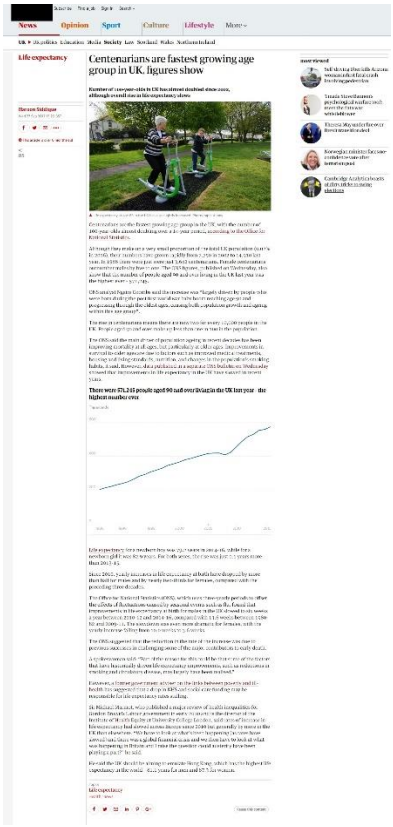
W2A1D2



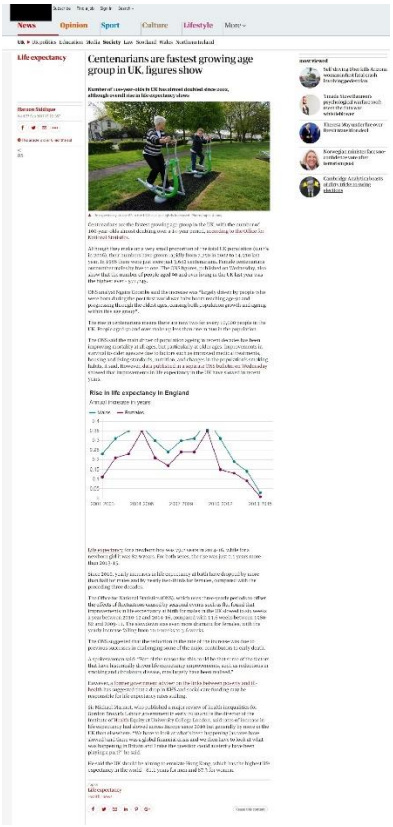
W2A2D0



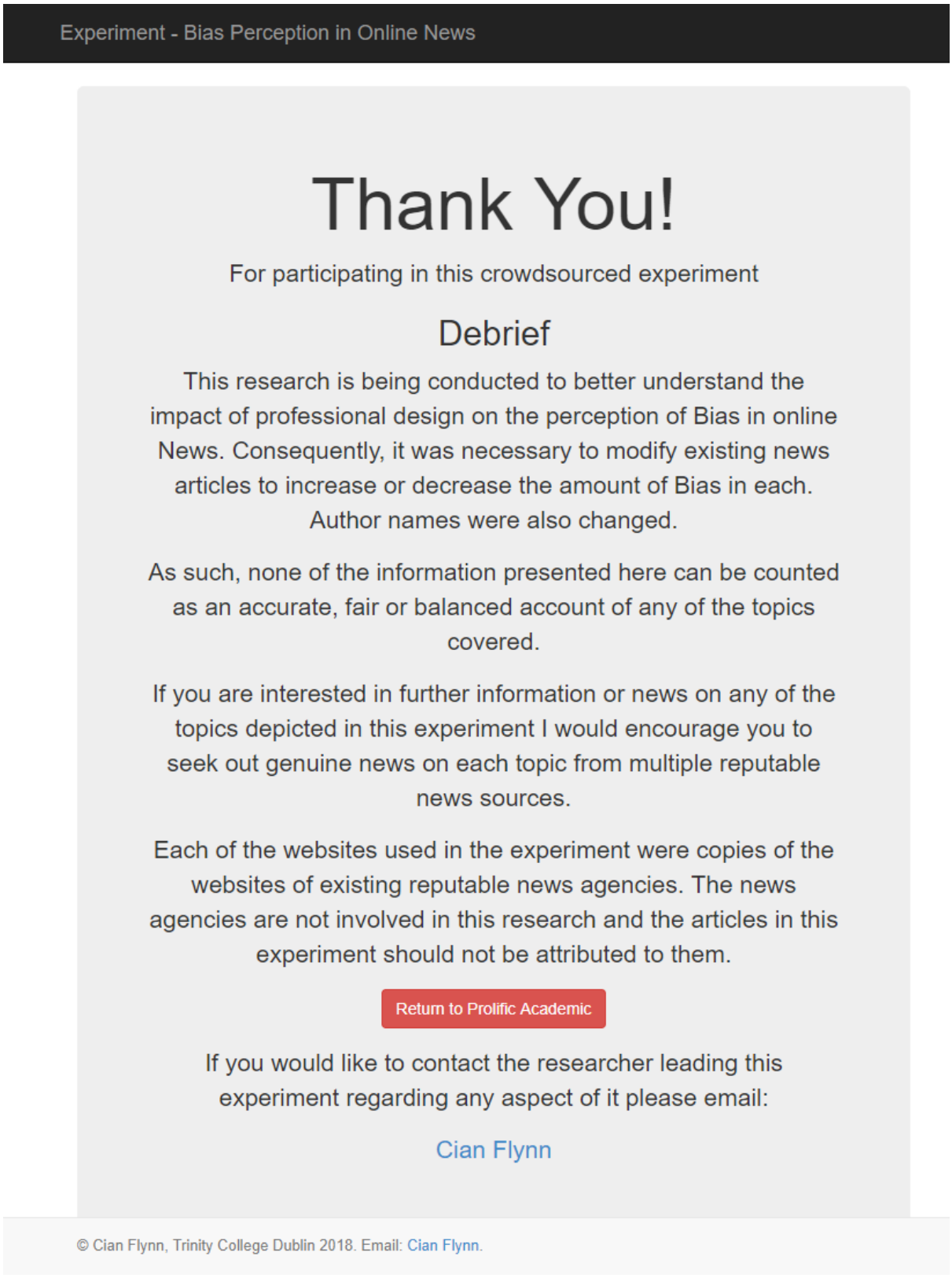
W2A2D1



W2A2D2



Appendix A5: Debrief Page

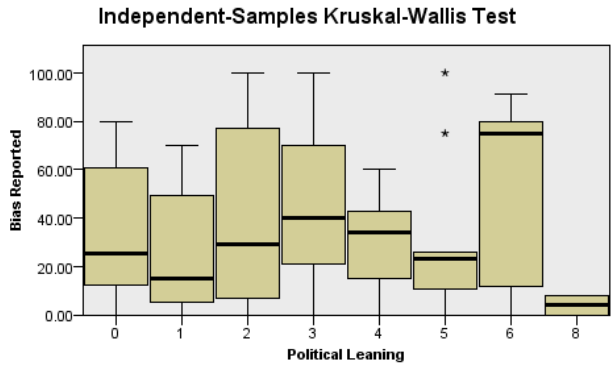


Appendix A6: Background Results

This appendix contains visualisations of links between social and economic data provided by participants, and the bias ratings they provided.

The group codes correspond to those detailed in Appendix A2. The results are to be interpreted as per Section 6.1.

A6.1 Political Leaning vs Reported Bias, Daily Mail



