Towards a dynamic Social Judgement Theory – an experiment using fake news

by

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DECLARATION

I, Vikesh Rajpaul, declare that the thesis, which I hereby submit for the degree Doctor of Philosophy at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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Abstract

Fake news creates a distorted perception of reality, with surreptitious influence on beliefs, attitudes and decision making. It can lead to suboptimal decisions for individuals and society in general, and more perversely can lead people to stop believing in facts altogether. Countering fake news remains a challenge to both academics and practitioners alike, and this study contributes towards closing this practice-knowledge gap through the lens of social judgement theory. While social judgement theory is important and useful for understanding anchor shifts from the fake news phenomenon, it is in itself incomplete as an account of persuasion and overlooks the impact of time on anchors. The contribution of this study comes from introducing a dynamic element to social judgement theory, while adding to the body of knowledge in persuasion theory to counter the scourge of fake news. The research design was a full experimental research that utilised two pilot studies and a main study comprising 190 participants. The results of the experiment led to new findings that time is an important factor in shifting people's anchors, despite no presence of a persuasive message as required by social judgement theory. The importance and benefits of longitudinal studies in persuasion is demonstrated as the conclusions drawn from this study could have been significantly different had it been a cross-sectional study, which typifies most studies in persuasion. Importantly, a comparison in a single study of the effects of messages questioning the source's bias against social consensus in the form of user comments at the end of a blog-post, has received remarkably little attention in the field of persuasion. This study compares these two important and critical aspects of persuasion in a single experimental research over a three month period, and finds that both discounting cues on source bias and social consensus had the same effect on participant's anchors over time, implying they could be used to equal effect to counter fake news. Although the study setting is fake news around climate change, it offers immense value in guiding resources towards countering fake news in other spheres of persuasion like politics and the tobacco industry.

1. Chapter 1 - Introduction

1.1. Chapter introduction

This chapter introduces this doctoral research and provides the foundations for the theoretical, practical and methodological contributions that are expanded upon in subsequent chapters. This longitudinal quantitative research adds to the body of knowledge in persuasion theory, while utilising social judgement theory as theoretical anchor to help fight the scourge of fake news in climate science.

Practical and theoretical foundations of this study

Fake news is false or deceptive news with misleading information that is spread by channels that mimic legitimate news sources (Torres, Gerhart, & Negahban, 2018). McCright and Dunlap (2017) conceptualised fake news as misinformation along four dimensions, namely shock-and-chaos; systemic lies; bullshit, and truthiness. This conceptualisation was adopted as the categorisation of misinformation in this doctoral research. The prevalence of misinformation in 2016 led to the Oxford dictionary declaring "Post-truth" as the word of the year in 2016 (Lewandowsky et al., 2019; Pennycook & Rand, 2019). In this post-truth era, people have forsaken established criteria of evidence and fact-seeking in favour of emotions and personal belief (Lewandowsky, Ecker, et al., 2017; Pennycook & Rand, 2019). Perhaps the biggest problem with fake news is that it leads to suboptimal decisions for individuals and society in general, and more perversely its presence can lead people to stop believing in facts altogether (Lewandowsky et al., 2012; Lewandowsky, Ecker, et al., 2017).

With its growing prevalence, fake news has attracted increased attention from both academics and practitioners, and Colliander (2019) summarised the areas of research on fake news to those generally focussing on: (i) the prevalence of the problem; (ii) the ways in which fake news travels within social networks; and (iii) the ways in which fake news can be corrected or debunked (Colliander, 2019). In addition, more and more research is being published on methods to detect fake news (Zhang et al., 2019). However, research on fake news is still nascent and there is general consensus that corrections alone is not an effective mechanism with which to debunk fake news, especially corrections that simply encourage people to consider the opposite of the initial information, as these often end up strengthening the misinformation (Chan et al., 2017). Moreover, people's reliance on discredited information continues even when they can remember and report the correction (Ecker et al., 2014). Therefore, in spite of the growing interest in the area of combatting fake news, correction of misinformation is complex and is still not completely understood (Chan et al., 2017).

The continuing uncertainty about the best strategies for combatting fake news, and the inability to coherently articulate mechanisms to combat fake news is of particular concern in the fight against climate change, especially since a considerable amount of literature has been published illustrating the deleterious impact of climate change (Brown et al., 2018; Harjanne & Korhonen, 2019; McCright & Dunlap, 2017; Pegels, 2010). In many cases politicians and some independent scientists have instilled a deep fear about climate science and technological solutions, through the manipulative and unscrupulous use of selected scientific information to drive specific agendas (Han, 2014). Therefore, this failure to adequately address fake news in climate science presented a practice-knowledge gap that this research study contributed towards closing.

This practice-knowledge gap was addressed utilising Social Judgement Theory as the theoretical anchor, but social judgement theory in itself is "manifestly incomplete" as an account of persuasion (O'Keefe, 2016, p.8). While the study made a practical contribution, the primary objective of this research was to close a theoretical gap in social judgement theory by introducing a dynamic element to social judgement theory that was non-existent. Social judgement theory is one of the theories within the ambit of persuasion theories that explains how people process information and make judgements about persuasive messages in relation to their existing attitudes toward something (Amos et al., 2019).

In social judgement theory, the individual's involvement in the topic determines how they process information and the individuals' prior attitudes serve as anchor points for judging communication (Lee & Chun, 2016). The central tenet of social judgement theory is that an individual's current attitude towards a topic serves as his or her anchor point, and there may be a range of positions on either side of this anchor that would not be objectionable to the individual (Stefanelli & Seidl, 2017b). Beyond these zones that are not objectionable are positions that would be rejected. Hence, attitude changes occur when messages are positioned within an individual's latitude of acceptance or within the latitude where they are not committed, but not within a latitude of rejection. However, because social judgement theory's focus lies predominantly on the distance between an individual's anchor point established from prior attitude and the location of the persuasive message, it overlooks the influence of time on these anchor shifts. Moreover, social judgement theory does not fully account for the impact of discounting cues (messages that refute the original persuasive message) on those anchors over time.

Therefore, social judgement theory is a rather static process and examining the complex roles of different discounting cues at different points in time to understand both their relative impacts as well as their relative durability, introduced a dynamic element to social judgement theory

which did not exist. Incorporating these aspects into social judgement theory helps our understanding of how to counter the current scourge of fake news by understanding how attitudes change over time when people are exposed to fake news and subsequently exposed to messages that cast aspersions on the message they received.

Dependent and Independent variables in this study

Although the term Fake News contains the word "news", it is not restricted to news outlets as blogs and social media have fast become key instruments in spreading fake news (Lewandowsky, Cook, Fay, & Gignac, 2019). With the shift towards social media as a source of information, and social conformity from other reader's comments having potential to influence people, scholars are shifting focus towards exploring the persuasive effect of user comments on people's attitudes, to understand further how fake news can be countered. Colliander (2019) found that conformity to other user's comments plays a significant role in guiding people's attitudes to fake news and could be an important factor in countering fake news. This finding is consistent with observations by Lewandowsky et al. (2019). Social consensus and its influence on attitudes are therefore considered a major contributor to attitudes towards fake news and attitudes will serve as the dependent variable in this study while social consensus serves as the first independent variable.

In the literature review that follows in chapter two, it is shown that misinformation adopted by the climate change countermovement, which is the context of our study, and which McCright and Dunlap (2017) classify as "Systemic Lies", is perhaps the most pernicious type of misinformation, typified by carefully constructed fabrications to obfuscate and confuse while protecting and promoting vested interests. Therefore, it stands to reason that the climate change countermovement will make use of strong arguments to protect their ideological interests, and as such argument strength was not manipulated in the present study but rather served as the control variable.

However, argument strength and source credibility are both established cornerstones of persuasive communication (Albarracín et al., 2017), and in order to fully understand the role of social consensus, it is important to do so in relation to those established cornerstones. This is so because efforts to counter fake news could be misdirected if each aspect is looked at in isolation. Additionally, although past research has established source credibility as a cornerstone of persuasive communication, it has typically associated source credibility with trustworthiness and expertise, and conflated trustworthiness with bias (Wallace et al., 2020a). Wallace et al. (2020a) showed us that source bias and source trustworthiness can have completely different effects.

Inherent in McCright and Dunlap (2017) systemic lies classification of misinformation are biased sources who come across as being credible, but are far from it. Therefore, source bias can influence people's attitudes towards fake news on climate change and will serve as the second independent variable in this study. Importantly, it is not fully understood whether social consensus or source bias has a greater influence on attitudes. Comparing the influence of these two constructs in a single study extends our understanding of how attitudes towards fake news are influenced and will guide the appropriate allocation of resources to counter fake news, thereby addressing a practice-knowledge gap. In this study, source bias served as a proxy for source credibility, and social consensus will serve as a proxy for social conformity.

Moreover, despite the importance of attitudes in persuasion, its durability has received remarkably little empirical attention in the field of social psychology, even though they often don't remain stable over time (Luttrell, Petty, & Briñol, 2016). Luttrell, Petty, and Briñol (2016) attribute this to the practical difficulties of measuring attitudes at different points in time in longitudinal studies. In order to provide a holistic view in closing the practice knowledge gap identified earlier, it is important to track the changes in attitudes over time, and in the present research study time serves as the third and final independent variable

While fake news in the context of climate change is utilised as a context for the study, the methodology adopted provides immense external validity in that the findings could be extended to other areas where this post-truth era has witnessed an increased use of misinformation, like in politics (Ballew et al., 2020), the tobacco industry (Marwick & Lewis, 2017) and the asbestos industry (McCright & Dunlap, 2017). Moreover, adding a dynamic element to social judgement theory allows for a better understanding of how attitudes shift over time, which would be beneficial in not just countering fake news, but benefits may extend to areas of marketing and investments.

Finally, the methodological contribution comes from tracking these changes in attitudes over a three-month period, while the standard tests for what is known as the sleeper effect (discussed further in chapter two) generally occurs over a two-week period. A three-month test period also reduces common method variance bias. Thus, this research makes a theoretical contribution towards extending social judgement theory, closes a practice-knowledge gap and makes a methodological contribution, while the quantitative nature of this research provides generalisability of results to extend beyond countering fake news in climate change, and broadening its reach to other areas of the social sciences.

1.2. Research problem

1.2.1. *Problem statement*

Social judgement theory provides valuable insights into understanding how attitudes shift in relation to people's anchors when they are exposed to persuasive messages, but it does not provide a complete or adequate account of attitude changes resulting from discounting cues, and it is deficient in explaining how these change over time. It is therefore static in nature. Introducing a dynamic element to social judgement theory provides an understanding of how attitudes shift over time in relation to people's anchors and how discounting cues influence attitudes in relation to one another. Addressing this not only closes a theoretical gap, but offers significant practical value in steering resources to counter fake news.

1.2.2. *Research purpose*

The primary purpose of this research is to close a theoretical gap in social judgement theory by introducing a dynamic element to social judgement theory that is currently non-existent. A secondary purpose is closing a practice knowledge gap in countering fake news. It does this by evaluating and comparing changes in attitudes within and between participants over the course of three months, by manipulating source bias and social consensus in order to determine which has a stronger influence on attitudes and how they endure over time. This in turn contributes towards the common good of countering the effects of fake news by providing an understanding of the dynamics of persuasion and social influence.

1.2.3. *Research question*

Following on from the introduction, problem statement and purpose, the research questions are expressed as follows:

> *RQ1: What is the relative impact of source bias and social consensus on people's anchors after they are exposed to fake news?*
>
> *RQ2: What influence does time have on people's attitudes, when they are exposed to fake news and discounting cues?*

1.3. Research gap and study contribution

There is no doubt that social judgement theory has provided valuable insights into understanding attitude change and persuasion processes, but it is "manifestly incomplete" (O'Keefe, 2016, p.8) as an account of persuasion. This is so because its focus lies predominantly on the distance between an individual's anchor point established from prior attitude and the location of a persuasive message, but ignores attributes of the communicator

(Shu & Cheng, 2012), and overlooks empirical testing of the effects of time. Thus, while positioning of an argument in relation to anchors are clear, what remains unclear is the impact of discounting cues and time within social judgement theory. This study extends social judgement theory by examining the complex roles of different discounting cues at different points in time to understand both their relative impacts as well as their relative durability. Addressing this would provide an understanding of which of the two discounting cues (source bias or social consensus) lasts longer thus extending our understanding of fake news as well as guiding the appropriate allocation of resources to counter fake news, thus not only closing a theoretical gap but closing a practice – knowledge gap as well.

Figure 1.3-1 illustrates this study contribution to social judgement theory. The concepts included in this figure become clearer in chapter two, but of importance is the shift in anchor on the upper half of Figure 1.3-1 is social judgement theory in its current state, while the shift in the lower half is due to a discounting cues and time, and is new to social judgement theory. This is the dynamic element referred to earlier.

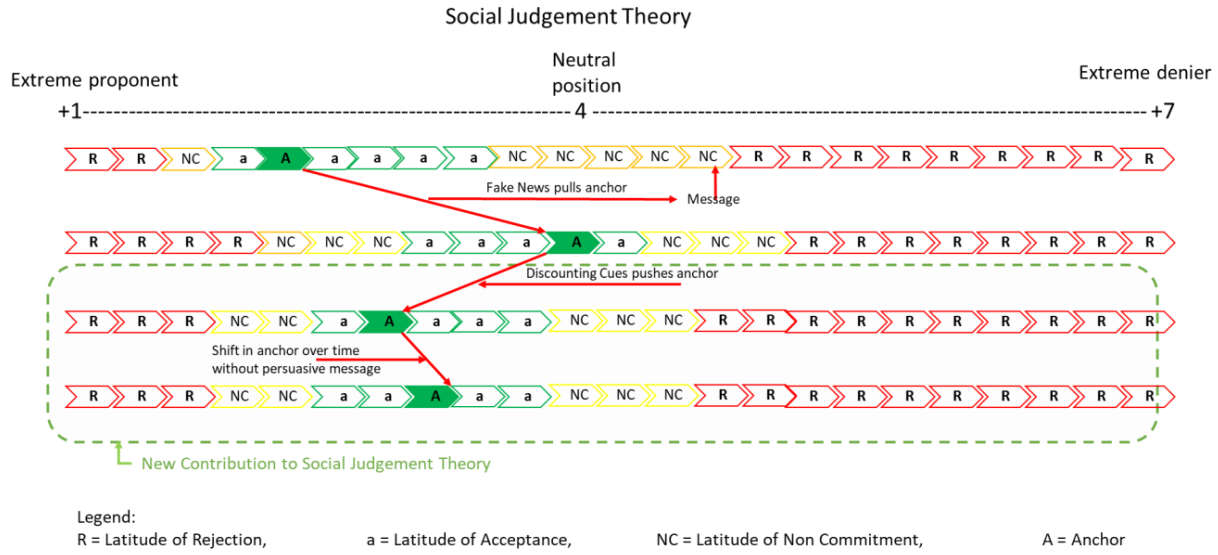

Figure 1.3-1: Study Contribution to Social Judgement Theory

Lending further support to this study is a Trotter and Maconachie (2018) observation that a largely understudied aspect of post-truth politics is public attitudes toward energy-related issues, specifically in developing countries. These are knowledge and population gaps that this study intends to address. With regard to the durability of the influence of credible communicators, Albarracín et al. (2017) posit that "filling this gap in knowledge is essential to better understand the dynamics of persuasion and social influence" (p.171). By extension, the same can be said about the durability of the influence of social consensus, specifically those that come from reading the comments section on blogs. This claim is supported by Lewandowsky et al. (2019) who found that the comment sections of blogs also play a

significant role in influencing people's attitudes, but "the effect of this content on people's attitudes is not fully understood" (p.1445).

Providing added support for this study is the following claim by Heinbach, Ziegele, and Quiring (2018) "no research has been published on the long-term effects of online news articles accompanied by user comments" (p.4773). Their research attempted to close that gap and the present research adds to that as Heinbach et al. (2018) used brand reputation as a proxy for source credibility and focussed more on the sleeper effect while the present study looks at fake news in climate science using source bias as a proxy for source credibility.

1.4. Research setting

A considerable amount of literature published on attitudes has been conducted in a laboratory or classroom setup using students (Karasmanaki & Tsantopoulos, 2019; Kumkale & Albarracín, 2004; Tormala et al., 2006). Since a necessary condition of this longitudinal study was the use of the same participants throughout the study period in order to measure and track attitudinal changes both within participants and between groups, the unit of analysis for the main study was established as university students. The research setting is fake news in climate science, and an added benefit of sampling university students is that they are in general more conscious of their environmental footprint, as students would associate with climate change better than the general public (Karasmanaki & Tsantopoulos, 2019). It could therefore be argued that university students represent the worst-case scenario in trying to peddle fake news around climate science, thus making it easier to generalise the findings from this research to the public in general. While the research setting is fake news in climate science, the findings have sufficient external validity to be extended to other spheres of persuasion where fake news is rife.

1.5. Summary of Research Method

The research consisted of two pilot studies and a main study. The first pilot used purposive sampling to test the user-friendliness and mechanics of the questionnaires. It comprised twelve participants. The unit of analysis for the second pilot study was students at a business school on Johannesburg, as well as schoolteachers and matriculants at two private schools in Johannesburg. There were 75 respondents on the pilot study. The main study comprised of 190 students from the University of Pretoria's Faculty of Humanities.

In both the second pilot study and the main study, participants were randomly divided into three groups – a control group and two treatment groups. As part of the first survey, all participants had initial anchors measured using a seven-point Likert scale and were exposed to the same fake news vignette on climate change, which denied the science around climate

change. That is, the vignette was positioned from a climate denier perspective. Attitudes were again measured. Participants in the control group (group 1) received no further treatment. Participants in group 2 received discounting cues in the form of user comments that typically follow blog articles. The user comments uniformly questioned the content of the vignette, and labelled it as fake news. Participants in group 3 received three letters addressed to the editor of the publication that had posted the article. All letters raised concerns about the author being biased. Attitudes were measured again using the same instrument as before. Follow up surveys were conducted after two weeks and again three months after the initial survey. An attitude index was established that was used to track attitude changes that occurred within participants and between groups.

1.6. Chapter conclusion

With its growing prevalence, fake news has attracted increased attention from both academics and practitioners (e.g. Ecker & Ang, 2019; Pennycook & Rand, 2019). However, in spite of the growing interest in the area of combatting fake news, correction of misinformation is complex and is still not completely understood (Chan, Jones, Hall Jamieson, & Albarracín, 2017). The continuing uncertainty about the best strategies for combatting fake news, and the inability to coherently articulate mechanisms to combat fake news is of particular concern in the fight against climate change (Lewandowsky et al., 2019), which served as the context for this study.

In order to address these concerns, an experimental study using quantitative data was conducted using social judgement theory as the theoretical lens, and a theoretical contribution came from extending social judgement theory. Social judgement theory focusses on the distance between a persuasive message and a person's anchor, but ignores attributes of the communicator, inadequately considers discounting cues after an anchor is formed, and more importantly it overlooks the impact of time on attitudes. These factors all play a role in establishing and shifting people's anchors but social judgement theory currently encapsulates them under a single umbrella of a 'persuasive message'. Thus, social judgement theory was a rather static process and this study introduced a dynamic element to social judgement theory which did not exist.

Social consensus and its influence on attitudes are considered major contributors to attitudes towards fake news. Hence attitudes served as the dependent variable in this study while social consensus served as the first independent variable. Additionally, source bias can influence people's attitudes towards fake news on climate change, and served as the second independent variable, while time served as the third and final independent variable.

In the next chapter, the theoretical foundations around fake news, truth and persuasion theories are explored, and the gaps identified in this chapter are explored further.

2. Chapter 2 - Literature Review

2.1. Chapter introduction

This chapter provides the theoretical underpinnings for persuasion, social judgement theory and fake news in the context of climate change. Various hypotheses are derived from theoretical observations, focussing specifically on the influence of social consensus and source bias on attitudes and how these endure over time. Understanding how these factors influence attitudes in relation to people's anchors, and how they evolve over time helps extend social judgement theory by introducing a dynamic element to social judgement theory that did not exist prior to this study.

2.2. Introduction to persuasion and social judgement theory

There is a rich body of knowledge on persuasion and the number definitions in this regard almost equals the number of scholars in persuasion (Cameron, 2009). Persuasion is a broad term used to denote any communication that is designed to, or has potential to influence people in order to change their mind (Petty & Briñol, 2008) or modify their values, beliefs or attitudes (Dainton & Zelley, 2004). O'Keefe (2016) categorise extant literature on persuasion into three general kinds of theories namely: theories of attitude and psychological processes; theories of voluntary action; and theories of persuasion and social influence. Social judgement theory is one of the theories within the ambit of theories of persuasion and social influence, as are the Elaboration Likelihood Model (ELM) and the Heuristic Systematic Model (HSM). Figure 2.2-1 locates social judgement theory within persuasion theories.

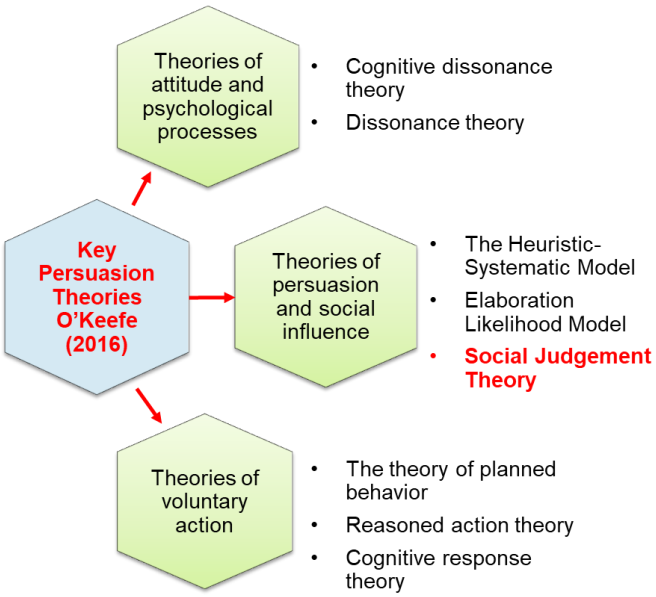

Figure 2.2-1: Social Judgement Theory located within other theories of persuasion as adapted from O'Keefe (2016)

Stefanelli and Seidl (2017) argued that the complexity of the more popular theories within persuasion theory like the Elaboration Likelihood Model (ELM) and the Heuristic Systematic Model (HSM) precluded their usage in their simulation model combining empirical data, and that social judgement theory provided the right balance between complexity and simplification for their study. The selection of social judgement theory in answering the research question posed in this doctoral research study is aligned with Stefanelli and Seidl (2017) rationale of finding the best possible compromise and balance between a suitable theory, a comprehensible model, and empirical information. However, while social judgement theory provides valuable insights into understanding how attitudes shift in relation to people's anchors when they are exposed to persuasive messages, social judgement theory does not provide a complete or adequate account of attitude changes resulting from discounting cues, and it is deficient in explaining how these change over time. It is therefore incomplete as an account of persuasion, and as such lends itself to further development and extension, which this doctoral research set out to do.

2.3. Social Judgement Theory

Social judgement theory explains how people process information and make judgements about persuasive messages in relation to their existing attitudes toward something (Amos et al., 2019), where the individual's involvement in the topic determines how they process information and the individuals' prior attitudes serve as anchor points for judging communication (Lee & Chun, 2016). The origins of social judgement theory can be traced back to the pre-world-war-2 philosophies of the Austrian-American psychologist Egon Brunswik as well as his 1955 publication on probabilistic functionalism (Doherty & Kurz, 1996). Sherif and Hovland (1961) advanced the theory by introducing the concept of ego involvement and anchors (Nicotera, 1995; Park et al., 2007), and in the late seventies Hammond extended probabilistic functionalism and Brunswik's Lens model to social judgement theory as we know it today (Cooksey et al., 1986; Ma & Chang, 2019; Mao et al., 2018). It was developed under the rubric of persuasion theory under the premise that attitude change of an individual is a process of judgement (Chau et al., 2014; Nicotera, 1995).

Social judgement theory is widely used in studies of attitude change and has been applied to an extensive range of applications including Amos et al's. (2019) study on customer views on service perceptions; to Pitas, Mowen, Graefe, and Kyle (2018) application of social judgement theory to help understand how recreationist attitudes relate to sponsorship, their place attachment, and funding preferences. Yablowitz and Raban (2016) used it to investigate investment decision making by comparing information delivered by technology blogs with

information from traditional financial newspapers in digital form. Unfortunately, since studies on fake news is relatively new, applications of social judgement theory in the context of fake news remains understudied.

2.3.1. *The mechanics of social judgement theory*

The central tenet of social judgement theory is that an individual's current attitude towards a topic serves as his or her anchor point, which falls in their latitude of acceptance. The size of the latitude of acceptance is a useful predictor of people's susceptibility to attitude change (Granberg & Steele, 1974). There may be a range of positions on either side of this latitude of acceptance that would be neutral to the individual (Stefanelli & Seidl, 2017b). Beyond these zones that are not objectionable are positions that would be rejected. This is best described through an illustration using climate science, which is the context around fake news that this study is based upon. Figure 2.3.1-1, which was adapted from Benoit (2020), illustrates an individual with a positive initial attitude towards climate science.

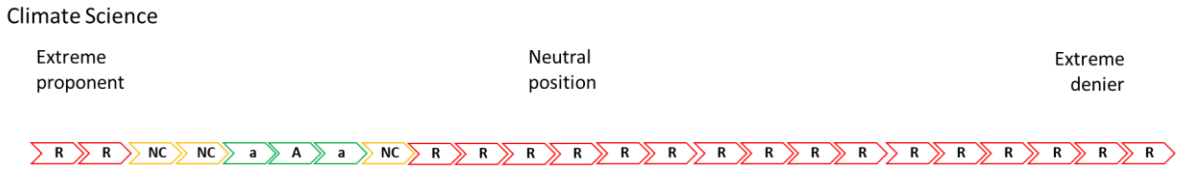

Figure 2.3.1-1: Slightly positive prior attitude towards climate change

The two red zones represented by "R" represent latitudes of rejection. The capital A reflects the current anchor. On either side of this anchor are positions that would be deemed acceptable, represented by "a". The green zone is referred to as the latitude of acceptance. The two yellow zones on either side of the latitude of acceptance are referred to as the latitude of non-commitment, represented by "NC" in Figure 2.3.1-1. There will always by a single latitude of acceptance and a latitude of non-commitment between the latitude of acceptance and any latitude of rejection. While other variations are shown in Figure 2.3.1-2 and Figure 2.3.1.3 to illustrate these concepts, it is important to note that the latitudes can occur anywhere in the continuum (Benoit, 2020).

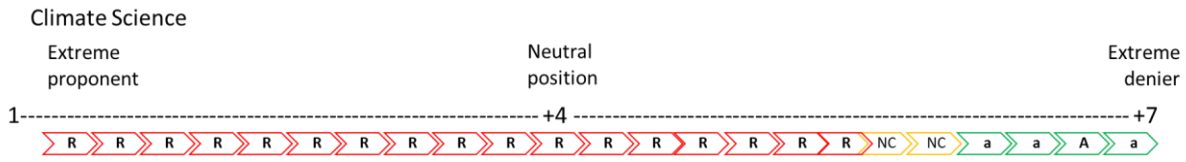

Figure 2.3.1-2 Extreme prior attitude as a proponent of climate change.

Figure 2.3.1-2 represents the latitudes of what could be an extreme denier of climate science. It could be someone like US President Trump (Greenpeace, 2020; McCright & Dunlap, 2017),

and could widen to a broader population if fake news on climate science is allowed to propagate unabated. A typical example at the opposite end of the spectrum could be a Greenpeace activist (see (Greenpeace, 2020)), but this could widen to a broader population as education around climate change increases and as more people become aware of the deleterious impact of climate change. People at either extremity hold with greater certainty their attitudes than people with moderate attitudes (Tormala & Rucker, 2018). Additionally, as attitude certainty increases, people become less inclined to apply thoughtful consideration about attitude- relevant information, and their attitudes becomes more fixed and resilient than people with low attitude certainty (Tormala & Rucker, 2018). Therefore, their latitude of acceptance is much smaller, which is the same for someone who has personal involvement in a subject, or "ego" as it is referred to in social judgement theory (Sherif & Hovland, 1961). Interestingly, social judgement theory positions high involvement as an inhibitor to the acceptance of a persuasive message while the dual-process models such as the ELM and the HSM positions it as a motivator to process persuasive messages, (Park et al., 2007). On the face of it, this may appear to be a contradiction but the difference is subtle. Ego involved people tend to have distorted perceptions of persuasive messages and while they may have motivation to process incoming communications they are not easily persuaded (O'Keefe, 2016).

Although Figure 2.3.1-2 illustrates an extreme position, ego involvement can occur anywhere in the continuum. While ego-involvement and position extremity are empirically related, they are conceptually different (Stefanelli & Seidl, 2017b). Ego speaks to a range of positions covering the significance of the issue to the person including but not limited to the person's personal involvement with the issue, how it defines their self-concept, and the importance of the issue for the individual (O'Keefe, 2016). Ego involvement is the most important factor in determining the widths of the three latitudes (Park et al., 2007). The added significance to the sender is that attempts to persuade people with high ego involvement on a topic is that they may have to settle for smaller levels of persuasion in comparison to those with low levels of ego involvement (O'Keefe, 2016). This resonates with the study on attitude certainty by Tormala and Rucker (2018) who reported that attitudes held with high certainty are more persistent over time, and more durable even when faced with direct change efforts from social influence. Therefore changes in their attitudes would not be rapid but rather incremental (Bechler et al., 2019). The concept is illustrated in Figure 2.3.1-3. Message 2 in Figure 2.3.1-3 would yield the incremental shift in attitude for people with high ego involvement.

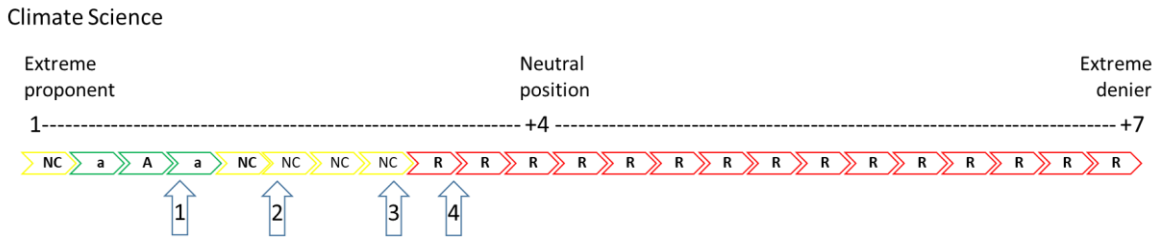

Figure 2.3.1-3: Extreme prior attitude as a climate change deinalist

Figure 2.3.1-3 illustrates four persuasive messages named 1; 2; 3; and 4. Social judgement theory dictates that message 4 will have no persuasive effect as it falls in the latitude of rejection. Messages 1; 2 and 3 will vary in the amount of influence they will exert on attitudinal change. Because message 3 is furthest from the anchor point A, and it is within the latitude of non-commitment, it will exert the greatest amount of influence and result in the greatest shift in attitude when compared to message 2, which also happens to be in the latitude of non-commitment (Doherty & Kurz, 1996). This concept was introduced as distal in Brunswik's original work (Doherty & Kurz, 1996) and is an indication of how discrepant (McGinnies, 1973; Stefanelli & Seidl, 2017b) the message is from the anchor point. Therefore, the more discrepant the message is from a recipient's anchor, the more persuasive it is (Stefanelli & Seidl, 2017b) provided it does not fall within the latitude of rejection. Social judgement theory also dictates that when individuals judge information or judge others' opinions and comments that are not within the latitude of rejection, their attitudes change and their latitude of acceptance as well as the anchor point shifts towards that persuasive message (Sherif & Hovland, 1961). Likewise, their latitudes of non-commitment and rejection will also shift.

There are two perceptual distortions that social judgement theory describe as an error in judgement, namely assimilation and contrast that are relevant to proximate and distal messages of persuasion (Ledgerwood & Chaiken, 2007; O'Keefe, 2016). Message 1 in Figure 2.3.1-3 is very close to the recipient's anchor point, and therefore has the least persuasive effect because the recipient views the message as not different from their own position, even though it is, and therefore assimilates to their own view without a change in attitude. The other error of judgement is the potential for the recipient to exaggerate the difference between their own view and message 3, because it is the most discrepant, that they view it as much further than their own position (O'Keefe, 2016; Stefanelli & Seidl, 2017b). Therefore the greater the distance between the actual message and the recipient's own attitude the more contrast will occur (Benoit, 2020; O'Keefe, 2016). Shamon et al. (2019) also report on an increased likelihood of counter-arguing and resisting counter-persuasion when there is a large discrepancy between recipient's initial attitude and the message. While these errors in judgement makes sense in theory, it has practical constraints requiring messages to be tailor-

made for each participant in relation to their anchor point and the size of their latitudes and their ego involvement. In conclusion, social judgement theory is a static process that accounts for only the positioning of a message in relation to a person's latitudes, and encapsulates all aspects of persuasion under a single umbrella called "a persuasive message".

2.3.1.1. Ordered Alternate Questionnaire

In order to obtain people's positions with reference to the three latitudes, as well as the size of the latitudes, Sherif and Hovland (1961) developed the Ordered Alternatives Questionnaire (OAQ), which they expanded upon in 1965 and Granberg and Steele (1974) operationalised in 1974. This type of questionnaire provides the respondent with a set of nine statements covering a range of possible positions on the issue, with the first and last statements representing the extreme opposites on the issue, and each question in between representing gradual and incremental shifts in position (Smith et al., 2006). The Granberg and Steele (1974) operationalisation asks respondents to first indicate the one statement that they finds most acceptable by placing a capital "A" in the corresponding blank. This represents their anchor. The respondent is then asked to indicate the other statements that are acceptable with a small "a". The one statement that is most objectionable will be marked "R" and the other statements that are objectionable will be marked "r". Those that the respondent is unsure of or is neutral on can be left blank or marked "NC". These instructions would not only be written on the questionnaires, but a classroom environment (which was the original intention of the study) offers the researcher an opportunity to engage with participants to explain the mechanisms around which such a questionnaire would be completed. As will be seen in Chapter 3, the opportunity to engage and provide guidance in a teaching environment is absent with on-line and mobile surveys.

2.3.2. *Gap and shortcomings in social judgement theory*

Inherent to social judgement theory are several implicit assumptions that humans are rational, intentional, and procedural, and that decisions and judgements are based on values (Nicotera, 1995). Rationality makes a presumption of reasoned and logical evaluation of persuasive messages, while intentionality implies the involvement of cognitive processing in decision making and judgement (Nicotera, 1995). These are both associated with the concept of logos described in section 2.5. However, these implicit assumptions within social judgement theory are problematic in the way they tie back to other theories within the rubric of persuasion theory. The assumption that recipients possess the ability and are motivated to apply cognitive processing to the persuasive message is not always true, and as the elaboration likelihood model of persuasion tells us, when people don't have motivation or ability they rely on heuristic cues to process information through the peripheral route (Petty & Cacioppo, 1986). It is also

in contrast with the basic precept of the Heuristic Systematic Model (HSM) which posits that people rely on heuristic cues to relieve themselves from the cognitive effort required to analyse information (Kumkale et al., 2010). In their study on susceptibility to partisan fake news, Pennycook and Rand (2019) found that people blatantly believe fake news and inaccurate news headlines, even though they assess whether the headline is plausible. Their susceptibility to fake news headlines stems from lazy thinking (Pennycook & Rand, 2019), which is in direct contrast to the assumptions of rationality and intentionality as stipulated by Nicotera (1995).

Additionally, the Elaboration Likelihood Model of persuasion informs us that many factors influence how and whether information is processed via the central or peripheral route, including personal relevance (Petty, Cacioppo, & Goldman, 1981); motivation (Shamon et al., 2019); the strength of the argument (Petty & Cacioppo, 1984); the nature of the source of a given communication and context variables (Petty et al., 1997); the person's various individual and situational factors (Petty & Cacioppo, 1984); self-interest (Martin & Hewstone, 2003); the need for cognition (Cook et al., 2004); and source credibility (Albarracín et al., 2017; Tormala et al., 2006). The more one elaborates on a message, the more durable the attitude becomes (Shamon et al., 2019), with a higher likelihood of the new attitude remaining, and forming a resistance towards a counter argument, thereby influencing behaviour (Petty et al., 1997).

These factors would all play a role in establishing people's anchors and while positioning of an argument in relation to anchors are clear, what remains unclear is the impact of discounting cues to an argument, as efforts to counter fake news progresses. Moreover, social judgement theory does not adequately explain how anchors shift over time when people adopt fake news as a tool for persuasion, and aspersions are subsequently cast on them or the veracity of the story. Figure 1.3-1 (duplicated below) illustrates this study contribution towards extending social judgement theory and how the dynamic element is incorporated to social judgement theory as it stands. Of importance is the shift in anchor on the upper half of Figure 1.3-1 is social judgement theory in its current state, while the shift in the lower half is not due to a persuasive message but rather discounting cues and time, and is new to social judgement theory.

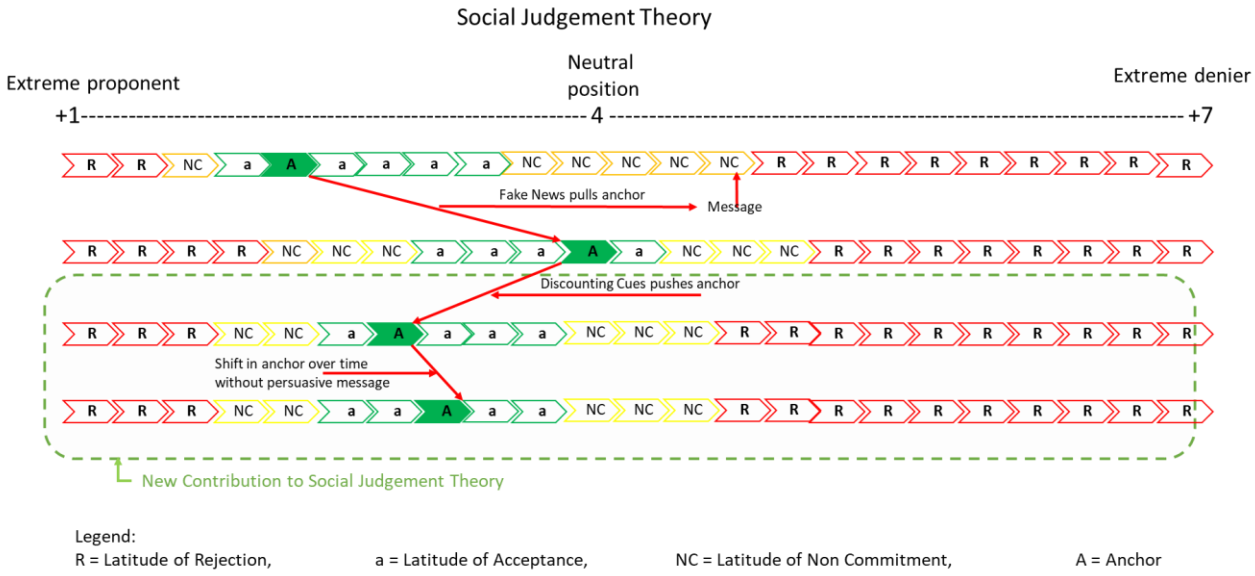

Figure 1.3-1 Study contribution to Social Judgement Theory

2.4. Fake news and truth

Zhang et al. (2019) define fake news as "the online publication of intentionally or knowingly false statements of fact" (p.1036). On the face of it, this definition may appear adequate, but it specifically demonstrates how problematic fake news is in terms of definitional rigour. Firstly, it is not limited to online publication as several news outlets published fake election-related stories during the US elections in 2016 including Fox News and talk radio (Lewandowsky, Cook, et al., 2017; Wallace et al., 2020a). Secondly, the definition provided by Zhang et al. (2019) states that it is intentional. However, it is clear from much research conducted in this area that the spread of fake news is not always intentional. Many authors including Shin, Jian, Driscoll, and Bar (2018); and Wang et al. (2019) have argued that fake news contains two separate branches based on intentionality: misinformation which is inadvertently false information shared without intent to cause harm; and disinformation which speaks to the deliberate spread of knowingly false information.

Much like the term "fake news" struggles with definitional rigour, so does the term "misinformation" as it does not enjoy universal interpretation. As an example Ecker, Lewandowsky, Fenton, and Martin (2014, p.292) define misinformation as "information that is initially believed to be valid but is subsequently retracted or corrected". Clearly this differs from the definition put forward by Shin et al. (2018) and Wang et al. (2019). Perhaps the most detailed analysis of misinformation comes from McCright and Dunlap (2017). They conceptualised misinformation along two dimensions. The first, based on the messenger's

ontological position on truth and facts and the second based on the messenger's typical rhetorical style and primary audience.

Based on this conceptualisation, they derived four types of misinformation: shock-and-chaos; systemic lies; bullshit, and truthiness. An adaptation of the McCright and Dunlap (2017) model is represented in Figure 2.4-1 and the texts in the quadrants were extracted from their publication. These quadrants have porous boundaries that may overlap (McCright & Dunlap, 2017). Of significance to the present study is the lower left quadrant that locates the climate change countermovement and provides some insight into their ontological position and rhetorical style. This is consistent with all other observations throughout the present research study and confirms the emphasis on persuasion that follows later in this chapter.