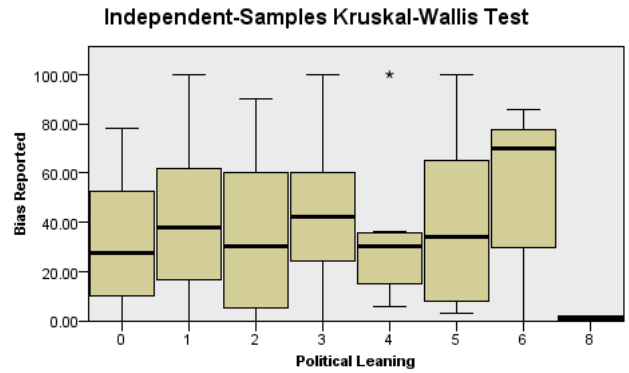
Report

Bias Reported

Political Leaning	Mean	N	Std. Deviation
0	33.61	28	27.341
1	27.27	15	25.401
2	37.04	25	36.316
3	45.44	25	30.053
4	29.86	7	21.950
5	29.00	11	30.760
6	50.00	11	37.701
8	4.00	2	5.657
Total	36.27	124	30.934

$X^2(7) = 8.533$, *p*-value = 0.288

A6.2 Political Leaning vs Reported Bias, BBC



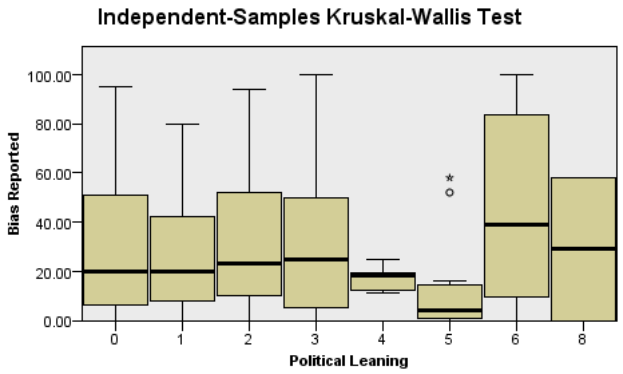
Report

Bias Reported

Political Leaning	Mean	N	Std. Deviation
0	32.89	28	25.382
1	40.87	15	31.514
2	33.08	25	31.070
3	42.52	25	30.817
4	33.86	7	31.445
5	39.45	11	33.512
6	52.64	11	33.494
8	1.00	2	1.414
Total	37.71	124	30.289

$X^2(7) = 8.108$, *p*-value = 0.323

A6.3 Political Leaning vs Reported Bias, Daily Mail



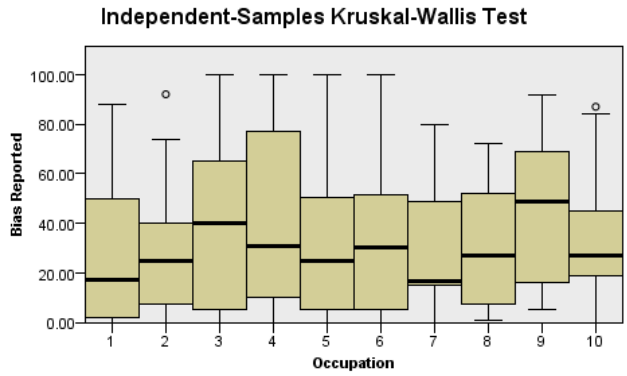
Report

Bias Reported

Political Leaning	Mean	N	Std. Deviation
0	30.93	28	29.747
1	27.13	15	25.809
2	32.72	25	29.457
3	31.28	25	30.066
4	16.86	7	5.146
5	14.09	11	20.945
6	46.73	11	40.856
8	29.00	2	41.012
Total	29.98	124	29.371

$X^2(7) = 6.175$, *p*-value = 0.519

A6.4 Occupation vs Reported Bias



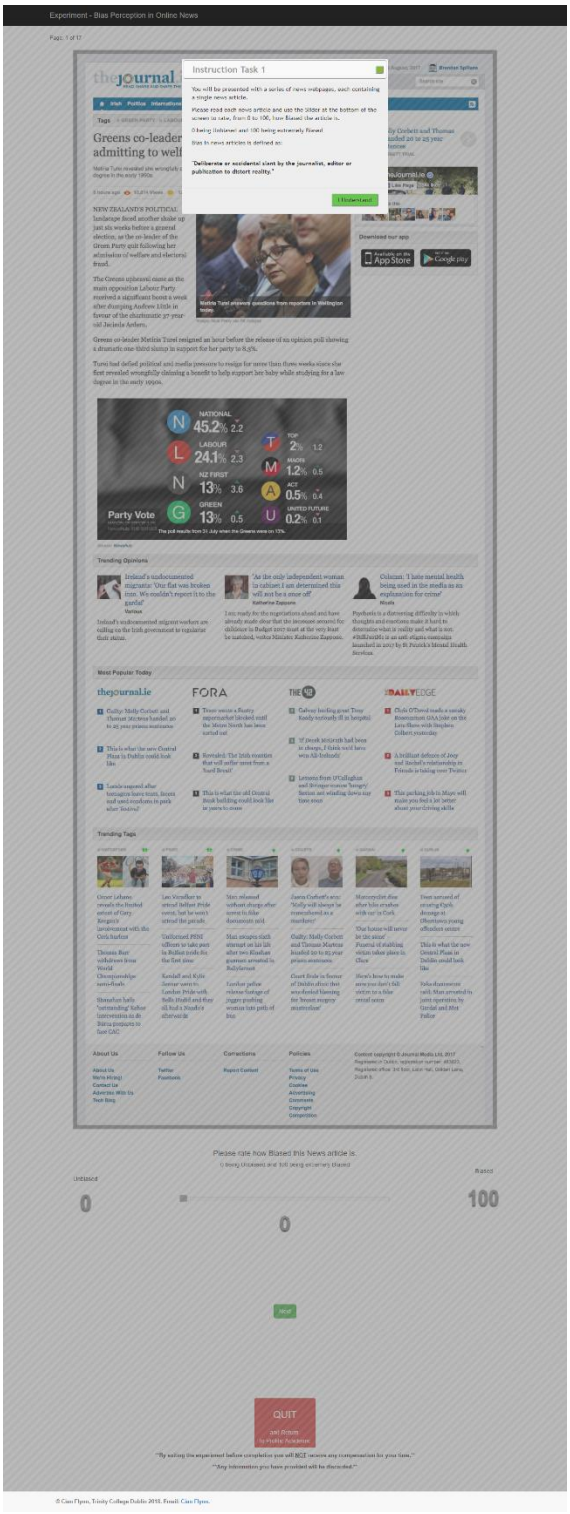
Bias Reported

Occupation	Mean	N	Std. Deviation
1	27.21	33	27.810
2	27.42	60	22.892
3	38.58	24	32.931
4	41.49	117	34.456
5	32.33	39	29.811
6	32.69	51	30.020
7	29.50	6	29.508
8	30.83	12	26.208
9	46.67	6	32.432
10	33.92	24	24.746
Total	34.66	372	30.310