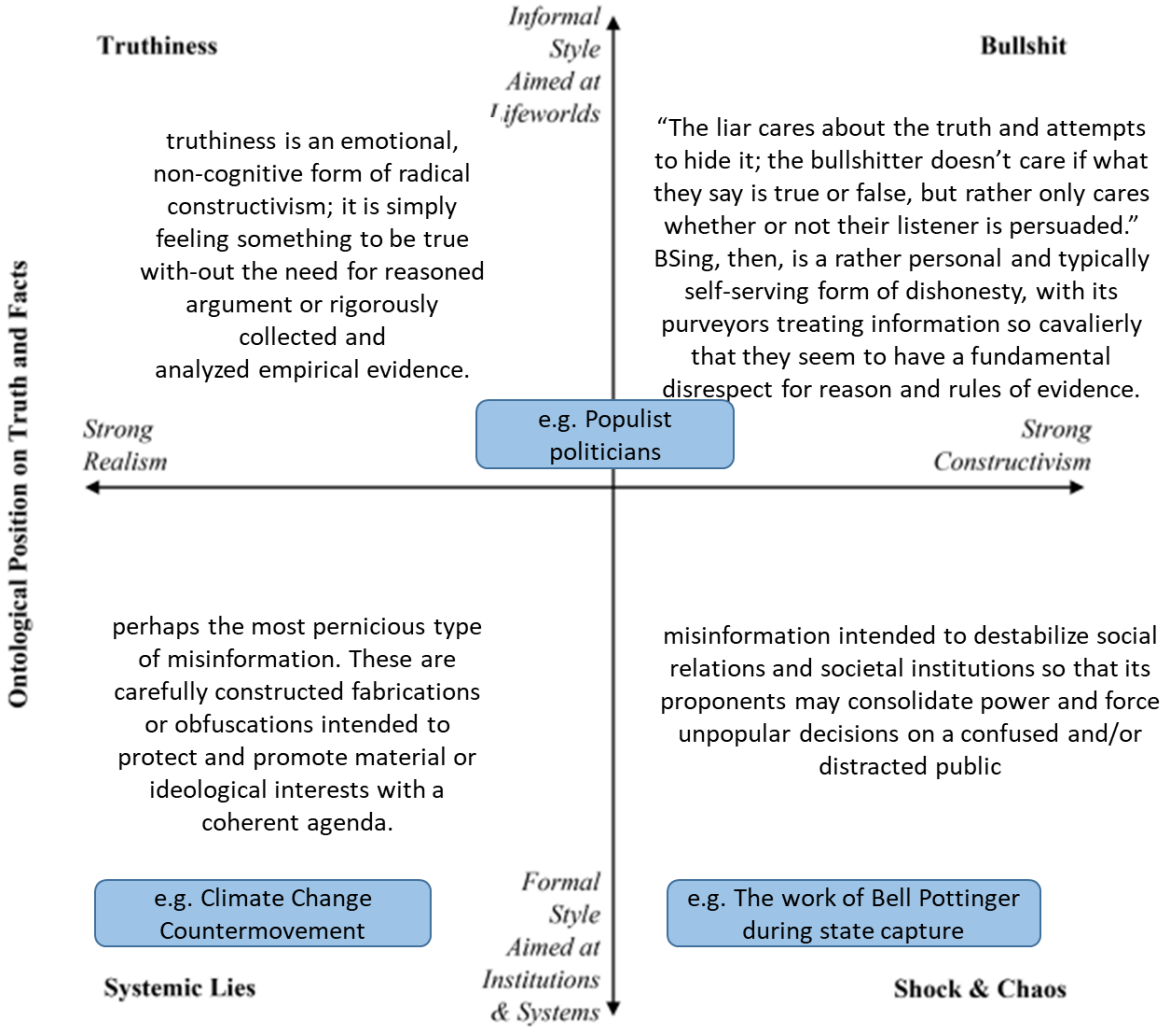

Figure 2.4-1: Types of misinformation as adapted from McCright and Dumlap (2017)

While McCright and Dunlap (2017) made a significant contribution to our understanding of misinformation, their conceptualisation based on ontology and rhetorical style does not differentiate between untrustworthy people and biased people. Wallace et al. (2020a); and

Wallace, Wegener, and Petty (2020b) provide an important distinction between untrustworthy and biased sources where they contend that biased people do not always intend to deceive and could provide their honest perspective about an issue, although it may be skewed, whereas people that are untrustworthy deliberately present false information. From these differing perspectives, it is clear that the concept of misinformation remains unresolved.

The present study does not attempt to resolve the definitional uncertainty in relation to fake news or misinformation. Instead it adopts the model provided by McCright and Dunlap (2017) that positions misinformation with regard to climate science as Systemic Lies. A biased source is therefore viewed as the generator of misinformation that suppresses the truth to protect ideological positions in support of vested interests.

While truth may, on the face of it, appear to be an antonym to fake and falsehood, it in itself is idiosyncratic and can be inferred from positioning of messages, feelings, and consistency with memories, all of which people use in constructing judgements of truth (Brashier & Marsh, 2020b). Truth is therefore subjective and predisposes people to cognitive illusions that are difficult to correct when the facts change because people prefer consistency, and unbelieving requires cognitive processing (Brashier & Marsh, 2020b). Thus, truth is subjective and, in many cases, illusory.

The "illusory-truth effect" (Brashier & Marsh, 2020; Lee & Shin, 2019; Polage, 2012), or "truth effect" is a well-established phenomenon in cognitive psychology where repeated statements are considered more true than new statements, and this is irrespective of their factual basis (Koch & Zerback, 2013). Lewandowsky et al. (2012) report that repetition could create the perception of social consensus even in the absence of such consensus. Repetition results in the fallacious belief of having heard the statement from different sources, and further contributes to the belief in the veracity of the statements, thereby validating and enhancing statement credibility (Koch & Zerback, 2013). This holds true even when those repeated messages have no factual basis, and particularly when statements appear alongside a related picture, in which case the truthiness persists for days (Brashier & Marsh, 2020b). The present study views information and truth as the subjective construction by the recipient of such information as done by Torres et al. (2018), and as Pollicino and Bietti (2018) surmise "truth would arise as the end result of a free exchange of true and false ideas" (p.7).

2.4.1. *The problem with fake news*

Fake news is abundantly evident in politics (Ballew et al., 2020), the tobacco industry (Albarracin et al., 2018), the asbestos industry (McCright & Dunlap, 2017), and more and more literature is being published on the presence of post-truth politics in climate change science (e.g. Colliander, 2019; Lewandowsky et al., 2017; McCright & Dunlap, 2017). The ubiquity of

post-truth politics poses significant risks to national security given its ability to influence national election results and manipulate people's perceptions about each other (Zhang et al., 2019). Not only does it create a distorted perception of reality, with surreptitious influence on beliefs, attitudes and decision making, it may also impact enterprises through loss of competitive advantage or through an adverse effect on their brand and image (Zhang et al., 2019). Fake news can cause unnecessary pandemonium at times of crises, like the Covid-19 pandemic plaguing the world in 2020, resulting in the South African Government issuing warnings about spreading fake news (see 'Fake news - Coronavirus COVID-19', 2020) and gazetting laws that criminalise the intentional publication of anything about Covid-19 that's false, including people's statuses and measures taken by the government (Capetalk567AM, 2020).

It also threatens the established cornerstones of journalism that was built on fact checking and veracity of news (Zhang et al., 2019), and compounded by the powerful amplification inherent in internet's instantaneous communication capability, has resulted in a quantum change in the way misinformation is spread over traditional media (Hsueh et al., 2015). Misinformation leads to suboptimal decisions for individuals and society in general, and more perversely its presence can lead people to not believing in facts altogether (Lewandowsky et al., 2012; Lewandowsky, Ecker, et al., 2017).

Inherent in this post truth world are the foundations for an increased presence of ideological groups online (Ault et al., 2017). This includes climate change denialists who spread propaganda in the advancement of their ideology and protection of their vested interests (Fraune & Knodt, 2018; Lewandowsky et al., 2019), to influence climate change policies through their adoption of a strategy of manufacturing uncertainty (McCright & Dunlap, 2017) intended to deflect attention from climate change caused by human activity. Thus they create the appearance of scientific controversy and uncertainty where there is none (McCright & Dunlap, 2017). Such rhetorical tactics are driven by a deliberate intent to deny the scientific consensus on climate change through the production of denialist content aimed at casting doubt on mainstream climate science positions (Lewandowsky et al, 2017). The fabrication of such denialist content serves as a catalyst in the intensification of readers' opinions and feeds into information polarization, since people have an inclination towards news and stories that are aligned with their beliefs or political preference (Zhang et al., 2019).

2.4.2. *Extant research and measures to counter fake news*

Given its deleterious effects, there has been considerable interest and an increased focus on efforts towards debunking and countering the effects of fake news (Shin et al., 2018). Colliander (2019) summarised the areas of research on fake news to those generally

focussing on: i. the prevalence of the problem; ii. the ways in which fake news travels within social networks; and iii. the ways in which fake news can be corrected or debunked. Research on fake news is still in the early stages, and more and more research is being published on methods to detect fake news (Zhang et al., 2019). Zhang et al. (2019) categorise them into two classes – "linguistic-based methods" and "network-based methods", both of which fall short as solutions for detecting fake news (Zhang et al., 2019).

Gorea and Gorea (2018) report on a successful collaboration between French state institutions and the media in forcing social networks (Facebook, Twitter, Instagram) to delete thousands of fake accounts in an attempt to clampdown on fake news during their 2017 elections. However, there is a fine line between honest legal measures of media censorship on the one hand and freedom of expression on the other. Therefore, what appears to be a simple solution of forcing social networks to manage the spread of fake news is not that simple after all, and there has been a considerable amount of research done on ways to debunk or counter it.

Such research encompasses a vast range of domains including but not limited to the corrective influence of fact checking (Fridkin et al., 2015), prior attitudes (Ecker et al., 2014), confirmation of validity (Torres et al., 2018), influence of biased online comments (Hsueh et al., 2015), partisan attitudes on the processing of retractions (Ecker & Ang, 2019), the comparative effects of implied versus explicitly stated misinformation (Rich & Zaragoza, 2016) and the categorisation of misinformation and the factors that facilitate its resonance and spread (McCright & Dunlap, 2017). While this list is far from exhaustive, it is generally agreed that corrections alone is not an effective mechanism with which to debunk fake news, especially corrections that simply encourage people to consider the opposite of the initial information, as these often end up strengthening the misinformation (Chan et al., 2017), and people's reliance on discredited information continues even when they can remember and report the correction (Ecker et al., 2014). This is especially so when there is a causal explanation between the misinformation and a newsworthy outcome (Rich & Zaragoza, 2016), or when the corrected misinformation corresponds with a person's worldview (Ecker & Ang, 2019).

A person's worldview or prior attitude play a significant role in understanding the persuasive effects of fake news and in the correction thereof (Ecker et al., 2014). Additionally, people continue to rely on misinformation irrespective of when the correction of such misinformation occurs; regardless of the number of times the correction is presented, and even when people are warned about dishonest information in news reports (Rich & Zaragoza, 2016). Thus, corrections reduce people's reliance on misinformation but both misinformation and the correction thereof remains in memory (Ecker et al., 2014; Rich & Zaragoza, 2016).

2.5. Persuasion in the context of fake news and climate change

The most renowned work on persuasion and the theoretical underpinning of rhetoric is undoubtedly derived from Aristotle's seminal work '*The Art of Rhetoric*', which describes the theory and practice of persuasion (Davoudi et al., 2020). Aristotle described three forms of rhetorical persuasion: *Ethos* [moral character], *Pathos* [emotion] and *Logos* [argument and logic] (Shanahan & Seele, 2015). Within Ethos, arête or virtue is viewed as the most prominent in persuasive appeals (Shanahan & Seele, 2015), with its subset- source credibility - established as one of the cornerstones of persuasive communication (Albarracín et al., 2017). Logos speaks to quasi-logical reasoning and application of logic and rationality for messages to be received as natural (Davoudi et al., 2020), with strong arguments based on the rules of logic enjoying equal importance to source credibility in persuasive communications (Albarracín et al., 2017). Since pathos violates the very basis of logic and rationality inherent within logos, it is perhaps the most contested of the rhetorical appeals but is used most often in motivating political action as it relies on emotive language to trigger emotions and the affective registers (Davoudi et al., 2020).

Davoudi et al. (2020) described a fourth form of persuasion called *Doxa*, which was introduced in Plato's teachings, and which speaks to assumed knowledge, opinion, and self-identity, arguing that in order for persuasive appeals to be effective, it is imperative that the disposition (or situated character) of the audience is known and considered. They further argued that the four persuasive appeals often work simultaneously when adopted by political ideologists in implementing strategies that aim to legitimise their ideologies, and incorporate them into planning processes. Plato viewed doxa as a tool for manipulation with no investment in knowledge and discarded it as being inferior to episteme (Clark & Zhang, 2018). However the rise of social media together with the increased use of internet blogs and in particular the comments section to disseminate contrarian positions on many scientific issues including climate change suggests that we may be in an age where doxa has triumphed over episteme (Clark & Zhang, 2018). Doxa is not limited to the individual and incorporates common belief, which when manifested as social consensus and conformity can influence the spread of adversarial positions questioning established positions on climate science (Lewandowsky et al., 2019; Clark & Zhang, 2018).

Therefore, the spread of misinformation regarding climate science is ultimately an extension of persuasion theory where the intention is to frame and redirect public discourse towards the advancement of ideological interests (McCright & Dunlap, 2017) in order to influence people's attitudes and technological choices (Fraune & Knodt, 2018). This is of concern because, with 2016 having been confirmed as the warmest year on record and the global average temperature continuing to rise over the past two decades (Heard, Brook, Wigley, & Bradshaw,

2017), climate change is now considered to be one of this century's most serious problems (Pegels, 2010). This rapid increase in the average global temperature can be attributed to the combustion of fossil fuels (Harjanne & Korhonen, 2019) and the rapid rise of atmospheric concentration of carbon dioxide (Heard et al., 2017), with human activity a leading contributor to global warming (Pegels, 2010). The growing body of evidence attributing human activity and anthropogenic greenhouse gas emissions as the cause of the planet's environmental challenges necessitates rapid (Heard et al., 2017) concerted (Gielen et al., 2019) and coordinated (Krupa & Burch, 2011) policy efforts to employ alternatives to fossil fuels in order to effectively respond to climate change demands.

However, in spite of the overwhelming evidence attributing human activity to anthropogenic greenhouse gas emissions, climate change remains a highly politicised and divisive issue in the United States (Ballew et al., 2020; McCright & Dunlap, 2017). Importantly, this is neither a new nor uniquely western phenomenon with populist leaders in sub-Saharan Africa having long prioritised political gains over energy legacies (Trotter & Maconachie, 2018). There is much evidence that populist political leaders use post-truth claims to secure popular support, where truth in a particular statement becomes subjective and constructionist as long as they are able to persuade the population (Fraune & Knodt, 2018; Trotter & Maconachie, 2018). Evidently, persuasion and the ability to influence are key instruments that climate change denialists adopt to spread propaganda in the advancement of their ideology and protection of their vested interests. Petty and Briñol (2008) argue that in psychological literature, people's attitudes are the most common target of persuasion, because of their influence on choice and action.

2.6. Attitudes

Attitude change is a determining factor of behaviour change (Petty, Heesacker & Hughes, 1997), and as O'Keefe (2016) aptly contend, attitude is *primus inter pares* (first among equals) in persuasion theory and in the research thereof. Hence, in applying social judgement theory Pittman et al. (2021) studied attitudinal changes while comparing the effects of fear and information in green advertising on non-green consumers, using attitude change as a proxy for anchor change. Dainton and Zelley (2004) define attitude as "a relatively enduring predisposition to respond favorably or unfavorably toward something" (p.104). Therefore initial attitudes exert a powerful influence on judgements when new information is evaluated (Kumkale et al., 2010). Also, people are most likely to support an argument if it is aligned with their previous attitude towards a subject, and the extremity of the initial attitude influences their desire to defend their initial attitude, even when strong arguments are made that oppose their view (Shamon et al., 2019). Together with persuasion, attitude change is among the most

widely studied branches of social psychology (Bechler et al., 2019) as it is a key factor in guiding choices and action (Petty & Briñol, 2008). Based on the literature review established above, it is hypothesised that exposure to fake news will result in a change of attitude and an associated shift in anchor as established by social judgement theory. Hypothesis 1 therefore reads:

> *H1: Exposure to fake news in climate science will lead to a shift in anchor, towards the position established by that fake news.*

Studies on fake news are increasingly focusing on attitudes to better understand how to counter fake news, and the rapid increase of misinformation on social media has resulted in an increase in the number of studies exploring the persuasive effect of user comments on attitudes (e.g. Colliander, 2019; Lewandowsky et al., 2019a). Colliander (2019) looked into the role of social consensus in attitude formation and people's propensity to spread misinformation. He found that conformity to other user's comments plays a significant role in guiding people's responses to fake news and could be an important factor in countering fake news. Conformity is a social phenomenon that explains an individual's desire to conform to the actions of others (Colliander, 2019).

Furthermore, Colliander showed that disclaimers from social media companies or network which alerts individuals to the fact that the news might be fake is less effective than critical comments from online users in influencing people's attitudes towards that fake news. By testing people's attitude changes when exposed to other online user responses, they were able to show how attitudes towards fake news aligned with user comments both in support of or critical of fake news stories. In other words, negative attitudes towards fake news increases when people see user comments that are consistently critical of the article or the poster. This finding is consistent with Lewandowsky, Cook, Fay, and Gignac's (2019) observation that people tend to copy the behaviour of others when they are uncertain about their own views, especially so as the size of that majority increases.

Both Colliander's (2019) and Lewandowsky et al's. (2019) work explored the persuasive effect of user comments on attitudes, but neither analysis took account of the influence of time on these attitudes, nor did they intend to examine the durability of attitudes formed as a result of exposure to fake news. This is a common challenge in studies on attitudes and despite the importance of attitudes in persuasion, its durability has received remarkably little empirical attention in the field of social psychology, even though they often don't remain stable over time (Luttrell, Petty, & Briñol, 2016). Luttrell, Petty, and Briñol (2016) attribute this to the practical difficulties of measuring attitudes at different points in time in longitudinal studies.

2.7. Social Consensus

The concept of individualism versus collectivism has recently come under scrutiny in relation to attitudes and beliefs in the post-truth era. Lewandowsky, Cook, et al. (2017) provide a definition for these terms as

> Individualism is “a view of the self as self-directed, autonomous, and separate from others,” and it stands in contrast to collectivism, which refers to an “interconnected view of the self that overlaps with close others, with individuals’ thoughts, feelings, and behaviors embedded in social contexts” (p.420).

Lewandowsky, Ecker, et al. (2017) argued strongly that understanding the post-truth world is not limited to individual cognition and encompasses a larger political, technological, and societal context, and coined the term technocognition which explores more than individual cognition but blends with technology. As a result, their list of six societal trends that may have contributed to the emergence of this post-truth world excluded individualism. However, Santos, Varnum, & Grossmann (2017) challenged Lewandowsky, Cook, et al.'s (2017) exclusion of individualism by providing argument through their analysis of data spanning 51 years and 78 countries that individualism is on the rise globally, and that this shift is not restricted to developed countries. They did acknowledge that this differs across cultures. In a follow-up paper, Lewandowsky, Cook, et al. (2017) acknowledged individualism as a ‘principal driver’ that lead people to reject many entrenched scientific positions, specifically climate change and conceded that it be included in their list. Ballew et al. (2020) echoed Santos et al.'s (2017) observation about individualism and attributed partisan polarization on climate change in the US to individualism. This is consonant with Kumkale et al's. (2010) observation on how a persuasive communication is processed in the judgement process that begins with the individual’s interpretation of the message as well as retrieval of information from their memory. Jost, Pünder, and Schulze-Lohoff (2020) agreed and positioned the individual processing phase as the starting point of the judgement formation in their framework for judgement in the context of fake news, which is shown in Figure 2.7-1.

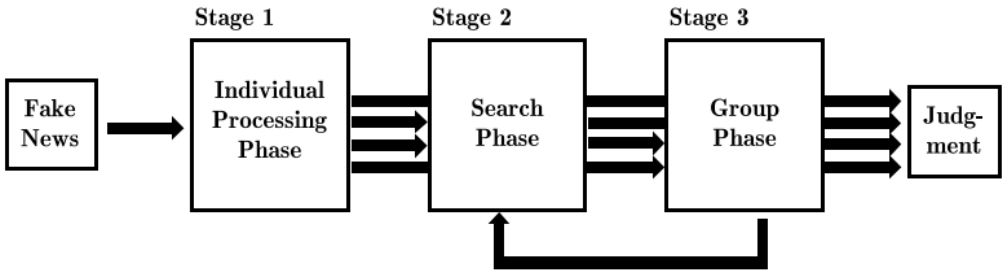

Figure 2.7-1: The process of judgement formation in the context of fake news. Source: Jost, Pünder, & Schulze-Lohoff (2020, p2)

In this framework, stage 1 sees the individual either making a judgement about an aspect of the subject of the received news or of the credibility or trustworthiness of the received news (Jost et al., 2020). Jost et al. (2020) posit that these assessments serve as an anchor when it comes to information processing and judgement formation, even though these are subjective judgements under uncertainty, and relying on heuristics like the appearance of authenticity or credibility of the source (Torres et al., 2018). Therefore the judgement process as it relates to misinformation begins with the individual level cognitive processes that relies on cues that inform attitudes (Lewandowsky et al., 2012).

With the definition of collectivism provided earlier, specifically in relation to behaviours embedded in social contexts, it begs the question of how and where social consensus and social conformity fits into a world shifting towards individualism. This is especially relevant in light of Colliander (2019); and Lewandowsky et al's. (2019) findings in separate and independent studies, that the attitudes and beliefs of blog-post readers are influenced by the opinions of other readers. Additionally Lewandowsky et al. (2019) found that people support an argument in a post more when it was endorsed by reader comments agreeing with the post irrespective of its content, and Colliander (2019) found that conformity to other's behaviour extends to individuals even in cases where they contradict their own convictions, and further posit that even people's own memories are influenced by the recollections of others. Kumkale et al. (2010) added that in the absence of ability or motivation to consider a message, or when an attitude is formed for the first time in the absence of other valuable information, people rely on cues like social consensus to the same extent as they rely on source credibility, message length, argument strength and number of arguments in forming a judgement. On the face of it, the role of social consensus therefore appears to sit contrary to the observed shift towards individualism globally.

Tormala and Rucker (2018) offer some insight into solving this contradiction. When attitudes are formed, people gain certainty in their own attitudes when they perceive that others share their views and evaluation of a persuasive message (Tormala & Rucker, 2018). Luttrell et al. (2016) define attitude certainty as "a subjective sense of conviction in one's attitude or the sense that one's attitude is valid" (p.57). Such attitude certainty arising from social consensus reinforces their belief that they either have accurate information or that they have made an accurate assessment of the information available (Tormala & Rucker, 2018). Attitude therefore starts with the individual and social consensus is sought to validate opinions. This is consonant with the Jost et al. (2020) framework, shown in figure 2.7-1, where reliance on the opinion of others forms part of the stage 2 process.

Conformity is a powerful social phenomenon that shapes and changes people's attitudes, drives people to conform to the behaviours of others, and is underscored by people wanting to gain social approval of others through building rewarding relationships, thus enhancing their self-esteem and defining their self-identity (Colliander, 2019). It also manifested in cases where people change their behaviour to match the responses of others (Cialdini & Goldstein, 2004), and is even evident in people from a very young age (van Kleef et al., 2019). Norm adherence has been observed in infants before they master formal language, and in citing the work of Vaish, Missana, & Tomasello (2011), van Kleef, Gelfand and Jetten (2019) describe how toddlers actively began to berate norm violators even before they reached the age of three. It is explained by a fundamental motivation in humans to create and maintain meaningful social relationships with others (Cialdini & Goldstein, 2004).

Interestingly, such relationships can even occur among anonymous internet users (Colliander, 2019). The significance of perceived social consensus on opinion formation was further endorsed by Lewandowsky et al. (2019) who found that blog comments unanimously endorsing or rejecting the contents of a post influenced consensus amongst readers. While conformity together with perceived social consensus can be instrumental in influencing people's attitudes, Lewandowsky et al. (2019) argued that its full effects on people's attitudes are yet to be completely understood.

The Jost et al. (2020) study used an experiment where participants had no prior knowledge of the topic of the experiment to test their framework for judgement in the context of fake news, as shown in Figure 2.7-1. They did not explore how judgements that have already been formed, through ego or personal involvement and prior knowledge, change upon seeking the opinion of others online in stage 2 and communicating with others in stage 3. It is expected that fake news will result in a primary shift in a person's anchor. It is hypothesised that social consensus as a discounting cue will then influence this primary shift in anchor, moving it towards the person's original anchor. Hypothesis 2 therefore reads:

> *H2: The shift in anchor after exposure to fake news will be influenced by social consensus from user comments proclaiming the story to be fake news.*

2.8. Source Bias

Since Aristotle described arête or virtue as one the most prominent persuasive appeals in his Art of Rhetoric, source credibility has remained firmly established in the psychology of persuasion as one of the cornerstones of persuasive communication (Albarracín et al., 2017). Cheung et al. (2012) define credibility as "believability or the characteristic that makes people believe and trust someone or something" (p.619). Highly credible sources produce more favourable attitudes and offer more persuasive appeal than low credibility sources, as they

produce higher influence on people's confidence in the thoughts (Cameron, 2009; McGinnies, 1973; Petty et al., 1997; Tormala et al., 2006; Wallace et al., 2020a). Source credibility also serves as simple acceptance or rejection cues with significant influence on people with low motivation or ability (Cheung et al., 2012; Kumkale & Albarracín, 2004; Zha et al., 2018), and less so when people have prior knowledge of the subject (Kumkale et al., 2010).

Furthermore, it is well established in persuasion literature that the degree of influence of a persuasive message largely depends on the recipient's perception of the source's expertise and trustworthiness (Cheung et al., 2012; Tormala et al., 2006). In fact, studies on persuasion have widely entrenched trustworthiness and expertise as a proxy for source credibility (Wallace et al., 2020a) and have historically conflated source bias with untrustworthiness (Wallace et al., 2020a, 2020b). However, they are not the same and as Wallace et al. (2020a) point out, a biased source is one that is motivated to adopt a certain position and may believe in that position, while an untrustworthy source exercises a choice to be dishonest. As a result their consequences can differ quite distinctly from one another (Wallace et al., 2020a). Therefore, a credible source can be viewed as a communication medium that not only provides correct information, but does so relatively free of bias (Visentin et al., 2019). It would therefore be expected that while fake news will result in a primary shift in a person's anchor, aspersions cast over the neutrality of the source would create attitude uncertainty in the recipient of that fake news story, which will then influence this primary shift in anchor. Hypothesis 3 therefore reads:

> *H3: The shift in anchor after exposure to fake news will be influenced by a discounting cue demonstrating that the source of the fake news story is biased.*

2.9. Durability of attitudes

The increased use of social media has seen an increased presence of ideological groups online (Ault et al., 2017) and a quantum change in the way misinformation is spread (Wang et al., 2019). This is the result of the powerful amplification inherent in internet's instantaneous communication capability and the evolution of the once unidirectional medium of communication to one where users are interactive and readers become contributors (Hsueh et al., 2015). In this evolved web, user-comments may be more influential than the source of the content (Hsueh et al., 2015), which conventional persuasion theory established as a bedrock of persuasion and attitude formation (Cheung et al., 2012; Kumkale et al., 2010; Zha et al., 2018). Given this transition associated with the rise of social media, together with the increased use of internet blogs and in particular the comments section to disseminate contrarian positions on many scientific issues including climate change, it could be argued that we may be in an age where doxa has triumphed over episteme (Clark & Zhang, 2018). In this

new reality, social conformity may exert a greater persuasive effect than a biased source, but how durable is this influence on attitudes?

Albarracín et al. (2017) argue that the literature on the persuasive effect of credible sources and strong arguments is extensive, yet the durability of attitudes from credible communicators is not clear. People often forget details of the source even if they notice that a source is questionable (Brashier & Marsh, 2020b). The delayed increase in persuasion observed when the memory of an untrustworthy source fades faster and becomes dissociated from the message itself is known as the sleeper effect.

In addition, there is overwhelming consensus in literature that while corrections reduce dependence on misinformation, such misinformation is not completely disregarded (Crozier & Strange, 2019; Ecker et al., 2014; Ecker & Ang, 2019; Lewandowsky et al., 2012; Seifert, 2017), and the memory of the newer correction decays at a faster rate than the memory of older misconception, according to Jost's law (Brashier & Marsh, 2020). The continued reliance on information known to be false is known as the continued influence effect. These two concepts in relation to the influence of time and durability of attitudes are discussed in more detail next.

2.9.1. *The Sleeper Effect*

Since its "discovery" during World War II and published in 1949 by Hovland, Lumsdaine and Sheffield, the sleeper effect has been the subject of many studies e.g. (Greenwald et al., 1986; Heinbach et al., 2018; Kumkale & Albarracín, 2004) to understand the time effect of persuasive messages that are from sources that are not trustworthy. It has been found that favourable attitudes towards a persuasive message may increase over time, despite cues refuting the message (Heinbach et al., 2018). Fundamental to the manifestation of the sleeper effect is that the cues must be disclosed only after the persuasive message is communicated otherwise the cue becomes associated with and attenuates the persuasive message (Heinbach et al., 2018). The mechanism by which the sleeper effect works is the differential decay between the cue and the message that sees the memory that the message was from an untrustworthy source erode at a faster rate than the persuasive message itself such that after time the persuasive effect remains or increases and the disclosure that the source was untrustworthy, forgotten (Albarracín et al., 2017; Heinbach et al., 2018; Kumkale & Albarracín, 2004).

2.9.2. *The Continued Influence Effect*

The literature on persistence of erroneous beliefs after correction of misinformation is extensive and complex (Lewandowsky et al., 2012). In this regard, misinformation and the correction coexist in memory, with people continuing to rely on discredited or invalidated information even after they demonstrably remember the correction information, in what's referred to as the continued influence effect (Ecker & Ang, 2019; Lewandowsky et al., 2012; Rich & Zaragoza, 2016). There is overwhelming consensus in literature that while corrections reduce dependence on misinformation, such misinformation is not completely disregarded (Crozier & Strange, 2019; Ecker et al., 2014; Ecker & Ang, 2019; Lewandowsky et al., 2012; Seifert, 2017). One explanation is Jost's law (Brashier & Marsh, 2020a) as described in section 2.7, and another is offered by both the Elaboration Likelihood Model (ELM) and the Heuristic-Systematic Model (HSM). According to these theories, the higher cognitive processing associated with analysing strong arguments by those with ability and motivation results in that message being stored in memory for a longer period than the heuristic influence of a discounting cue, which due to its effortless processing will be short lived (Kumkale & Albarracín, 2004).

Drawing from literature demonstrating the influence of time on attitudes, as described by both the sleeper effect and the continued influence effect, it is anticipated that the persuasive effect of a strong argument in a fake news story will endure longer than the memory of an untrustworthy source or user comments that the story is fake. Hypothesis 4 therefore reads:

> *H4: Over time, anchors will shift back towards the position established after exposure to fake news, with the memory of an untrustworthy source or user comments that the story is fake, eroded.*

2.10. Chapter conclusion

Although the formal definitions on fake news and misinformation, are yet to be resolved, it is clear that there are many challenges associated with fake news and correction of misinformation is complex and is still not completely understood. Additionally, in spite of the overwhelming evidence attributing human activity to anthropogenic greenhouse gas emissions, climate change remains a highly politicised and divisive issue, with the climate change countermovement employing a strategy of manufacturing uncertainty to protect their vested interests. As such, they are biased in the messages they produce, even though they aim to come across as credible - typical of systemic lies as categorised by McCright and Dunlap (2017). Furthermore, it has been shown that social consensus impacts attitudes, and

a study that explores the relative impact of these two constructs (source bias and social consensus) over time would contribute towards the fight in countering fake news. Of note is the theoretical contribution of this study, which introduces a dynamic element to social judgement theory. Social judgement theory was identified as the theoretical anchor for the study to answer the research question posed in chapter one, and hypotheses were identified in relation to answering these questions. The mechanism to answer the research questions is based on a positivist ontology, utilizing quantitative methods, and the research methodology is described in more detail in the chapter 3.

3. Chapter 3 - Methodology

3.1. Chapter introduction

The experimental methods and the statistical techniques used to test the hypotheses as established in chapter two are described in this chapter. There were two pilot studies conducted prior to the main study. This chapter describes all three studies, as well as the manner in which the questionnaires evolved from the pilots to the main study. Included in this chapter are the basis for the vignette used as the persuasive message as well as the discounting cues utilised as the independent variables. Additionally, manipulation tests are discussed in detail, as are tests for validity and reliability, including the treatment of missing data. The chapter concludes with a discussion on the ethical considerations applied in the execution of this research.

3.2. Philosophical underpinning

The philosophy that underpins this research is positivism, which is generally associated with quantitative research (Saunders, Lewis, & Thornhill, 2016). It conceptualises causality (cause and effect) to achieve explanation or prediction in a "universality of closed systems" (Sousa, 2010, p.464). An explanation explores why and how events and conditions occur or trends develop without paying too much attention to their significance or meaning (6 & Bellamy, 2012). The research is based on an empirical realist ontology, with an underlying assumption that the methodologies adopted in the natural sciences could be extended to the social sciences, where research evidence is based on "observable, perceptible, measurable, and quantifiable" (Sousa, 2010, p.465) data, as opposed to being socially constructed.

Aligned with a positivist philosophy, this research is based on an objective reality that subscribes to the view that concepts must be operationalised and measurable, and that problems are better understood and addressed if complexity is reduced to basic measurable elements.

3.3. Research design

This study explores the relative influence of social consensus and source bias on attitudinal resilience, durability, and people's anchors. It is a quantitative, longitudinal study that is experimental in nature, and measures attitudinal changes (dependent variable) over time. The flow chart in figure 3.3-1 represents the research design for this study and illustrates where the hypotheses were located.

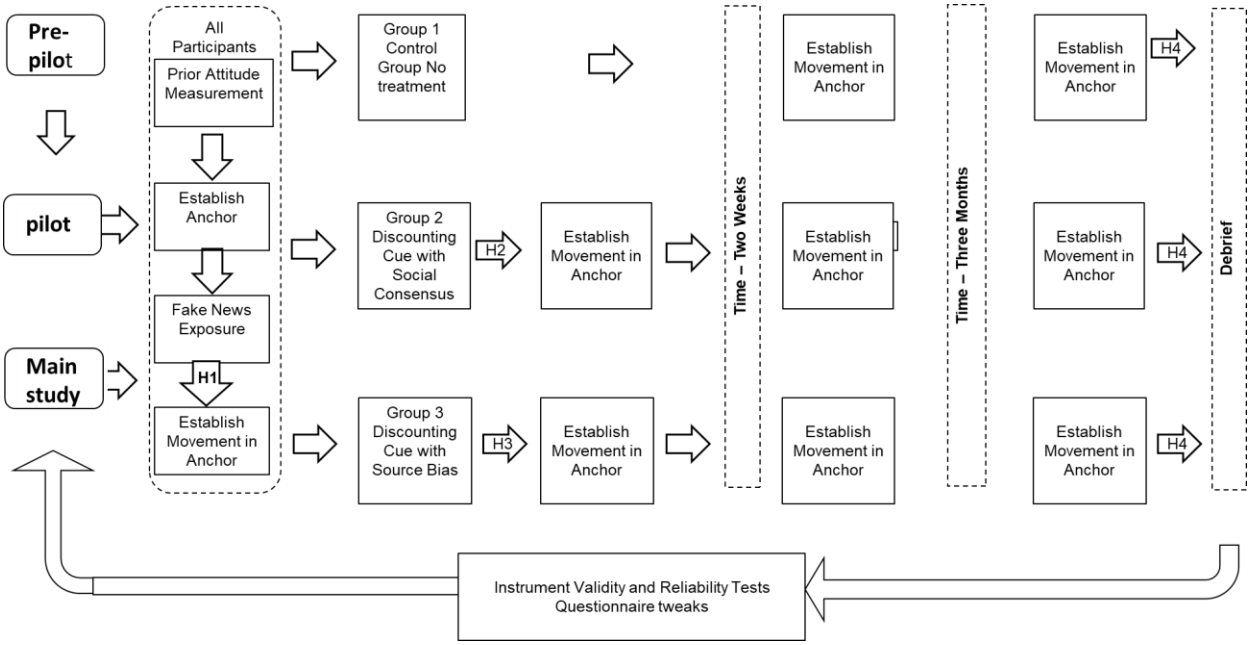

Figure 3.3-1 Flow chart depicting Research Design

Attitudinal change is at the heart of this study, and the obvious and most common mechanism to gauge attitudinal change is by measuring attitudes at different points in time, prior to and after manipulation or treatment, and comparing differences in the degree of change (Bechler et al., 2019) In keeping with this principle, participants in all groups of the pilot and main studies were asked four questions, on a 7 point Likert scale (SA-SD) to record their initial attitudes. This four-point scale was tested extensively during the pilot study for internal and external validity, and reliability. This chapter is based predominantly on feedback and data from the first pilot study and the second pilot study. The results are captured in section 3.13. In accordance with the methodology described by Colliander (2019), the mean score of the measures was calculated to represent each participant's initial attitude. This was done on SPSS 27. All participants were then given a fabricated fake news message (vignette) from a climate change denialist, as shown in Annexure 1, with strong arguments that deny the science around climate change. The vignette was adopted from the fake news vignette utilised by Lewandowsky et al. (2019), and adapted after feedback from the pre pilot study. Thereafter, all participants were asked to indicate how much effort they put into reading the message and were asked two questions to gauge their understanding of what they had read. Attitudes were measured again using the same instrument that was utilised to measure the initial attitude. The same methodology was used to determine participant's attitudes throughout the study.

Aligned with established literature on the sleeper effect (Foos et al., 2016; Heinbach et al., 2018; Kumkale et al., 2010; Kumkale & Albarracín, 2004), a follow up assessment was conducted in the pilot and main study two weeks after the initial study, as a test for the sleeper effect as described in chapter 2. Prior to gauging attitudes, participants were asked whether they had been exposed to any information about climate science since the initial survey, and if so whether this had influenced their opinions / attitudes towards climate change. Those that responded that they had been influenced by external sources were subsequently removed from the analysis.

One of the problems that affects questionnaire based research studies such as this is common method variance (CMV) bias (Gorrell et al., 2011). This is widely addressed using different respondents (Podsakoff et al., 2012), but since this study is a within-between study, the use of different respondents is not possible. Podsakoff et al. (2012); and Rindfleisch et al. (2015) suggest temporal separation as an alternative to reduce CMV bias when the use of different respondents is not possible. Wang et al. (2014) contend that a two-week lag (which characterises most studies on the sleeper effect) do not adequately overcome the challenge of reducing common-method variance bias between the predictor and criterion variables. In their longitudinal study (not related to the sleeper effect) on organizational career growth and subsequent voice behaviour, Wang et al. (2014) adopted a three-month interval between data collection to minimize common method error variance, contending that it was a good balance between minimisation of CMV bias and event recollection. Mindful of the practical constraints that longitudinal studies present with regard to attitude measurement at different points in time as observed by Luttrell, Petty, and Briñol (2016), this study adopted the Wang et al. (2014) methodology in setting the time interval between the initial survey and the final survey at three months to reduce CMV bias.

Importantly, this experimental research consisted of two pilot studies and a main study. The first pilot was a cross sectional study to test how user friendly, realistic, and workable the questionnaires were. It proved exceptionally useful in identifying areas for improvement on the questionnaires, but data analysis was not done since there were only 12 participants recruited through purposive sampling. Since data analysis was not done on the first pilot, the second pilot in chapter 4 (data analysis) is referred to as the pilot study, while the main study is referred to as the main study. The second pilot was a longitudinal study that extended over three months and tested a much larger audience compared to the first pilot. It was used to gauge the effectiveness of the changes implemented from the first pilot, as well as conduct tests for reliability and validity of the instruments used. The second pilot randomly divided participants who had opted into the study via an opt-in link, and in total there were 75 respondents to the

second pilot study. Learnings from both pilot studies informed the final questionnaires used for the main study.

3.4. Research Method

Kumkale and Albarracín's (2004) meta-analytic review of the sleeper effect in persuasion showed the vast majority of attitude studies were conducted in a laboratory or classroom setup. Tormala, Briñol, and Petty (2006) also showed the effectiveness of a classroom setting for attitudinal change studies, and Petty, Heesacker and Hughes (1997) provided numerous examples of studies on the Elaboration Likelihood Model (ELM) where students in a classroom environment were utilised as the subjects. Additionally, Karasmanaki and Tsantopoulos' (2019) observed that university students are in general more conscious of their environmental footprint, and that students would associate with climate change better than the general public. Importantly, attitudes and perceptions are subjective by nature and soliciting such requires participant's self-awareness and ability to articulate these, especially if they have not fully formed a clear opinion having never before considered certain aspects that may be present in a questionnaire (Clifton & Carrasco, 2018).

Based on these observations, the original intent of the research was to conduct surveys in a classroom environment. When the research proposal was formulated, the long-term impact of Covid 19 on face-to-face contact in a classroom environment was not fully understood, as it was in the very early days of the Covid 19 pandemic. As a proactive measure the questionnaires were modified to suit online surveys, and with the ubiquitous nature of mobile phones, the questionnaires also accommodated participant's completion of surveys on mobile phones. All three studies in the research were conducted during the Covid pandemic, with no face-to face contact.

As opposed to quasi-experimental research where participants are not randomly chosen, this study randomly divided participants into three groups where participants in the control group (group 1) only received the fake news article and were not exposed to discounting cues. The first treatment group (group 2) received discounting cues for the first independent variable (social consensus) represented by user comments uniformly berating the article as fake news while providing reasons for their assertions, while the second treatment group (group 3) received discount cues for the second independent variable (source bias) represented by letters to the editor indicating the source has vested interest and is biased. The discounting cue received by group 3 did not challenge the contents of the article but spoke only of source bias.

A database was established on Excel to keep track of when participants were sent the initial survey and when they completed them. This informed the reminder prompts as well as when

the follow-up surveys would be sent. Since the surveys were conducted on-line, there was no control over when participants would actually complete the surveys, and reference to the two-week survey is actually an approximation as the follow-up surveys were sent to participants two weeks after the initial survey. The same applies to the three-month surveys.

At the end of the data collection phase, participants were sent a debrief as described in section 3.12 and captured in Annexure 4. This was not only sent to participants who had completed the study, but was sent to all participants who had opted-in to the study, including those that partially completed surveys and those who left prior to taking the first surveys.

3.5. First Pilot study

The first pilot was conducted on-line using questionnaires developed on Qualtrics software under licence of the University of Pretoria. A purposive sampling method was used, and upon receiving ethical clearance, questionnaires were sent to twelve participants that would not be part of subsequent studies. There was a 100 % response rate. This first pilot study provided valuable insight into the workings of Qualtrics and helped avoid challenges that could have been disastrous in the bigger studies. A key learning included the need to publish before distributing surveys otherwise participants receive working copies of the questionnaires, and in some cases did not receive all questions. Fortunately, those affected were amenable to retaking the surveys when this and other minor challenges were addressed. On agreement, some subjects participated in more than one group, and this was welcomed as data analysis was not conducted on this study.

Feedback from participants was crucial in improving the overall user-friendliness, realism, and workability of the questionnaires. Importantly, the first pilot proved invaluable in informing changes to the vignette including reducing its length and highlighting certain text with bold font to emphasise some points made in the vignette. The length was reduced as some participants felt it may risk participant loss of interest, as it came across as tedious and long for an on-line survey. The highlighting of certain text in bold was done because two participants in the first pilot had incorrectly answered the manipulation question which was included to gauge participant's understanding of the contents of the vignette. As part of the research design, participants who answered this incorrectly were to be excluded from further analysis. It was felt that highlighting key text including the one the manipulation question was based on, would decrease the likelihood of eliminating participants from subsequent studies. As will be seen later, some participants in the second pilot still responded to the manipulation question incorrectly, which prompted additional changes for the main study.

A noteworthy observation from the first pilot was in relation to the Ordered Alternative Questionnaire (OAQ), and its potential to cause participant attrition due to the cognitive

processing required to complete it. The OAQ is used to establish participant's anchors. Granberg and Steele's (1974) operationalisation of the OAQ was modified to suit the context of the present study, with the following nine questions asked on a seven-point Likert scale (SA-SD).

1. There is no doubt - humans are NOT responsible for climate change and there is absolutely NO need to make any changes.
2. On the whole, it would be best to ignore climate change, as humans are not responsible.
3. It seems that it would be better if we did not respond to climate change, as humans are not responsible.
4. Although it is hard to decide, it would probably be better if we did not respond to Climate change.
5. It is hard to decide whether or not climate change is within our control.
6. Although it is hard to decide, it would probably be better if we addressed climate change.
7. It seems that it would be better if we were to put in place measures to address climate change.
8. On the whole, it would be best to put in place measures to address climate change.
9. There is no doubt that human activity is the cause of climate change and immediate efforts are essential to effectively respond to climate change.

Feedback on this instrument was that the subtle differences in the wording would require a fairly high understanding of the language and extensive cognitive processing, which may likely result in respondents becoming bored or frustrated and exiting the study. This was especially so as it was a repeated measure, which in the case of the two treatment groups would be asked three times in the same sitting (initial, after exposure to fake news, and after exposure to the discounting cue). Additionally, and importantly, the OAQ as presented in the first pilot study made it difficult to establish participant's anchors, as some participants had strongly agreed or disagreed with more than one statement. This prompted a revision prior to the second pilot study.

3.6. The Pilot study

Prior to issuing questionnaires for the second pilot, the OAQ was modified. The nine statements from the first pilot study were modified to read better and participants were given the following specific instructions:

> Below are some statements expressing various beliefs about climate change. Please read all the statements carefully before making any selections.

1. From the drop-down menu select the ONE statement which is most acceptable to you.
2. Are there any other statements which are also acceptable? If so, from the drop-down menu select which are also acceptable.
3. Now indicate the ONE statement which is most objectionable to you.
4. Are there any other statements which are also objectionable? If so, from the drop-down menu select the statements you find objectionable.
5. Select any statement you are unsure of or are neutral on as "neutral" from the drop-down menu.

While keeping the general semantic differential used by Granberg and Steele (1974), the nine statements were modified to read as follows:

1. It is absolutely essential that we put in place measures to urgently address climate change.
2. On the whole, it would be best to put in place measures to address climate change.
3. It seems that it would be better if we to put in place measures to address climate change.
4. Although it is hard to decide, it would probably be better if we addressed climate change.
5. It is hard to decide whether human intervention is urgently required to address climate change.
6. Although it is hard to decide, it would probably be better if we did not intervene to address climate change.
7. It seems that it would be better if we did not intervene to address climate change.
8. On the whole, it would be best to not put in place measures to address climate change.
9. It is absolutely essential NOT to intervene in climate change.

The drop-down menu presented to participants ranged from: Most acceptable (1); Acceptable (2); Neutral (3); Objectionable (4); Most objectionable (5)

The sampling population for the second pilot was intended to only comprise of students at the Gordon Institute of Business Science (GIBS). Due to restrictions imposed by the Protection of Personal Information (POPI) Act, the institution was not legally permitted to give out students' email addresses. Therefore, notices were sent to the relevant programme managers with a request to post those notices on their respective portals inviting students to opt-in by clicking on a link provided. This allowed them to provide their names and email address so that the questionnaires could be sent directly to them. The uptake was not as desired, and in order to obtain a meaningful sample size for statistical testing, a decision was taken to extend the study

to schoolteachers and matriculants from two private schools in Johannesburg. The school principals were engaged personally on the purpose of the study. The same restrictions imposed by the Protection of Personal Information (POPI) Act applied and the two principals were sent the same message that was given to the programme managers at GIBS asking students and teachers to opt in. Additionally, parental consent forms were sent with the opt in requests, which was applicable to matriculants.

Participants who opted-in to the study were randomly allocated to each of the three groups. A database was established on MS Excel to keep track of when the participant was sent the first survey and when their response was received. This helped inform when the two-week and three-month surveys would be sent out, as well as reminder prompts to those that had not completed the surveys. The first survey consisted of three attitude measurements at different time points, as captured below. Only times 1 and 2 were applicable to the control group.

Measure: *Attitude*

time	Dependent Variable	Measurement
1	Attitude1	Initial Attitude
2	Attitude2	Attitude after exposure to Fake News
3	Attitude3	Attitude after exposure to a discounting cue

In total, there were 119 participants that had opted-in to the study, and 75 respondents that had completed the first survey in full. Upon further scrutiny, it was observed that 28 had not responded to the questionnaire although they had opted in, but importantly 16 participants had begun but dropped out of the study prior to completing the first survey, all during completing the OAQ question. It was one of the risks identified in the first pilot. This equalled a dropout rate due to the OAQ of 17.6 % considering the 91 participants that had begun the surveys, and posed an unacceptably high risk of participant attrition in subsequent surveys and the main study.

In addition, notwithstanding participants being asked to select only ONE statement they found “Most acceptable”, the vast majority had chosen more than one statement as Most Acceptable and more than one as Most objectionable. This made it difficult to establish their anchors. It was concluded that the OAQ is acceptable for a classroom environment when completed on a piece of paper, and where the researcher has the opportunity to explain to participants how to complete it, but it proved difficult for an online survey, especially when participants would most likely complete the surveys on mobile phones. A decision was then taken, as a risk mitigation measure to reduce participant attrition in the main study, to drop the OAQ from the questionnaire in the main study, in favour of Pittman et al. (2021) use of attitudes only as an indication of anchors.

The other key finding from the second pilot was in relation to the manipulation question introduced to test participant's understanding of what they had read. Participants were asked a true / false question, pertaining to information presented in the blog article, where true was used as an indicator that they had processed the information presented to them, while false indicated that they did not process what was read. The following question was asked:

> According to the article, over 31,000 scientists signed a petition saying that there's no evidence that greenhouse gases are causing global warming.

This was aligned with the approach adopted by Bechler et al. (2019) and Colliander (2019). After gauging participant involvement, Bechler et al. (2019) asked a question about a statement in the arguments presented, as a test of the level of cognitive processing applied to thoughtful consideration of the persuasive message. On review, and in hindsight, the question asked on our study was more of an information recollection question rather than an information processing question. Eight participants had answered this question incorrectly. This prompted the addition of a second true / false question for the main study where participants would be eliminated if they answered both questions incorrectly. Lewandowsky et al. (2019) used three questions and eliminated participants that answered two of the three questions incorrectly. The following true / false question was introduced into the questionnaire prior to conducting the main study.

> According to the article, humans are not responsible for greenhouse gases or global warming.

This was a much better indicator of participant's understanding of what they had read and as will be seen later, resulted in a much better participant retention for analysis during the main study. Only participants who answered both questions incorrectly would be excluded from analysis.

3.7. Main Study

As with the second pilot, the main study consisted of a control group and two treatment groups, and was a within-between longitudinal study that spanned over three months. It measured attitudes and established attitude changes in participants (within) while comparing them to attitude changes in groups that received different stimuli (between).

3.7.1. *Sampling framework – unit of analysis*

As mentioned previously, and aligned with other studies in social psychology, the unit of analysis for the main study was initially established as university students, and the original setting was to be done in a classroom environment. This supported a necessary condition of this study that the same respondents be utilised throughout the three-month study period.

However, due to the uncertainty at the time of the Covid 19 pandemic and its long-term impact on face to face contact in a classroom environment, this was reviewed and questionnaires were modified to suit online surveys, specifically accommodating completion of surveys on mobile devices, given their ubiquity. The unit of analysis for the main study was students from the faculty of Humanities at the University of Pretoria. Participants were only engaged after receiving the appropriate ethical clearance from the University and the faculty.

3.7.1.1. Sampling framework – sample size

Ecker et al. (2014) established the sample size for their study on pre-existing attitudes and the continued influence of misinformation using G power (Erdfelder, Faul, Buchner, & Lang, 2009) free software with the following input: size effect of $\eta p^2 = 0.1$ at $\alpha = 0.05$ and $1 - \beta = 0.80$. Utilising the same inputs for the present study but changing the statistical test to Anova: Repeated measures, within-between interaction (see section 4.3 for more details) yields a sample size of 153 for the main study. This is captured in figure 3.7.1.1-1, and is based on 3 groups (control group, plus two treatment groups) measured at five time points. As will be seen in Chapter 4, the main study exceeded this requirement, achieving a sample size of 187 after removal of outliers.

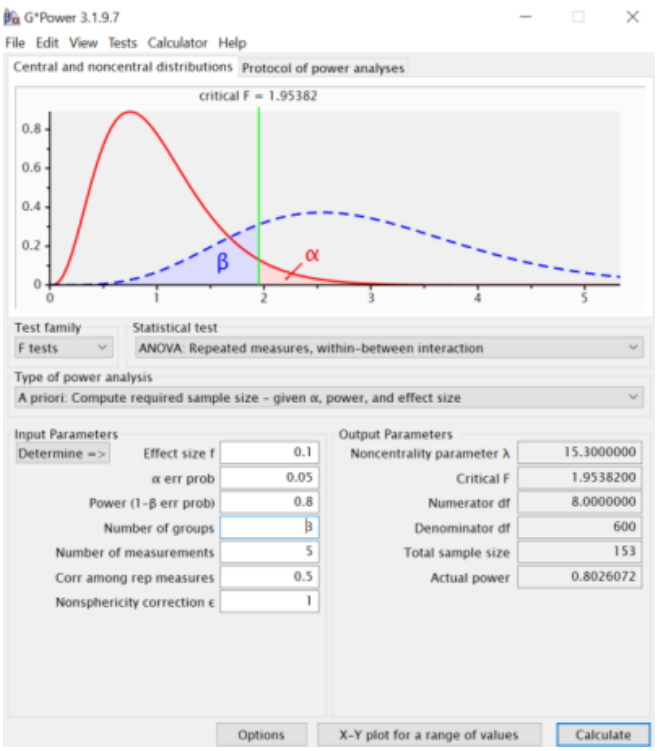

Figure 3.7.1.1-1: Results of G power analysis on sample size

3.8. Control variable

Taking into consideration the vast amount of research demonstrating the persuasive effect of a strong argument (Chan et al., 2017; Gandarillas et al., 2018; Park et al., 2007; Petty & Cacioppo, 1986), it was not the intention of this study to repeat tests on the persuasive impact of arguments of various quality (strong, neutral, weak), but to rather create a change in attitude and to measure that change over time. Also, aligned with subjective evidence on the use of strong arguments in fake news on climate science, only strong arguments were utilised in this study as the control variable. While it is acknowledged that refutational two-sided messages are the most persuasive when compared to non-refutational two-sided messages or one-sided

messages (Allen, 1991; Sung & Lee, 2015), this study only utilised a one sided message, consistent with fake news articles in general, and adopted the fake news message used by Lewandowsky et al. (2019). The Vignette is shown in Annexure 1. For the first pilot, the contents of the article were copied in its entirety, (with two exceptions described below) from Lewandowsky et al. (2019) study on "*Science by social media: Attitudes towards climate change are mediated by perceived social consensus*" and was made public by the authors at: https://github.com/StephanLewandowsky/Blog-comments. The exceptions were the name of the author of the article (Dr Edmund Savant) and specialists (Professor Richard Roland, Professor James Spencer and Dr. John Moore) referred to in the article were fabricated bearing no resemblance to any real-life character, and the second exception was that all graphics and graphs were removed.

During the first pilot, there were two participants that incorrectly responded to the manipulation question testing their understanding of what they had read. Also, feedback was that the vignette was too long and participants may lose interest, especially during an online survey conducted on a mobile device. This prompted a reduction in the length of the vignette and changes to highlight several items of text with bold font to emphasise some points made in the vignette. The reduction in length did not affect the face or content validity, and the data analysis of the pilot study, as captured in annexure 6, confirms that the vignette was effective in influencing attitudes. The changes were done to decrease the likelihood of eliminating participants from the main study due to incorrectly responding to the manipulation question or losing participants prematurely due to boredom.

3.9. Independent variables

There were two independent variables in this study, other than time. These were social conformity represented by social consensus in the form of user comments, and source bias in the form of letters to the editor.

3.9.1. *Social Consensus*

The first independent variable in this study is social conformity, with social consensus used as a proxy for this. In group 2, one sided user comments (non-refutational) were used as a proxy for social conformity or social consensus as evidenced by the works of Colliander (2019) ; and Lewandowsky, Cook, Fay, and Gignac (2019). Six user comments were selected from the posts and comment streams, made available by Lewandowsky et al. (2019) at https://github.com/StephanLewandowsky/Blog-comments. Modifications were made to include clauses declaring the article fake and subtle changes were made to the flow. The usernames for each comment were fabricated, to provide more of a local balance. The discounting cues used for the social consensus group (group 2) are shown below.

J-lee

Just mentioning the OISM petition signed by more than 31,000 scientists is a sign that a lot is wrong with this post! For one, only a very small number of those 31,000 scientists were really working climate scientists. Its like asking a heart specialist to perform brain surgery. Most were working on totally different subjects. Typical example of fake news to deflect attention away from human induced climate change.

stevieG

Fake Fake Fake !!!! Was CO_2 that much higher 100's of millions of years ago? Yes. Does this mean that CO_2 has no effect? No. Why? This ignores some basic evidence. In the distant past, the Sun was COOLER! Over the Earth's 4.5 billion year life, the sun has increased its heat output by 30%. Extra CO_2 was needed to compensate for the fact that the Sun was cooler. Roughly speaking, when we go back in time, CO_2 levels needed to have been double every 150 million years just to keep temperatures high enough. So, the claim carbon dioxide is the main driver of climate change is in fact based on much of Earth's history.

Jerico

The extent these climate change deniers would go to is sad. This is fake news. Even though it is true that CO_2 makes up only a very small amount of our overall atmosphere, you have to take a closer look. Most of the gases in our atmosphere don't have heat-trapping properties. So you can safely ignore inert gases like Oxygen and Nitrogen. Only look at CO_2 in comparison to its "buddies", the other greenhouse gases. What you'll find is that the "tiny" amount of CO_2 makes up about 25% of those and that is certainly nothing to ignore!

Kabelo

Classic example of fake news. The amount of water vapour in the atmosphere depends on the temperature of the atmosphere. If the planet isn't warming, the amount of water vapour won't increase. Water vapour itself doesn't cause global warming. It can only amplify global warming (known as a 'feedback') caused by other factors. Right now, the warming is caused by the increased greenhouse effect. This is due to human greenhouse gas emissions. Sadly this article is riddled with these misunderstandings of basic climate science.

Cyril S

Fake News. Don't bother with it. What's worse is that anyone who has ever bothered to take a look at solar output graphics would know that TSI only increased by less than 1 Watt/square meter since the start of the Industrial Era. Again, you're telling half the story but not all. Climate change is real and is caused by none other than humans.

Moses

It's hilarious that this article cites Usoskin 2005. That paper concludes that in the last few decades, the correlation between sun and climate breaks down. Recent warming must have some other cause. This article's own sources debunk its claim that the sun is causing global warming! Typical of fake news stories.

3.9.2. *Source Bias*

The discounting cue used did not focus on the inaccuracies of the article, but solely on source bias. Wallace et al., (2020) report that persuasion researchers have traditionally conflated trustworthiness and expertise as a reflection of source credibility, and the few that did look at source bias showed that sources without a vested interest were perceived as more credible and more persuasive. Heinbach et al. (2018) conducted a study similar to the present one where they evaluated the persuasiveness of news articles by comparing the effects of user comments against source credibility, over a two-week period. They used brand reputation (high / low) as a proxy for source credibility for their first independent variable. Brand reputation is associated with trustworthiness, and as Wallace, Wegener, and Petty (2020) point out, bias and untrustworthiness can have differing effects.

In the present study, source bias is the second independent variable. Group 3 Participants were given three letters to the editor, that were fabricated for the purpose of this research, and that resembled genuine letters to an editor of any publication, as a discounting cue. The use of the company name and author is fabricated and general enough so that it does not associate with any real company or individual (except for the reference to the now defunct Bell Pottinger). The contents are shown below.

Dear Mr Editor,

I am deeply concerned that a publication of your stature would publish an article of this nature without declaring the author's prior track record, affiliations and interest in this subject. Allow me to elaborate. Dr Edmund Savant is the past president of the regional Fossil fuel foundation and serves on the Board of Directors of ProCoal Holdings. It is well known that ProCoal has vast interest in coal mines across Mpumalanga and recently applied for environmental licencing for the expansion of their operations to include power generation from fossil fuels. There was much public outcry given the deleterious effect of CO_2 which prompted Dr Savant and CoalCo to employ a public relations arm of Bell Pottinger to assist with the creation of a number of articles questioning the science behind climate change and casting doubt over human contribution towards climate change. I will not get into the factual inaccuracies of the article as I am sure you will get plenty takers for that. However, I believe it is important to emphasise to your readers that ProCoal will lose billions of Rands of revenue over the 20 life of the power plant and as such have vested interest in ensuring that the

plant proceeds. Your publication of this article without reference to such an important consideration is of grave concern and a crying shame.

Sincerely

Dr Y. Lazarus

01 August 2020

……

Dear Mr Editor,

I write in support of the letter written by Dr Lazarus that raised valid concern about the author's bias and vested interest in denying climate science. I too will not get into the factual inaccuracies as others have already done that but would like to point out an additional piece of important information that Dr Lazarus omitted. Dr Edmund Savant not only sits on the Board of ProCoal in South Africa but also owns shares in Coalco in Zimbabwe. They have extensive mining rights in Zimbabwe and their recent application to build a coal fired plant at one of their mines in Bulawayo came under severe criticism due to them flouting environmental laws. They indeed do have vested interest in denying the science around climate change and I am glad Dr Lazarus brought it up. They have billions to gain from denying climate change and I am not surprised to hear that Bell Pottinger was involved.

Yours truly

Dr Dlamini

07 August 2020

……

Dear Mr Editor,

I wonder if, prior to publication, you paid attention to Dr Edmund Savant's reputation as a climate science denier and his history of employing public relations companies as spin doctors to manufacture uncertainty in denying climate science. His vested interests in denying climate science is without doubt and evidenced in his various publications where it was proven that he generates alternative facts, pseudoscience claims, and real "fake news", in undermining scientific evidence on climate science. This blog is no different and it is disappointing that a publication such as yours omitted such important facts prior to publication.

Sincerely

Professor James Edwards

07 August 2020

3.10. Dependent variable (attitudes)

Petty and Briñol (2008) contend that in psychological literature, people's attitudes are the most common target of persuasion, because of their influence on choice and action. Attitude change is a determining factor of behaviour change (Petty, Heesacker & Hughes, 1997). As O'Keefe (2016) aptly argue, attitude is *primus inter pares* (first among equals) in persuasion theory and in the research thereof. The dependent variable in this study is attitudes, and the same instrument was used in each intervention that required a measure of attitudes.

3.10.1. *Measures of attitude*

Colliander (2019) measured respondent's attitudes towards their fake news story with three items on seven-point Likert scales (1 = completely disagree, 7 = completely agree), and averaged the three items to form an index with Cronbach's alpha = 0.96. Lewandowsky et al. (2019) used a five item, five-point Likert scale, and some of their questions were very similar and appropriate to this study. Existing scales from Colliander (2019) and Lewandowsky et al. (2019) were adapted to suit this study, and a four item, seven point Likert scale (SA-SD) was used with Cronbach's alpha at each measurement time exceeding the established threshold of .7, centring around the following question:

How much do you agree with the statements below about climate change?

It is attributable to carbon dioxide.

Human activity is the cause of climate change.

Human intervention is required to address climate change

There should be urgency to address climate change

This instrument also aligned with Wang et al. (2014) who used four items also on a seven-point Likert scale to measure attitudes towards teammates.

3.10.2. *Attitude Change.*

Luttrell, Petty, Briñol, et al. (2016) averaged each participants response to form a "summary attitude index" with higher numbers associated with more positive attitudes. Their instrument had good internal reliability (α= .96). Similarly, Lewandowsky et.al. (2019) averaged the five items probing climate attitudes to form a single composite score, called "anthropogenic global warming (AGW). Colliander (2019) had done the same with their three-item instrument. Borrowing from their methodology, this study averages the four measures of attitude at each time to form single composites called Attitude 1; Attitude 2; Attitude 3; Attitude 4; and Attitude 5. The changes in the mean score of each of these composites is used to establish changes

in attitudes, both within participants and between groups, through the appropriate statistical techniques as laid out in chapter 4.

3.11. Questionnaire development

Park et al. (2007) began their questionnaire with the title and instructions and immediately followed that with a question asking whether the participant had considered the issue before. Since the basis of our study was participant's ability to be influenced by social conformity and by source bias, the following questions were asked on a seven-point Likert scale (SA-SD), after the introductory paragraph:

- My opinion about a blogpost or opinion piece is influenced by the comments made on the article by others.
- I am more influenced by the CONTENTS of an article than by the author's credentials.
- I am more influenced by user COMMENTS on an article than by the author's credentials.

Park et al. (2007) followed this with items testing issue familiarity. Aligned with their practice, our study used a two item, five-point semantic differential scale to gauge familiarity (Extremely familiar; Very familiar; Moderately familiar; Slightly familiar; Not familiar at all), with the following questions:

How familiar are you with the concept of climate change?

How familiar are you with the arguments for and against climate change?

3.11.1. *Manipulation checks*

Manipulation checks were done as appropriate during each engagement with participants, to gauge their level of cognitive processing, and to remove the influence of external factors. These are expanded upon next.

3.11.1.1. First manipulation check

Bechler et al. (2019) advocate as common practice in attitude research that the extent to which participants processed information be gauged. They utilised an involvement measure where participants were asked to report their involvement and attention paid while reading the persuasive message. Bechler et al. (2019) asked questions ranging from "skimmed it quickly, not at all involved" to "paid a lot of attention, very involved"" (p.161). This was further tested with a question about a statement in the arguments presented. This test provides a good

indication of the level of cognitive processing applied to thoughtful consideration of the persuasive message, and was applied to this study.

Colliander (2019) followed a similar approach and in accordance with Bechler et al. (2019) and Colliander (2019), a manipulation check was conducted before analysing the dependent variables, where participants were asked the following question, which ranged from: A great deal ; A lot ; A moderate amount ; A little ; None at all.

> How much effort would you say you put into reading the article?

Participants were then asked two true / false questions, pertaining to information presented in the blog article, where true was used as an indicator that they had processed the information presented to them, while false indicated that they did not process what was read. The following questions were asked:

> According to the article, over 31,000 scientists signed a petition saying that there's no evidence that greenhouse gases are causing global warming.
>
> According to the article, humans are not responsible for greenhouse gases or global warming.

Participants that answered incorrectly to both questions were excluded from further analysis.

3.11.2. Second and third manipulation checks

A concern with longitudinal studies of this nature is the influence of external factors post-treatment that could influence participant's attitudes. Heinbach et al. (2018) asked the delayed post-test participants whether they had sought information regarding Superfoods (the subject of their study) during the 2 weeks between the surveys, but did not specify how this was treated. The presence of external influences is of particular concern in our study as climate change is widely discussed on social media and in the news, and not taking into consideration these external influences would increase the likelihood of type I and type II errors. In this study the following question(s) were asked of participants completing the two-week and three-month surveys.

> Q1. Have you read / seen/ heard any arguments either for or against climate change since the initial assessment: Yes / No

Participants that answered Yes were automatically prompted to answer the following question:

> Do you believe this additional information had any influence on your attitudes or changed your perspectives towards climate change: Yes / No

If participants replied to the affirmative on both these questions, they were unfortunately excluded from that part of the analysis. In other words, they may have been included in the mixed Anova at times 1; 2; and 3, but excluded from the subsequent statistical test at the stage where they were influenced by external factors. On SPSS, such participants were allocated the number “105” for the two-week assessment and “106” for the three-month assessment and the respective variable listed 105 and 106 as missing values. As mentioned, the reason for their exclusion is that external influences jeopardise the integrity of the research with increased potential for Type I or Type II errors.

3.11.3. Additional manipulation checks

In addition to the above, participants were asked the following yes / no questions:

> Reader's comments usually follow such articles. Do you believe that other readers would agree with the contents of the article?
>
> Do you believe that the author of this article is biased?

For the control group these questions appeared at the end of the survey. For participants in the two treatment groups, they were asked this question just before exposure to the discounting cues.

3.12. Debrief

Following the receipt of the three-month surveys, participants were sent a debrief as shown in Annexure 4. This was not only sent to participants who had completed the study, but was sent to all participants that had opted into the study, including those that left prior to completing the first surveys. This was considered key from an ethical perspective to let participants know the full purpose of the surveys but more importantly to provide them with correct information about climate change and to debunk any myths that may have arisen as a result of this study. The contents of this debriefing document was copied in its entirety from Lewandowsky et al. (2019) study on “Science by social media: Attitudes towards climate change are mediated by perceived social consensus” and is available at:

https://github.com/StephanLewandowsky/Blog-comments.

3.13. Instrument validity and reliability

Hair, Risher, Sarstedt, and Ringle (2014) contend that researchers should verify both the reliability and validity of an instrument when assessing reflective measures. Reflective measures, in a literal sense, occurs when indicators are a reflection of the construct or the construct causes a change to, or effects, the indicators (Diamantopoulos & Winklhofer, 2001). Validity is a test of whether a scale measures what is meant or intended to be measured, and

the concept is well established in literature. Instrument reliability is an indication of a measure's stability, consistency and repeatability such that repeat measurements utilising the instrument, under constant conditions produce the same result (Taherdoost, 2016). The second pilot study was used to establish instrument validity and reliability.

3.13.1. Validity

The tests used to establish the validity of the research instrument utilised in this study are as follows:

3.13.1.1. Construct Validity

Convergent validity

Convergent validity for this study was established on SPSS using the four items utilised to measure participant's attitudes at each of the different points in time. Table 3.13.1.1-1 shows the results of the SPSS analysis for the mid-point (attitude 3) and confirms Convergence Validity with a lowest inter-item correlation of .572 at a significant value $p < .001$. Additionally, the KMO and Bartlett test evaluated all available data together. A KMO value over .5 and a significance level for the Bartlett's test below .05 suggest there is substantial correlation in the data. The results shown in Table 3.13.1.1-2 with a KMO value of .803 and significance $p < .001$ confirms substantial correlation in the data. Since this was the only measure of the construct, discriminant validity was not required and Construct validity was achieved.

Table 3.13.1.1.1
Correlation Matrix for attitude 3

		Attitude 3 measure 1	Attitude 3 measure 2	Attitude 3 measure 3	Attitude 3 measure 4
Correlation	Attitude 3 measure 1	1.000	.673	.626	.572
	Attitude 3 measure 2	.673	1.000	.877	.749
	Attitude 3 measure 3	.626	.877	1.000	.815
	Attitude 3 measure 4	.572	.749	.815	1.000
Sig. (1-tailed)	Attitude 3 measure 1		.000	.000	.000
	Attitude 3 measure 2	.000		.000	.000
	Attitude 3 measure 3	.000	.000		.000
	Attitude 3 measure 4	.000	.000	.000	

Table 3.13.1.1.2
KMO and Bartlett's Test for attitude 3

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.803
Bartlett's Test of Sphericity	Approx. Chi-Square	836.780
	df	6
	Sig.	.000

Face Validity:

The instrument used to measure attitudes was not a general measure of attitude towards climate science but was compiled with specific reference to the messages presented in the Vignette. That was the main reason Lewandowsky (2019) questionnaire was not used in its entirety, but tailored to suit the purpose of the current study. On the face of it the attitude-measure measured what it was intended to measure.

Content Validity

As with face validity, content validity is a subjective measure, and refers to the extent to which the items on a test fairly represent the entire domain the test seeks to measure. In other words, do items being measured deal only with the subject being addressed, are appropriate to the subject being studied and does not include anything else. In this case, the measuring instrument was tailored to suit the messages presented in the vignette and respective discounting cues, and as confirmed with convergent validity above, the instrument demonstrated suitable content validity.

Criterion Validity

Concurrent Validity

This is a test to gauge whether the scale correlates with older established scales for attitudinal measurements. For our study, existing scales from Colliander (2019) and Lewandowsky (2019) were adapted to suit the requirements of this study. Colliander (2019) measured respondent's attitudes towards their fake news story with three items on seven-point Likert scales (1 = completely disagree, 7 = completely agree), and averaged the three items to form an index with Cronbach's alpha = 0.96. Lewandowsky (2019) used a five item, five-point Likert scale, and some of their questions were very similar and appropriate to this study. Moreover, Lee and Chun (2016) measured prior attitudes with a four item, seven-point semantic differential scale in accordance with Holbrook and Batra (1987) scale for attitude measurement

with exceptionally high internal consistency reported. Likewise, Park et al. (2007) used a four-item seven-point semantic differential scale (favour / disfavour) to gauge prior attitude in their study with equally high internal consistency reported.

Predictive Validity:

A survey has predictive validity if it accurately predicts what it is intended to predict (Taherdoost, 2016). The key consideration in this research is attitudinal changes and participant's responses, as measured with the 4-item measuring instrument repeatedly produced results that were aligned with the hypotheses established. This occurred in both the second pilot study as well as the main study and although correlation analyses were not conducted between the two studies, it is evident from the overall findings that they both produced similar results. The fact that two studies conducted at different times using the same instrument produced similar results is confirmation of the predictive validity of the instrument used.

3.13.2. Instrument reliability

Bolarinwa (2015) describe three major tests for reliability testing: Internal consistency, alternate-form reliability testing and test-retest reliability. Gerbing and Anderson (1988) describe a fourth test called split-half which treats each half of any test as a separate administration and correlates the results from each. The alternate form test, which utilises two or more instruments at the same time to correlate results, is the least utilized as it is "difficult, if not impossible, to verify that two tests are indeed parallel (i.e., have equal means, variances and correlations with other measures" (Bolarinwa, 2015, p.198).

Internal Consistency:

The most common method of testing internal consistency is to determine the Cronbach alpha (α). It provides an indication of the average correlation among items in a scale, and ranges from 0 to 1 with greater reliability represented by higher values (Pallant, 2016). It is widely established from Nunnally's work in 1978 that the minimum internal consistency reliability standard of .70 is required for group comparisons (Pallant, 2016; Varni et al., 2011). This threshold was used in the present study as an indicator of internal consistency. Analyses was carried out for the instrument used to measure attitudes for the pilot study. Table 3.13.2-1 shows the Cronbach's alpha as calculated on SPSS.

Table 3.13.2.1
Chronbach's alpha for attitudes 1 to 5

	Valid	Excluded	Total (N)	Number of items	Chronbach's α
Attitude 1	75	0	75	4	.827
Attitude 2	75	0	75	4	.912
Attitude 3	75	0	75	4	.913
Attitude 4	49	26	75	4	.908
Attitude 5	47	28	75	4	.800

It is evident that Chronbach's alpha was lowest at time 5, but at a value of .8 remained above the generally accepted threshold of .7.

3.14. Missing data

A complete set of data is rarely obtained in every case (Pallant, 2016), especially with longitudinal studies where attrition is possible, participants fail to complete a questionnaire due to fatigue or loss of motivation, they are unavailable for a specific test but available later, or leave out some items on the questionnaire i.e. item non-response (Jeličić et al., 2010).

In line with established missing data terminology from the seminal work of Little and Rubin (2002), Jeličić et al. (2010) differentiate three missing data mechanisms as: Data not missing at random (NMAR); Data missing completely at random (MCAR); and Data missing at random (MAR).

1. Data not missing at random (NMAR), reflects the probability that missing data is a function of the variable that is missing, but which in itself is not measured. This was the case with the control group where participant's attitudes were not measured at time 3 because this group did not receive a discounting cue. The missing values causes SPSS to exclude the participant from analysis of attitudes, not just for time 3 but from the entire dataset. Jeličić et al. (2010) advise against the use of listwise deletion, and advocate based on statistical theory both Direct Maximim Likelihood (DirML) and Multiple Imputation (MI) methods as better alternatives for external validity (generalisability). Since participants in the Control Group received the same fake news exposure as all other participants but did not receive the discounting cues for either social conformity or source bias, it stands to reason that their attitudes would not change between times 2 and 3. Therefore, the missing values for the control group was addressed by copying participant's actual responses in time 2 and pasting those values as their responses in time 3. In this way, attitudinal changes between groups could be analysed at time 3.

2. Data missing completely at random (MCAR) occurs when missing data is not related to any measured variable and implies, as the name suggests, that non-response is completely at random, and the probability of missingness is the same for all units of measure. It suggests that the instrument was not the cause of the non-responsiveness, and therefore the management thereof does not bias the study. Given the longitudinal nature of this study, participants that did not complete the two-week and three-month responses were missing completely at random. Deleting those participants from the entire database would lose valuable insights from those who had completed the surveys at times 1; 2 and 3 but not at times 4 or 5, and substituting values to replace those missing would defeat the purpose of the study. To address this, data analysis was split with a mixed ANOVA performed for participants over time periods 1,2, and 3 which were measured as part of survey 1, and independent samples T-Tests, and Kruskal Wallis H tests were conducted for the reduced sample sizes at times 4 and 5.

3. Data missing at random (MAR) occurs when missing data is not related to the underlying values of the missing data and is caused by other factors that are measured in the study (Jeličić et al., 2010), with the randomness being dependent on available information. A particular concern in our study using climate change as the setting was that climate change is widely discussed on social media and in the news, which could have introduced external factors into the study. To cater for this all participants were asked, at the start of the two-week and three-month studies, whether they had read / seen/ heard any arguments either for or against climate change since the initial assessment. The questionnaire was set up on Qualtrics to ask participants that answered Yes to this question, whether they believed this additional information had any influence on their attitudes or changed their perspectives towards climate change. Participants that replied to the affirmative on both these questions, were excluded from the analysis at times 4 and 5 and analysis was done in the same way as MCAR above.

3.15. Ethical considerations

Prior to issuing any questionnaires, an application for ethical clearance was made to the Doctoral Research Ethics Committee at GIBS. The application was approved on 02 December 2020. The first pilot study commenced two weeks later on 15 December 2020. Since the university was not, in terms of the Protection of Personal Information Act (POPIA), legally permitted to give out students' email addresses, students were invited, via the respective programme managers at GIBS, to opt-in to the study by clicking on the link provided and

supplying their email address. Only students who had opted into the study were sent the questionnaires. The mass communication sent to programme managers is shown in Annexure 5. Similar letters were sent to the school principals at two private schools (Abbots college – Johannesburg South and Waterstone College) for them to communicate with schoolteachers and matriculants alike. Additionally, a permission slip was compiled for matriculants to seek permission to participate in the study. Only teachers and matriculants who had opted-in to the study were sent the questionnaires.

The main study extended to students in the Faculty of Humanities at the University of Pretoria. Prior to issuing any questionnaires, applications for ethical clearance were made to the Research Ethics Committee at the Faculty of Humanities, and the UP Survey Coordinating Committee. The application was approved by the Survey coordinating committee on 05 August 2021, and the Faculty of Humanities Research Ethics Committee on 10 August 2021. Data collection from students at the UP faculty of Humanities began on 11 August with a communication to the programme managers at UP, requesting students to opt-in to the study. This communication is shown in Annexure 5.

The importance of confidentiality in soliciting responses cannot be overemphasised in this specific study as participants may not share their honest feelings if they fear their attitudes may fall outside the norm (Clifton & Carrasco, 2018, p.497). Participants were given assurances of confidentiality and were guaranteed anonymity with the option to opt out should they desire. The following was stipulated in the communication requesting students to opt-in to the study.

> If the results from this study are published, only aggregated results will be reported and individual responses will not be identifiable. Additionally, the confidentiality of participant's responses is of utmost importance, and it shall be managed in accordance with the university guidelines. Participation in this study is entirely voluntary. Completion of this survey is taken to constitute your consent to participate in the study and subsequent debrief. If you do not wish to participate even after you have opted-in, you may exit the study at any stage without penalty. There will be a debrief at the end of the study sent to all participants.

A key consideration with the UP ethics application was the issue of Access and Storage of information. The following were questions asked, and responses provided.

Q: Where will the data be stored?

> A: On Qualtrics and SPSS during data evaluation and report compilation, and in the university archives thereafter.

Q: How will the data be protected?

A: Qualtrics is username and password protected, as is the laptop used for data analysis and reporting.

Q: Who will have access to the data?

A: Only the researcher and the supervisor.

Q: Is there NDA in place if third parties have access to the data?

A: Not applicable. However, should it become applicable such NDA will be established prior to data share.

Q: For how long will the data be stored?

A: According to university guidelines. Data will be given to the University and duration will be dictated by the university.

Q: Who will be responsible for archiving or disposal of the data after the project ends?

A: The researcher – (student's name)

Q: How and when will the data be disposed of?

A: Data will be disposed of after ensuring it is successfully archived in the university. Disposal will be through deleting the surveys on Qualtrics and closing the account, and permanently deleting raw data containing participant responses from the computer used for the study.

Debrief - Following the receipt of the three-month surveys, participants were sent a debrief as shown in Annexure 4. This was not only sent to participants who had completed the study, but was sent to all participants that had opted into the study, including those that left prior to completing the first surveys. This was considered key from an ethical perspective to let participants know the full purpose of the surveys but more importantly to provide them with correct information about climate change and to debunk any myths that may have arisen as a result of this study.

3.16. Chapter conclusion

This chapter described the experimental methods used in testing the hypotheses established in chapter two. As opposed to quasi-experimental research where participants are not randomly chosen, this study randomly divided participants into three groups and this full experimental research involved two pilot studies prior to the main study. This chapter described all three studies, as well as the manner in which the questionnaires evolved from the pilots to the main study. Included in this chapter were the basis for the vignette used as the persuasive message as well as the discounting cues utilised as the independent variables. Tests for validity and reliability were presented and discussed. The chapter concluded with the treatment of outliers and missing data, and with the ethical considerations applied in the execution of this research.

The next step in the research is the analysis of data, which is described in detail in Chapter 4.

4. Chapter 4 - Results

4.1. Chapter introduction

This chapter presents the data analysis and results of the main study. Data analysis for the pilot study is captured in detail in Annexure 6. This was a longitudinal survey, spanning over three months, where subjects were engaged on three separate occasions, over and above the initial opt-in request and debrief at the end. During the first engagement, participants attitude scores were captured on three occasions called attitude 1, attitude 2, and attitude 3, or time 1, time 2, and time 3. These terms are used interchangeably. Attitude scores were captured again after two weeks and three months, called attitude 4 and attitude 5 respectively, or time 4 and time 5 respectively.

Respondents to the second and third surveys were asked whether they had been exposed to related information in the period between the initial survey and the respective survey, and whether they believed that additional information had influenced their attitudes. As part of the research design, those participants who had been influenced by external stimuli were to be excluded from the analysis from the point where they were influenced by such stimuli. Through a combination of participant attrition and exclusion due to external influence, almost half of the 190 respondents to the initial survey had remained at the end of the three-month period.

Attrition in longitudinal studies poses a threat to both internal and external validity if not handled and reported adequately (Barry, 2005). A single analysis over the five time periods would result in a loss of power due to the reduced sample size, as well as the exclusion of valuable data in testing the hypotheses at times prior to participant's exposure to external stimuli. Therefore, the data analysis was segmented based on intervention where attitudes 1; 2 and 3 were treated as a single analysis to test the hypotheses 1 to 3 (H1 to H3) while attitudes 4 and 5 were each evaluated separately to test hypothesis 4. Towards the end of the chapter, attitudes at all five time periods were combined in a single analysis. The chapter concludes with additional observations based on supplementary manipulation questions included in the questionnaire.

4.2. Summary of hypotheses to be tested.

The experimental methods and the statistical techniques used to test the hypotheses as established in chapter two were described in chapter 3. The hypotheses established are as follows:

> H1: Exposure to fake news in climate science will lead to a shift in anchor, towards the position established by that fake news.

Null hypothesis (Ho): The difference in the means of attitude scores prior to exposure to fake news (μ_{time1}) and after exposure to fake news (μ_{time2}) is zero. i.e. $\mu_{time2} - \mu_{time1} = 0$,

H2: The shift in anchor after exposure to fake news will be influenced by social consensus from user comments proclaiming the story to be fake news.

Null hypothesis: The difference in the means of attitude scores prior to exposure to a discounting cue in the form of user comments proclaiming the story to be fake news (μ_{time2}) and after exposure to a discounting cue in the form of user comments proclaiming the story to be fake news (μ_{time3}), is zero. i.e. $\mu_{time3} - \mu_{time2} = 0$,

H3: The shift in anchor after exposure to fake news will be influenced by a discounting cue demonstrating that the source of the fake news story is biased.

Null hypothesis: The difference in the means of attitude scores prior to exposure to a discounting cue indicating that the source of the fake news is biased (μ_{time2}) and after exposure to a discounting cue indicating that the source of the fake news is biased (μ_{time3}), is zero. i.e. $\mu_{time3} - \mu_{time2} = 0$,

H4: Over time, anchors will shift back towards the position established after exposure to fake news, with the memory of an untrustworthy source or user comments that the story is fake, eroded.