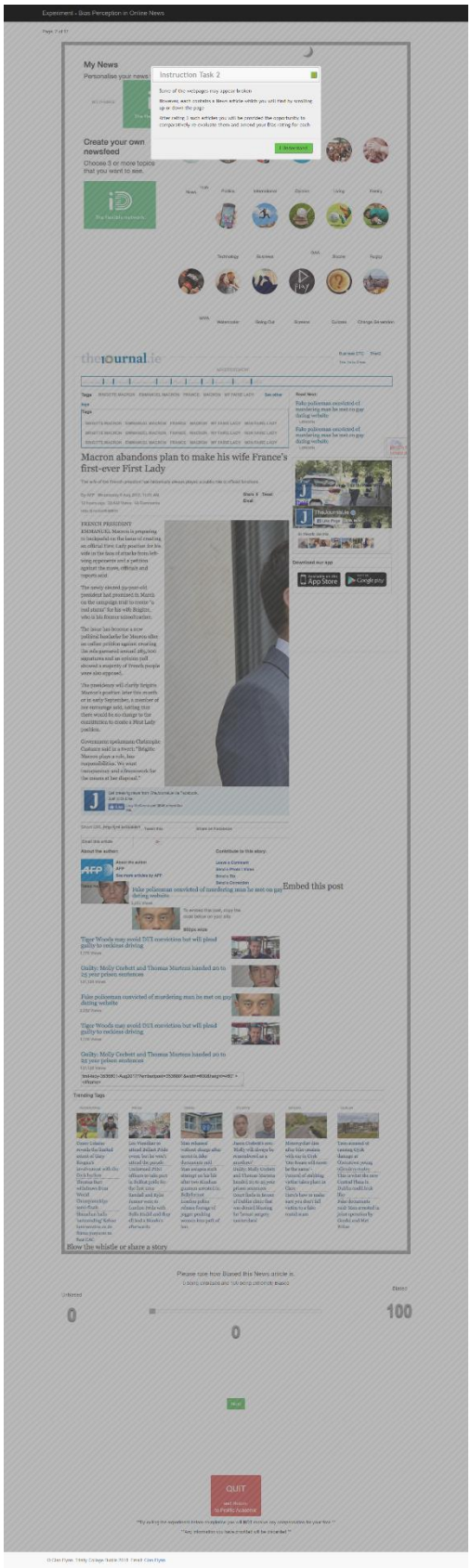
$X^2(9) = 10.240$, *p*-value = 0.331

Appendix A7: Instruction Tasks

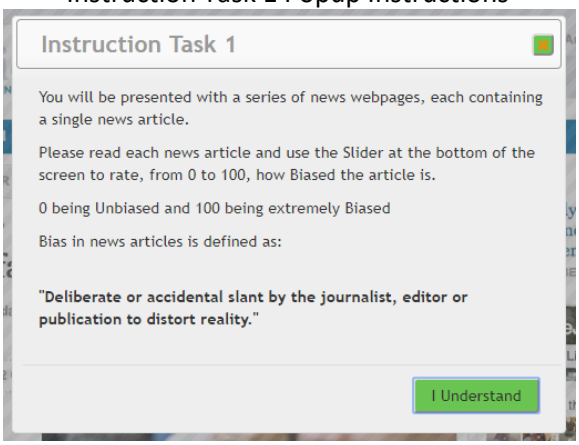
Instruction Task 1



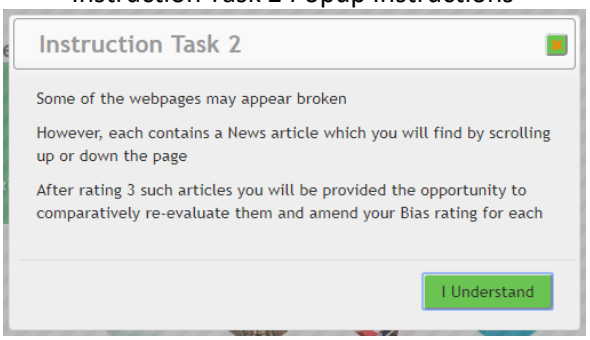
Instruction Task 2



Instruction Task 1 Popup Instructions

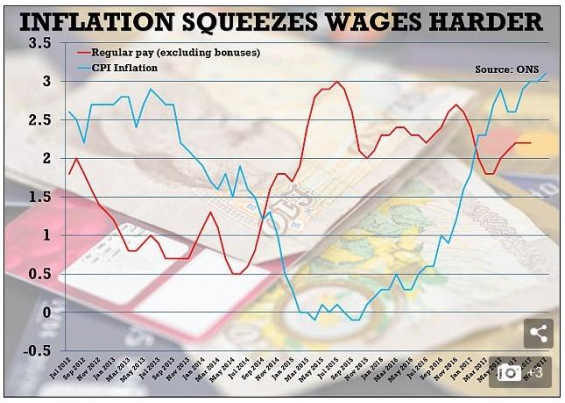


Instruction Task 2 Popup Instructions

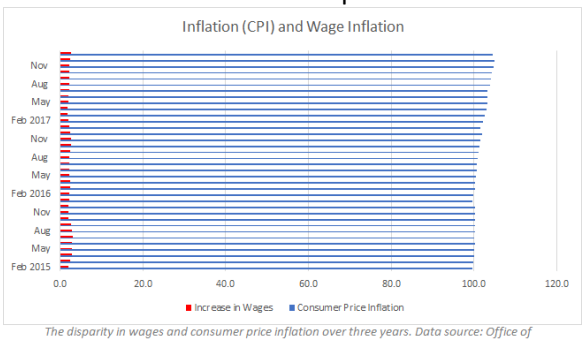


Appendix A8: D1 and D2 Graphics

W0A0D1 Graphic



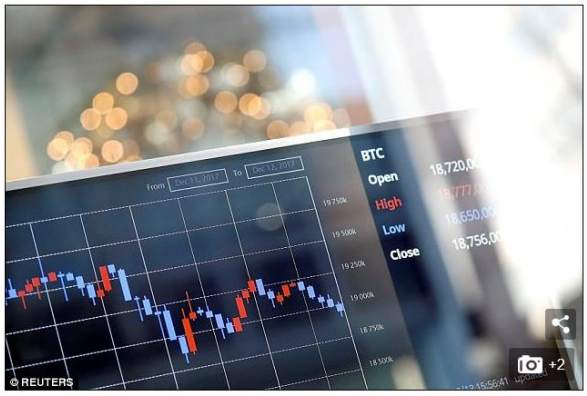
W0A0D2 Graphic