Null hypothesis: The difference in the means of attitude scores after two weeks (μ_{time4}) and after three months (μ_{time5}) respectively will be statistically significant when compared to attitude mean score after exposure to fake news (μ_{time2}). i.e. $\mu_{time4} \neq \mu_{time2}$; $\mu_{time5} \neq \mu_{time2}$, $p < .05$

4.3. Data analysis for the main study.

Before data analysis was conducted, checks for instrument reliability were repeated but since validity tests conducted in the pilot study were extensive, they were not repeated for the main study. The full reliability analysis report is captured in Annexure 16, and the Chronbach's α results are extracted and captured in table 4.3.1

Table 4.3.1
Chronbach's α for main study attitudes 1 to 5

	Valid	Excluded	Total (N)	Number of items	Chronbach's α
Attitude 1	190	0	190	4	.759
Attitude 2	190	0	190	4	.889
Attitude 3	190	0	190	4	.906
Attitude 4	156	34	190	4	.856
Attitude 5	136	54	190	4	.874

In summary, questionnaires were employed to measure attitudes at five points in time using the same instrument consisting of four questions. The scale was assessed in two separate studies and had a high level of internal consistency and as determined by Cronbach's alpha, with the lowest value across the ten time periods recorded at .759. In all cases, the lowest value exceeded the generally accepted threshold of .7 (Pallant, 2016). Therefore, the data analysis could proceed with reasonable assurance that the instrument used to record such data has validity and reliability.

In total, 190 participants had completed the first survey of the main study, 153 responded to the second survey and 133 responded to the third and final survey, representing a drop-out rate of 20 % and 30 % respectively. Of these 33 and 39 respectively had indicated that they were exposed to additional information which had influenced their attitudes. If a single data analysis were done, it would have halved the sample size from 190 to 94, and the balance would have been viewed as missing data. Based on this, the data analysis was split into three segments for attitudes 1, 2 and 3 in a single analysis followed by attitude 4 and attitude 5 separately.

A key factor that informed the selection of the appropriate statistical technique was the fact that all participants were exposed to the same initial stimulus (fake news) in the form of a vignette, but participants in the control group got no further stimuli while participants in the two treatment groups received different stimuli (discounting cues). Measurement of attitudes were repeated using the same instrument over the three time periods. Since there was independence of participation, where no subject had participated in more than one group, the appropriate analytical technique was identified as the within-between repeated measures Analysis of Variance (ANOVA), also referred to as the two-way mixed ANOVA. While a repeated measures ANOVA may seem appropriate this is not the case as that requires all participants to undergo all treatments, while in this study, participants were subject to different treatments.

Prior to conducting the statistical test, the dataset was tested for compliance to the requirements or assumptions of the statistical technique. This informed whether additional non-parametric tests were required, where and when violations occurred and where appropriate what adjustments were necessary to reduce type I and type II errors. The section and sub-sections that follow tests the dataset for compliance to the assumptions of a two-way mixed ANOVA. Stemming from these tests, other tests are introduced as appropriate. The assumptions as stated are based on established tests for this statistical technique as described by Laerd Statistics (2015) and Pallant (2016).

4.4. Descriptive Statistics for Times 1, 2, and 3

The first hypothesis in this study (H1) tests whether exposure to fake news will lead to a shift in anchor. The second and third hypotheses tests whether there is a further shift when the same participants are then exposed to a discounting cue. The first part of this analysis is therefore a within-subjects analysis, with the factors captured in Table 4.4-1. This table reflects the levels of within-subjects factor and the coding system applied on SPSS.

Table 4.4.1

Within-Subjects Factor

Measure: Attitude time	Dependent Variable	Measurement
1	Attitude1	Initial Attitude
2	Attitude2	Attitude after exposure to Fake News
3	Attitude3	Attitude after exposure to a discounting cue

Comparison of the impact of the discounting cues requires a comparison across groups. This part of this analysis is therefore a between-subjects analysis, with the factors captured in Table 4.4-2. This table captures the levels of between-subjects factor, the coding system applied on SPSS, and the number of cases in each group.

Table 4.4.2

Between Subjects Factors

		Value Label	N
Test Group	1	Control	63
	2	Social consensus	59
	3	source bias	68
		Total	190

Table 4.4-3 is the Descriptive Statistics table that provides a summary of the changes in mean scores both within and between-subjects at each of the three time intervals. As mentioned in section 3.1.2 (missing data), the control group results were copied from time 2 and pasted into time 3, hence the identical data for the control group at times 2 and 3. The questionnaires were set up so that the lower the value of the attitude, the closer the participant's attitude is towards a climate change proponent, and the higher the value, the closer their attitude towards climate change denier. Important to note is that the fake news message in the vignette was positioned from a climate change denier perspective while the discounting cues were positioned from a climate change proponent perspective. Therefore, in interpreting the table of descriptive statistics and the plots that follow, an increase in value moves a participant's attitude towards a climate change denier aligned with the message in the vignette, while a

decrease in value moves the participant's attitude towards a climate change proponent aligned with the discounting cues. In all three groups, the initial attitude scores suggested that participants were climate change proponents, which is understandable given the ubiquity of news around climate change. The shift in attitudes at Time 2 showed that attitudes did not move to the other extreme of the scale when exposed to fake news, but rather shifted towards the direction of advocacy as hypothesised.

Table 4.4.3

Descriptive Statistics

	Test Group	Mean	Std. Deviation	N
Attitude at time 1	Control	1.8413	.75975	63
	Social consensus	1.6695	.68927	59
	source bias	1.6618	.62558	68
	Total	1.7237	.69339	190
Attitude at time 2	Control	2.8651	1.50123	63
	Social consensus	2.4492	1.22191	59
	source bias	2.7574	1.49250	68
	Total	2.6974	1.42023	190
Attitude at time 3	Control	2.8651	1.50123	63
	Social consensus	1.9110	.97905	59
	source bias	1.9154	1.04704	68
	Total	2.2289	1.27432	190

4.5. Understanding and cleaning the data – times 1, 2 and 3

As described in section 4.3 (data analysis for the main study), the appropriate statistical technique is the within-between repeated measures ANOVA, also referred to as the two-way mixed ANOVA. The section and sub-sections that follow tests the dataset for compliance to the assumptions of a two-way mixed ANOVA. This is important, in that in order to conduct and interpret any statistical analyses, compliance to the appropriate technique and violations thereof need to be understood and managed as appropriate. The assumptions as stated are based on established tests for this statistical technique as described by both Laerd Statistics (2015) and Pallant (2016). Further details including tables and charts are captured in Annexure 14.

4.5.1. *Assumptions 1-3 of the two-way mixed ANOVA*

Since each participant in our study was measured on the same continuous scale (representing the dependent variable i.e. attitudes) on three occasions at different time periods, and there are two independent variables that were categorical (social consensus and source bias), the

first three assumptions of the two-way mixed ANOVA were met i.e. (a) a continuous dependent variable; (b) between-subjects factor that is categorical with two or more categories; and (c) one within-subjects factor (time) that is categorical with two or more categories.

4.5.2. *Assumption 4 - Outliers*

The fourth assumption for a two-way mixed ANOVA is that there should be no significant outliers in any cell of the design. Since Outliers have potential to increase the estimated sample variances, resulting in a decreased F statistic with an increased chance of a type I error, it is vital that they are identified and managed appropriately (Pallant, 2016). The next section discusses the tests for outliers and the management thereof in more detail.

4.5.3. *Test for Outliers.*

Outliers were detected via the studentized residuals output of the mixed ANOVA analysis. Values greater than + 3 and lower than -3 were considered outliers (Laerd Statistics, 2015b). On attitude 1, there were three participants identified as outliers. These were cases 46, 83 and 111 with SR values of +5.33; +4.49; and +3.40 respectively. Comparison of their respective scores at different times showed that they were still influenced by the vignette as they have moved closer to the climate denier end of the spectrum. Participant 46 attitude mean score went from 5.5 to 6.25 and because the participant was in the control group, remained at 6.25 for the period under evaluation. Participant 83 was in the social consensus group and their attitude mean score moved from 4.75 to 5.5 and stayed at 5.5 at time 3. Further inspection of these participant's mean attitude scores revealed that their initial attitudes were already higher relative to other participants in the study. Participant 111 was in the social consensus group and was also influenced by the vignette, with attitude mean score moving from 4.00 to 4.75 between times 1 and 2.

At time point 2, there was one outlier (case 116) with a studentized residual of +3.06. This participant's initial attitude mean score was 2 (close to a climate change proponent) and it went to a 6.75 (climate denier) after reading the vignette.

At time point 3, there were four participants identified as outliers using studentized residuals. These were cases 129, 25, 15 and 83 with SR values of +4.27; +3.06; and +3.06 and +3.02 respectively. The first three were similar to case 116 mentioned above where the participants had moved from one extreme to the other, aligned with the position established in the vignette. The fourth was the same participant 83 identified at timepoint 1. Case 129 did not behave in the expected manner with attitude mean scores moving from 1.00 to 5.50 to 7.00 at times 1, 2 and 3.

Some researchers recommend removal of all extreme outliers, while others change the values to less extreme ones (Pallant, 2016, p. 64). Pallant (2016) compared the sample mean to the 5% trimmed mean and because the values were similar, opted to retain those cases. In our study, none of the outliers had originated from an incorrect data entry, and they were all within the range of expected values. In all cases, the delta between times 2 and 1 was positive. However a review of the descriptive statistics table revealed skewness and kurtosis values that exceeded the -2 and +2 range considered acceptable (DiStefano & Hess, 2005; Javier, 2015). Removal of cases 46, 83 and 129 brought the skewness and kurtosis values to within acceptable range.

The removal of these cases reduced the sample size to 187. With this, the 4th assumption of the mixed two-way ANOVA was met. The 5th assumption for a mixed two-way ANOVA is that the dependent variable should be approximately normally distributed for each cell of the design. This is discussed next.

4.5.4. *Assumption 5 - Normality checks*

Normality checks were done using the Shapiro-Wilk test of normality. The null hypothesis for the Shapiro-Wilk test is that a variable is a normally distributed representation of population, and it is rejected if $p < .05$. The results of the Shapiro-Wilk test performed on attitudes 1 to 3 indicated that data was not normally distributed, with significance < .05 in all cases. However, normality checks based on attitude scores as well as on studentized residuals using Normal Q-Q Plots, found attitudes 1; 2 and 3 to be normally distributed. These plots are presented in Annexure 14. Assessment also showed positively skewed data as was the case in the pilot study.

In the pilot study, data was transformed using the square root methodology and it was found that there were no significant differences between the output of the original data and the transformed data (See Annexure 6). Most statistical techniques are reasonably robust to violations of normality for sample sizes greater than 30 (Pallant, 2016, p. 208). Moreover, data transformation is also a divisive topic with diametrically opposing views on the subject (Pallant, 2016, p.96). Based on findings from the pilot study, data for the main study was not transformed since the sample sizes across groups are similar and substantially bigger than the threshold of 30 as established by Pallant (2016).

4.5.5. *Assumption 6 - Equality of variances (assumption of homogeneity of variances)*

The 6th assumption to be met in conducting a mixed two-way ANOVA is to test for homogeneity of variances, which tests whether the variance in scores is the same for each of the three groups. This assumes that if samples obtained are from populations of equal variances, parametric tests would produce similar variability scores for each of the groups. The ANOVA F test is fairly robust to violations of this assumption when sample sizes are approximately equal i.e. largest / smallest <1.5 (Pallant, 2016). The Levene's test is used to establish equality of variances with a targeted significance level greater than .05 confirming that the test is not significant, i.e. the groups are homogenous. The results of the analysis are as captured in Annexure 14.

At time point 1 (Attitude 1), the null hypothesis for equal variances was not rejected and the variances were equal $F(2,184) = .742$, $p = .477$. In other words, the assumption of homogeneity of variances was not violated.

At time point 2 (Attitude 2), the null hypothesis for equal variances was not rejected and the variances were equal $F(2,184) = 1.939$, $p = .147$. In other words, the assumption of homogeneity of variances was not violated.

At time point 3 (Attitude 3), the null hypothesis for equal variances was rejected and the assumption of homogeneity of variance was violated $F(2,184) = 13.658$, $p < .001$. An independent samples t-test was conducted to further understand this violation. The results are included in Annexure 8. It was found that there was homogeneity of variances for attitude scores for Social Consensus and Source Bias, as assessed by Levene's test for equality of variances ($p = .835$). However, the assumption of homogeneity of variances for attitude scores for the Control Group and Social Consensus was violated, as assessed by Levene's test for equality of variances ($p < .001$) with a large effect size as calculated by Cohens' d of .8. The assumption of homogeneity of variances for attitude scores for the Control Group and Source Bias was also violated ($p < .001$) with a large effect size as calculated by Cohens' d of .826. This is explained by the fact that the attitude scores for the Control Group at time 3 was a copy and paste of scores at time 2. Since ANOVA tests are quite robust when sample sizes are approximately equal, the violation of homogeneity of variances for attitude 3 was noted but not acted upon.

4.5.6. *Assumption 7 - Equality of covariance matrices*

Box's test of equality of covariance matrices was used to determine whether there were similar covariances, with a significance value established at $p < .001$ (Pallant, 2016). If $p > .001$ it implies the test is not statistically significant, that there are equal covariances, and that the assumption of homogeneity of covariances has not been violated.

Table 4.5.6.1

Box's Test of Equality of Covariance Matrices

Box's M	15.798
F	2.563
df1	6
df2	103615.178
Sig.	.018

The Box's test of equality of covariance matrices, as shown in table 4.5.6.1 shows that there is homogeneity of covariances ($p = .018$). Thus, the seventh assumption was met. The 8th and final assumption states that the variance of the differences between groups should be equal, and is widely referred to as the assumption of sphericity. This is discussed next.

4.5.7. *Assumption 8 - the assumption of sphericity*

Sphericity implies that the variance in population difference between two conditions is the same as the variance in population difference for any other two conditions (Pallant, 2016). This assumption of sphericity is commonly violated (Pallant, 2016), and the Mauchly's test of sphericity is considered a poor method to detect violations of sphericity (Field, 2013). In practice the assumption of sphericity is considered difficult not to violate (Laerd Statistics, 2015a). Even if the assumption of sphericity is violated, a correction can be made to correct for this bias by adjusting the degrees of freedom used in calculating the *p*-value. Therefore, the loss of power and increased probability of obtaining a Type II error can be addressed with this correction called **epsilon** (**ε**) (Field, 2013). Three methods have been developed to estimate this adjustment (called the Greenhouse-Geisser, Huynh-Feldt and the Lower-bound estimates, where the Huynh-Feldt correction is used if the Greenhouse-Geisser (ε) > .75 (Field, 2013).

Table 4.5.7.1

Mauchly's Test of Sphericity

Measure: Attitude							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.740	55.142	2	.000	.794	.808	.500

As evidenced in Table 4.5.7.1, we have a statistically significant result with $p < .001$ indicating that the assumption of sphericity was violated for the two-way interaction. Statistical significance occurs at $P > .05$. Analysis of Table 4.5.7.1 shows a Greenhouse-Geisser value of 0.794 implying that the Huynh-Feldt figures should be used to assess whether a statistically significant two-way interaction exists (Field, 2013). Now that it has been established that the data satisfies the requirements of a two-way mixed ANOVA, the statistical technique can be performed to answer the research questions posed in chapter 1, and to test the hypotheses established in chapter 2.

4.6. Hypothesis testing – Hypothesis 1

The research methodology described in Chapter 3 locates H1 after exposure to fake news and is applicable to all participants. H1, as established in Chapter 2 reads:

> H1: Exposure to fake news in climate science will lead to a shift in anchor, towards the position established by that fake news.
>
> Null hypothesis (Ho): The difference in the means of attitude scores prior to exposure to fake news (μ_{time1}) and after exposure to fake news (μ_{time2}) is zero. i.e. $\mu_{time2} - \mu_{time1} = 0$,

H1 compares changes in each participant's attitude score prior to and after exposure to fake news. It is therefore a within-subjects analysis. The descriptive statistics applicable to the main study after removal of outliers, are shown in Table 4.6.1.

Table 4.6.1

Descriptive statistics for the main study attitudes at times 1 to 2

Main study		Mean	Std. Deviation	N
Attitude at time 1	Control	1,7823	0,60307	62
	Social consensus	1,6164	0,56042	58
	source bias	1,6716	0,62494	67
	Total	1,6912	0,59896	187
Attitude at time 2	Control	2,8105	1,44906	62
	Social consensus	2,3966	1,16325	58
	source bias	2,7164	1,46480	67
	Total	2,6484	1,37654	187

Before performing a detailed within-subjects analysis, and although participants were split randomly into the groups, it was important to test and confirm that the three groups began on an equal footing. To do this, univariate tests were run on SPSS 27 to test for simple main effects between groups. The results are captured in Annexure 9. The relevant tables have been extracted for discussion here.

4.6.1. *Tests for simple main effects between groups at time 1*

Attitude 1 was measured prior to any treatment and participants were randomly divided into each of the three groups. Since the same instrument was used to measure attitudes, it would be expected that the difference between groups would not be statistically significant. Table 4.6.1.1 confirms that the means across groups are similar.

Table 4.6.1.1

Group Means and standard error at time 1

Dependent Variable: Attitude at time 1				
Test Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	1.782	.076	1.632	1.932
Social consensus	1.616	.079	1.461	1.771
source bias	1.672	.073	1.527	1.816

The result of the Univariate test for Attitudes at time 1 is shown in table 4.6.1.2. Analysis of results confirms that **the difference in attitudes at time 1 between the three groups was not statistically significant, $F(2, 184) = 1.207$, $p = .301$, partial $\eta^2 = .013$.**

Table 4.6.1.2

Univariate test – Attitude at time 1

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	.864	2	.432	1.207	.301	.013
Error	65.864	184	.358			

The F tests the effect of Test Group. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Pairwise comparisons as captured in 4.6.1.3 also confirms that differences between groups is not statistically significant (α > .05) with p values = .131 ; .295 ; and .607 for the control-social consensus, control – source bias, and social consensus – source bias groups respectively.

Table 4.6.1.3
Pairwise Comparisons for attitudes at time 1

(I) Test Group	(J) Test Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.166	.109	.131	-.050	.382
	source bias	.111	.105	.295	-.097	.319
Social	Control	-.166	.109	.131	-.382	.050
consensus	source bias	-.055	.107	.607	-.267	.156
source bias	Control	-.111	.105	.295	-.319	.097
	Social consensus	.055	.107	.607	-.156	.267

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

A statistically significant difference would have been cause for concern. This finding confirms that the analysis began on an equal footing, with all participants having a similar upfront score. A two-way mixed ANOVA was conducted on data from the main study, and the full details are included in Annexure 7. Since the assumption of sphericity (from Table 4.5.6.1) was violated, and the Greenhouse-Geisser value exceeds 0.75, analysis based on the Huynh-Feldt results indicates **that there was a statistically significant interaction between the intervention and time on attitudes, F(3.232, 297.352) = 8.793, p < .001, partial η^2 = . 087.**

4.6.2. *Tests for simple main effects between groups at time 2*

Attitude 2 was measured after exposure to fake news and since all participants received the same vignette, it would be expected that the difference between groups would not be statistically significant. Table 4.6.2.1 shows that the mean for the social consensus group is lower than the other two groups, but as noted in the univariate test to follow, this difference is not statistically significant.

Table 4.6.2.1

Group Means and standard error at time 2

Dependent Variable: Attitude at time 2				
Test Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	2.810	.174	2.466	3.154
Social consensus	2.397	.180	2.041	2.752
source bias	2.716	.168	2.385	3.047

The result of the Univariate test carried out on SPSS for Attitudes at time 2 is shown in table 4.6.2.2. Analysis of results confirms that **the difference in attitudes at time 2 between the three groups was not statistically significant, $F(2, 184) = 1.490$, $p = .228$, partial $\eta^2 = .016$.**

Table 4.6.2.2

Univariate test – Attitude at time 2

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	5.618	2	2.809	1.490	.228	.016
Error	346.827	184	1.885			

The F tests the effect of Test Group. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Pairwise comparisons as captured in 4.6.2.3 confirms that differences between groups is not statistically significant ($\alpha > .05$) with p values = .101 ; .698 ; and .196 for the control-social consensus, control – source bias, and social consensus – source bias groups respectively.

Table 4.6.2.3

Pairwise Comparisons for attitudes at time 2

(I) Test Group	(J) Test Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.414	.251	.101	-.081	.909
	source bias	.094	.242	.698	-.383	.571
Social	Control	-.414	.251	.101	-.909	.081
consensus	source bias	-.320	.246	.196	-.806	.166
source bias	Control	-.094	.242	.698	-.571	.383
	Social consensus	.320	.246	.196	-.166	.806

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

This was anticipated as participants were randomly allocated to groups, and all three groups were assessed using the same instrument after receiving the identical treatment (exposure to fake news). A statistically significant difference would have been cause for concern. Now that it has been established through the between-groups analysis that the three groups had responded as expected at both time intervals, the analysis of the within-subjects tests may proceed to test hypothesis 1. Conducting this analysis per group at this stage rather than combining all participants in a single analysis helps maintain consistency and continuity in the analyses of the subsequent hypotheses.

4.6.3. *Within-subjects changes in attitudes – times 1 and 2.*

From the tests of within subjects effects for the control group, there was a statistically significant effect of time on attitudes for the control group, $F(1,61) = 39.05$. $p < .001$, partial $\eta^2 = .39$. This is captured in Annexure 10. The pairwise comparisons in also confirms that the difference in attitude mean score for the control group, between time 1 and time 2 is statistically significant with $p < .001$. The effect size of this attitude change was large with Cohen's $d = 0.926$, as captured in table 4.6.3.1.

From the tests of within subjects effects for the social consensus group, there was a statistically significant effect of time on attitudes, $F(1.824,103.99) = 24.12$. $p < .001$, partial $\eta^2 = .297$. This is also displayed in Annexure 10. The pairwise comparisons confirm the difference in attitude mean score between time 1 and time 2 is statistically significant with $p < .001$. The effect size of this attitude change was large with Cohen's $d = 0.854$.

From the tests of within subjects effects for the source bias group, there was a statistically significant effect of time on attitudes, $F(1.389, 91.647) = 32.90$. $p < .001$, partial $\eta^2 = .333$ –

see Annexure 10. The pairwise comparisons confirm the difference in attitude mean score between time 1 and time 2 is statistically significant with $p < .001$. The effect size of this attitude change was large with Cohen's d = 0.928.

Table 4.6.3.1 shows the attitudinal changes within participants in each of the three groups and calculates the effect sizes for these changes. Using established criteria in assessing effect size as follows: Cohen's d: .2 = small effect, .5 = medium effect, .8 = large effect sizes (Pallant, 2016; Rice & Harris, 2005; Tabachnick & Fidell, 2013), it is evident that the effect sizes for changes in attitudes from time 1 to time 2 for all three groups were large.

Table 4.6.3.1

Effect sizes for change in attitudes times 1 and 2

		Control		Social Consensus		Source Bias	
		time 1 (T_1)	time 2 (T_2)	time 1 (T_1)	time 2 (T_2)	time 1 (T_1)	time 2 (T_2)
mean	M_1 ; M_2	1,7823	2,8105	1,6164	2,3966	1,6716	2,7164
Std. Deviation	SD_1 ; SD_2	0,60307	1,44906	0,56042	1,16325	0,62494	1,46480
Sdpooled (T_1,T_2)	$\frac{\sqrt{SD_1^2 + SD_2^2}}{2}$	1,1098		0,9130		1,1261	
Cohen's d (T_1,T_2)	$\frac{M2 - M1}{SD_{pooled,}}$	0,926		0,854		0,928	

In conclusion, in all three groups, the attitude changes from the initial anchor to the anchor after exposure to fake news was statistically significant, at significance level (α) established at .05. Additionally, in all three groups the effect size, as calculated using Cohen's d was large, exceeding the established threshold of .8 that denotes large effect sizes. **Thus H1, which states that exposure to fake news in climate science will lead to a shift in anchor towards the position established by that fake news, was empirically supported. The null hypothesis for H1 is therefore rejected, and the chance of it being true is less than 5%.** This is the case for all three groups (control group, the social consensus group and the source bias group).

4.7. Hypothesis testing – Hypothesis 2 and 3

The research methodology described in chapter 3 locates H2 and H3 after exposure to the relevant discounting cues subsequent to fake news exposure. This is effectively at the same point in time although they were different treatments to different groups. Therefore, H2 and H3 were analysed together to not only establish movements in anchor but to also compare such movements between groups in order to answer research question 1, which reads: *What*

is the relative impact of source bias and social consensus on people's anchors after they are exposed to fake news?

H2 and H3, as established in chapter 2 read:

> H2: The shift in anchor after exposure to fake news will be influenced by social consensus from user comments proclaiming the story to be fake news.
>
> Null hypothesis: The difference in the means of attitude scores prior to exposure to a discounting cue in the form of user comments proclaiming the story to be fake news (μtime2) and after exposure to a discounting cue in the form of user comments proclaiming the story to be fake news (μtime3), is zero. i.e. μtime3 – μtime2 = 0,
>
> H3: The shift in anchor after exposure to fake news will be influenced by a discounting cue demonstrating that the source of the fake news story is biased.
>
> Null hypothesis: The difference in the means of attitude scores prior to exposure to a discounting cue indicating that the source of the fake news is biased (μtime2) and after exposure to a discounting cue indicating that the source of the fake news is biased (μtime3), is zero. i.e. μtime3 – μtime2 = 0,

Both H2 and H3 compares changes in each participant's attitude score prior to and after exposure to the discounting cue on social consensus and source bias respectively. This comparison is also done against the control group, and the analysis is therefore a within-subjects analyses as well as a between-groups analyses. Attitude 3 was measured after exposure to the discounting cues for the treatment groups, while for the control group was a copy and paste of the measure at time 2 since there was no measurement at time 3. The descriptive statistics after removal of outliers, are shown in Table 4.7.1.

Table 4.7.1

Descriptive statistics for the main study attitudes at times 2 and 3

Main study		Mean	Std. Deviation	N
Attitude at time 2	Control	2,8105	1,44906	62
	Social consensus	2,3966	1,16325	58
	source bias	2,7164	1,46480	67
	Total	2,6484	1,37654	187
Attitude at time 3	Control	2,8105	1,44906	62
	Social consensus	1,8491	0,86341	58
	source bias	1,8396	0,84578	67
	Total	2,1644	1,17434	187

4.7.1. Within subjects analysis between time points 2 and 3.

This analysis gives an indication of how participant's attitudes in each group changed with each intervention, and is a within-subjects analysis assessed using the repeated measures ANOVA on SPSS 27. Prior to this analysis, the data file was split on SPSS based on the three groups. For purposes of testing H2 and H3, a within-subjects analysis was not required for the control group as attitude at time 3 was a copy and paste of attitude at time 2. However, SPSS did run the analysis and the detailed analysis and output report for all three groups is captured in Annexure 10. The relevant tables have been extracted for analysis here.

4.7.1.1. Social Consensus group shift in anchor after exposure to the discounting cue.

For the group that received discounting cues in the form of user comments (group 2), the Mauchly's test of sphericity indicates that we have a statistically significant result with $p < .001$ indicating that the assumption of sphericity was violated for the two-way interaction. Statistical significance occurs at $P > .05$. Analysis of Table 4.7.1.1.1 shows a Greenhouse-Geisser value exceeding the threshold of .75 as stated earlier implying that the Huynh-Feldt figures should be used to assess whether a statistically significant two-way interaction exists (Field, 2013).

Table 4.7.1.1.1

Mauchly's Test of Sphericity for Main study Social Consensus Group

Measure: Attitude							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.871	7.724	2	.021	.886	.912	.500

From the tests of within subjects effects for the social consensus group, there was a statistically significant effect of time on attitudes, $F(1.824,103.99) = 24.12$. $p < .001$, partial $\eta^2 = .297$. This is extracted from table 4.7.1.1.2.

Table 4.7.1.1.2

Tests of Within-Subjects Effects for Main study Social Consensus Group

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	18.608	2	9.304	24.120	.000	.297
	Greenhouse-Geisser	18.608	1.772	10.503	24.120	.000	.297
	Huynh-Feldt	**18.608**	**1.824**	**10.200**	**24.120**	**.000**	**.297**
	Lower-bound	18.608	1.000	18.608	24.120	.000	.297
Error(time)	Sphericity Assumed	43.975	114	.386			
	Greenhouse-Geisser	43.975	100.989	.435			
	Huynh-Feldt	43.975	**103.993**	.423			
	Lower-bound	43.975	57.000	.771			

Importantly, for purposes of testing hypothesis 2, pairwise comparison for attitudes at times 2 and 3, as captured in table 4.7.1.1.3 shows the difference in mean prior to receiving the discounting cue (time 2) and after exposure to the discounting cue (time 3) is statistically significant ($p < .001$). An key observation is that the difference in mean between the initial assessment (time 1) and after exposure to the discounting cue (time 3) is not statistically significant ($p = .101$). This will be explored further in section 4.7.2. (Between groups analysis at time point 3).

Table 4.7.1.1.3

Pairwise Comparisons for Main study Social Consensus Group

Pairwise Comparisons[a]

Measure: Attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	95% Confidence Interval for Difference[c]	
					Lower Bound	Upper Bound
1	2	-.780	.134	.000	-1.111	-.449
	3	-.233	.107	.101	-.497	.031
2	1	.780	.134	.000	.449	1.111
	3	.547	.102	.000	.296	.799
3	1	.233	.107	.101	-.031	.497
	2	-.547	.102	.000	-.799	-.296

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

a. Main study = Social consensus

c. Adjustment for multiple comparisons: Bonferroni.

Table 4.7.1.1.4 summarises the mean attitude scores at each of the three time points, together with the standard deviations. These were used to calculate the pooled standard deviations as well as the effect size using Cohen's d for changes in attitude between times 1 and 2, and times 2 and 3. Since the change in mean attitude scores between times 1 and 3 was not statistically significant, Cohen's d was not required and thus not calculated.

Table 4.7.1.1.4

Social Consensus Group Effect sizes for times 1 to 3

	Social Consensus		
	time 1 (T_1)	time 2 (T_2)	time 3 (T_3)
Mean (M)	1,6164	2,3966	1,8491
Std. Deviation (SD)	0,56042	1,16325	0,86341
Sd_{pooled} (T_1,T_2)	0,9130		
Cohen's d (T_1,T_2)	**0,854**		
Sd_{pooled} (T_2,T_3)		1,0244	
Cohen's d (T_2,T_3)		**0,534**	
Sd_{pooled} (T_1,T_3)			-
Cohen's d (T_1,T_3)			-

Figure 4.7.1.1-1 is a graphical representation of the changes in attitude scores for the social consensus group that spans initial attitude, attitude after exposure to fake news, and attitude after the discounting cue in the form of user comments declaring the news article to be fake, and providing counter arguments. It is evident, both visually and statistically, that the anchor shifts in participants in the social consensus group from after exposure to fake news and after exposure to the discounting cue was statistically significant, at significance level (α) established at .05.

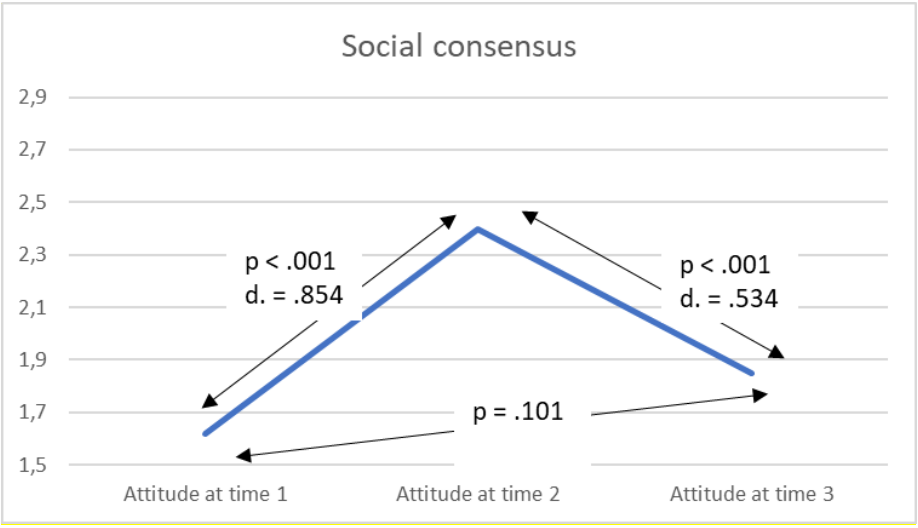

Figure 4.7.1.1-1 Social Consensus effect sizes for statistically significant changes in attitude

Additionally, the effect size of the change in attitude after exposure to the discounting cue, as calculated using Cohen's d was medium, exceeding the established threshold of .5 that denotes medium effect sizes. While this effect size as determined by the within-subjects analysis is medium, section 4.7.4 that compares the between groups changes will show that this is large when compared to the control group. **In conclusion, H2, which states that the shift in anchor after exposure to fake news will be influenced by social consensus from user comments proclaiming the story to be fake news, was empirically supported. The null hypothesis for H2 is therefore rejected, and the chance of it being true is less than 5%.**

4.7.1.2. Source Bias group shift in anchor after exposure to the discounting cue.

The descriptive statistics after removal of outliers was captured in table in 4.7.1. For the group that received discounting cues in the form of letters to the editor indicating a biased source (group 3), the Mauchly's test of sphericity indicated that we had a statistically significant result with $p < .001$ signifying that the assumption of sphericity was violated for the two-way interaction. Statistical significance occurs at $P > .05$. Analysis of Table 4.7.1.2.1 shows a Greenhouse-Geisser value of 0.694. Since it is less than .75, the Greenhouse-Geisser values were utilised to assess statistical significance.

Table 4.7.1.2.1

Mauchly's Test of Sphericity for Main study Source Bias Group

Measure: Attitude							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.560	37.724	2	.000	.694	.704	.500

From the tests of within subjects effects for the source bias group, there was a statistically significant effect of time on attitudes, $F(1.389, 91.647) = 32.90$. $p < .001$, partial $\eta^2 = .333$. This is reflected in table 4.7.1.2.2.

Table 4.7.1.2.2

Tests of Within-Subjects Effects for Main study Source Bias Group

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	42.180	2	21.090	32.902	.000	.333
	Greenhouse-Geisser	**42.180**	**1.389**	**30.376**	**32.902**	**.000**	**.333**
	Huynh-Feldt	42.180	1.409	29.937	32.902	.000	.333
	Lower-bound	42.180	1.000	42.180	32.902	.000	.333
Error(time)	Sphericity Assumed	84.612	132	.641			
	Greenhouse-Geisser	84.612	**91.647**	.923			
	Huynh-Feldt	84.612	92.992	.910			
	Lower-bound	84.612	66.000	1.282			

Importantly, for purposes of testing hypothesis 3, pairwise comparison for attitudes at times 2 and 3, as captured in table 4.7.1.2.3 shows the difference in mean prior to receiving the discounting cue (time 2) and after exposure to the discounting cue (time 3) is statistically significant ($p < .001$). An key observation, as with group 2, is that the difference in mean between the initial assessment (time 1) and after exposure to the discounting cue (time 3) is not statistically significant ($p = .179$). This will be explored further in section 4.7.2.(Between groups analysis at time point 3).

Table 4.7.1.2.3

Pairwise Comparisons for Main study Source Bias Group

Pairwise Comparisons[a]

Measure: Attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	95% Confidence Interval for Difference[c]	
					Lower Bound	Upper Bound
1	2	-1.045	.172	.000	-1.467	-.622
	3	-.168	.088	.179	-.383	.047
2	1	1.045	.172	.000	.622	1.467
	3	.877	.142	.000	.528	1.225
3	1	.168	.088	.179	-.047	.383
	2	-.877	.142	.000	-1.225	-.528

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

a. Main study = Social consensus

c. Adjustment for multiple comparisons: Bonferroni.

Table 4.7.1.2.4 summarises the mean attitude scores at each of the three time points, together with the standard deviations for the source bias group. These were used to calculate the pooled standard deviations as well as the effect size using Cohen's d for changes in attitude between times 1 and 2, and times 2 and 3. Since the change in mean attitude scores between times 1 and 3 was not statistically significant, Cohen's d was not required and thus not calculated.

Table 4.7.1.2.4

Source Bias Group Effect sizes for times 1 to 3

	Social Consensus		
	time 1 (T_1)	time 2 (T_2)	time 3 (T_3)
Mean (M)	1,6716	2,7164	1,8396
Std. Deviation (SD)	0,62494	1,46480	0,84578
Sd_{pooled} (T_1,T_2)		1,1261	
Cohen's d (T_1,T_2)		**0,928**	
Sd_{pooled} (T_2,T_3)			1,1960
Cohen's d (T_2,T_3)			**0,733**

Figure 4.7.1.2-1 is a graphical representation of the changes in attitude scores for the source bias group that spans initial attitude, attitude after exposure to fake news, and attitude after the discounting cue in the form of letters to the editor declaring the source as biased. It is evident not just statistically but visually as well that a discounting cue questioning the source's bias results in anchor shifts in participants, which was statistically significant, at significance level (α) established at .05.

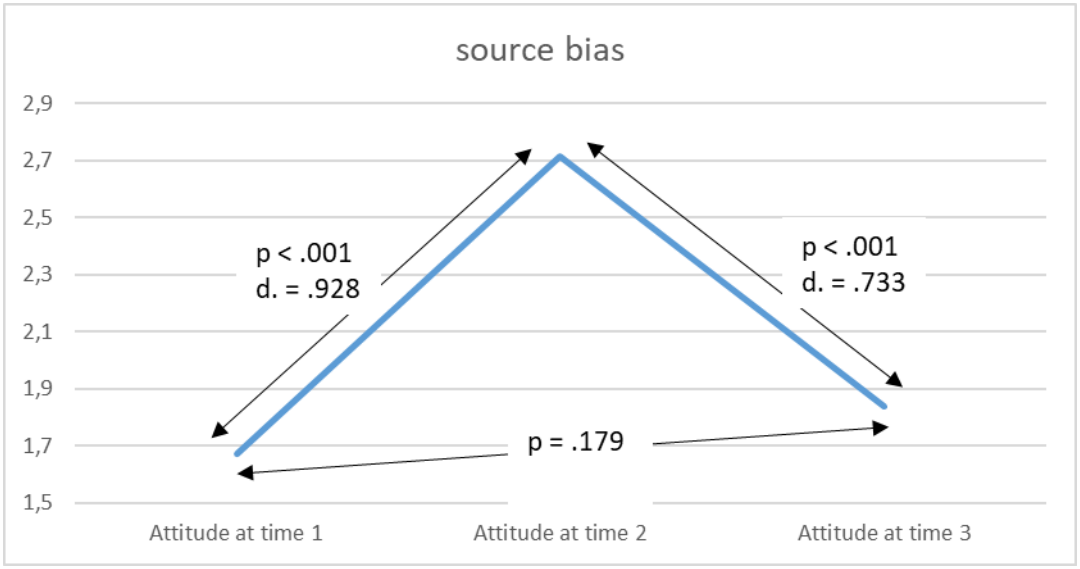

Figure 4.7.1.2-1 Source Bias effect sizes for statistically significant changes in attitude

Additionally, the effect size of this change, as calculated using Cohen's d was medium, exceeding the established threshold of .5 that denotes medium effect sizes. While this effect size as determined by the within-subjects analysis is medium, section 4.7.4 that compares the between groups changes will show that this is large when compared to the control group. **In conclusion, H3, which states that the shift in anchor after exposure to fake news will be influenced by a discounting cue demonstrating that the source of the fake news story is biased, was empirically supported. The null hypothesis for H3 is therefore rejected, and the chance of it being true is less than 5%.**

4.7.2. Between groups analysis at time point 3

Although both groups 2 and 3 displayed a statistically significant shift in anchor between times 2 and 3, both had a medium effect size when evaluating the within-subjects analysis. However, since this study used a control group, analysis of the between-groups changes in attitude in comparison with the control group puts the means of other experimental groups into context (Colliander, 2019).Univariate tests were conducted on SPSS 27 on the three groups at time 3. The results are shown in table 4.7.2.1, and analysis confirms that **the difference in attitudes at time 3 between the three groups was statistically significant, $F(2, 184) = 16.354$, $p < 0.001$, partial $\eta^2 = .151$.**

Table 4.7.2.1

Univariate test – Attitude at time 3

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	38.715	2	19.358	16.354	.000	.151
Error	217.791	184	1.184			

The F tests the effect of Test Group. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Pairwise comparisons as captured in 4.7.2.2 show that differences between the control group and the two treatment groups is statistically significant ($\alpha < .05$) with p values < .001, while the difference between the two treatment groups is not statistically significant (p= .961).

Table 4.7.2.2

Pairwise Comparisons for attitudes at time 3

(I) Test Group	(J) Test Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.961	.199	.000	.569	1.353
	source bias	.971	.192	.000	.593	1.349
Social	Control	-.961	.199	.000	-1.353	-.569
consensus	source bias	.010	.195	.961	-.375	.395
source bias	Control	-.971	.192	.000	-1.349	-.593
	Social consensus	-.010	.195	.961	-.395	.375

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Cohen's d was used to calculate the effect size using data extracted from the descriptive statistics table 4.7.1. Of importance is the effect size between the control group and the social consensus group at time 3, which was large with Cohen's d = .806. Equally important was the effect size between the control group and the source bias group at time 3, which was also large with Cohen's d = .818. The results are captured in table 4.7.2.3.

Table 4.7.2.3

Effect sizes for changes in attitudes – times 1-3

	Time1	Time2	TIme3
Control mean	1,782	2,810	2,810
Control std dev.	0,603	1,449	1,449
Social Consensus mean	1,616	2,397	1,849
Social Consensus std dev.	0,560	1,163	0,863
Source Bias mean	1,672	2,716	1,840
Source Bias std dev.	0,625	1,465	0,846
SdPooled - Control - social consensus	0,582	1,314	1,193
Control - social consensus effect size			**0,806**
SdPooled Control - source bias	0,614	1,457	1,186
Control - source bias effect size			**0,818**
Sdpooled social cons. - source bias	0,594	1,323	0,855
social cons. - source bias effect size	0,093	0,242	-0,011

The between groups changes in attitudes with appropriate significance levels and effect sizes are shown in figure 4.7.2.1.

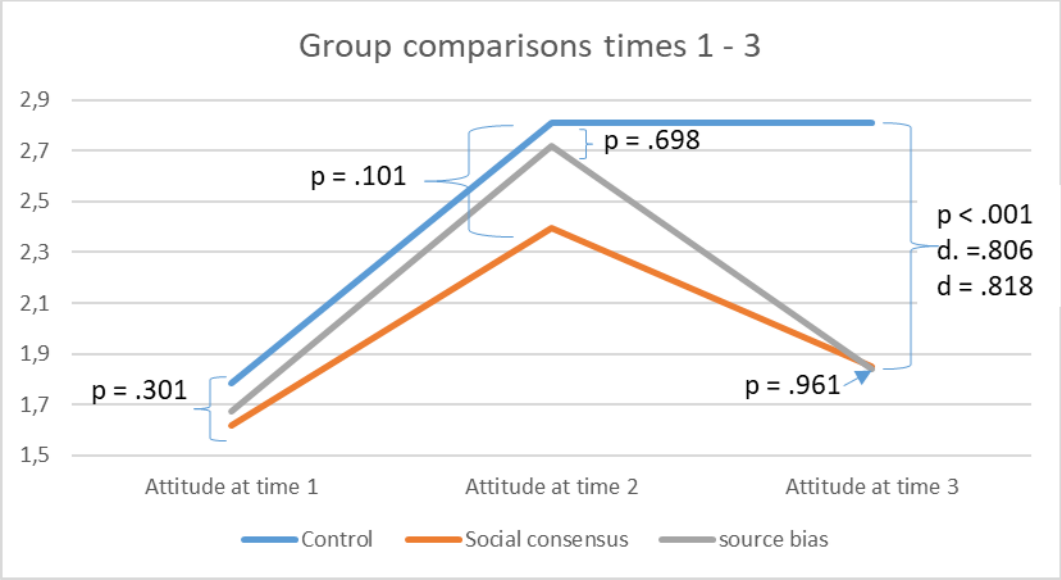

Figure 4.7.2-1 Between Group comparisons for changes in attitude times 1 - 3

While the within-subjects analysis for the social consensus group shows the difference between times 2 and 3 as being statistically significant ($p < .001$) with a medium effect ($d = .534$), the between groups analysis shows this difference to be statistically significant as well ($p < .001$) but with a large effect ($d = .806$) in relation to the control group. Visual inspection of figure 4.7.2-1 shows a visible difference between group 1 and group 2 at time 2, although it is not statistically significant ($p=.101$). This might explain the difference in findings between the within subjects' analysis and the between groups analysis. However, the reason for the visible difference between groups 1 and 2 is not fully understood as the grouping of participants was done at random, and there was homogeneity of variance among attitudes at time 2 ($p = .147$), as established in section 4.5.4. .

4.8. Hypothesis testing – Hypothesis 4

The research methodology described in Chapter 3 locates H4 three months after the initial survey. However, the analysis of H4 occurs both after two weeks as well as after three months, as they both gauge the influence of time on attitudes. Hypothesis 4 answers research question 2, which reads: *What influence does time have on people's anchors, when they are exposed to fake news and discounting cues?*

H4, as established in chapter 2 reads:

> H4: Over time, anchors will shift back towards the position established after exposure to fake news, with the memory of an untrustworthy source or user comments that the story is fake, eroded.
>
> Null hypothesis: The difference in the means of attitude scores after two weeks (μ_{time4}) and after three months (μ_{time5}) respectively will be statistically significant when compared to attitude mean score after exposure to fake news (μ_{time2}). i.e. $\mu_{time4} \neq \mu_{time2}$; $\mu_{time5} \neq \mu_{time2}$, $p < .05$

Since there was a time lapse of greater than two weeks and greater than three months between the first survey and the second and third surveys respectively, it is very possible that the survey may have sparked participant's interest in the subject to conduct additional research on the matter, or other external influences like media, courses, or any other discussion about climate change, may have influenced participants attitudes toward climate change. In analysing data, it is critical to cater for the influence of external factors, as not taking this into consideration increases the potential of Type I and Type II errors. The following questions were asked of participants that took the survey after two-weeks and again after three-months.

> Q4 Have you been exposed to any information about climate change since taking the initial survey?
>
> Yes ⬭ No ⬭

Those that answered Yes to the above question were presented with the following question:

> Do you believe this additional information had any influence on your attitudes or changed your perspectives towards climate change, since taking the initial survey?
>
> Yes ⬭ No ⬭

Those that answered Yes to this question were excluded from the database for further analysis, while those that answered No were retained.

4.8.1. *Analysis of attitudes – time point 4 (two weeks after the initial survey)*

Of the initial 190 respondents, 153 responded to the second survey. This is a response rate of 80.52 %. Of the 153 responses, 33 indicated that the additional information had an influence on their attitudes. They were allocated a number of 105 on SPSS to denote them as missing values. Table 4.8.1.1 captures the descriptive statistics for the group.

Table 4.8.1.1

Descriptive statistics for Attitudes at time point 4

Survey after 2 weeks

		Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Attitude at time 4	Control	46	80,7%	11	19,3%	57	100,0%
	Social consensus	40	87,0%	6	13,0%	46	100,0%
	source bias	34	66,7%	17	33,3%	51	100,0%
	105 (Missing)	33	100,0%	0	0,0%	33	100,0%

Since the sample size in each group is less than 50, the Shapiro-Wilk test was utilised to establish normality, rather than the normal Q-Q plots utilised earlier for analysis of attitudes 1 – 3, which had the larger samples. The null hypothesis for the Shapiro-Wilk test is that a variable is normally distributed in some population, and it is rejected if $p < .05$. A normality check was performed on attitude 4. The output is captured in table 4.8.1.2. Analysis indicates that data was not normally distributed as assessed by the Shapiro-Wilk test, with significance < .05 in all cases.

Table 4.8.1.2

Normality test for attitudes at time point 4

Tests of Normality

Survey after 2 weeks	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control	.131	46	.047	.927	46	.007
Social consensus	.149	40	.026	.897	40	.002
source bias	.201	34	.001	.713	34	.000
105 (Missing)	.196	33	.002	.893	33	.004

a. Lilliefors Significance Correction

Although a one-way ANOVA is said to be robust to deviations from normality, the difference is sample size between the control group (46) and the source bias group (34) was cause for concern of an increased potential for a type I error. In cases of violation of normality of data, an alternative to data transformation is a suitable non-parametric alternative. The Kruskal-Wallis H test, is the non-parametric alternative to the one-way ANOVA, and is more tolerant to deviations from normality (Pallant, 2016). In order to run a Kruskal-Wallis H test, there are a set of four rules that must be met. The first three are based upon the measuring instrument and variables of choice, whilst the fourth is a function of nature of the data (Laerd Statistics, 2015a; Pallant, 2016)

Requirement 1: There should be one dependent variable that is measured at the continuous or ordinal level. In our study, the dependent variable is attitudes measured, and as described throughout this study, it is continuous, thus meeting the first requirement of this non-parametric test.

Requirement 2: There should be one independent variable that consists of two or more categorical, independent groups. This is the case in this study as the three groups (control, social consensus, and source bias) are independent and categorical, thus meeting the second requirement of this non-parametric test

Requirement 3: There should be independence of observations, Independent here implies that there is no cross-pollination where participants are subject to treatment of another group. This is indeed the case with this study, where there were different participants in each group with no participant being in more than one group, thus meeting the third requirement of this non-parametric test.

Requirement 4: The fourth requirement relates to the distribution of scores for each group of the independent variable, which informs how the output of the Kruskal-Wallis H test is interpreted. This is obtained after performing the test, and is analysed through a combination of analysing the “Hypothesis test summary” generated by SPSS as well as the box plots also generated by SPSS. Table 4.8.1.3 shows the Kruskal Wallis test result as generated by SPSS. Of importance is the outcome of the tests with a non significant result ($p = .256$), which suggests that the distribution of attitudes at time 4 is the same across categories.

Table 4.8.1.3

Hypothesis Test Summary of the Independent-Samples Kruskal-Wallis Test

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of Attitude at time 4 is the same across categories of Survey after 2 weeks.	Independent-Samples Kruskal-Wallis Test	.256	Retain the null hypothesis.

a. The significance level is .050. b. Asymptotic significance is displayed.

Figure 4.8.1-1 confirms visually through the boxplot analysis that the distributions are the same.

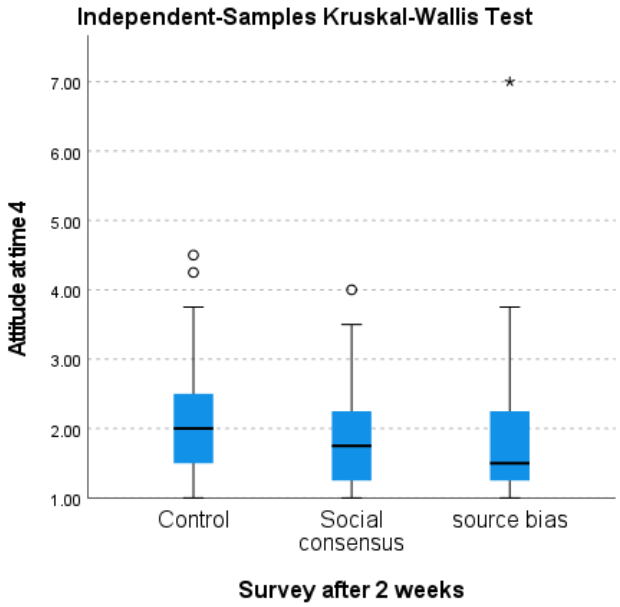

Figure 4.8.1-1 Boxplots of the Kruskal Wallis analysis for attitudes at time 4

Analysis of both table 4.8.1.3 and figure 4.8.1-1 confirm that the distribution of attitude at time 4 is the same across categories, thus complying with the fourth requirement of the Kruskal-Wallis test. We can therefore interpret the output of the test.

In summary, a Kruskal-Wallis H test was run to determine if there were differences in attitude score between the three groups, two weeks after exposure to fake news and in the case of the two treatment groups, after exposure to the discounting cues as well. Distributions of attitude scores were similar for all groups, as assessed by visual inspection of the boxplot. Median attitude scores were not statistically significantly different between groups, $\chi^2(2) = 2.723$, $p = .256$. Additional details are captured in Annexure 11 – Kruskal Wallis test for attitude 4.

4.8.2. *Analysis of attitudes – time point 5 (three months after the initial survey)*

Of the initial 190 respondents, 133 responded to the third and final survey. This is a response rate of 70 %. Of the 133 responses, 39 indicated that the additional information had an influence on their attitudes. They were allocated a number of 106 on SPSS to denote them as missing values. Table 4.8.2.1 captures the descriptive statistics for the group.

Table 4.8.2.1

Descriptive statistics for Attitudes at time point 5

Survey after 3 months							
		Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Attitude at time 5	Control	35	66.0%	18	34.0%	53	100.0%
	Social consensus	29	67.4%	14	32.6%	43	100.0%
	source bias	30	57.7%	22	42.3%	52	100.0%
	106(Missing)	39	100.0%	0	0.0%	39	100.0%

Since the sample size in each group is less than 50, the Shapiro-Wilk test will be utilised to establish normality, rather than the normal Q-Q plots utilised earlier to test attitudes 1-3, which had larger samples. The null hypothesis for the Shapiro-Wilk test is that a variable is normally distributed in some population, and it is rejected if $p < .05$. A normality check was performed on attitude 5. The output is captured in table 4.8.2.2. Analysis indicates that data was not normally distributed as assessed by the Shapiro-Wilk test, with significance < .05 in all cases.

Table 4.8.2.2
Normality test for attitudes at time point 5

Tests of Normality

Survey after 3 months	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control	.168	35	.014	.862	35	.000
Social consensus	.173	29	.026	.886	29	.005
source bias	.295	30	.000	.670	30	.000
106 (Missing)	.193	39	.001	.769	39	.000

a. Lilliefors Significance Correction

Aligned with the analysis at time point 4, the Kruskal-Wallis H test was evaluated for appropriateness at time point 5 since it is more tolerant to deviations from normality than the one-way ANOVA. The first three requirements for the test as evaluated at time point 4 remained valid for timepoint 5. The fourth requirement relates to the distribution of scores for each group of the independent variable, which informs how the output of the Kruskal-Wallis H test is interpreted. This is obtained after performing the test, and is analysed through a combination of analysing the "Hypothesis test summary" generated by SPSS as well as the box plots also generated by SPSS.

Table 4.8.2.3

Hypothesis Test Summary of the Independent-Samples Kruskal-Wallis Test

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of Attitude at time 5 is the same across categories of Survey after 3 months.	Independent-Samples Kruskal-Wallis Test	.368	Retain the null hypothesis.

a. The significance level is .05.

b. Asymptotic significance is displayed.

Analysis of both table 4.8.2.3 and figure 4.8.2-1 confirm that the distribution of attitudes at time 5 is the same across categories, thus complying with the fourth requirement of the Kruskal- Wallis test. We can therefore interpret the output of the test.

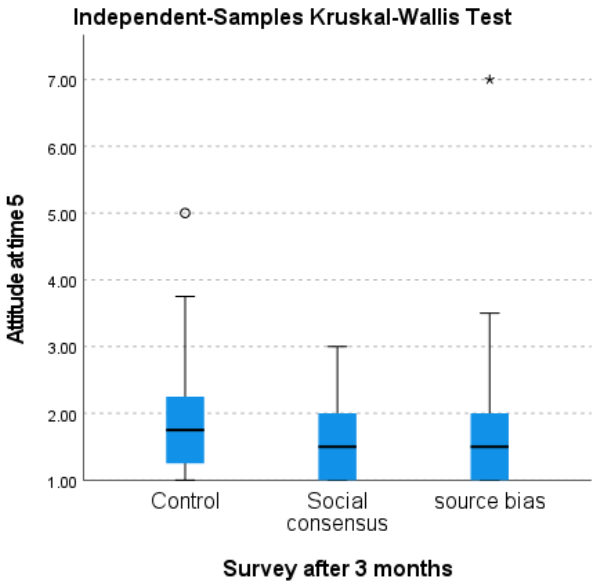

Figure 4.8.2-1: Boxplots for distribution of attitudes at time point 4

In summary, a Kruskal-Wallis H test was run to determine if there were differences in attitude score between the three groups, three months after exposure to fake news and in the case of the two treatment groups, three months after exposure to the respective discounting cues as well. Distributions of attitude scores were similar for all groups, as assessed by visual inspection of a boxplot. Median attitude scores were not statistically significantly different between groups, $\chi^2(2) = 2.001$, $p = .368$. Additional details are captured in Annexure 12 – Kruskal Wallis test for attitude 5.

4.8.3. *Influence of time on attitudes – time periods 1 to 5*

There is no non-parametric technique equivalent to the mixed within-between ANOVA (Pallant, 2016, p.206). The assessment of the impact of time was analysed using the repeated measures technique on SPSS 27. For samples with larger sizes (as was the case when the ANOVA for times 1 to 3 was conducted) power is not an issue, but with smaller sample sizes (as is the case here when the influence of external factors are taken into account), there is a possibility that a non-significant result may be due to loss of power (Pallant, 2016, p.210). As a compensation, they suggest setting a cut-off to .1 or .15 as opposed to the traditional .05. Based on these guidelines, both alpha levels were run to compare results. In both cases the findings and conclusions were not influenced by the alpha level.

Table 4.8.3.1 shows the pairwise comparisons for time with alpha set at .05.

Table 4.8.3.1

Pairwise comparisons for attitudes with alpha = .05

Pairwise Comparisons

Measure: attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.834*	.123	.000	-1.187	-.481
	3	-.369*	.101	.005	-.660	-.077
	4	-.223	.088	.132	-.477	.031
	5	-.124	.083	1.000	-.365	.116
2	1	.834*	.123	.000	.481	1.187
	3	.465*	.073	.000	.256	.674
	4	.611*	.123	.000	.258	.964
	5	.710*	.129	.000	.338	1.081
3	1	.369*	.101	.005	.077	.660
	2	-.465*	.073	.000	-.674	-.256
	4	.146	.100	1.000	-.143	.435
	5	.244	.106	.239	-.062	.551
4	1	.223	.088	.132	-.031	.477
	2	-.611*	.123	.000	-.964	-.258
	3	-.146	.100	1.000	-.435	.143
	5	.099	.106	1.000	-.208	.405
5	1	.124	.083	1.000	-.116	.365
	2	-.710*	.129	.000	-1.081	-.338
	3	-.244	.106	.239	-.551	.062
	4	-.099	.106	1.000	-.405	.208

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 4.8.3.2 shows the pairwise comparisons for time with alpha set at .1.

Table 4.8.3.2

Pairwise comparisons for attitudes with alpha = .1

Pairwise Comparisons

Measure: attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.834	.123	.000	-1.157	-.511
	3	-.369	.101	.005	-.635	-.102
	4	-.223	.088	.132	-.455	.009
	5	-.124	.083	1.000	-.344	.096
2	1	.834	.123	.000	.511	1.157
	3	.465	.073	.000	.274	.656
	4	.611	.123	.000	.288	.934
	5	.710	.129	.000	.370	1.049
3	1	.369	.101	.005	.102	.635
	2	-.465	.073	.000	-.656	-.274
	4	.146	.100	1.000	-.118	.410
	5	.244	.106	.239	-.036	.524
4	1	.223	.088	.132	-.009	.455
	2	-.611	.123	.000	-.934	-.288
	3	-.146	.100	1.000	-.410	.118
	5	.099	.106	1.000	-.182	.379
5	1	.124	.083	1.000	-.096	.344
	2	-.710	.129	.000	-1.049	-.370
	3	-.244	.106	.239	-.524	.036
	4	-.099	.106	1.000	-.379	.182

Based on estimated marginal means

*. The mean difference is significant at the ,1 level.

b. Adjustment for multiple comparisons: Bonferroni.

It is evident from both tables that the difference in mean scores between the initial attitudes recorded at time 1, and the final attitudes recorded at time 5 was not statistically significant (p= 1.000), irrespective of the alpha value used. Therefore, significance level p = .05 was used and results from the two-way mixed Anova for times 1-5 is captured in annexure 13. However, only the results for times 4 and 5 were utilised, while the results of the first ANOVA carried out

for attitudes 1-3 as captured in annexure 7 were used for attitudes 1-3. The means and standard deviations were extracted from annexure 7 and annexure 13 as appropriate and pasted onto an Excel spreadsheet where the effect sizes were calculated, and graphs created to illustrate the changes in attitudes for each group over the study period. Table 4.8.3.3 shows the mean attitudes scores and standard deviations for the control group.

Table 4.8.3.3

Means and standard deviations: control group times 1 to 5

	time 1 (T1)	time 2 (T2)	time 3 (T3)	time 4 (T4)	time 5 (T5)
Mean	1,7823	2,8105	2,8105	2,1127	1,9375
Std. Deviation	0,6031	1,4491	1,4491	0,8864	0,8510

From the data in this table, the following equations were used to calculate effect size. The results for the control group are captured in table 4.8.3.4. Effect sizes were only calculated at time points where changes were statistically significant ($p < .05$)

$$\text{Cohen's d} = (M_2 - M_1) / SD_{pooled,}$$

$$\text{where } SD_{pooled} = \sqrt{((SD1^2 + SD2^2) / 2)},$$

Table 4.8.3.4

Effect size for changes in attitude - control group

	T1 / T2	T3 / T4	T1 / T4	T3 / T5
Sdpooled	1,1098	1,2012	0,7581	1,1883
Cohen's d	0,926	-0,581	0,436	0,735

Figure 4.8.3-1 is a graphical representation of the contents in table 4.8.3.4 and shows changes in means, significance and effect sizes for the control group.

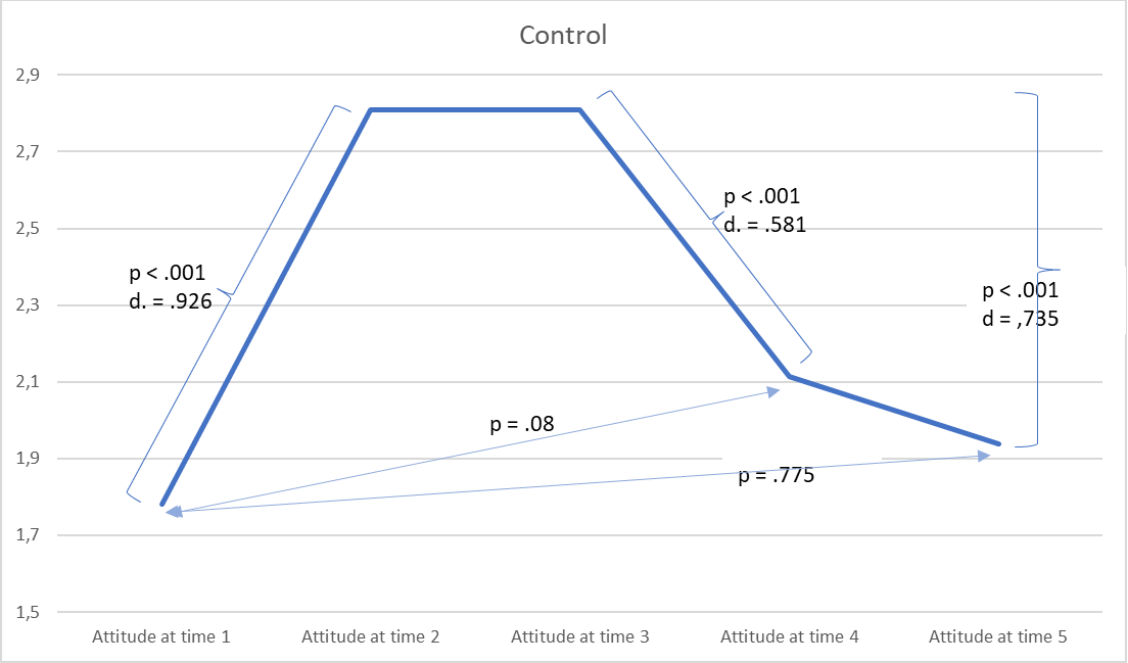

Figure 4.8.3-1 Control Group – changes in attitudes over the study period

In the same manner, as the control group, information was extracted from annexures 7 and 13 and pasted into Excel to establish means and standard deviations for the social consensus group as captured in table 4.8.3.5.

Table 4.8.3.5

Means and standard deviations: social consensus group - times 1 to 5

	time 1 (T1)	time 2 (T2)	time 3 (T3)	time 4 (T4)	time 5 (T5)
Mean	1,6164	2,3966	1,8491	1,8464	1,6591
Std. Deviation	0,5604	1,1632	0,8634	0,7877	0,8389

The information from table 4.8.3.5 was then used to calculate effect sizes as captured in table 4.8.3.6.

Table 4.8.3.6

Effect size for changes in attitude - social consensus group

	T1 / T2	T2 / T3	T2 / T4	T2 / T5
Sdpooled	0,9130	1,0244	0,9934	1,0141
Cohen's d	0,854	0,534	0,554	0,727

Figure 4.8.3-2 is a graphical representation of the contents in table 4.8.3.6 and significance levels as established in annexure 7 and annexure 13, and shows changes in means, significance and effect sizes for the social consensus group.

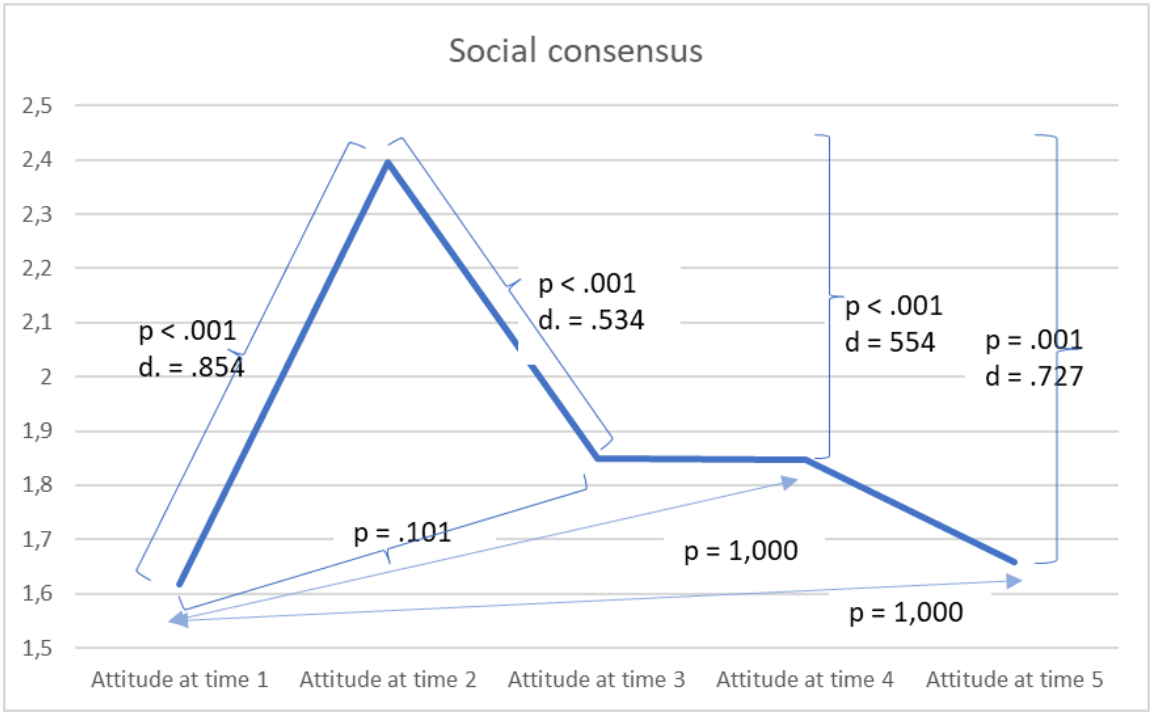

Figure 4.8.3-2 Social Consensus Group – changes in attitudes over the study period

In the same manner, as described for the control and social consensus groups, information was extracted from annexures 7 and 13 and pasted into Excel to establish means and standard deviations for the source bias group as captured in table 4.8.3.7. This information was then used to calculate effect sizes as captured in table 4.8.3.8.

Table 4.8.3.7

Means and standard deviations: source bias group - times 1 to 5

	time 1 (T1)	time 2 (T2)	time 3 (T3)	time 4 (T4)	time 5 (T5)
Mean	1,6716	2,7164	1,8396	1,9300	1,8278
Std. Deviation	0,6249	1,4648	0,8458	1,0051	1,0631

Table 4.8.3.8

Effect size for changes in attitude for the source bias group

	T1 / T2	T2 / T3	T2 / T4	T2 / T5
Sdpooled	1,1261	1,1960	1,2562	1,2798
Cohen's d	0,928	0,733	0,626	0,694

Figure 4.8.3-3 is a graphical representation of the contents in table 4.8.3.8 and information from annexure 7 and annexure 13, and shows changes in means, significance and effect sizes for the source bias group.

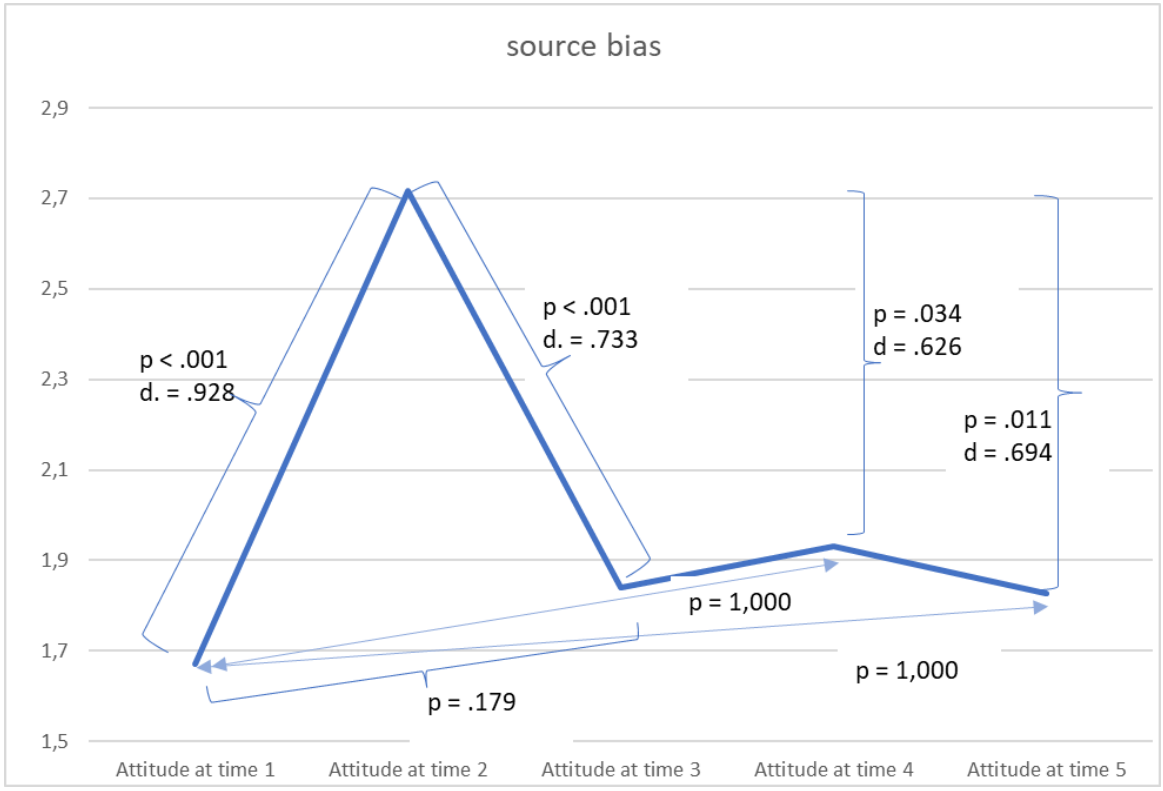

Figure 4.8.3-3 Source Bias Group – changes in attitudes over the study period

The information extracted into Excel was then used to construct table 4.8.3.9, which is useful in capturing both within groups as well as between groups changes in attitudes over the study period.

Table 4.8.3.9

Summary of means within and between groups over study period

	Attitude				
	time 1	time 2	time 3	time 4	time 5
Control	1,782	2,810	2,810	2,112	1,937
Social consensus	1,616	2,396	1,849	1,846	1,659
source bias	1,671	2,716	1,839	1,93	1,827

This was then used to illustrate graphically changes in attitudes both within and between groups as captured in figure 4.8.3-4.

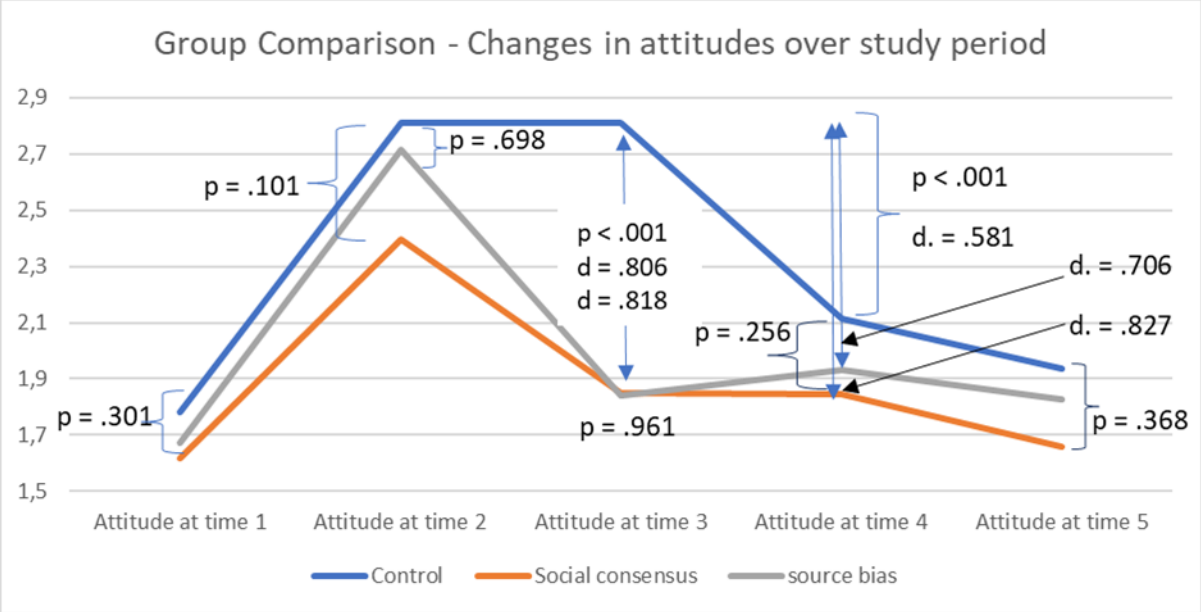

Figure 4.8.3-4 Group comparisons – changes in attitudes over the study period

To recap, it was hypothesised that over time, anchors will shift back towards the position established after exposure to fake news. It was expected that people would continue to rely on discredited or invalidated information, as the memory of the discounting cues would fade faster than the memory of the misinformation. The null hypothesis expected that the difference in the means of attitude scores after two weeks (μ_{time4}) and after three months (μ_{time5}) respectively will be statistically significant when compared to attitude mean score after exposure to fake news (μ_{time2}). i.e. $\mu_{time4} \neq \mu_{time2}$; $\mu_{time5} \neq \mu_{time2}$, $p < .05$. Instead, it was found that anchors had migrated towards their initial positions prior to exposure to fake news.

Therefore, **this study technically fails to reject the null hypothesis for H4**, in that it found $\mu_{time4} \neq \mu_{time2}$ and $\mu_{time5} \neq \mu_{time2}$, $p < .05$. However, **the findings also failed to empirically**

support the main hypothesis 4 as it expected $\mu_{time4} = \mu_{time2}$ and $\mu_{time5} = \mu_{time2}$, $p < .05$. Instead, it found $\mu_{time4} = \mu_{time1}$ and $\mu_{time5} = \mu_{time1}$, $p < .05$, and that the strong argument made in the fake news article about climate change had faded in participant's memory and people's anchors had migrated towards their initial position.

Interestingly, despite the control group not receiving discounting cues, participant's anchors in this group had migrated towards their original value prior to the intervention, albeit not to the same position as they were initially. Since participants who had been influenced by external factors were removed from the analysis, the shift in control group anchors after two weeks and three months occurred without the influence of a persuasive message as required by social judgement theory. Interestingly, all three groups had converged two weeks after treatment and converged further three months after, where in both cases the differences were not statistically significant. This suggests that irrespective of the discounting cue (group 2 and 3), or whether participants had even received a discounting cue (group 1), after time attitudes tended to converge. Additionally, although the difference in attitude mean scores at time 4 between the three groups was not statistically significant, the control group mean is visibly higher than the two treatment groups at time 4, suggesting that the discounting cues play a role in the time it takes for attitudes to be corrected.

4.9. The role of familiarity and ego involvement on anchor shifts.

To understand the role of issue familiarity in our specific study, all participants were asked the following two questions as part of the initial survey, on a five-point semantic differential scale (Extremely familiar; Very familiar; Moderately familiar; Slightly familiar; Not familiar at all).

> How familiar are you with the concept of climate change?
>
> How familiar are you with the arguments for and against climate change?

In addition, and as part of establishing participant's initial anchor, as well as establishing their ego involvement (see section 2.3), they were also asked the following question on a 7 point Likert scale (SA-SD)

> I am personally involved in either addressing climate change or arguing against it.

Each participant's difference in mean scores prior to and after exposure to fake news was calculated on SPSS and for purposes of analysis referred to as "delta". A Bivariate correlation was done to establish Pearson's correlation between participant's familiarity with the subject, their ego involvement and changes in attitudes. The results are captured in table 4.9.1

Table 4.9.1

Correlations with changes in attitude, familiarity and ego involvement

		delta	Familiarity with the concept	Familiarity with the arguments	Ego / Personal involvement
delta	Pearson Correlation	1	.221**	.151*	.138
	Sig. (2-tailed)		.002	.039	.059
	N	187	187	187	187
Familiarity with the concept of climate change	Pearson Correlation	.221**	1	.664**	.402**
	Sig. (2-tailed)	.002		.000	.000
	N	187	187	187	187
Familiarity with the arguments for and against climate change	Pearson Correlation	.151*	.664**	1	.434**
	Sig. (2-tailed)	.039	.000		.000
	N	187	187	187	187
Ego / Personal involvement	Pearson Correlation	.138	.402**	.434**	1
	Sig. (2-tailed)	.059	.000	.000	
	N	187	187	187	187

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

As expected, there was a positive correlation between familiarity with the concept of climate change and familiarity with the arguments both for and against it, with high correlation coefficient of .664 and $p < .001$. There was also a statistically significant correlation between participant's familiarity with the concept of climate change and the respective change in attitude with significance $p = .002$, although the strength of the relationship as established through the Pearson's correlation coefficient was small at .221. Similarly, there was a statistically significant correlation between participant's familiarity with the arguments both for and against climate change and the respective change in attitude with significance $p = .039$, with the strength of the relationship as established through the Pearson's correlation coefficient similarly small at .151.

However, it was surprising to note that the correlation between participant's ego involvement and their changes in attitude was not statistically significant ($p = .059$), and Pearson's correlation was small at .138. In other words, there was no correlation between attitudinal changes of those participants who indicated they had been personally involved in arguing for or against climate change and those who did not. Analysis of the data confirmed this. As an example, case 165 strongly agreed that they were personally involved in either arguing for or against climate change but had a positive delta of 4.5 while case 161 indicated the same level

of ego involvement but had a zero change in attitude. At the opposite end, cases 35 and 69 disagreed that they had personal involvement and had a zero change in attitude, while cases 15 and 139 had changes of attitudes of 4.25 and 5 for the same indicated level of involvement.

Interestingly, the relationship between ego involvement and familiarity with climate change was statistically significant with $p < .001$ and Pearson's correlation coefficient of .434. Similarly, the relationship between ego involvement and Familiarity with the concept of climate change was statistically significant with $p < .001$ and Pearson's correlation coefficient of .402. Ego involvement is an established concept in social judgement theory and the most important factor in determining the widths of the three latitudes (Park et al., 2007). The added significance to the sender of a message who attempts to persuade people with high ego involvement on a topic is that they may have to settle for smaller levels of persuasion in comparison to those with low levels of ego involvement (O'Keefe, 2016).

Since the focal point of this study was attitudinal changes and durability, the question gauging ego involvement was a single item measure used more as a manipulation check. If conclusions are to be drawn, a more robust process would need to be established, including internal and external validity tests and reliability checks on the specific instrument. Therefore, the discrepancy between this study's findings on ego involvement and the theoretical foundations of social judgement theory is noted but no inferences are drawn on the theory or conclusions made in this regard. Rather, it could be subject of further research using the data from this study as secondary data but done in combination with the collection of primary data to test the specific concept in a similar setting.

4.10. Chapter conclusion

This chapter presented the results of the experimental research conducted at five points in time. The mixed two-way Analysis of Variance (ANOVA) was identified as the suitable statistical technique to analyse the data, but prior to conducting this analysis, the data was checked for compliance to the requirements of the two-way mixed ANOVA. Violations were dealt with as appropriate, and where applicable data was analysed using non-parametric alternatives, or treated as otherwise stated. The analysis was split into sections based on the data available for each of the three surveys conducted. This allowed for the appropriate treatment of participant attrition as well as treating for the effect of external influences without compromising data prior to such attrition or external influence.

The data analysis and results found that H1, which states that exposure to fake news in climate science will lead to a shift in anchor towards the position established by that

fake news, was empirically supported. The null hypothesis for H1 was therefore rejected, and the chance of it being true is less than 5%. This was the case for all three groups (control group, the social consensus group and the source bias group).

Additionally, **H2, which states that the shift in anchor after exposure to fake news will be influenced by social consensus from user comments proclaiming the story to be fake news, was empirically supported. The null hypothesis for H2 was therefore rejected, and the chance of it being true was less than 5%.**

Likewise, **H3, which states that the shift in anchor after exposure to fake news will be influenced by a discounting cue demonstrating that the source of the fake news story is biased, was empirically supported. The null hypothesis for H3 was therefore rejected, and the chance of it being true is less than 5%.**

Interestingly, **this study technically failed to reject the null hypothesis for H4**, in that it found that the mean attitude score at time 4 (μ_{time4}) was not equal to the attitude score at time 2 (μ_{time2}) and the mean attitude score at time 5 (μ_{time4}) was not equal to the attitude score at time 2 (μ_{time2}), $p < .05$. However, **the findings also failed to empirically support the main hypothesis 4** in that attitudes were expected to migrate towards the position established after exposure to fake news, but instead had migrated towards their original (initial) position.

The chapter also found that both discounting cues had an identical impact on attitudes in that attitudes after exposure to the discounting cues were statistically significantly different from attitudes after exposure to fake news, but the difference in participant's attitude mean scores in both these groups at time points 4 and 5 were not statistically different.

Chapter 5 discusses the findings from this research and provides interpretation thereof in relation to the theoretical underpinnings of this doctoral research.

5. Chapter 5 – Findings and discussion

5.1. Chapter introduction

Before interpreting the results as analysed in Chapter 4, it is important to recap the context around which this research was conducted so that the results are interpreted within the given context of the study. This chapter begins with a brief summary to provide the said context. The sections that follow tests each hypothesis tying them back to the research questions as well as the theoretical underpinnings and practical considerations. The unquestionable value of longitudinal studies, which are uncommon due to the practical considerations, is demonstrated as confirmed by the findings on hypothesis 4.

5.2. Brief overview of this research

The primary purpose of this research is to close a theoretical gap in social judgement theory by introducing a dynamic element to social judgement theory that is currently non-existent. A secondary purpose is closing a practice knowledge gap in countering fake news in climate science and social influence. In this regard, the following research questions were raised in chapter 1, which served as the core focus of this research:

> *RQ1: What is the relative impact of source bias and social consensus on people's anchors after they are exposed to fake news?*
>
> *RQ2: What influence does time have on people's anchors, when they are exposed to fake news and discounting cues?*

In order to answer these research questions, an experimental research methodology was adopted to test four hypotheses established in chapter 2. In chapter 4, it was found that the data analysis and results found that H1, which stated that exposure to fake news in climate science will lead to a shift in anchor towards the position established by that fake news, was empirically supported. The null hypothesis for H1 was therefore rejected, and the chance of it being true is less than 5%. Chapter 4 also empirically supported H2, which stated that the shift in anchor after exposure to fake news will be influenced by social consensus from user comments proclaiming the story to be fake news. The null hypothesis for H2 was therefore rejected, and the chance of it being true was less than 5%. Likewise, H3, which stated that the shift in anchor after exposure to fake news will be influenced by a discounting cue demonstrating that the source of the fake news story is biased, was also empirically supported. The null hypothesis for H3 was therefore rejected, and the chance of it being true is less than 5%. Of importance, this study technically failed to reject the null hypothesis for H4, and also failed to empirically support the main hypothesis 4 in that attitudes were expected to migrate

towards the position established after exposure to fake news, but instead had migrated towards their original (initial) position.