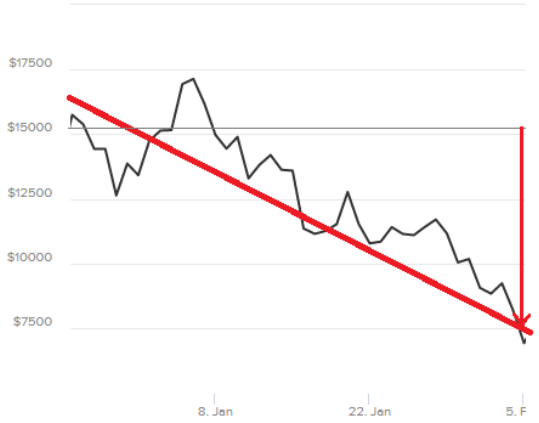
The disparity in wages and consumer price inflation over three years. Data source: Office of National Statistics

This graphic massively exaggerates the difference between CPI inflation and wage inflation, while also being relatively difficult to extract any precise information from.

W0A1D1 Graphic



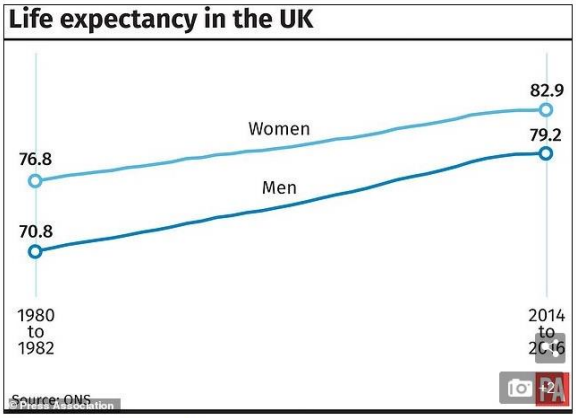
W0A1D2 Graphic



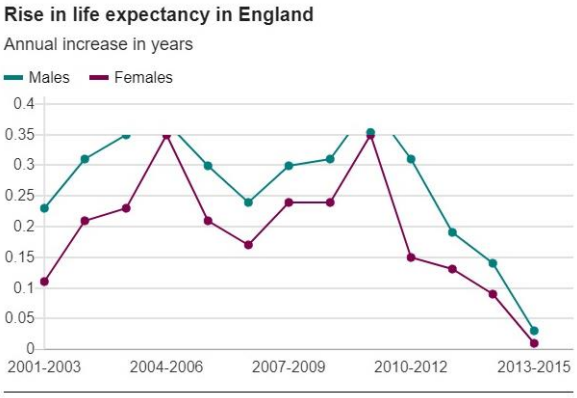
Price of bitcoin in US Dollars over three months, with overall trend in red. Data source: coindesk.com