This chapter ties these findings back to theory and in doing so closes the gap identified in social judgement theory while also closing a practice knowledge gap in countering fake news.

5.3. Exposure to fake news moves anchor

In Chapter 4, it was shown that the three groups had begun on an equal footing and the shift in anchor after exposure to fake news in all three groups was statistically significant, with significance level $p < .001$ in all cases. Importantly, the effects sizes exceeded the established threshold of .8 for large effect sizes (Pallant, 2016; Rice & Harris, 2005; Tabachnick & Fidell, 2013), for all three groups. Mindful of Allen (1991), and Sung and Lee (2015) observations on the persuasive strength of refutational two-sided messages when compared to non-refutational or one-sided messages, this study took a conscious decision to use non-refutational (one-sided) strong arguments adapted from Lewandowsky et al. (2019) and consistent with arguments put forward by the climate change counter-movement in peddling fake news on climate science. The observed shifts in anchor in each of the three groups is evidence of the persuasive effect of fake news and is consistent with the vast amount of research demonstrating the persuasive effect of strong arguments (Chan et al., 2017; Gandarillas et al., 2018; Park et al., 2007; Petty & Cacioppo, 1986). It is not known whether refutational two-sided arguments would have had a bigger effect, but rejecting the null hypothesis for hypothesis 1, vindicates the decision taken at the beginning of the study to use one-sided strong arguments, aligned with observed practice.

The findings support the observations made in Chapter 2 that showed that the spread of misinformation regarding climate science is ultimately an extension of persuasion theory, where deniers of the science use strong arguments to frame and redirect public discourse towards the advancement of ideological interests (McCright & Dunlap, 2017) in order to influence people's attitudes and technological choices (Fraune & Knodt, 2018). Additionally, in chapter two it was shown that misinformation adopted by the climate change countermovement, which McCright and Dunlap (2017) classify as "Systemic Lies", is perhaps the most pernicious type of misinformation, typified by carefully constructed fabrications to obfuscate and confuse while protecting and promoting vested interests. The vignette used in this study was indeed carefully constructed to obfuscate and confuse, and the shift in anchor observed in this research demonstrates exactly how dangerous fake news can be, and why it should be eradicated. This is especially so since attitude change can be a determining factor of behaviour change (Petty et al., 1997).

5.4. The role of ego involvement on anchor shifts.

A surprising observation from the study was that the correlation between participants' ego involvement and their changes in attitude, was not statistically significant ($p = .059$), and Pearson's correlation was small at .138. The concept of ego involvement, as introduced into social judgement theory by Sherif and Hovland in 1961, is considered the most important factor in determining the widths of the three latitudes (Park et al., 2007), and is a key construct in social judgement theory. Therefore, the observation that there was no correlation between attitudinal changes and ego involvement, gauged from participants responses on whether or not they had been personally involved in arguing for or against climate change, was not as expected.

Since the focal point of this study was attitudinal changes and durability, the question gauging ego involvement was a single item measure used more as a manipulation check. It was based on a conscious decision not to clutter the questionnaire with questions not central to answering the research questions, and was done on the assumption that ego involvement reflected a homogenous construct. Should further work be required in this regard, a more robust process would be recommended, including internal and external validity tests and reliability checks on the specific instrument. Multiple items would also be recommended as they help average out errors and specificities that are inherent in single items, thus leading to increased reliability and construct validity (Diamantopoulos et al., 2012). Therefore, the discrepancy between this study's findings on ego involvement and the theoretical foundations of social judgement theory is noted but no inferences are drawn on the theory or conclusions made in this regard.

Additionally, this study's attempt to measure anchor positions through the use of the Ordered Alternate Questionnaire, proved challenging in both pilot studies and was abandoned in the main study. Since ego involvement has a direct influence on the width of the latitudes (Park et al., 2007), and the width of the latitudes could not be measured with the online instruments developed in the pilot studies, conclusions cannot be made with reference to the findings in this study and the theory.

5.5. Source bias and social consensus have the same impact on people's anchors

In Chapter 4, the null hypothesis for both H2 and H3 were rejected, and the chance of them being true was less than 5%. In group2 (social consensus), it was found that exposure to a discounting cue in the form of user comments commonly berating a fake news article led to a statistically significant shift in anchor, away from the position established after exposure to

fake news. While the difference in means between times 3 and 1 was not statistically significant (p = .101), it is evident that the anchor did not shift back to its original position. This is confirmed not only graphically in figure 5.4.1, but in assessing the difference in effect sizes from the shifts in anchor both after exposure to the fake news message and after exposure to the discounting cue on social consensus.

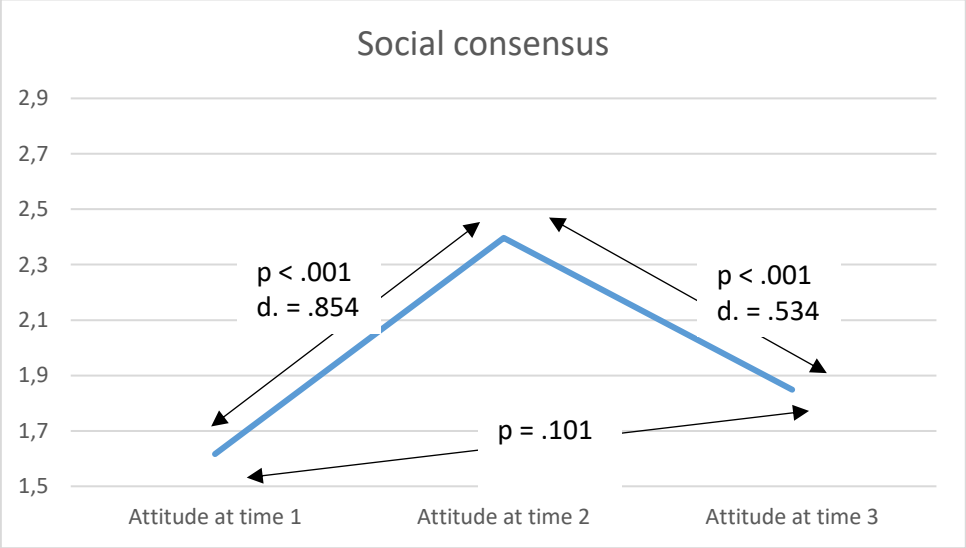

Figure 5.5-1 Social Consensus effect sizes for statistically significant changes in attitude

The inference is that despite user comments arguing that the contents of the article was false and deeming it fake news, the discounting cue did not have the same pull on attitudes as the fake news message did in the opposite direction. This observation aligns with the overwhelming consensus in literature that while corrections reduce dependence on misinformation, such misinformation is not completely disregarded (Crozier & Strange, 2019; Ecker et al., 2014; Ecker & Ang, 2019; Lewandowsky et al., 2012; Seifert, 2017). Thus there was an incremental shift in anchor when comparing the initial anchor and the anchor at time 3. Even when comparing the anchor shift against the control group, it is evident that anchors did not return to their original positions.

Like group 2, in group 3 (source bias), it was found that exposure to a discounting cue in the form of letters to the editor with concerns about source bias led to a statistically significant shift in anchor, away from the position established after exposure to fake news. While the difference in means between times 3 and 1 was not statistically significant (p = .179), it is evident that the anchor did not shift back to its original position. This is confirmed not only graphically in Figure 5.4.2, but in assessing the difference in effect sizes from the shifts in

anchor both after exposure to the fake news message and after exposure to the discounting cue on source bias, as noted in chapter 4.

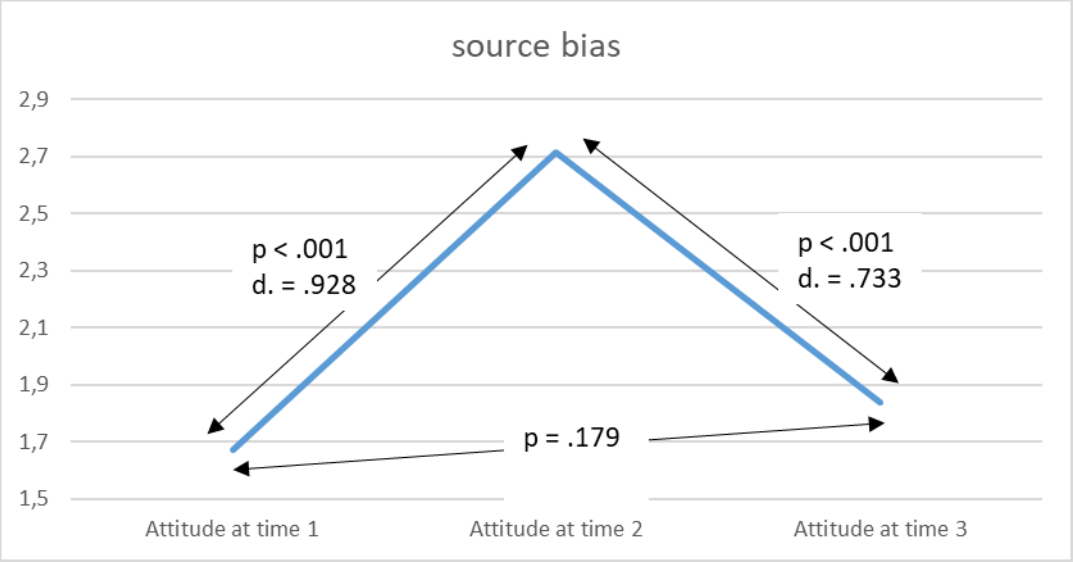

Figure 5.5-2 Source Bias effect sizes for statistically significant changes in attitude

In Chapters 1 and 2, it was established that social judgement theory is a rather static process and examining the complex roles of different discounting cues at different points in time to understand both their relative impacts as well as their relative durability, introduces a dynamic element to social judgement theory which did not exist prior to this study. By rejecting the null hypothesis for hypotheses 2 and 3, it is shown that there was a statistically significant shift in anchor when participants were exposed to discounting cues subsequent to exposure to a fake news article.

When analysing the between groups changes, it is evident that the difference between the social consensus group and the source bias group at time point 3 is not statistically significant ($p = .961$). This is shown in Figure 5.4.3. Additionally, the effect size of the change in attitude after exposure to the discounting cues, as calculated by Cohen's d, is similar for both groups.

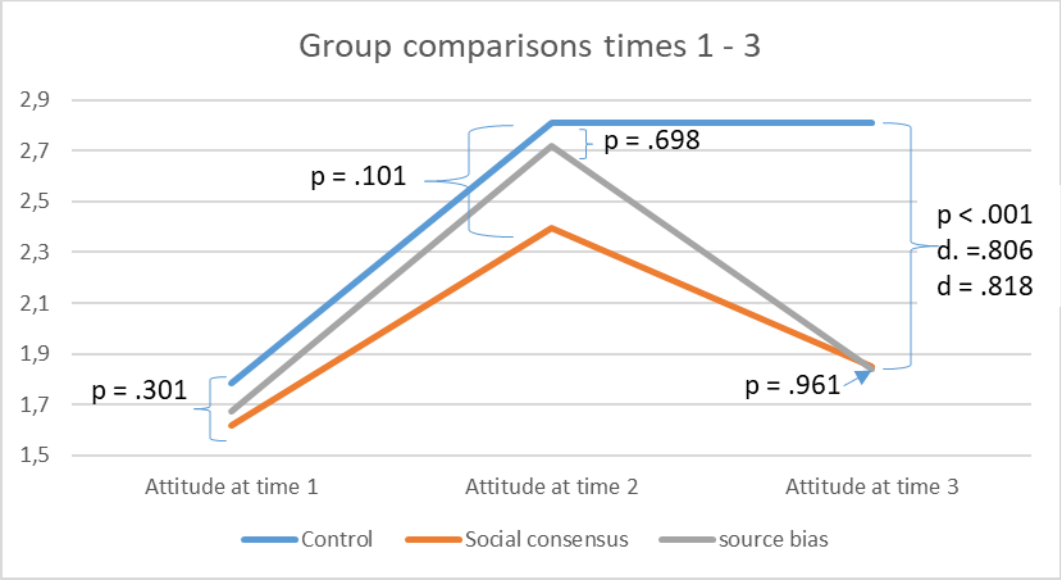

Figure 5.5-3 Between Group comparisons for changes in attitude times 1 - 3

It is well established in persuasion literature that the degree of influence of a persuasive message largely depends on the recipient's perception of the source's expertise and trustworthiness (Cheung et al., 2012; Tormala et al., 2006), and studies on persuasion have widely entrenched trustworthiness and expertise as a proxy for source credibility (Wallace et al., 2020a). The influence of user comments at the end of a blog-post is a relatively newer concept and Colliander (2019); and Lewandowsky et al. (2019) found in separate and independent studies, that the attitudes and beliefs of blog-post readers are influenced by the opinions of other readers. A comparison in a single study of these two vastly different but powerful constructs have received surprisingly little attention in understanding persuasion, and this study is the first to compare them on an equal footing to understand their relative influence on attitudes towards fake news. The study's finding that discounting cues in the form of user comments uniformly berating the contents of an article and labelling it as fake news has the same effect on people's anchors as discounting cues questioning the source's bias, is therefore an important one in the fight against fake news, and offers an insight into the relative influence of these two constructs that was not known prior to the study. The implication that they can both be used with equal effect to counter the surge of fake news in climate science, is useful to practitioners and constitutes the practical contribution of this doctoral research.

5.6. Theoretical implications of rejecting the null hypotheses for H2 and H3

In chapter 1, the study's contribution to social judgement theory was established. Based on this study's rejection of the null hypotheses for hypotheses 1, 2 and 3, it is evident that anchors as described by social judgement theory move as a result of a strong argument containing fake news, and can be moved back with discounting cues. Importantly, even though the differences between the anchor positions after exposure to the discounting cues and the initial attitude were not statistically significant, anchors did not move back to the original positions. This is illustrated in figure 5.4.4

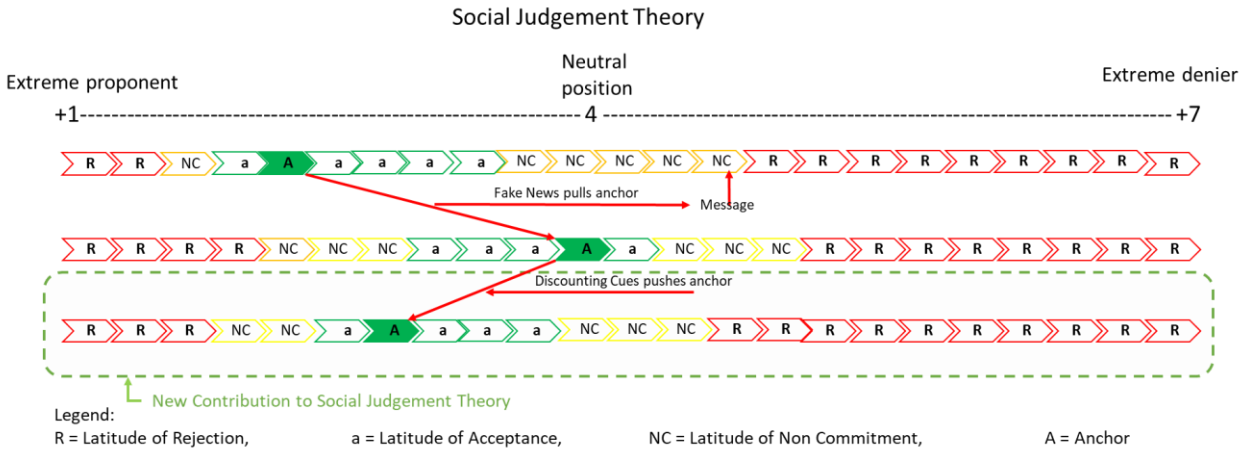

Figure 5.6-1 Study first contribution to Social Judgement Theory

While this helps us move towards a dynamic social judgement theory, it could be argued that both movements in anchor were the result of persuasive messages in opposite directions. This may be true but prior to this study the impact of discounting cues was not fully understood from a social judgement theory context. The findings help close that gap in knowledge. Importantly, there was an incremental shift in anchor from time 1 to time 3. One explanation is Jost's law (Brashier & Marsh, 2020a) as described in section 2.7, that states that the memory of the newer correction decays at a faster rate than the memory of older misconception.

Another explanation, offered by the Heuristic-Systematic Model (HSM), is the higher cognitive processing associated with analysing strong arguments by those with ability and motivation results in that message being stored in memory for a longer period than the heuristic influence of a discounting cue, which due to its effortless processing will be short lived (Kumkale & Albarracín, 2004). This could suggest that there would be a continued reliance on information known to be false, in what is known as the continued influence effect, where misinformation and the correction coexist in memory (Ecker & Ang, 2019; Lewandowsky et al., 2012; Rich &

Zaragoza, 2016). The risk is that people continue to rely on discredited or invalidated information even after they demonstrably remember the correction information.

An alternate explanation to the incremental shift in anchor is questionnaire fatigue where participants applied cognitive processing to the fake news article presented upfront and skimmed through the comments / letters toward the end. The Elaboration Likelihood Model of persuasion helps to explain the precursors and consequences of attitude change (Petty et al., 1997) resulting from, on the one hand, elaboration (Petty & Cacioppo, 1984), extensive consideration (Kitchen et al., 2014) and thoughtful processing (Gandarillas et al., 2018) in what's referred to as the central route, while on the other hand, little cognitive effort (Kitchen et al., 2014) and non-thoughtful (Petty et al., 1997) processing in what is called the peripheral route. The central route is associated with cognitive thought processing and requires motivation and ability to generate thoughts about the persuasive message which results in the attitudes formed via the central route that are longer lasting and more durable (Gandarillas et al., 2018). These two ends on a continuum represent the likelihood of elaborating on and thinking about a message (Gandarillas et al., 2018), and forms the backbone the Elaboration Likelihood Model of persuasion.

In this theory, many factors inform whether information is processed via the central or peripheral route, including personal relevance (Petty, Cacioppo, & Goldman, 1981); motivation (Shamon et al., 2019); the strength of the argument (Petty & Cacioppo, 1984); the nature of the source of a given communication and context variables (Petty et al., 1997); the person's various individual and situational factors (Petty & Cacioppo, 1984); the need for cognition (Cook et al., 2004); and source credibility (Albarracín et al., 2017; Tormala et al., 2006). The more one elaborates on a message, the more durable the attitude becomes (Shamon et al., 2019), with a higher likelihood of the new attitude remaining, and forming a resistance towards a counter argument, thereby influencing behaviour (Petty et al., 1997).

5.7. The impact of participant self-awareness on attitude changes

To gauge awareness, all participants were asked the following yes / no questions just before exposure to the discounting cues in the case of the two treatment groups, and at the end of the survey in the case of the control group.

> Reader's comments usually follow such articles. Do you believe that other readers would agree with the contents of the article?
>
> Do you believe that the author of this article is biased?

The detailed analysis is included in Annexure 15, and the salient points are captured here. There was an equal split between participants who believed other readers would agree with the contents and those who did not. Irrespective of participant's prior belief about how others would respond, the change in attitude between these two subgroups was the same after exposure to user comments uniformly berating the article. In other words, those who believed other readers would agree with the contents of the article and those who believed other readers would not agree with it had the same average change in attitude score after exposure to the discounting cue on social consensus. It is possible that participants may not have considered this prior to the question so it might be far fetched to classify this as a prior attitude. The fact that there was an even split and equal change in attitude among the two groups suggests that a belief about how others may respond might be less important than how others actually respond as captured in the discounting cue on social consensus.

The finding was different with regard to the second manipulation question asking whether participants believed that the author of this article is biased. In this case 113 respondents (64 %) believed that the author was indeed biased, while 64 (36 %) believed he was not. As with group 2, irrespective of participant's prior belief about the source's bias, the change in attitude between these two subgroups was the same after exposure to discounting cues indicating source bias. Again, the belief that the source is biased might be less important than confirmation that he was actually biased.

5.8. Time has an influence on people's anchors

The research methodology used in this doctoral research has H4 located three months after the initial survey. H4 tests attitudinal durability and compares all three groups to understand shifts in anchor, both within participants and between groups over time. H4 hypothesised that over time, anchors will shift back towards the position established after exposure to fake news, and was based on the sleeper effect as described in section 2.9.1 (The sleeper effect). The mechanism by which the sleeper effect works is the differential decay between the cue and the message that sees the memory that the message was from an untrustworthy source (or was fake news) erode at a faster rate than the persuasive message itself such that after time the persuasive effect remains or increases and the disclosure that the source was untrustworthy, forgotten (Albarracín et al., 2017; Heinbach et al., 2018; Kumkale & Albarracín, 2004). Therefore, it was expected that people would continue to rely on discredited or invalidated information, as the memory of the discounting cues would fade faster than the memory of the misinformation. The null hypothesis expected that the difference in the means of attitude scores after two weeks (μtime4) and after three months (μtime5) respectively will be statistically significant when compared to attitude mean score after exposure to fake news

(μtime2). i.e. μtime4 ≠ μtime2 ; μtime5 ≠ μtime2, p < .05. Instead, it was found that anchors had migrated towards their initial positions prior to exposure to fake news. Hence, this study technically failed to reject the null hypothesis for H4, in that it found μtime4 ≠ μtime2 and μtime5 ≠ μtime2, p < .05. However, the study also failed to empirically support the main hypothesis 4 as it expected μtime4 = μtime2 and μtime5 = μtime2, p < .05. Instead, it found μtime4 = μtime1 and μtime5 = μtime1, p < .05, and that the strong argument made in the fake news article about climate change had faded in participant's memory and people's anchors had migrated towards their initial position.

In the discussion on the continued influence effect in section 2.9.2, it was pointed out that misinformation and the correction coexist in memory, with people continuing to rely on discredited or invalidated information even after they demonstrably remember the correction information, in what's referred to as the continued influence effect (Ecker & Ang, 2019; Lewandowsky et al., 2012; Rich & Zaragoza, 2016). There is overwhelming consensus in literature that while corrections reduce dependence on misinformation, such misinformation is not completely disregarded (Crozier & Strange, 2019; Ecker et al., 2014; Ecker & Ang, 2019; Lewandowsky et al., 2012; Seifert, 2017). Based on this it was expected that anchors after two weeks would shift towards the anchor scores at time 2. However, this was not the case and in fact, the control group attitudes had converged towards the attitude scores of the two treatment groups. Therefore, while this observation would fail to reject the null hypothesis, the findings are not exactly as expected. The findings at time 5 were similar to the findings at time 4 in that the three groups were not significantly different at the respective times. The results are shown graphically on Figure 4.9.3-4. (repeated here).

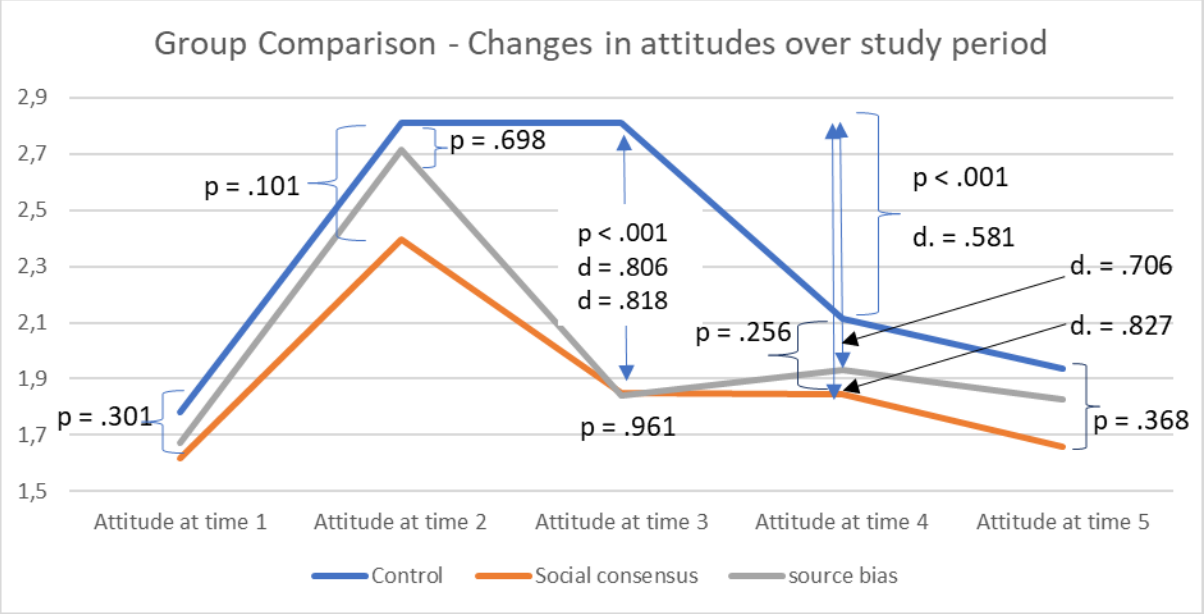

Figure 4.9.3-4 Group comparisons of attitudes over the full study period

As with the two-week survey (time point 4), and despite the control group not receiving discounting cues, participant's anchors in this group had migrated towards their original value prior to the intervention. Since participants who had been influenced by external factors were removed from the analysis, the shift in control group anchors after two weeks and three months occurred without the influence of a persuasive message as required by social judgement theory. Time therefore plays a key role in shifting anchors, which prior to this study had been overlooked by social judgement theory.

Notably, all three groups had converged two weeks after treatment and converged further three months after, where in both cases the differences were not statistically significant. This suggests that irrespective of the discounting cue (group 2 and 3), or whether participants had even received a discounting cue (group 1), after time attitudes tended to converge. This finding does not align with the central tenet of the sleeper effect which states that the memory of the discounting cue will be forgotten over time and the initial persuasive message remain in memory.

However, this observation should not disregard the use or importance of discounting cues because a closer look at the slopes of the three curves as well as the differences in effect sizes for times 3; 4; and 5 suggests that even though the differences are not statistically significant, the control group attitude mean scores remained higher than the two treatment groups. In other words, there is a difference in manner with which the two treatment groups respond in relation to the control group. From the slopes of the graphs and the differences in effect sizes, it can be inferred that realignment or readjustment of attitudes after exposure to fake news may occur faster due to discounting cues than it would, should there be no discounting cue. This could be the subject of future research that tests the shift in attitudes when discounting cues are delayed.

The impact of time on correction of attitudes is a significant contribution of this study. Another noteworthy contribution is the change in attitudes in the control group in relation to the relatively stagnant attitudes of the two treatment groups at times 4 and 5. This is especially so since participants who were exposed to external influences and believed that the external influences had informed their attitudes at these two points in time were removed from this analysis. It may be that the original message had decayed in participant's memories or that participants had actually been unconsciously exposed to correct information about climate change and did not realise it.

Additionally, the study spanned over three months principally to reduce Common Method Variance (CMV) bias. It was informed by Wang et al. (2014), who observed that a three-month interval provided a good balance between minimisation of CMV bias and event recollection.

This period was selected despite the practical constraints that longitudinal studies present with regard to attitude measurement at different points in time as observed by Luttrell, Petty, and Briñol (2016). This study found no significant difference in respondent's attitudes (irrespective of group) between the two-week survey and the three-month survey. However, this observation should not disregard the importance and benefits of longitudinal studies in persuasion. Had the study been cross sectional with only the single intervention spanning attitudes 1 to 3, as is the case with many studies in persuasion, the results and interpretation thereof would have been completely different. The effect of time especially on the control group's attitudes would not have been known beyond such a cross sectional study. Also, even though attitude changes between the two-week survey and the three month surveys were not statistically significant, had the study spanned two weeks, it would have left a lot of questions unanswered. This is the methodological contribution of this study.

Figure 5.8-1 displays the average mean attitude scores for all three groups over the three-month period. It clearly demonstrates the influential effect of fake news, discounting cues, and time on attitudes. Also evident in figure 5.8-1 is the incremental shift in anchor from time 1 to time 5.

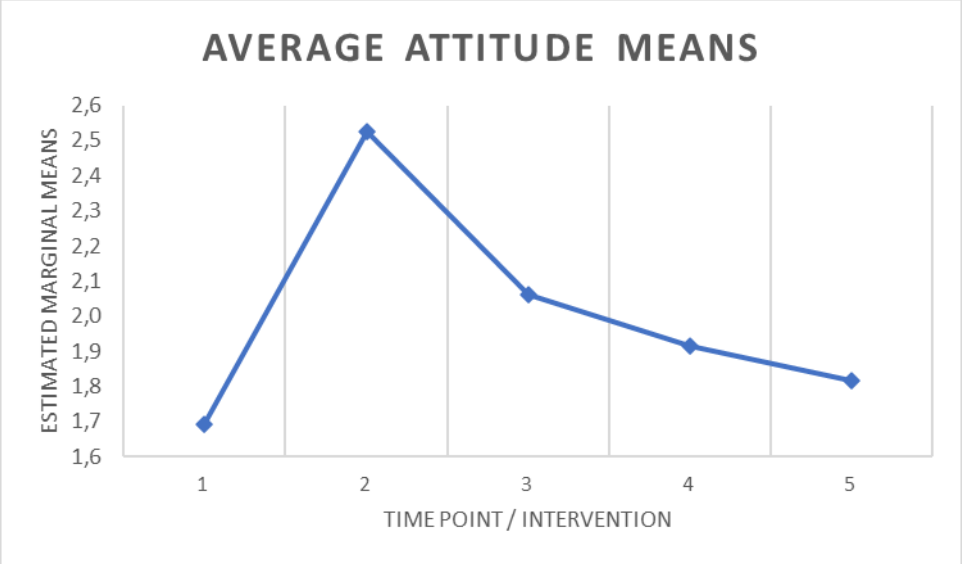

Figure 5.8-1: Observed changes in anchors over a three month period

Superimposing the shape of the graph in Figure 5.8-1 onto the general model depicting social judgement theory as developed in chapter two, results in Figure 5.8-2, which shows how fake news exposure (1) moves anchors (2), which represents social judgement theory prior to this study. Thereafter, the discounting cues push the anchor (3) towards their original position, which is new to social judgement theory. Thereafter, with time and without the influence of a

persuasive message, the anchors migrate even further towards their original positions (4). However, these anchors don't reach their original position as represented by participants initial attitudes, resulting in an incremental shift in anchor (5), which also represents the dynamic element of social judgement theory introduced by this research.

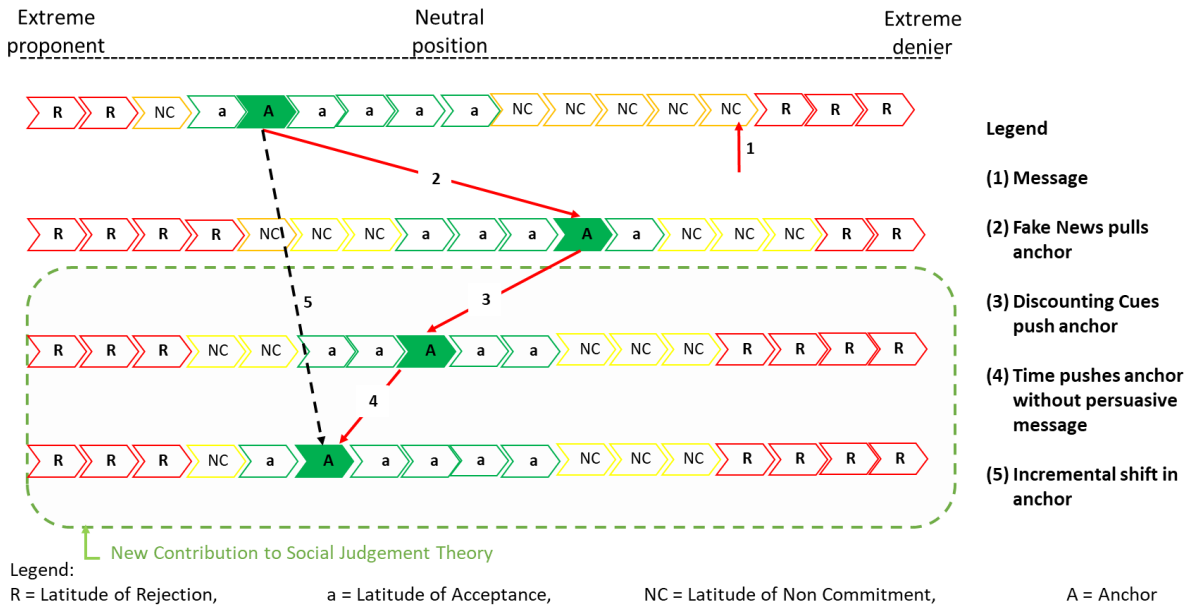

Figure 5.8-2 Graphical representation of the study's contribution to social judgement theory.

5.9. Familiarity heuristic and anchor shifts.

Initial attitudes exert a powerful influence on judgements when new information is evaluated, and past attitudes are highly influential on message processing as they serve as heuristic cues to relieve individuals of exerting cognitive effort to analyse information (Kumkale et al., 2010). The incremental shift in anchor as reflected in figure 5.8-2 will serve as an initial attitude when a subsequent message is received by the recipient. Should that subsequent message be exposure to another fake news article about climate science, attitudes will further develop from what is referred to as the familiarity heuristic (Koch & Zerback, 2013). This occurs unconsciously resulting from repeated exposure to messages giving credence to it under the false assumption of having heard it before, thus enhancing belief in the statement (Koch & Zerback, 2013). Familiarity heuristic differs from knowledge-based inference in that it is applicable firstly to difficult inference problems, and secondly correlates with the amount of prior knowledge regardless of its content, while knowledge-based inference is utilized when inference problems are easy and is based on the substance of that knowledge (Honda et.al., 2017). The incremental shift in anchor coupled with the potential for further incremental shifts from subsequent fake news articles is of particular concern in the fight against climate change.

This study did not set out to test the impact of repeated exposure to either the fake news article, fake news from different sources supporting the first article, repeated exposure to the discounting cues, or repeated exposure to factual articles based on climate science. The various sources serve to validate and enhance statement credibility (Koch & Zerback, 2013), resulting in the well-established phenomenon in cognitive psychology called the "truth effect." This extension of the framing effect unfortunately holds true even when those repeated messages have no factual basis.

It is therefore important in the fight against climate change that messages in different formats showing the deleterious effects of climate change are repeated constantly, so that advantage can be taken of the familiarity heuristic. While the discounting cues used in this experimental research proved effective in restoring attitudes, they alone or solely responding to fake news articles is inadequate in countering fake news. They would however form part the repertoire of tools available to counter fake news, and as this study found the two constructs would have an equal effect in countering fake news.

5.10. Chapter conclusion

The influence of time on attitudes has received remarkably little attention within the field of social psychology, even though they often don't remain stable over time (Luttrell, Petty, & Briñol, 2016). Since there are practical difficulties with measuring attitudes at different points in time in longitudinal studies, the research to date has tended to be more cross-sectional. This study overcame the challenges of not only measuring attitudes over a three month period but also in the analysis thereof, thereby providing an important opportunity to advance the understanding of time on attitudes, and further entrenched the importance of longitudinal studies. This study was able to show that attitudes can change over time even without the influence of a persuasive message as required by social judgement theory. As such, the findings make an important contribution to the field of social psychology. Moreover, this study provides an exciting opportunity to advance our knowledge of how to counter fake news. Due to the generalisability of results, such findings could extend beyond fake news climate science which was the setting for this study, to other spheres of persuasion like politics and the tobacco industry to name a few.

This chapter began with an overview of the study and provided the context within which the hypotheses were formulated. The null hypothesis for hypothesis 1 was rejected and it was shown that fake news had a statistically significant influence on participant's attitudes in the control group as well as the two treatment groups. Interestingly, no correlation was found

between participant's ego/personal involvement and changes in attitudes, but as indicated this is perhaps an indicator of the instrument used rather than raising questions about the theory.

There are several important areas where this study makes an original contribution to advancing our understanding of countering fake news. Among these is a significant finding that the discounting cues in the form of user comments uniformly berating the contents of an article and labelling it as fake news has the same effect on people's anchors as discounting cues questioning the source's bias. Thus this study has contributed to this growing area of research by guiding practitioners to add both constructs to the repertoire of tools available to counter the surge of fake news in climate science, with equal effect.

Notably, despite the control group not receiving discounting cues, participant's anchors in this group had migrated towards their original value prior to the intervention. At time points 4 (after two weeks) and time point 5 (after three months) the difference between attitude means in the three groups were not statistically significant. From the slopes of the graphs and the differences in effect sizes, it is evident that realignment or readjustment of attitudes after exposure to fake news may occur faster due to discounting cues than it would, should there be no discounting cue. This represents yet another area of original contribution made by this research study.

6. Chapter 6 – Summary, findings, conclusions and recommendations

6.1. Overview of the study

The primary purpose of this research was to close a theoretical gap in social judgement theory by introducing a dynamic element to social judgement theory that was non-existent. The practical contribution came from closing a practice knowledge gap in countering fake news in climate science, with tremendous external validity to help address fake news in other spheres of persuasion. The study did this through an experimental design by evaluating and comparing changes in attitudes within groups and between participants over the course of three months, by manipulating source bias and social consensus in order to determine which has a stronger influence on attitudes and how they endure over time. This led to the methodological contribution of this study. The research questions were formulated as follows: "what is the relative impact of source bias and social consensus on people's anchors after they are exposed to fake news?" and "what influence does time have on people's anchors, when they are exposed to fake news and discounting cues?" Each chapter built upon the previous one with a focus on answering these research questions through the lens of social judgement theory. A brief overview of each chapter follows:

CHAPTER 1 introduced this doctoral research and provided the foundations for the theoretical, practical, and methodological contributions that were expanded upon in subsequent chapters. It outlined the background to the research problem and specified the research objectives while laying out the research approach for be followed in answering the research questions. The proposed experimental methods and structure of the research were introduced.

CHAPTER 2 provided the theoretical underpinnings for persuasion, social judgement theory and fake news in the context of climate change. Various hypotheses were derived from theoretical observations, focussing specifically on the influence of social consensus and source bias on attitudes and how these endure over time. The chapter provided an understanding how these factors influence attitudes in relation to people's anchors, and how they evolve over time helps extend social judgement theory by introducing a dynamic element to social judgement theory that did not exist prior to this study.

CHAPTER 3 described the experimental methods and the statistical techniques used to test the hypotheses as established in chapter two. This chapter described the two pilot studies and the main study, as well as the manner in which the questionnaires evolved from the pilots to the main study. Included in this chapter were the basis for the vignette used as the persuasive message as well as the discounting cues utilised as the independent variables. Additionally, manipulation tests were discussed in detail, as were tests for instrument validity and reliability, including the treatment of missing data. The chapter concluded with a discussion on the ethical considerations applied in the execution of this research.

CHAPTER 4 presented the data of the main study as well as the statistical analyses to test the hypotheses. Tests were carried out on the data for compliance with the requirements of the mixed two-way Analysis of Variance and violations were dealt with as appropriate. Where applicable data was analysed using non-parametric alternatives, or treated as otherwise stated. The analysis was split into sections based on the data available for each of the three surveys conducted. This allowed for the appropriate treatment of participant attrition as well as treating for the effect of external influences without compromising data prior to such attrition or external influence.

CHAPTER 5 provided an interpretation of the data analysis conducted in chapter four, with explanations for hypotheses that were both supported and not supported. The contributions that this study made to theory and practice were discussed in-depth and the chapter concluded with a model on how the variables fit together.

CHAPTER 6 provides an overview of the study and summarises the key findings, with conclusions and recommendations. The chapter includes limitations of the study and recommendations for future work.

6.2. Major Findings of the Study

There were two central questions in this doctoral research and the first part of the study answered the first research question comparing the relative influence of source bias and social consensus as discounting cues on participants attitudes after they had been exposed to fake news in climate science. The study makes an original contribution in advancing our understanding of countering fake news by comparing in a single study these two vastly

different but powerful constructs, and the finding that they can be used to equal effect is a new contribution that this study makes in the field of persuasion theory. Its significance can be linked back to Aristotle's and Plato's teachings on rhetorical persuasion. Aristotle classified persuasion into three categories, namely *Ethos* [moral character], *Pathos* [emotion] and *Logos* [argument and logic] (Shanahan & Seele, 2015). Within Ethos, arête or virtue is viewed as the most prominent in persuasive appeals (Shanahan & Seele, 2015), with its subset, source credibility, established as one of the cornerstones of persuasive communication (Albarracín et al., 2017). However, this study's finding that *Doxa,* as incorporated in Plato's teachings (Davoudi et al., 2020) and when manifested as social consensus can have the same effect as arête makes a new and important contribution to advance our understanding of persuasion. It not only guides practitioners in countering the scourge of fake news, but also extends social judgement theory by introducing a dynamic element in showing that anchors can be further influenced after exposure to a strong message.

An important contribution was that the discounting cues did not have the same pull on attitudes as the original message did in the opposite direction, which resulted in an incremental shift in anchor towards the position put forward in the fake news article. This observation aligns with prior literature on the continued influence effect that found that misinformation and the correction coexist in memory, with people continuing to rely on discredited or invalidated information (Ecker & Ang, 2019; Lewandowsky et al., 2012; Rich & Zaragoza, 2016). However, the slopes of the curves of attitudes over time does not align with the expectation of the sleeper effect which states that the differential decay between the cue and the message will see the memory that the message was from an untrustworthy source erode at a faster rate than the persuasive message itself such that after time the persuasive effect remains or increases and the disclosure that the source was untrustworthy, forgotten (Albarracín et al., 2017; Heinbach et al., 2018; Kumkale & Albarracín, 2004). This discrepancy could be the subject of future researchers.