This graphic adds a bold red downward trendline to the price of bitcoin graph, and arrow showing the difference from the start of the graph. This trendline is ignores any nuance in the graphic, by being bolder and more attention grabbing than the line itself, and bolsters the narrative of an overall sharp decline in price.

W0A2D1 Graphic

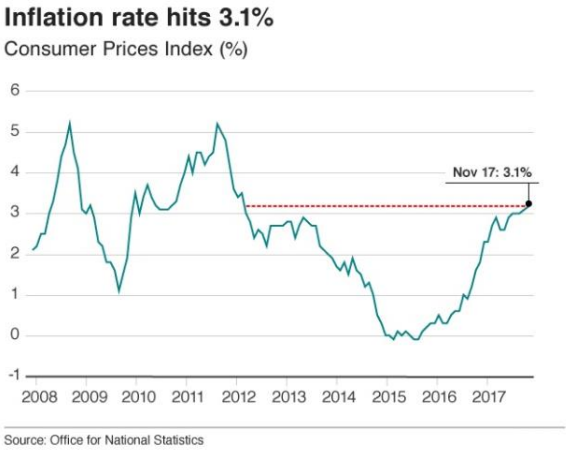


W0A2D2 Graphic

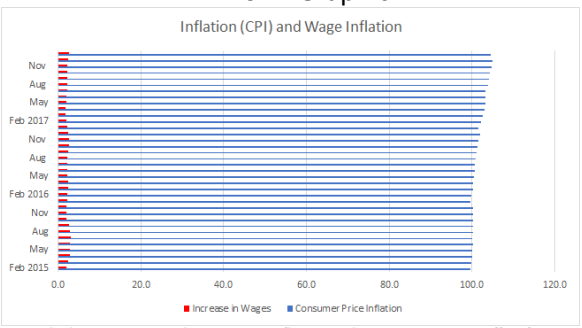


This graphic presents the information differently to the D1 graphic, giving the measure in change of life expectancy rather than just life expectancy. The graphic also appears to be incomplete.

W1A0D1 Graphic



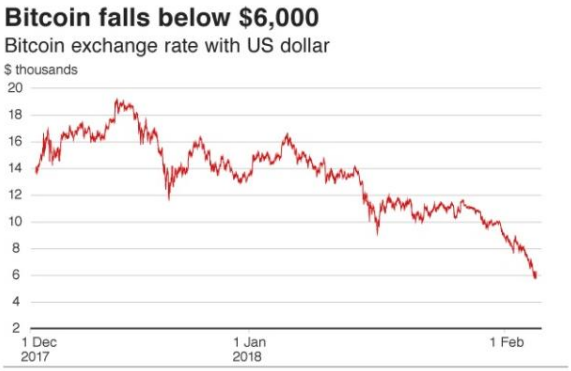
W1A0D2 Graphic



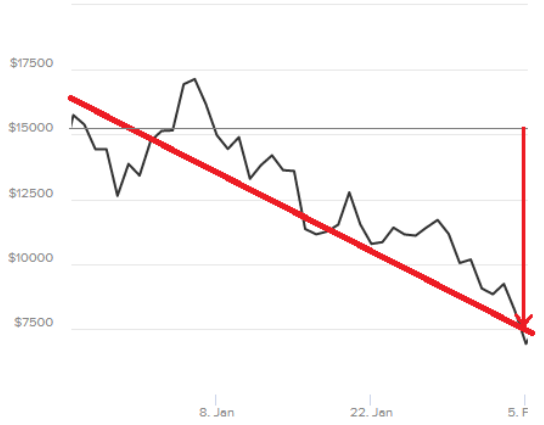
The disparity in wages and consumer price inflation over three years. Data source: Office of National Statistics

This graphic massively exaggerates the difference between CPI inflation and wage inflation, while also being relatively difficult to extract any precise information from.

W1A1D1 Graphic



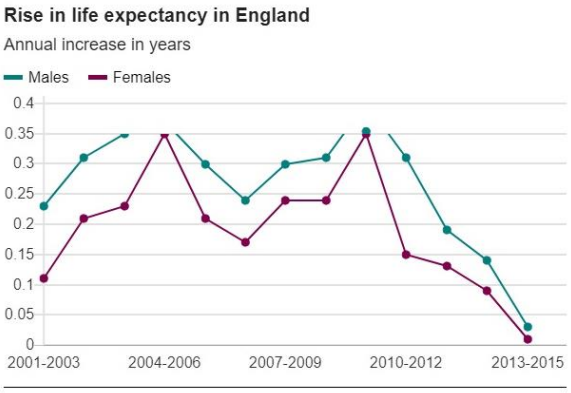
W1A1D2 Graphic



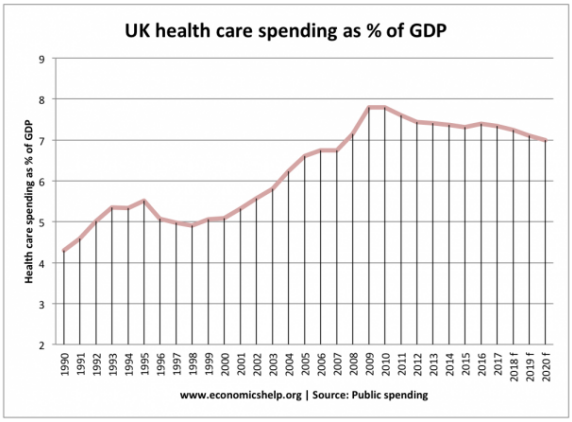
Price of bitcoin in US Dollars over three months, with overall trend in red. Data source: coindesk.com

This graphic adds a bold red downward trendline over the actual price of bitcoin, and arrow showing the difference from the start of the graph. This trendline is ignores any nuance in the graphic, by being bolder and more attention grabbing than the line itself, and bolsters the narrative of an overall sharp decline in price.

W1A2D1 Graphic

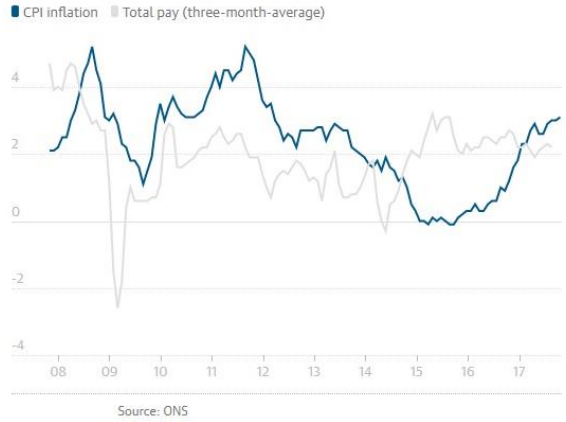


W1A2D2 Graphic



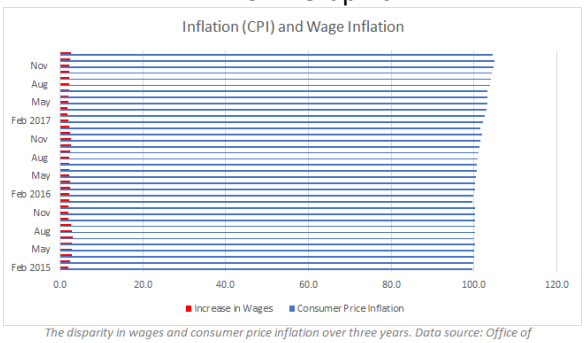
This graphic focusses on a different detail picked out in the article than the original graphic, although it is from the same cited data source. The article's narrative suggests a link between decline rate of life expectancy increase with decline healthcare spend in an apparent politic point. This graphic aims to bolster that narrative.