A noteworthy observation of this study is that despite the control group not receiving discounting cues, participant's anchors in this group had migrated towards their original value prior to the intervention, albeit not to the same position as they were initially. Since participants who had been influenced by external factors were removed from the analysis, the shift in control group anchors after two weeks and three months occurred without the influence of a persuasive message as required by social judgement theory. This new finding makes a substantial theoretical contribution towards extending social judgement theory, where anchors were observed to shift even in the absence of a persuasive message, thus adding a dynamic element to social judgement theory. Significantly, all three groups had converged two weeks after treatment and converged further three months after, where in both cases the differences

between groups were not statistically significant. This suggests that irrespective of the discounting cues received by the two treatment groups or whether participants had even received a discounting cue (control group), after time attitudes tended to converge towards their original value. However, the study did show that the discounting cues play a role in the time it takes for attitudes to be corrected, as the control group mean attitude scores remained visibly higher that the treatment groups even though the differences were not statistically significant. From the slopes of the graphs and the differences in effect sizes, it can be inferred that realignment or readjustment of attitudes after exposure to fake news may occur faster due to discounting cues, than it would in the absence of a discounting cue.

The second part of the study answered research question two on the durability of attitudes, and the study makes a significant contribution towards cementing the importance and benefits of longitudinal studies in persuasion. The research to date on attitudes has tended to be more cross-sectional, and had this study followed that trend with only the single intervention spanning attitudes 1 to 3, the results and interpretation thereof would have been completely different, as the effect of time especially on the control group's attitudes would not have been known beyond the initial intervention. This study overcame the challenges of measuring attitudes over a three month period by through personalised follow up email to those that did not respond on time. Additionally, splitting the analysis between the cross-sectional element of the study and the longitudinal element represents a novel way to address the challenges of conducting longitudinal studies and represents the methodological contribution of this study. This is something that could be emulated by other researchers in conducting longitudinal studies as it also helped achieve sample numbers above the minimum threshold at each stage. In summary, the study make an important contribution to the field of social psychology, while providing an exciting opportunity to advance our knowledge in countering fake news. Due to the generalisability of results, such findings could extend beyond fake news in climate science, which was the setting for this study, to other spheres of persuasion.

6.3. Limitations of the study

There were naturally many limitations to this experimental research which future researchers would be encouraged to address. Firstly, this research did not utilise refutational two-sided arguments to simulate the fake news article, because it wanted to simulate fake news in climate science, which typically utilises strong one-sided arguments. Additionally, the discounting cues were one-sided, to simulate only social consensus or letters indicating source bias. Typically, comment threads offer a mixture of positive and negative comments

and future research could investigate how a combination of positive and negative comments affect responses, as well as the length and perhaps order of those comments.

Secondly, the study was limited to a single interaction of presenting the fake news article and then the discounting cues. The research design did not provide opportunity to repeat either the fake news vignette to participants or to have the discounting cues repeated. Future researchers would be encouraged to explore the effect of repeated messages, and the timing and frequency of those messages, to understand whether the incremental shift in anchor observed in this study can be moved in either direction.

Additionally, this study did not differentiate between or analyse differences in age, race, gender, or educational levels or draw conclusions on whether these categories would have responded differently to fake news or to the discounting cues. Future research may investigate whether people in these categories would respond differently, to allow for a more targeted approach in countering fake news.

Lastly, the three-month duration was chosen from a practical perspective to reduce common method variance bias while managing the risk of participant attrition. Therefore, conclusions drawn about durability is limited to a three-month period, and future research could look at whether anchor shifts remain at the levels observed in this study or converge even further towards their original values, over a longer period.

6.4. Recommendations

Practitioners seeking to counter fake news in climate science can rely on messages questioning the source's bias as well as comments from other users claiming the article to be fake news, to equal effect. These should not be used in isolation, but rather incorporated into the basket of options to counter fake news including corrections, the corrective influence of fact checking, and retractions to name a few. Importantly, it is highly recommended that research into attitude formation and attitude changes be done through longitudinal studies in spite of the practical constraints associated with them. The rich data obtained from such longitudinal studies far outweigh the convenience of cross-sectional studies.

6.4.1. Recommendations for future research.

The recommendations for future research were introduced when discussing the limitations of this study. In addition to those recommendations, future research could explore delaying the discounting cues as opposed to providing them in the same intervention as the fake news.

Thus, the shift in attitudes when discounting cues are delayed could be assessed against the changes in the control group to better understand if the observed change in attitude would be repeated. In practice, comments from other users are not always immediately available or they evolve over time, and this would help simulate such a scenario.

Finally, extending the study period beyond three months, combined with a mixture of message repetition and refutational / non-refutational messages could provide a better understanding of how people are influenced by fake news, and how durable those attitudes are.

6.5. Conclusions

This study makes theoretical and methodological contributions, and the results of this study have implications to practice as well. Theoretically, it adds a dynamic element to social judgement theory that was not present prior to this study. The practical contribution comes from closing a practice-knowledge gap in countering fake news. While research into countering fake news is nascent, the peddling of fake news is not, and it is ultimately an extension of persuasion theory. The persuasive effect of fake news was confirmed when participants exposed to fake news had a statistically significant shift in anchors with large effect. The two discounting cues proved equally effective in restoring attitudes. The findings did not perfectly align with the theory behind the sleeper effect, with attitudes having migrated towards their original values over time, but the incremental shift in attitudes suggests the presence of the continued influence effect. Moreover, despite the practical constraints, the benefits of longitudinal studies in persuasion cannot be over emphasised, as the findings in this study would have been completely different had it been limited to a cross sectional study, which typifies most studies on persuasion and attitudes. The mechanisms adopted to ensure sufficient sample size at each evaluation, combined with the splitting of the analysis as appropriate represents the methodological contribution of this study.

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Annexure 1: Questionnaire sent to Group 1 - Main study

Q1 **Understanding Blogs** This study explores your beliefs about the topic discussed and your attitudes towards the material presented. It consists of an initial survey, which should take no more than 15 minutes to complete, and there will be TWO subsequent surveys - one after approximately two weeks and the other after approximately three months. These should take no longer than 5 minutes to complete. If the results from this study are published, only aggregated results will be reported and individual responses will not be identifiable. Additionally, confidentiality of participant's responses is of utmost importance and it shall be managed in accordance with the university guidelines. Participation in this study is entirely voluntary. Completion of this survey is taken to constitute your consent to participate. If you do not wish to participate, you may exit this survey at any stage without penalty. If you have any questions please do not hesitate to contact the researcher, at 19397209@mygibs.co.za.

Q2 Please type your name in the block below (you may use a nickname or pseudonym)

_____

Q3 Please type your email address in the block below

_____

Q4 How much do you agree with the statements below?

My opinion about a blogpost or opinion piece is influenced by the comments made on the article by others.

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

I am more influenced by the CONTENTS of an article than by the author's credentials

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

I am more influenced by user COMMENTS on an article than by the author's credentials

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Q5 Please indicate your familiarity on the following:

How familiar are you with the concept of climate change?

O	Extremely familiar	O	Very familiar	O	Moderately familiar	O	Slightly familiar	O	Not familiar at all

How familiar are you with the arguments for and against climate change?

O	Extremely familiar	O	Very familiar	O	Moderately familiar	O	Slightly familiar	O	Not familiar at all

Q6 How much do you agree with the statements below about climate change?

It is attributable to carbon dioxide

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human activity is the cause of climate change.

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human intervention is required to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

There should be urgency to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Q7. I am personally involved in either addressing climate change or arguing against it.

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Q8 Please read the following blog post carefully, as you will be asked some questions about it at the end.

Why we can chill out about climate change

Posted on 27 July 2020 by Dr. Edmund Savant

While there is general agreement that climate change is happening, there is no consensus on the cause. After all, the climate has always changed. Several centuries ago, the Earth experienced a Little Ice Age where people ice skated on the Thames River in the UK. A thousand years ago during the Medieval Warm Period, Vikings settled in Greenland, which got its name from the lush, green conditions at the time. If there is one truism that holds throughout Earth's history, long before the invention of SUVs and plasma televisions, it's that climate changes. So the key question of the climate debate is this - are humans causing global warming now?

Many scientists say no. **Over 31,000 scientists signed a petition saying there's no evidence that greenhouse gases are causing global warming.** Eminent climate scientists such as Professor Richard Roland, Professor James Spencer and Dr. John Moore, who have published hundreds of peer-reviewed papers between them, argue that humans will not have a significant effect on the climate. Climate change is still hotly debated among scientists, indicating the science is not settled. To make expensive changes to society or spend a lot of taxpayer money on climate action before the scientists have even made up their mind is rash.

What are some of the points of disagreement among scientists? The 31,000+ scientists who signed the OISM Petition argue that it's wrong headed to label carbon dioxide a pollutant. Carbon dioxide is a natural gas. It's invisible, non-toxic and you can't smell it. If there were no carbon dioxide in the air, every plant in the world would die. Carbon dioxide is plant food. To claim that carbon dioxide is a pollutant goes against biology and common sense. For heaven sake, carbon dioxide is even added to fizzy drinks like Coke and sparkling water to make them fizzy. Whos ever died from that? Carbon emissions will improve plant growth and are a welcome addition to our environment.

Climate alarmists like to use large, misleading numbers to frighten people. They talk about carbon dioxide levels having increased 40% from pre-industrial levels, as if the current level of 390 parts per million is a high, unusual amount. However, most people don't realise this is only 0.039% of the atmosphere. This is an historically small fraction, with CO2 levels having been much higher in the past. Fact - some 450 million years ago, CO2 levels were a staggering 4000ppm. This is more than 10 times greater than current

levels and yet the Earth didn't burn away in a runaway greenhouse effect. During this period, the Earth slipped into an ice age while CO2 levels were much higher than today's levels. To claim carbon dioxide is the main driver of climate is to ignore much of Earth's history. In fact, carbon dioxide is not even the strongest greenhouse gas in the atmosphere. The strongest greenhouse effect comes from water vapour.

Also, a key driver of climate change is variations in solar activity. The sun provides almost all the energy in our climate system. This means our climate is sensitive to changes in the sun's output. When the sun gets warmer, our planet builds up heat. This results in global warming. Over the last few decades, the sun has been unusually warm, achieving its warmest levels in 1,150 years (Usoskin 2005). The unusually warm sun has coincided with an unusually warm Earth. Considering the close relationship between solar activity and climate, its no wonder climate scientists downplay the role of the sun.

Another big driver of climate change is the ocean. Powerful ocean cycles drive large exchanges of heat between the ocean and the atmosphere. The strongest of these cycles is the El Nino Southern Oscillation, which has a large impact on global temperature. Over periods of months, the Pacific Ocean can switch from El Nino conditions to La Nina conditions. This causes cooling which wipes out decades of gentle warming from CO2 and speaks of a stronger relationship between climate and the oceans. This is not surprising considering the oceans form a major part of our climate system.

So we see many natural drivers of climate change that are more dominant than the invisible trace gas carbon dioxide. Nevertheless, there is a strong push for costly carbon regulation. This is because there is no revenue to be made from blaming climate change on nature. We can't pay a sun tax to control solar activity. We can't put a price on ocean cycles to regulate El Nino. It's a human impulse to desire control over our environment. **However, Earth's long history tells us climate change is out of our control, we are not responsible for it, and it is extremely egotistical to believe we can control it.** We should be very wary of those climate change proponents with their hidden agendas, as some things are best simply left to nature.

End…

Q9 How much attention would you say you put into reading the article?

O A great deal O O A moderate amount O A little O None at all

Q10 According to the article, over 31,000 scientists signed a petition saying that there's no evidence that greenhouse gases are causing global warming.

O True O False

According to the article, humans are not responsible for greenhouse gases or global warming.

O True O False

Q11 Having read Dr Savant's article, how much do YOU agree with the statements below about climate change?

It is attributable to carbon dioxide

O Strongly agree O Agree O Somewhat agree O Neither agree nor disagree O Somewhat disagree O Disagree O Strongly disagree

Human activity is the cause of climate change.

O Strongly agree O Agree O Somewhat agree O Neither agree nor disagree O Somewhat disagree O Disagree O Strongly disagree

Human intervention is required to address climate change

O Strongly agree O Agree O Somewhat agree O Neither agree nor disagree O Somewhat disagree O Disagree O Strongly disagree

There should be urgency to address climate change

O Strongly agree O Agree O Somewhat agree O Neither agree nor disagree O Somewhat disagree O Disagree O Strongly disagree

Q12 Reader's comments usually follow such articles. Do you believe that other readers would agree with the contents of the article?

O Yes O No

Q13 Do you believe that the author of this article is biased?

O Yes O No

This is the end of this survey. Thank you very much for your participation. A follow up survey will be sent to you in approximately two weeks, which should not take longer than five minutes to complete. Your continued support is most appreciated.

Annexure 2A: Independent variable 1. Social Consensus

The questionnaire provided to the control group as provided in Annexure 1 was identical to the questionnaires provide to the other two groups. Annexure 1 ended with the following question prior to the end of survey message.

Q13 Do you believe that the author of this article is biased?

O Yes O No

Immediately thereafter group 2 participants received the following:

The following comments were taken from the blogsite that followed publication of the article. Please take time to read these carefully as questions will be asked about this later.

J-lee

Just mentioning the OISM petition signed by more than 31,000 scientists is a sign that a lot is wrong with this post! For one, only a very small number of those 31,000 scientists were really working climate scientists. Its like asking a heart specialist to perform brain surgery. Most were working on totally different subjects. Typical example of fake news to deflect attention away from human induced climate change.

stevieG

Fake Fake Fake !!!! Was CO2 that much higher 100's of millions of years ago? Yes. Does this mean that CO2 has no effect? No. Why? This ignores some basic evidence. In the distant past, the Sun was COOLER! Over the Earth's 4.5 billion year life, the sun has increased its heat output by 30%. Extra CO2 was needed to compensate for the fact that the Sun was cooler. Roughly speaking, when we go back in time, CO2 levels needed to have been double every 150 million years just to keep temperatures high enough. So, the claim carbon dioxide is the main driver of climate change is in fact based on much of Earth's history.

Jerico

The extent these climate change deniers would go to is sad. This is fake news. Even though it is true that CO2 makes up only a very small amount of our overall atmosphere, you have to take a closer look. Most of the gases in our atmosphere don't have heat-trapping properties. So you can safely ignore inert gases like Oxygen and Nitrogen. Only look at CO2 in comparison to its "buddies", the other greenhouse gases. What you'll find is that the "tiny" amount of CO2 makes up about 25% of those and that is certainly nothing to ignore!

Kabelo

Classic example of fake news. The amount of water vapour in the atmosphere depends on the temperature of the atmosphere. If the planet isn't warming, the amount of water

vapour won't increase. Water vapour itself doesn't cause global warming. It can only amplify global warming (known as a 'feedback') caused by other factors. Right now, the warming is caused by the increased greenhouse effect. This is due to human greenhouse gas emissions. Sadly this article is riddled with these misunderstandings of basic climate science.

Cyril S

Fake News. Don't bother with it. What's worse is that anyone who has ever bothered to take a look at solar output graphics would know that TSI only increased by less than 1 Watt/square meter since the start of the Industrial Era. Again, you're telling half the story but not all. Climate change is real and is caused by none other than humans.

Moses

It's hilarious that this article cites Usoskin 2005. That paper concludes that in the last few decades, the correlation between sun and climate breaks down. Recent warming must have some other cause. This article's own sources debunk its claim that the sun is causing global warming! Typical of fake news stories.

Almost there!! Last question.

Having read the comments, how much do YOU agree with the statements below about climate change?

It is attributable to carbon dioxide

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human activity is the cause of climate change.

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human intervention is required to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

There should be urgency to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

This is the end of this survey. Thank you very much for your participation. A follow up survey will be sent to you in approximately two weeks, which should not take longer than five minutes to complete. Your continued support is most appreciated.

Annexure 2B: Independent variable 2. Source Bias

The questionnaire provided to the control group as provided in Annexure 1 was identical to the questionnaires provide to the other two groups. Annexure 1 ended with the following question prior to the end of survey message.

Q13 Do you believe that the author of this article is biased?

O Yes O No

Immediately thereafter group 3 participants received the following:

The following letters were taken from the blogsite that followed publication of the article. Please take time to read these carefully as questions will be asked about this later.

Dear Mr Editor,

I am deeply concerned that a publication of your stature would publish an article of this nature without declaring the author's prior track record, affiliations and interest in this subject. Allow me to elaborate. Dr Edmund Savant is the past president of the regional Fossil fuel foundation and serves on the Board of Directors of ProCoal Holdings. It is well known that ProCoal has vast interest in coal mines across Mpumalanga and recently applied for environmental licencing for the expansion of their operations to include power generation from fossil fuels. There was much public outcry given the deleterious effect of CO2 which prompted Dr Savant and CoalCo to employ a public relations arm of Bell Pottinger to assist with the creation of a number of articles questioning the science behind climate change and casting doubt over human contribution towards climate change. I will not get into the factual inaccuracies of the article as I am sure you will get plenty takers for that. However, I believe it is important to emphasise to your readers that ProCoal will lose billions of Rands of revenue over the 20 life of the power plant and as such have vested interest in ensuring that the plant proceeds. Your publication of this article without reference to such an important consideration is of grave concern and a crying shame.

Sincerely

Dr Y. Lazarus

01 August 2020

……

Dear Mr Editor,

I write in support of the letter written by Dr Lazarus that raised valid concern about the author's bias and vested interest in denying climate science. I too will not get into the factual inaccuracies as others have already done that but would like to point out an additional piece of important information that Dr Lazarus omitted. Dr Edmund Savant not only sits on the Board of ProCoal in South Africa but also owns shares in Coalco in Zimbabwe. They have extensive mining rights in Zimbabwe and their recent application to build a coal fired plant at one of their mines in Bulawayo came under severe criticism due to them flouting environmental laws. They indeed do have vested interest in denying climate science around climate change and I am glad Dr Lazarus brought it up. They have billions to gain from denying climate change and I am not surprised to hear that Bell Pottinger was involved.

Yours truly

Dr Dlamini

07 August 2020

……

Dear Mr Editor,

I wonder if, prior to publication, you paid attention to Dr Edmund Savant's reputation as a climate science denier and his history of employing public relations companies as spin doctors to manufacture uncertainty in denying climate science. His vested interests in denying climate science is without doubt and evidenced in his various publications where it was proven that he generates alternative facts, pseudoscience claims, and real "fake news", in undermining scientific evidence on climate science. This blog is no different and it is disappointing that a publication such as yours omitted such important facts prior to publication.

Sincerely

Professor James Edwards

07 August 2020

Almost there!! Last question.

Having read the letters to the editor, how much do YOU agree with the statements below about climate change?

It is attributable to carbon dioxide

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human activity is the cause of climate change.

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human intervention is required to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

There should be urgency to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

This is the end of this survey. Thank you very much for your participation. A follow up survey will be sent to you in approximately two weeks, which should not take longer than five minutes to complete. Your continued support is most appreciated.

Annexure 3: Questionnaire sent to All participants after two weeks and after three months

Q1 Thank you so much for completing my initial survey. It is most appreciated. This is a follow on to the survey conducted approximately two weeks ago (three months in the case of the three month survey) on your views on climate change. Please answer as honestly as possible. There are no right or wrong answers and responses are treated with the utmost confidentiality. If results are published, only aggregated results will be published with no reference to names.

Q2 Please type your name in the space below

_____

Q3 Please type your email address in the space below

_____

Q4 Have you been exposed to any information about climate change since taking the initial survey?

O Yes O No

Respondents that answered "yes" to Q4 were automatically presented with Q5. Those that answered "No" skipped Q5

Q5 Do you believe this additional information had any influence on your attitudes or changed your perspectives towards climate change, since taking the initial survey?

O Yes O No

Q6 How much do YOU agree with the statements below about climate change?

It is attributable to carbon dioxide

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human activity is the cause of climate change.

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Human intervention is required to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

There should be urgency to address climate change

O	Strongly agree	O	Agree	O	Somewhat agree	O	Neither agree nor disagree	O	Somewhat disagree	O	Disagree	O	Strongly disagree

Q8 This is the end of this survey. Thank you very much for your participation. A follow up survey will be sent to you in approximately three months, which should take no longer than five minutes to complete. That will be the final survey, and a debrief will follow shortly thereafter. Your continued support is always appreciated.

At the end of the three month survey, the following message was displayed

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This is the end of this survey. Thank you very much for your participation. There will be a debrief sent to all participants when the study is complete. Your continued support is always appreciated.

Annexure 4: Debriefing: Information provided to participants at end of study

The contents of the debriefing document that was sent to all participants was copied in its entirety from Lewandowsky et al. (2019) study on "Science by social media: Attitudes towards climate change are mediated by perceived social consensus" and is available at: https://github.com/StephanLewandowsky/Blog-comments. The debrief was sent via Qualtrics to the email addresses provided by participants when they opted in to the study. The contents of the email is pasted below.

Dear ${m://FirstName}
I would like to extend my deepest gratitude to you for your valued time and support in participating in my study, which explores your attitudes towards the material presented. A heartfelt Thank You.

While all information presented focussed on climate change, the real purpose of my study is FAKE NEWS, classified as systemic lies that the climate change countermovement adopt to manufacture uncertainty and redirect the narrative on climate change. The study offers tremendous value in countering fake news in other spheres of persuasion like politics and the tobacco industry. Not only does fake news create a distorted perception of reality, with surreptitious influence on beliefs, attitudes and decision making, it can lead to suboptimal decisions for individuals and society in general, and more perversely can lead people to stop believing in facts altogether. Countering fake news remains a challenge to both academics and practitioners alike, and my study evaluates how attitudes change over time when people are exposed to fake news and then exposed to discounting cues about either the source's vested interests (source bias) or social consensus (social conformity) in the form of user comments questioning the veracity of the story.

It is important to note that the article "Why we can chill out about global warming" was in fact incorrect and misrepresents the current state of climate science. All names presented in the article, comments and letters were fictitious and any resemblance to real people is coincidental.

Unfortunately, the study is still in progress and I am unable to share findings at this stage. I would gladly make the findings available at the appropriate time.

Please click on the link below and read the content carefully, as this represents the current state of climate science. Once more, a heartfelt THANK YOU.

If you have any questions please do not hesitate to contact me at 19397209@mygibs.co.za.

When participants clicked on the link provided on the email, the following opened:

Note to Participants:

All the information that was given to you in the article "Why we can chill out about global warming" was in fact incorrect and misrepresents the current state of climate science. Please read the following correct content carefully, as you will be asked questions about it later.

FACT: The past warns us that climate reacts strongly to heat trapped by greenhouse gases.

Throughout Earth's history, we've seen dramatic changes in climate, from ice ages to relatively warm periods. This led one scientist to conclude that "…far from being self-stabilizing, the Earth's climate system is an ornery beast which overreacts to even small nudges." But now, we're not just nudging our climate. We are hitting it with a large stick. Humans are emitting billions of tonnes of heat-trapping greenhouse gases into the atmosphere each year. The distant past warns us that our planet will react strongly to the heat trapped by greenhouse gas emissions.

However, a misleading argument is that because climate has changed naturally in the past, long before humans were around, current warming must therefore be natural also. This logic is flawed. This is like examining a dead body with a knife in its back and arguing that "people died naturally in the past so this death must be of natural causes."

FACT: 97% of climate scientists agree humans are causing global warming.

Several surveys of climate scientists have found that 97% agree that humans are causing global warming. Also, over the last 21 years, 97% of scientific papers that state a position on whether humans were causing global warming agree with the consensus. There is overwhelming scientific agreement that humans are driving recent global warming.

However, some groups try to cast doubt on the consensus. They do this by painting a false picture of disagreement. One example is the argument that 31,000 scientists dispute the consensus. This is based on the 'Petition Project'—a list of 31,000 scientists who dispute that humans are disrupting climate.The petition uses the tactic of fake experts. These are people who convey the impression of expertise but do not have any experience in climate science. Around 99.9% of the signatories of the Petition Project are not climate scientists. Anyone with a Bachelor of Science is eligible to sign up. The Petition Project is a transparent ploy to foster the impression of disagreement. In reality, there is overwhelming agreement among experts that humans are causing global warming.

FACT: Climate patterns confirm human-caused global warming, rule out the sun.

A number of climate patterns confirm that heat-trapping greenhouse gases are causing global warming. Winters are warming faster than summers and nights are warming faster than days. The upper atmosphere is cooling while the lower atmosphere warms. These patterns rule out the sun as a potential cause of global warming. They also constitute a 'fingerprint' for the fact that humans are causing global warming through greenhouse gas emissions.

Despite the evidence, a persistent myth is that the Sun is causing global warming. People persist in this myth by cherry picking data. For example, they look at times in the Earth's past when temperature and solar activity moved in the same direction. But they ignore recent data. In the last few decades of global warming, solar activity and climate have moved in opposite directions. Surface temperatures have increased and global temperatures hit the hottest on record in 2010. At the same time, the Sun has shown a slight cooling trend. In 2009, solar activity reached its lowest levels in over a century. If anything, the drop in solar activity has had a slight cooling influence on climate in recent decades.

FACT: Many lines of evidence measure the warming effect of carbon dioxide.

How do we know carbon dioxide is trapping heat? Many lines of evidence confirm that carbon dioxide is causing warming. Satellites measure less heat escaping to space. More heat has been measured coming down from the atmosphere. The warming effect from carbon dioxide is a directly measured reality. One myth is that carbon dioxide comprises such a small percentage of the atmosphere, less than 0.04%, that it cannot have a significant effect.

The fact that carbon dioxide makes up a small percentage of the atmosphere is irrelevant. Small amounts of an active substance can have a strong effect. When blood alcohol level reaches 0.05%, which is comparable to the percentage of carbon dioxide in the air, a person is over the legal driving limit.

FACT: Carbon dioxide traps heat, disrupting society and our environment.

As we emit heat trapping gases like carbon dioxide, more heat is being trapped in our climate system. The extra heat is disrupting our environment. Ice sheets are melting, causing sea level rise. Heatwaves are now five times more likely than if global warming wasn't happening. More heat in the oceans is fuel for extreme weather such as flooding rains. The extra heat in our climate system is how carbon dioxide emissions are changing the environment and impacting society.

One myth about carbon dioxide is that it's harmless because it's an invisible gas. The fact that carbon dioxide is invisible is irrelevant to whether it is harmful. In fact, carbon dioxide's invisibility is a key aspect of the greenhouse effect.

Greenhouse gases like carbon dioxide are invisible and hence let sunlight pass freely through the atmosphere, warming the Earth's surface. The warmed Earth then radiates infrared heat at a different wavelength to sunlight. Greenhouse gases absorb this heat. The greenhouse effect happens because greenhouse gases—like glass—let sunlight in, but trap heat from the Earth's surface.

Annexure 5: Communication sent to request participants to opt-in to the study

The following communication was sent to programme managers in the faculty of Humanities at the University of Pretoria to forward to students via their portals. Similar messages were sent to programme managers at GIBS and to the two school principals to forward to their respective students and teachers.

> Dear students,
>
> A doctoral student at GIBS is conducting an exciting study that explores beliefs and attitudes about our climate. The survey in the study consists of answering some questions and reading a blog article, followed by further questions related to the blog. The study consists of an initial survey, which should take no more than 15 minutes to complete, and there will be two short surveys that follow- one after approximately two weeks and the other after approximately three months. These should take no longer than 5 minutes to complete.
>
> In order to conduct this study, the student would need to email you the questionnaires directly and not through a mass distribution method. However, the university is not, in terms of POPIA, legally permitted to give out students' email addresses. You are therefore invited to opt-in by clicking on the link below and supplying your email address so that the questionnaires could be sent directly to you.
>
> If the results from this study are published, only aggregated results will be reported and individual responses will not be identifiable. Additionally, the confidentiality of participant's responses is of utmost importance, and it shall be managed in accordance with the university guidelines. Participation in this study is entirely voluntary. Completion of this survey is taken to constitute your consent to participate in the study and subsequent debrief. If you do not wish to participate even after you have opted-in, you may exit the study at any stage without penalty. There will be a debrief at the end of the study sent to <u>all</u> participants.
>
> If you have any questions please do not hesitate to contact the researcher at 19397209@mygibs.co.za.
> **Follow this link to opt-in to the study and the study link will be emailed thereafter to you:**
>
> <u>https://pretoria.eu.qualtrics.com/jfe/form/SV_b9mz05Z2mIZ31dQ</u>

The link contained two questions only. 1. Please enter your name in the block below. 2. Please enter your email address in the block below.

Annexure 6: Data analysis for the pilot study (second pilot study)

1.1. Understanding and cleaning the data – times 1, 2 and 3

There were 75 respondents that had completed the first survey which consisted of measuring attitudes at three points in time as captured in table 4.3.1.

Table 1.1.1

Within-Subjects Factor

Measure: Attitude time	Dependent Variable	Measurement
1	Attitude1	Initial Attitude
2	Attitude2	Attitude after exposure to Fake News
3	Attitude3	Attitude after exposure to a discounting cue

The first manipulation question, as discussed in chapter 3, sought to exclude participants who had answered the question about the vignette incorrectly as it was deemed that they were not influenced by the vignette. This was a true/false question about a statement in the vignette, and as described in chapter 3 was intended to reduce the potential for Type I and Type II errors. In analysing the responses received, there were 7 out of 75 participants (9.3%) who had answered the first manipulation question incorrectly. Upon reviewing their responses, it was evident that two participants (cases 56 and 61) who answered incorrectly had a zero (.0) change in their attitudes over the three time periods, implying that they were not influenced by the vignette. They were allocated a value of 99 on SPSS, to denote them as missing values, and as such were removed from further analysis. Additionally, one participant (case 45) who had answered the manipulation question incorrectly had their attitude move in the opposite direction from all other participants, indicating again that they did not process the information provided. In the same manner as cases 56 and 61, this participant was removed from further analysis. The remaining four participants, in spite of them having failed the manipulation question had changes in attitude aligned with the expected changes, indicating that they had probably processed the information provided to them and had been influenced by the vignette and discounting cues. They were retained as participants in the study. On review of the manipulation question, it was apparent that this question was more of a memory / recollection test rather than a test for understanding. The percentage of participants incorrectly answering this question, together with the fact that it was not the intention of the study to test content recollection prompted the addition of a second manipulation question for the second study. Table 1.1.2 provides a breakdown of the number of participants in each group after removal of these three participants.

Table 1.1.2

Between Subjects Factors

Test Group	Value Label	N
1	Control	29
2	Social consensus	23
3	source bias	20
	Total	72

Table 1.1.3 is the Descriptive Statistics table that provides a summary of the changes in mean scores both within and between-subjects at each of the three time intervals. As mentioned in section 3.1.2 (missing data), the control group results were copied from time 2 and pasted into time 3, hence the identical data for the control group at times 2 and 3. The questionnaires were set up so that the lower the value of the attitude, the closer the participant's attitude is towards a climate change proponent, and the higher the value, the closer their attitude towards climate change denier. Important to note is that the fake news message in the vignette was positioned from a climate change denier perspective while the discounting cues were positioned from a climate change proponent perspective. Therefore, in interpreting the table of descriptive statistics, an increase in value moves a participant's attitude towards a climate change denier aligned with the message in the vignette, while a decrease in value moves the participant's attitude towards a climate change proponent aligned with the discounting cues.

Table 1.1.3

Descriptive Statistics Pilot study

	Test Group	Mean	Std. Deviation	N
Attitude at time 1	Control	1.9310	.74371	29
	Social consensus	2.0761	.66757	23
	source bias	1.7500	.54411	20
	Total	1.9271	.67192	72
Attitude at time 2	Control	2.7414	1.46153	29
	Social consensus	2.7391	1.34941	23
	source bias	2.7250	1.62808	20
	Total	2.7361	1.45465	72
Attitude at time 3	Control	2.7414	1.46153	29
	Social consensus	2.1630	1.19803	23
	source bias	1.8750	.94416	20
	Total	2.3160	1.28917	72

1.2. Selecting the appropriate statistical technique.

In this study, all participants were exposed to the same initial stimulus (fake news) in the form of a vignette, but participants in the control group got no further stimuli while participants in the two treatment groups received different stimuli (discounting cues). Repeated measures of attitudes using the same instrument were conducted over the three time periods. Since there was independence of participation, where no subject had participated in more than one group, the appropriate analytical technique is the within-between repeated measures Analysis of Variance (ANOVA), also referred to as the two-way mixed ANOVA. While a repeated measures ANOVA may seem appropriate this is not the case as that requires all participants to undergo all treatments, while in this study, participants are subject to different treatments.

The section and sub-sections that follow tests the dataset for compliance to the assumptions of a two-way mixed ANOVA. This is important, in that in order to conduct and interpret any statistical analyses, compliance to the appropriate technique and violations thereof need to be understood and managed as appropriate. The assumptions as stated are based on established tests for this statistical technique as described by Laerd Statistics (2015) and Pallant (2016).

1.2.1. Assumptions 1-3 of the two-way mixed ANOVA

Since each participant in our study was measured on the same continuous scale (representing the dependent variable i.e. attitudes) on three occasions at different time periods, and there are two independent variables that were categorical (social consensus and source bias), the first three assumptions of the two-way mixed ANOVA were met i.e. (a) a continuous dependent variable; (b) between-subjects factor that is categorical with two or more categories; and (c) one within-subjects factor (time) that is categorical with two or more categories.

1.2.2. Assumption 4 - Outliers

The fourth assumption for a two-way mixed ANOVA is that there should be no significant outliers in any cell of the design. Since Outliers have potential to increase the estimated sample variances, resulting in a decreased F statistic with an increased chance of a type I error, it is vital that they are identified and managed appropriately. The next section discusses the tests for outliers and the management thereof in more detail.

1.2.2.1. Test for Outliers.

Outliers were detected via the studentized residuals output of the mixed ANOVA analysis. Values greater than + 3 and lower than -3 were considered outliers (Laerd Statistics, 2015b). On attitude 1, only case 28 was identified as an outlier, with a studentized residual of +3.91. Further inspection of this participant's mean attitude scores revealed that their initial attitude of 4.5 was already higher than most other participants and it moved to 5.25 after exposure to fake news. Case 7 had moved from one extreme (1.25) to the other extreme (7) after processing the fake news article. Even though the participants had responded to the stimuli presented, they were allocated a score of 101 to denote them as a missing value to be removed from further analysis. The boxplots shown in figure1.2.2.1-1 confirm the absence of significant outliers.

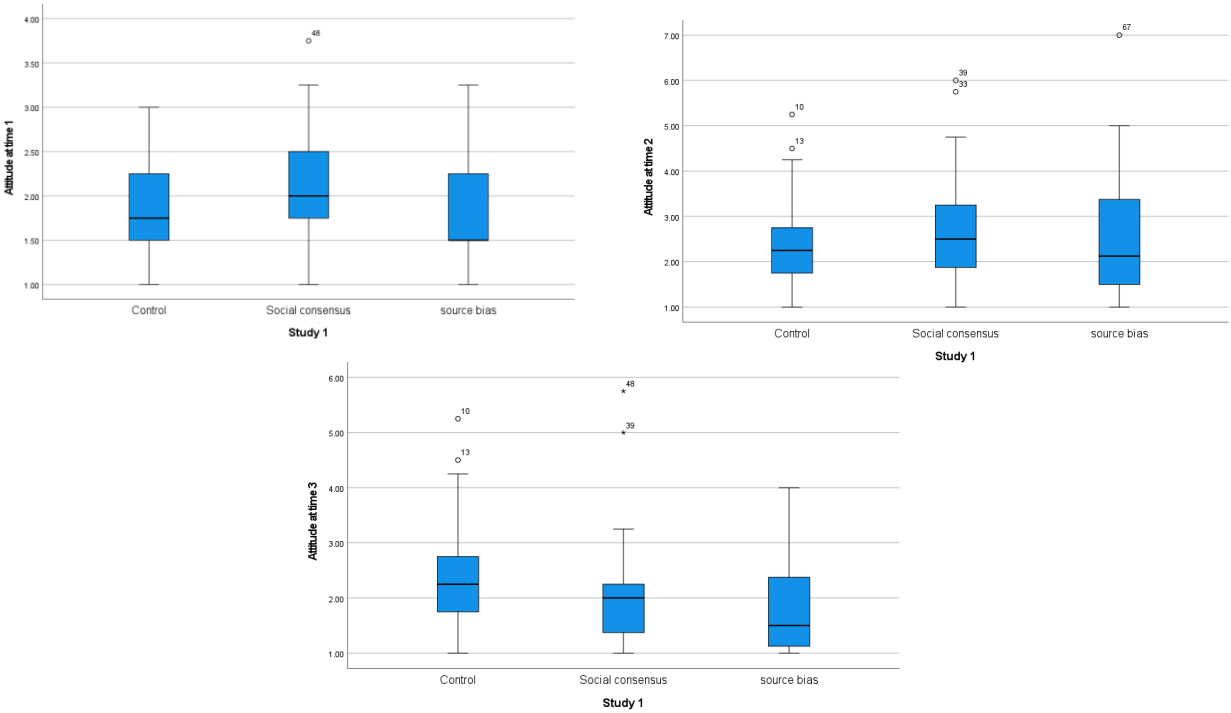


Figure 1.2.2.1-1 Boxplots for attitudes 1, 2, and 3

The 5th assumption for a mixed two-way ANOVA is that the dependent variable should be approximately normally distributed for each cell of the design. This is discussed next.

1.2.3. Assumption 5 - Normality checks

Normality checks were done using the Shapiro-Wilk test of normality. The null hypothesis for the Shapiro-Wilk test is that a variable is a normally distributed representation of a population, and it is rejected if $p < 0.05$. Analysis of table 1.2.3.1 indicates that data was not normally distributed, with significance < .05 in all cases, except one.

Table 1.2.3.1

Normality tests for attitudes 1, 2, and 3

Tests of Normality

Pilot study based on Attitudes		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Attitude at time 1	.146	27	29	.082	.876	29	.003
	.198	23	23	.020	.946	23	.245
	.227	20	20	.008	.890	20	.027
Attitude at time 2	.194	27	29	.001	.861	29	.001
	.162	23	23	.118	.907	23	.035
	.205	20	20	.027	.853	20	.006
Attitude at time 3	.194	27	29	.001	.861	29	.001
	.293	23	23	.000	.790	23	.000
	.246	20	20	.003	.847	20	.005

a. Lilliefors Significance Correction

The normal distribution curves for attitudes 1, 2, and 3 are shown in Figure 1.2.3.1. It is evident from these curves that the data is right or positively skewed.

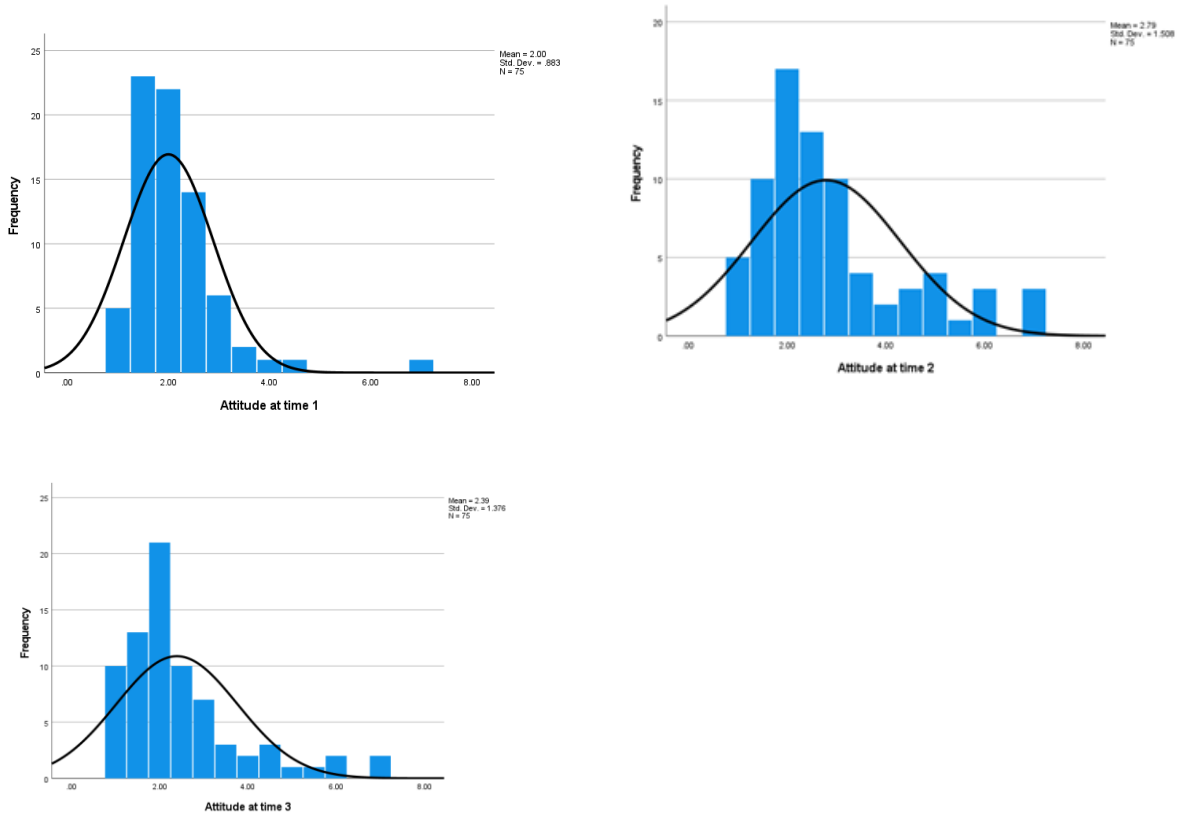


Figure 1.2.3-1 Boxplots for attitudes 1, 2 and 3

Pallant (2016, p.208) advise that most statistical techniques are reasonably robust to violations of normality for sample sizes greater than 30. In cases where this is not met, options exist for data transformation or the use of non-parametric alternatives to proceed with data analysis. Since there are no non-parametric alternatives to the mixed two-way ANOVA, and since our study did not meet the threshold of >30 participants, data transformation was performed on attitudes 1, 2 and 3. Based on the distribution scores and suggested transformations offered by Pallant (2016, p.98), the data was transformed utilising the Square root method in accordance with guidelines provided by Tabachnick and Fidell (2013). Table 1.2.3.2 shows the results of the tests of Normality based on the transformed data. In all cases (except for social consensus and social bias group on attitude 3) the transformed data was normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$). These deviations were noted but further data cleaning was deemed unnecessary.