W2A0D1 Graphic



Source: ONS

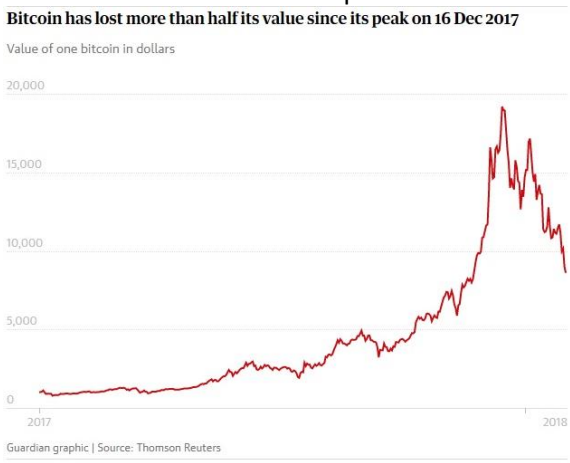
W2A0D2 Graphic



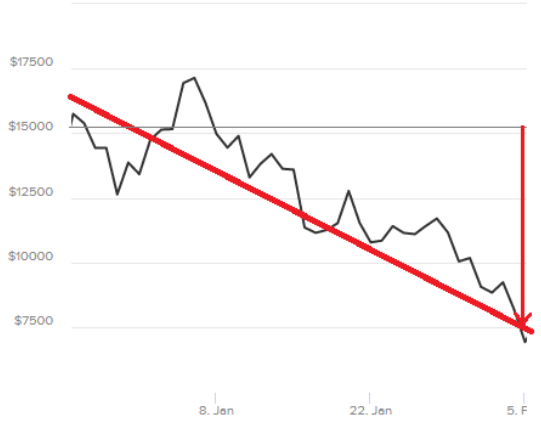
The disparity in wages and consumer price inflation over three years. Data source: Office of National Statistics

This graphic massively exaggerates the difference between CPI inflation and wage inflation, while also being relatively difficult to extract any precise information from.

W2A1D1 Graphic



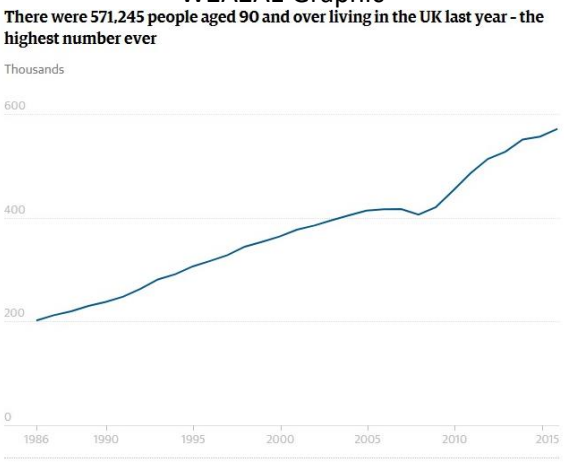
W2A1D2 Graphic



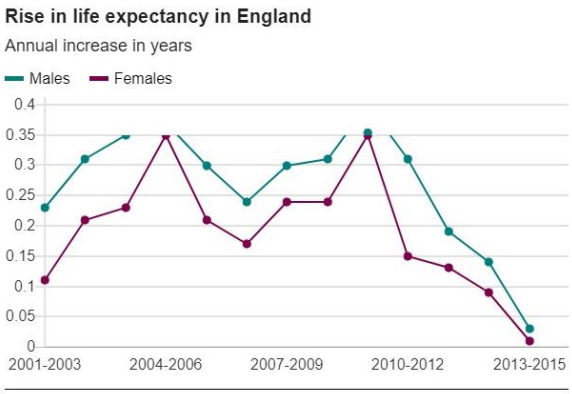
Price of bitcoin in US Dollars over three months, with overall trend in red. Data source: coindesk.com

This graphic adds a bold red downward trendline to the actual price of bitcoin, and arrow showing the difference from the start of the graph. This trendline is ignores any nuance in the graphic, by being bolder and more attention grabbing than the line itself, and bolsters the narrative of an overall sharp decline in price.

W2A2A1 Graphic



W2A2D2 Graphic



This graphic presents the information differently to the D1 graphic, giving the measure in change of life expectancy rather than just life expectancy. The graphic also appears to be incomplete.

Appendix A9: Chi-squared Tables

	P										
DF	**0.995**	**0.975**	**0.20**	**0.10**	**0.05**	**0.025**	**0.02**	**0.01**	**0.005**	**0.002**	**0.001**
1	0.0000393	0.000982	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.550	10.828
2	0.0100	0.0506	3.219	4.605	5.991	7.378	7.824	9.210	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.860	16.924	18.467
5	0.412	0.831	7.289	9.236	11.070	12.833	13.388	15.086	16.750	18.907	20.515
6	0.676	1.237	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.690	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.180	11.030	13.362	15.507	17.535	18.168	20.090	21.955	24.352	26.124
9	1.735	2.700	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	14.631	17.275	19.675	21.920	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	15.812	18.549	21.026	23.337	24.054	26.217	28.300	30.957	32.909
13	3.565	5.009	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	20.465	23.542	26.296	28.845	29.633	32.000	34.267	37.146	39.252
17	5.697	7.564	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.790
18	6.265	8.231	22.760	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312
19	6.844	8.907	23.900	27.204	30.144	32.852	33.687	36.191	38.582	41.610	43.820
20	7.434	9.591	25.038	28.412	31.410	34.170	35.020	37.566	39.997	43.072	45.315

Source: https://www.medcalc.org/manual/chi-square-table.php