Table 1.2.3.2

Normality tests on Log 10 Transformed attitudes 1 - 3

Tests of Normality

Pilot study based on transformed Attitudes		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Attitude1 Sqrt	Control	.133	27	.200	.958	27	.327
	Social consensus	.169	23	.088	.972	23	.732
	source bias	.213	20	.018	.921	20	.102
Attitude2 Sqrt	Control	.152	27	.109	.944	27	.152
	Social consensus	.117	23	.200	.959	23	.437
	source bias	.157	20	.200	.913	20	.073
Attitude3 Sqrt	Control	.152	27	.109	.944	27	.152
	Social consensus	.254	23	.000	.874	23	.008
	source bias	.244	20	.003	.875	20	.014

*This is a lower bound of the true significance.
a. Lilliefors Significance Correction

The revised normal distribution curves based on the square root transformed data on attitudes 1-3 are shown in figure 1.2.3-2.

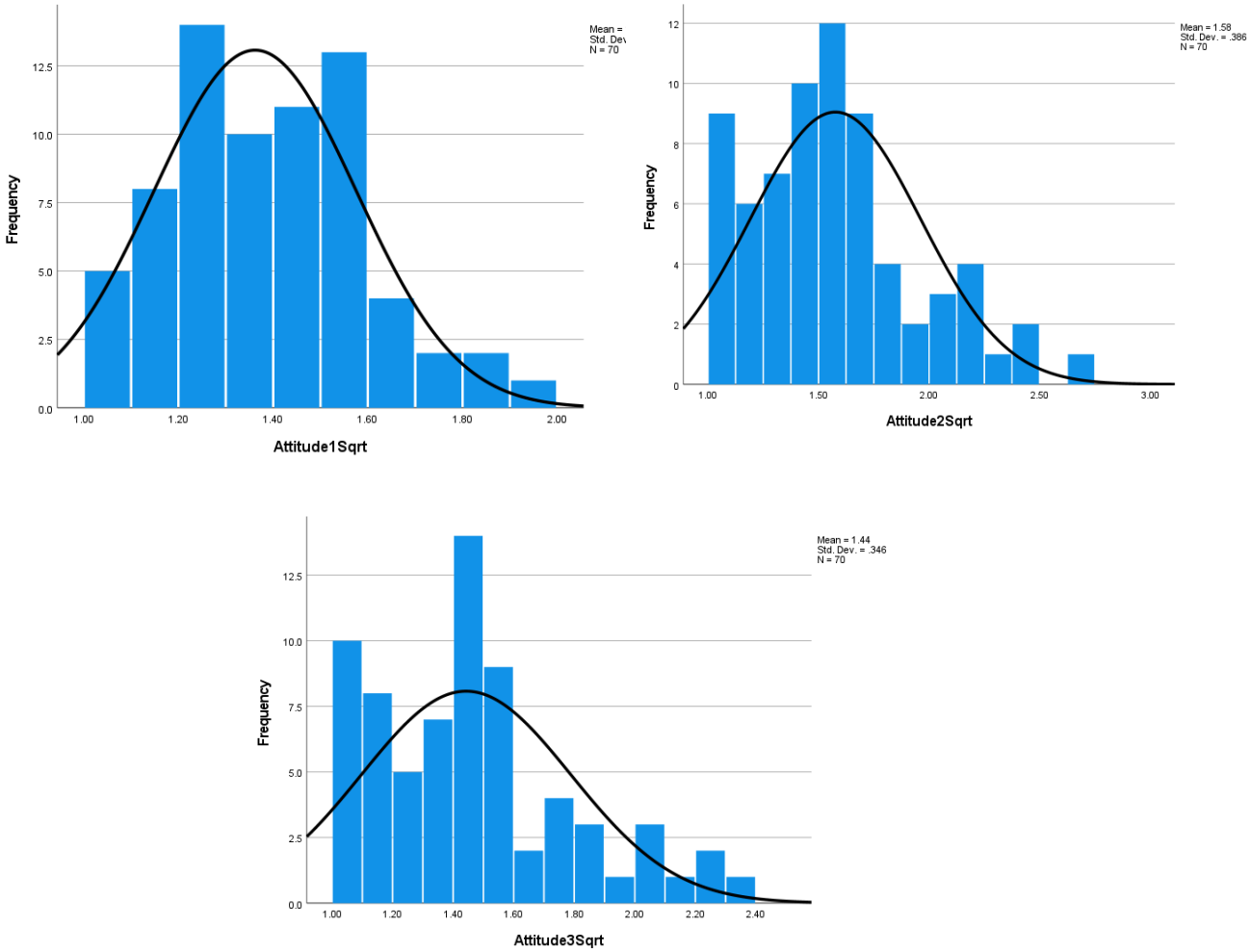


Figure 1.2.3-2 Revised normality curves after transformation of data

The issue of data transformation is divisive with diametrically opposing views on the subject (Pallant, 2016, p.96). In the absence of a nonparametric alternative to the two-way mixed ANOVA, an option would be to run the two-way mixed ANOVA on the transformed and non-transformed data to see if there are any meaningful differences, and to proceed with the original data if there are no meaningful differences (Laerd Statistics, 2015b). This was the approach adopted and the two-way mixed ANOVA was run for both sets of data. Comparison of the two sets of output (based on original attitude scores that were not normally distributed, and the transformed data) showed no meaningful differences between the two, on all analyses conducted except for the pairwise comparisons on attitude for the effect of time. Table 1.2.3.3 and table 1.2.3.4 show the differences between times 1 and 3 where the original non-transformed shows that the difference between times 1 and 3 is statistically significant (p = .038) while the attitudes transformed on square root shows it to be not statistically significant (p = .097).

Table 1.2.3.3

Pairwise comparisons for the effect of time based on original / non-transformed attitudes

Pairwise Comparisons

Measure: Attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.750*	.142	.000	-1.099	-.400
	3	-.274*	.107	**.038**	-.537	-.012
2	1	.750*	.142	.000	.400	1.099
	3	.475*	.100	.000	.229	.721
3	1	.274*	.107	**.038**	.012	.537
	2	-.475*	.100	.000	-.721	-.229

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 1.2.3.4

Pairwise comparisons for the effect of time based on Sqrt transformed attitudes

Pairwise Comparisons

Measure: Attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.219	.039	.000	-.316	-.122
	3	-.072	.033	**.097**	-.153	.009
2	1	.219	.039	.000	.122	.316
	3	.147	.029	.000	.077	.217
3	1	.072	.033	**.097**	-.009	.153
	2	-.147	.029	.000	-.217	-.077

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

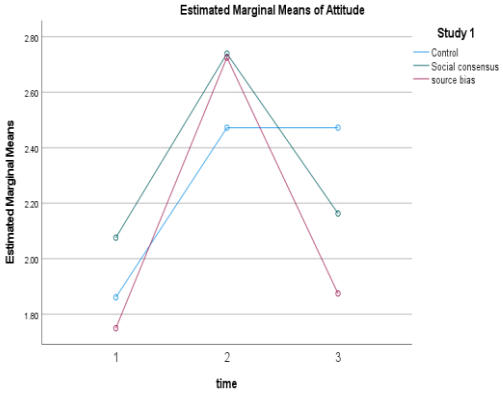


Figure 1.2.3-3 Estimated marginal means of attitudes for original /non transformed attitude

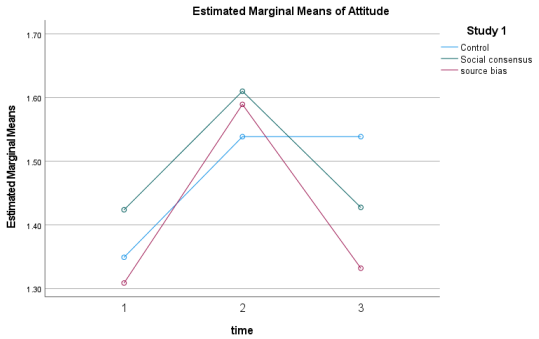


Figure 1.2.3-4 Estimated marginal means of attitudes for Square root transformed attitudes

Given the overall similarities in results, with one exception, the violation of the assumption of normality was noted but the original dataset was retained for further analysis. This was supported by the fact that the sample sizes were approximately equal and exceeded the minimum threshold of 30 as established by Pallant (2016).

1.2.4. Assumption 6 - Equality of variances (assumption of homogeneity of variances)

The 6th assumption to be met in conducting a mixed two-way ANOVA is to test for homogeneity of variances, which tests whether the variance in scores is the same for each of the three groups. This assumes that if samples obtained are from populations of equal variances, parametric tests would produce similar variability scores for each of the groups. Pallant (2016) point out that ANOVA F test is fairly robust to violations of this assumption when sample sizes are approximately equal i.e. largest / smallest <1.5. The Levene's test is used to establish equality of variances with a targeted significance level greater than 0.05 confirming that the test is not significant, i.e. the groups are homogenous. The results of the analysis are as captured in Table 1.2.4.1

Table 1.2.4.1

Levene's Test of Equality of Error Variances

		Levene Statistic	df1	df2	Sig.
Attitude at time 1	Based on Mean	.335	2	67	.716
	Based on Median	.272	2	67	.763
	Based on Median and with adjusted df	.272	2	62.601	.763
	Based on trimmed mean	.281	2	67	.756
Attitude at time 2	Based on Mean	1.623	2	67	.205
	Based on Median	.888	2	67	.416
	Based on Median and with adjusted df	.888	2	56.207	.417
	Based on trimmed mean	1.289	2	67	.282
Attitude at time 3	Based on Mean	.055	2	67	.947
	Based on Median	.028	2	67	.972
	Based on Median and with adjusted df	.028	2	62.317	.972
	Based on trimmed mean	.043	2	67	.958

At time point 1 (Attitude 1), the null hypothesis for equal variances was not rejected and the variances were equal F(2,67) = .335, p = .716. That is, the assumption of homogeneity of variances was not violated.

At time point 2 (Attitude 2), the null hypothesis for equal variances was not rejected and the variances were equal F(2,67) = .1.623, p = .205. That is, the assumption of homogeneity of variances was not violated.

At time point 3 (Attitude 3), the null hypothesis for equal variances was not rejected and the variances were equal F(2,67) = .055, p = .947. That is, the assumption of homogeneity of variances was not violated.

Therefore, the 6th assumption in conducting a mixed two-way ANOVA was met, and there was homogeneity of variances.

1.2.5. Assumption 7 - Equality of covariance matrices

Box's test of equality of covariance matrices was used to determine whether there were similar covariances, with a significance value established at $p < .001$ (Pallant, 2016). If p > .01 it implies the test is not statistically significant, that there are equal covariances, and that the assumption of homogeneity of covariances has not been violated.

Table 1.2.5.1

Box's Test of Equality of Covariance Matrices

Box's M	4.830
F	.740
df1	6
df2	11512.798
Sig.	.617

The output generated by SPSS, as shown in table 1.2.5.1 shows that there is homogeneity of covariances (p = .617), thus complying with the 7th assumption. The 8th and final assumption states that the variance of the differences between groups should be equal, and is widely referred to as the assumption of sphericity. This is discussed next.

1.2.6. Assumption 8 - the assumption of sphericity

Sphericity implies that the variance in population difference between two conditions is the same as the variance in population difference for any other two conditions (Pallant, 2016). This assumption of sphericity is commonly violated, and Mauchly's test of sphericity is considered a poor method to detect violations of sphericity (Field, 2013; Pallant, 2016). In practice the assumption of sphericity is considered difficult not to violate (Laerd Statistics, 2015b). Even if the assumption of sphericity is violated, a correction can be made to correct for this bias by adjusting the degrees of freedom used in calculating the *p*-value. Laerd Statistics (2015a) Therefore, the loss of power and increased probability of obtaining a Type II error can be addressed with this correction called **epsilon** (**ε**) (Field, 2013). Three methods have been developed to estimate this adjustment and they are called the Greenhouse-Geisser, Huynh-Feldt and the Lower-bound estimates. Field (2013) advise that if the Greenhouse-Geisser (ε) > .75, then the Huynh-Feldt correction should be used.

Table 1.2.6.1

Mauchly's Test of Sphericity

Measure: Attitude Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilonb		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.789	15.649	2	.000	.826	.869	.500

As evidenced in Table 1.2.6.1, we have a statistically significant result with p < .001 indicating that the assumption of sphericity was violated for the two-way interaction. Statistical significance occurs at P > .05. Analysis of Table 1.2.6.1 shows a Greenhouse-Geisser value

of .826 implying that the Huynh-Feldt figures should be used to assess whether a statistically significant two-way interaction exists.

1.3. Assessment for a statistically significant two-way interaction– times 1, 2 and 3

After establishing that the data satisfied the requirements of a two-way mixed ANOVA, the two-way mixed ANOVA was performed on the original dataset (not transformed) after exclusion of the outliers. Table 1.3.1 shows the results of the Tests of Within-Subjects Effects of the two-way mixed ANOVA , as produced by SPSS. Since the assumption of sphericity was violated, and the Greenhouse-Geisser value exceeds 0.75, the assessment for interaction effects will be based on the Huynh-Feldt results.

Table 1.3.1

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial η^2	Noncent Parameter
time	Sphericity Assumed	19.844	2	9.922	20.705	.000	.236	41.410
	Greenhouse-Geisser	19.844	1.651	12.017	20.705	.000	.236	34.193
	Huynh-Feldt	**19.844**	**1.738**	**11.416**	**20.705**	**.000**	**.236**	**35.993**
	Lower-bound	19.844	1.000	19.844	20.705	.000	.236	20.705
time * Test Group	Sphericity Assumed	4.989	4	1.247	2.602	.039	.072	10.410
	Greenhouse-Geisser	4.989	3.303	1.510	2.602	.050	.072	8.595
	Huynh-Feldt	**4.989**	**3.477**	**1.435**	**2.602**	**.047**	**.072**	**9.048**
	Lower-bound	4.989	2.000	2.494	2.602	.082	.072	5.205
Error (time)	Sphericity Assumed	64.213	134	.479				
	Greenhouse-Geisser	64.213	110.643	.580				
	Huynh-Feldt	64.213	**116.468**	.551				
	Lower-bound	64.213	67.000	.958				

Analysis of the tests of within-subjects effects indicates that there was a statistically significant interaction between the intervention and time on attitudes, F(3.477, 116.468) = 1.435, p = .047, partial η2 = . 072.

To determine where this significance lies, the difference between groups at each category of time and vice versa, called **simple main effects** was determined.

1.4. Tests for simple main effects between groups

The tests for simple main effects between groups is a between-subjects analysis and performing these comparisons is the same as running three separate between-subjects ANOVAs (i.e., three separate one-way ANOVAs) on the data. Univariate tests were conducted on SPSS and the relevant tables have been extracted for analysis here. Table 1.4.1 captures the between-subjects factors indicating the group name and number of participants in each group. This is the same for all three times.

Table 1.4.1
Between-Subjects Factors

		Value Label	N
Test Group	1	Control	62
	2	Social consensus	58
	3	source bias	67

1.4.1. Tests for simple main effects between groups at time 1

Attitude 1 was measured prior to any treatment and participants were randomly divided into each of the three groups. Since the same instrument was used to measure attitudes, it would be expected that there would be no statistically significant difference between groups. Table 1.4.1.1 shows that the means across groups are similar.

Table 1.4.1.1

Group Means and standard error at time 1

Dependent Variable: Attitude at time 1

Test Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	1.782	.076	1.632	1.932
Social consensus	1.616	.079	1.461	1.771
source bias	1.672	.073	1.527	1.816

The result of the Univariate test carried out on SPSS for Attitudes at time 1 is shown in table 4.6.1.2. Analysis of results confirms that the difference in attitudes at time 1 between the three groups was not statistically significant, $F(2, 184) = 1.207$, $p = .301$, partial $\eta^2 = .864$.

Table 1.4.1.2

Univariate test – Attitude at time 1

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	.864	2	.432	1.207	.301	.864
Error	65.864	184	.358			

The F tests the effect of Test Group. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Pairwise comparisons as captured in 1.4.1.3 confirms that differences between groups is not statistically significant ($\alpha > .05$) with p values = .131 ; .295 ; and .607 for the control-social consensus, control – source bias, and social consensus – source bias groups respectively.

Table 1.4.1.3

Pairwise Comparisons for attitudes at time 1

(I) Test Group	(J) Test Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.166	.109	.131	-.050	.382
	source bias	.111	.105	.295	-.097	.319
Social	Control	-.166	.109	.131	-.382	.050
consensus	source bias	-.055	.107	.607	-.267	.156
source bias	Control	-.111	.105	.295	-.319	.097
	Social consensus	.055	.107	.607	-.156	.267

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

1.4.2. Tests for simple main effects between groups at time 2

Attitude 2 was measured after exposure to the vignette and since all participants received the same vignette, it would be expected that there would be no statistically significant difference between groups. Table 1.4.2.1 shows that the mean for the social consensus group is lower than the other two groups, but as noted in the univariate test to follow, this difference is not statistically significant.

Table 1.4.2.1

Group Means and standard error at time 2

Dependent Variable: Attitude at time 2				
Test Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	2.810	.174	2.466	3.154
Social consensus	2.397	.180	2.041	2.752
source bias	2.716	.168	2.385	3.047

The result of the Univariate test carried out on SPSS for Attitudes at time 2 is shown in table 1.4.2.2. Analysis of results confirms that the difference in attitudes at time 2 between the three groups was not statistically significant, $F(2, 184) = 1.490$, $p = .228$, partial $\eta^2 = 5.618$.

Table 1.4.2.2

Univariate test – Attitude at time 2

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	5.618	2	2.809	1.490	.228	5.618
Error	346.827	184	1.885			

The F tests the effect of Test Group. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Pairwise comparisons as captured in 1.4.2.3 confirms that differences between groups is not statistically significant ($\alpha > .05$) with p values = .101 ; .698 ; and .196 for the control-social consensus, control – source bias, and social consensus – source bias groups respectively.

Table 1.4.2.3

Pairwise Comparisons for attitudes at time 2

(I) Test Group	(J) Test Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.414	.251	.101	-.081	.909
	source bias	.094	.242	.698	-.383	.571
Social	Control	-.414	.251	.101	-.909	.081
consensus	source bias	-.320	.246	.196	-.806	.166
source bias	Control	-.094	.242	.698	-.571	.383
	Social consensus	.320	.246	.196	-.166	.806

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

1.4.3. Tests for simple main effects between groups at time 3

Attitude 3 was measured after exposure to the discounting cues for the two treatment groups and was a copy and paste of the measure at time 2 for the Control group since there was no measurement at time 3 for the control group. Table 1.4.3.1 shows that the mean for the two treatment groups are similar and lower than the control group.

Table 1.4.3.1

Group Means and standard error at time 3

Dependent Variable: Attitude at time 3				
Test Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	2.810	.138	2.538	3.083
Social consensus	1.849	.143	1.567	2.131
source bias	1.840	.133	1.577	2.102

The result of the Univariate test carried out on SPSS for Attitudes at time 3 is shown in table 1.4.3.2. Analysis of results confirms that the difference in attitudes at time 3 between the three groups was statistically significant, $F(2, 184) = 16.354$, $p < .001$, partial $\eta^2 = 38.715$.

Table 1.4.3.2

Univariate test – Attitude at time 3

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	38.715	2	19.358	16.354	.000	38.715
Error	217.791	184	1.184			

The F tests the effect of Test Group. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Pairwise comparisons as captured in 1.4.3.3 show that differences between the control group and the two treatment groups is statistically significant ($\alpha < .05$) with p values < .001, while the difference in mean scores between the two treatment groups is not statistically significant (p= .980).

Table 1.4.3.3

Pairwise Comparisons for attitudes at time 3

(I) Test Group	(J) Test Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.961	.199	.000	.569	1.353
	source bias	.971	.192	.000	.593	1.349
Social	Control	-.961	.199	.000	-1.353	-.569
consensus	source bias	.010	.195	.961	-.375	.395
source bias	Control	-.971	.192	.000	-1.349	-.593
	Social consensus	-.010	.195	.961	-.395	.375

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Since the differences between the control group and the two treatment groups were statistically significant, an independent samples T test was conducted at time 3, to establish the effect sizes. Pallant (2016 p. 248) provide the following criteria in assessing Cohens' d. .2 = small effect, .5 = medium effect, .8 = large effect. The results are captured in Table 1.4.3.4.

Table 1.4.3.4

Independent Samples Effect Sizes at Attitude 3

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
Control and Social Consensus	Cohen's d	1.20232	**.800**	.426	1.170
	Hedges' correction	1.21003	.794	.423	1.163
	Glass's delta	.86341	1.113	.698	1.522
Control and Source Bias	Cohen's d	1.17486	**.826**	.465	1.185
	Hedges' correction	1.18186	.822	.462	1.178
	Glass's delta	.84578	1.148	.748	1.541
Source Bias and Social Consensus	Cohen's d	.85400	**.011**	-.340	.363
	Hedges' correction	.85925	.011	-.338	.361
	Glass's delta	.84578	.011	-.340	.363

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

The independent samples T test indicated a large effect size between the control group and the social consensus group at time 3 (with Cohen's d =.800). It also indicated a large effect size between the control group and the source bias group at time 3 (with Cohen's d =.826)

1.5. Simple main effects for time.

The simple main effects for time gives an indication of how participant's attitudes in each group changed with each intervention, and allows us to test the hypotheses established in chapter 2, thereby making a theoretical contribution to Social Judgement Theory. This part of the study is a within-subjects analysis and was assessed using the repeated measures ANOVA on SPSS. Prior to this analysis, the data file was split based on the three groups.

1.5.1. Simple main effects for time – Control Group.

For the Control group, the Mauchly's test of sphericity did not produce a significance value, as captured in table 1.5.1.1, This was expected as attitude 3 was a copy and paste of attitude 2. In analysing the results, it was assumed that the assumption of sphericity was violated, and the Greenhouse-Geisser values were utilised to assess statistical significance, since it is less than 0.75.

Table 1.5.1.1

Mauchly's Test of Sphericity for the pilot study Control Group

Measure: Attitude							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.000	.	2	.	.500	.500	.500

From the tests of within subjects effects for the control group, there was a statistically significant effect of time on attitudes for the control group, $F(1,61) = 39.05$. $p < .001$, partial $\eta^2 = .39$. This is reflected in table 1.5.1.2.

Table 1.5.1.2

Tests of Within-Subjects Effects for the pilot study Control Group

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	43,700	2	21,850	39,053	0,000	0,390
	Greenhouse-Geisser	**43,700**	**1,000**	**43,700**	**39,053**	**0,000**	**0,390**
	Huynh-Feldt	43,700	1,000	43,700	39,053	0,000	0,390
	Lower-bound	43,700	1,000	43,700	39,053	0,000	0,390
Error(time)	Sphericity Assumed	68,259	122	0,559			
	Greenhouse-Geisser	68,259	**61,000**	1,119			
	Huynh-Feldt	68,259	61,000	1,119			
	Lower-bound	68,259	61,000	1,119			

Pairwise comparisons help us understand where these effects lie. Table 1.5.1.3 shows the pairwise comparisons for the control group at times 1, 2, and 3. The difference in mean between the initial assessment (time 1) and after exposure to the vignette (time 2) is statistically significant ($p < .001$) and remains so between time 1 and time 3 which would be expected as time 3 is a copy and paste of time 2.

Table 1.5.1.3

Pairwise Comparisons for Control Group

Pairwise Comparisons[a]

Measure: Attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	95% Confidence Interval for Difference[c]	
					Lower Bound	Upper Bound
1	2	-1.028	.165	.000	-1.433	-.623
	3	-1.028	.165	.000	-1.433	-.623
2	1	1.028	.165	.000	.623	1.433
	3	.000	.000	.	.000	.000
3	1	1.028	.165	.000	.623	1.433
	2	.000	.000	.	.000	.000

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

a. The main study = Control ; c. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

1.5.2. Simple main effects for time – Social Consensus.

For the group that received discounting cues in the form of user comments (group 2), the Mauchly's test of sphericity indicates that we have a statistically significant result with $p < .001$ indicating that the assumption of sphericity was violated for the two-way interaction. Statistical significance occurs at $P > .05$. Analysis of Table 1.5.2.1 shows a Greenhouse-Geisser value of 0.886 implying that the Huynh-Feldt figures should be used to assess whether a statistically significant two-way interaction exists. It was pointed out earlier that the Greenhouse-Geisser values are utilised to assess statistical significance when they are less than .75.

Table 1.5.2.1

Mauchly's Test of Sphericity for the pilot study Social Consensus Group

Measure: Attitude							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.871	7.724	2	.021	.886	.912	.500

From the tests of within subjects effects for the social consensus group, there was a statistically significant effect of time on attitudes, $F(1.824,103.99) = 24.12$. $p < .001$, partial $\eta^2 = .297$. This is reflected in table 1.5.2.2.

Table 1.5.2.2

Tests of Within-Subjects Effects for the pilot study Social Consensus Group

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	18.608	2	9.304	24.120	.000	.297
	Greenhouse-Geisser	18.608	1.772	10.503	24.120	.000	.297
	Huynh-Feldt	**18.608**	**1.824**	**10.200**	**24.120**	**.000**	**.297**
	Lower-bound	18.608	1.000	18.608	24.120	.000	.297
Error(time)	Sphericity Assumed	43.975	114	.386			
	Greenhouse-Geisser	43.975	100.989	.435			
	Huynh-Feldt	43.975	**103.993**	.423			
	Lower-bound	43.975	57.000	.771			

Pairwise comparisons help us understand where these effects lie. Table 1.5.2.3 shows the pairwise comparisons for the social consensus group at times 1, 2, and 3. The difference in

mean between the initial assessment (time 1) and after exposure to the vignette (time 2) is statistically significant ($p < .001$). The difference in mean prior to receiving the discounting cue (time 2) and after exposure to the discounting cue (time 3) is statistically significant ($p < .001$). The difference in mean between the initial assessment (time 1) and after exposure to the discounting cue (time 3) is not statistically significant ($p = .101$).

Table 1.5.2.3

Pairwise Comparisons for the pilot study Social Consensus Group

Pairwise Comparisons[a]

Measure: Attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	95% Confidence Interval for Difference[c]	
					Lower Bound	Upper Bound
1	2	-.780	.134	.000	-1.111	-.449
	3	-.233	.107	.101	-.497	.031
2	1	.780	.134	.000	.449	1.111
	3	.547	.102	.000	.296	.799
3	1	.233	.107	.101	-.031	.497
	2	-.547	.102	.000	-.799	-.296

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

a. The main study = Social consensus

c. Adjustment for multiple comparisons: Bonferroni.

1.5.3. Simple main effects for time – Source Bias.

For the group that received discounting cues in the form of letters to the editor indicating a biased source (group 3), the Mauchly's test of sphericity indicated that we had a statistically significant result with $p < .001$ signifying that the assumption of sphericity was violated for the two-way interaction. Statistical significance occurs at $P > .05$. Analysis of Table 1.5.3.1 shows a Greenhouse-Geisser value of .694. Since it is less than .75, the Greenhouse-Geisser values were utilised to assess statistical significance. It was pointed out earlier that the Greenhouse-Geisser values are utilised to assess statistical significance when they are less than .75.

Table 1.5.3.1

Mauchly's Test of Sphericity for the pilot study Source Bias Group

Measure: Attitude							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.560	37.724	2	.000	.694	.704	.500

From the tests of within subjects effects for the source bias group, there was a statistically significant effect of time on attitudes, $F(1.389, 91.647) = 32.90$. $p<.001$, partial $\eta^2 = .333$. This is reflected in table 1.5.3.2.

Table 1.5.3.2

Tests of Within-Subjects Effects for the pilot study Source Bias Group

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	42.180	2	21.090	32.902	.000	.333
	Greenhouse-Geisser	**42.180**	**1.389**	**30.376**	**32.902**	**.000**	**.333**
	Huynh-Feldt	42.180	1.409	29.937	32.902	.000	.333
	Lower-bound	42.180	1.000	42.180	32.902	.000	.333
Error(time)	Sphericity Assumed	84.612	132	.641			
	Greenhouse-Geisser	84.612	**91.647**	.923			
	Huynh-Feldt	84.612	92.992	.910			
	Lower-bound	84.612	66.000	1.282			

Pairwise comparisons help us understand where these effects lie. Table 1.5.3.3 shows the pairwise comparisons for the source bias group at times 1, 2, and 3. The difference in mean between the initial assessment (time 1) and after exposure to the vignette (time 2) is statistically significant ($p < .001$). The difference in mean prior to receiving the discounting cue (time 2) and after exposure to the discounting cue (time 3) is statistically significant ($p < .001$). The difference in mean between the initial assessment (time 1) and after exposure to the discounting cue (time 3) is not statistically significant ($p = .179$).

Table 1.5.3.3

Pairwise Comparisons for the pilot study Source Bias Group

Pairwise Comparisons[a]

Measure: Attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	95% Confidence Interval for Difference[c]	
					Lower Bound	Upper Bound
1	2	-1.045	.172	.000	-1.467	-.622
	3	-.168	.088	.179	-.383	.047
2	1	1.045	.172	.000	.622	1.467
	3	.877	.142	.000	.528	1.225
3	1	.168	.088	.179	-.047	.383
	2	-.877	.142	.000	-1.225	-.528

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

a. The main study = Social consensus

c. Adjustment for multiple comparisons: Bonferroni.

1.6. Durability of attitudes

The fourth hypothesis of the study states that over time, anchors will shift back towards the position established before exposure to fake news. The null hypothesis states that over time, the difference in the means of attitude scores will be statistically significant when compared to attitude mean score prior to the intervention. $\mu 1 \neq \mu 2$, $p < .05$

Since there was a time lapse of > two weeks and > three months between the first survey and the second and third surveys respectively, it is very possible that the survey may have sparked participant's interest in the subject to conduct additional research on the matter, or other external influences like media, courses or any other discussion about climate change, may have influenced participants attitudes toward climate change. In analysing data it is critical to cater for the influence of external factors, as not taking this into consideration increases the potential of Type I and Type II errors. The following questions were asked of participants that took the survey after two-weeks and again after three-months.

Q4 Have you been exposed to any information about climate change since taking the initial survey?

Yes ◯ No ◯

Those that answered affirmative to the above question were presented with the following question: Do you believe this additional information had any influence on your attitudes or changed your perspectives towards climate change, since taking the initial survey?

Yes ⬭ No ⬭

Those that answered Yes to this question were excluded from the analysis, while those that answered No were retained.

1.6.1. Analysis of attitudes – time point 4 (two weeks after the initial survey)

Of the initial 75 respondents, 49 responded to the second survey. This is a response rate of 65.33 %. Of the 49 responses, 4 indicated that the additional information had an influence on their attitudes. They were allocated a number of 105 on SPSS to denote them as missing values. Of the 49 respondents, 4 had already been excluded in the first analysis (three from answering the first manipulation question incorrectly (99) and one as an outlier (101). Table 1.6.1.1 captures the descriptive statistics for the group. This left a total sample size of (14+14+13) = 41, which vindicates the decision to split the analysis into three segments. This will follow through on the analysis of the main study.

Table 1.6.1.1

Descriptive statistics for pilot study attitudes at time point 4

Survey after 2 weeks

		Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Attitude at time 4	Control	14	60.9%	9	39.1%	23	100.0%
	Social consensus	14	60.9%	9	39.1%	23	100.0%
	source bias	13	65.0%	7	35.0%	20	100.0%
	99 (Missing)	3	100.0%	0	0.0%	3	100.0%
	101 (Missing)	1	50.0%	1	50.0%	2	100.0%
	105 (Missing)	4	100.0%	0	0.0%	4	100.0%

The Shapiro-Wilk test was used to establish normality. The null hypothesis for the Shapiro-Wilk test is that a variable is normally distributed in some population, and it is rejected if $p < .05$. Analysis of table 1.6.1.2 indicates that data was normally distributed for the groups 1 and

3 (control group and source bias) while group 2 failed the normality test, with significance < .05.

Table 1.6.1.2

Normality test for attitudes at time point 4

Tests of Normality

Survey after 2 weeks	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control	.176	14	.200	.891	14	.083
Social consensus	.173	14	.200	.846	14	.019
source bias	.234	13	.050	.891	13	.099

a. Lilliefors Significance Correction

Pallant (2016) advise that one-way ANOVA is robust to deviations from normality for similar sample sizes. A one-way ANOVA was conducted on attitudes at time point 4. There was homogeneity of variances F (2,38) = 2.56, p= .087. The difference between groups was not statistically significant F(2,40) = 1.134, p= .333. In other words, we fail to reject the null hypothesis two weeks after the intervention as the difference in means between the control group, the group that received a discounting cue on social consensus, and the group that received a discounting cue on source bias, was not significantly different.

1.6.2. Analysis of attitudes – time point 5 (three months after the initial survey)

Of the initial 75 respondents, 47 responded to the third survey. This is a response rate of 62.67%. Of the 47 responses, 9 indicated that the additional information had an influence on their attitudes. They were allocated a number of 106 on SPSS to denote them as missing values. Of the 47 respondents, 4 had already been excluded in the first analysis (three from answering the first manipulation question incorrectly (99) and one as an outlier (101). Table 1.6.2.1 captures the descriptive statistics for the group. This left a total sample size of (12+10+12) = 34, which again vindicates the decision to split the analysis into three segments, and will be adopted for the analysis of the main study.

Table 1.6.2.1

Descriptive statistics for Attitudes at time point 5

Survey after 2 weeks

		Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Attitude at time 4	Control	12	50.0%	12	50.0%	24	100.0%
	Social consensus	10	52.6%	9	47.4%	19	100.0%
	source bias	12	66.7%	6	33.3%	18	100.0%
	99 (Missing)	3	100.0%	0	0.0%	3	100.0%
	101 (Missing)	1	50.0%	1	50.0%	2	100.0%
	105 (Missing)	9	100.0%	0	0.0%	9	100.0%

The Shapiro-Wilk test was used to establish normality. The null hypothesis for the Shapiro-Wilk test is that a variable is normally distributed in some population, and it is rejected if $p < .05$. Analysis of table 1.6.2.2 indicates that data was normally distributed for all groups, with significance $p > .05$.

Table 1.6.2.2

Normality test for attitudes at time point 5

Tests of Normality

Survey after 2 weeks	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control	.259	12	.025	.866	12	.058
Social consensus	.221	10	.184	.872	10	.105
source bias	.213	12	.139	.927	12	.350

a. Lilliefors Significance Correction

A one-way ANOVA was conducted on attitudes at time point 5. The Levene's test was used to establish equality of variances with a targeted significance level greater than .05 confirming that the test is not significant, i.e. the groups are homogenous. The null hypothesis for equal variances was rejected and the assumption of homogeneity of variance was violated $F(2,31) = 4.41$, $p =. 021$. Pallant (2016) point out that ANOVA F test is fairly robust to violations of this assumption when sample sizes are approximately equal i.e. largest / smallest <1.5.

From the results of the one-way ANOVA, it was concluded that the difference between groups was not statistically significant F(2,31) = 1.292, p= .289. In other words, we fail to reject the null hypothesis three months after the intervention as the difference in means between the control group, the group that received a discounting cue on social consensus, and the group that received a discounting cue on source bias, was not significantly different.

1.6.3. Influence of time on attitudes – time periods 1 to 5

Although the sample size was reduced significantly with participant attrition, outliers and failed manipulation checks, a mixed ANOVA was done for time periods 1 to 5 to examine the effect of treatment and time on attitudes. The difference in sample sizes compared to the previous tests on attitude 4 is due to the fact that some participants completed survey 3 but not survey 2. The descriptive statistics is captured in table 1.6.3.1.

Table 1.6.3.1

Descriptive statistics for the pilot study attitudes time 1 to 5

Descriptive Statistics

	The pilot study	Mean	Std. Deviation	N
Attitude at time 1	Control	2.0909	.45101	11
	Social consensus	2.0250	.75875	10
	source bias	1.6000	.45947	10
	Total	1.9113	.59354	31
Attitude at time 2	Control	2.8864	1.28142	11
	Social consensus	2.6750	1.63745	10
	source bias	2.6500	1.72482	10
	Total	2.7419	1.50206	31
Attitude at time 3	Control	2.8864	1.28142	11
	Social consensus	2.4250	1.69169	10
	source bias	1.9000	.90676	10
	Total	2.4194	1.34998	31
Attitude at time 4	Control	1.8864	.71031	11
	Social consensus	2.1500	1.24833	10
	source bias	1.5500	.36893	10
	Total	1.8629	.85839	31
Attitude at time 5	Control	2.2727	1.02746	11
	Social consensus	2.1750	1.15500	10
	source bias	1.7000	.55025	10
	Total	2.0565	.95243	31

There was equality of covariance as confirmed by the Box's test with p = .161. For all cases, homogeneity of variances was met with p > .05. Mauchly's test of sphericity showed that the assumption of sphericity was violated p < .05. Since the Greenhouse Geisser value is less than .75, it will be used to assess statistical significance of the influence of time on attitudes.

Table 1.6.3.2

Mauchly's test of sphericity for the pilot study attitudes 1-5

Measure: Attitude

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilonb		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	0,127	54,520	9	0,000	0,468	0,537	0,250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + TestGroupAttitude5
Within Subjects Design: time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 1.6.3.3

Within-subjects effects – the pilot study

Measure:

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
time	Sphericity Assumed	17,121	4	4,280	9,623	0,000	0,256	38,493	1,000
	Greenhouse-Geisser	17,121	1,874	9,136	9,623	0,000	0,256	18,033	0,969
	Huynh-Feldt	17,121	2,147	7,975	9,623	0,000	0,256	20,660	0,982
	Lower-bound	17,121	1,000	17,121	9,623	0,004	0,256	9,623	0,849
time * TestGroupAttitude5	Sphericity Assumed	2,818	8	0,352	0,792	0,611	0,054	6,336	0,352
	Greenhouse-Geisser	2,818	3,748	0,752	0,792	0,529	0,054	2,968	0,230
	Huynh-Feldt	2,818	4,294	0,656	0,792	0,543	0,054	3,401	0,247
	Lower-bound	2,818	2,000	1,409	0,792	0,463	0,054	1,584	0,171
Error(time)	Sphericity Assumed	49,816	112	0,445					
	Greenhouse-Geisser	49,816	52,470	0,949					

Huynh-Feldt	49,816	60,115	0,829
Lower-bound	49,816	28,000	1,779

a. Computed using alpha = ,05

Assessment of the impact of time utilising the Greenhouse Geisser values confirmed that the impact of time on attitudes was statistically significant F (1.874, 52.47) = 9.623, p < .001. Given the small sample sizes, it was pointless trying to identify where the statistical differences lay or to make inferences from the results, other than the fact that the changes in attitudes were in accordance with the anticipated changes and would provide useful input into the analysis of the main study. Figure 1.6.3.1 shows graphically the impact of time on each of the three groups.

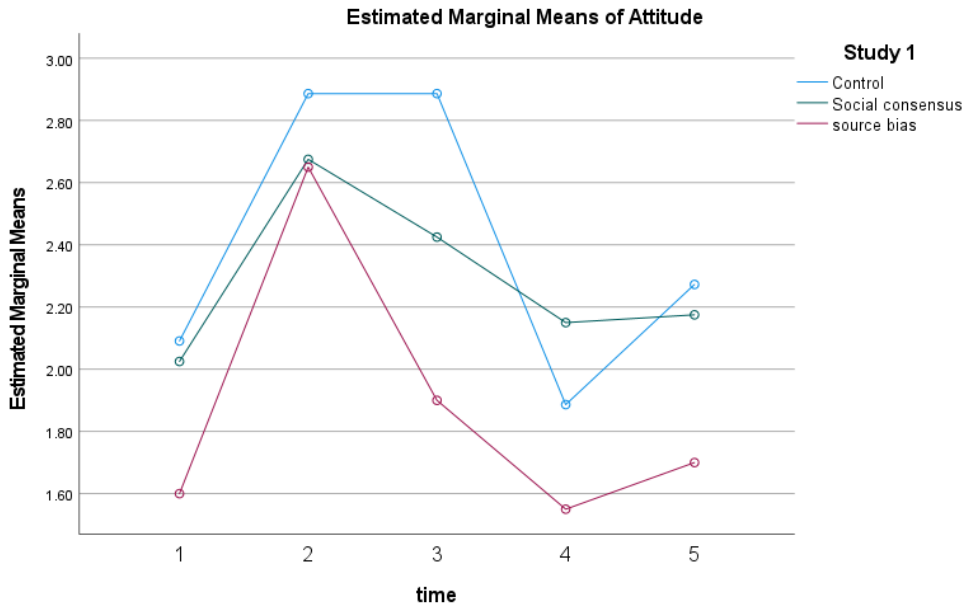


Figure 1.6.3-1 Estimated marginal means of attitudes for study times 1 to 5

Study 1 = pilot study

Annexure 7: Main study Mixed ANOVA times 1-3

Table 0.1

Within-Subjects Factors

Measure: Attitude

time	Dependent Variable
1	Attitude1
2	Attitude2
3	Attitude3

Table 0.2

Between-Subjects Factors

		Value Label	N
The main study	1	Control	62
	2	Social consensus	58
	3	source bias	67

Table 0.3

Descriptive Statistics

	Main study	Mean	Std. Deviation	N
Attitude at time 1	Control	1.7823	.60307	62
	Social consensus	1.6164	.56042	58
	source bias	1.6716	.62494	67
	Total	1.6912	.59896	187
Attitude at time 2	Control	2.8105	1.44906	62
	Social consensus	2.3966	1.16325	58
	source bias	2.7164	1.46480	67
	Total	2.6484	1.37654	187
Attitude at time 3	Control	2.8105	1.44906	62
	Social consensus	1.8491	.86341	58
	source bias	1.8396	.84578	67
	Total	2.1644	1.17434	187

Table 0.4

Box's Test of Equality of Covariance Matrices[a]

Box's M	15.798
F	2.563
df1	6
df2	103615.178
Sig.	.018

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.[a]

a. Design: Intercept + Study2

Within Subjects Design: time

Table 0.5

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Pillai's trace	.372	54.202[a]	2.000	183.000	.000	.372	108.405	1.000
Wilks' lambda	.628	54.202[a]	2.000	183.000	.000	.372	108.405	1.000
Hotelling's trace	.592	54.202[a]	2.000	183.000	.000	.372	108.405	1.000
Roy's largest root	.592	54.202[a]	2.000	183.000	.000	.372	108.405	1.000

Each F tests the multivariate effect of time. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = ,05

Table 0.6

Mauchly's Test of Sphericity[a]

Measure: Attitude

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.740	55.142	2	.000	.794	.808	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Study2

Within Subjects Design: time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 0.7

Tests of Within-Subjects Effects

Measure: Attitude

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
time	Sphericity Assumed	84.279	2	42.139	78.779	.000	.300	157.558	1.000
	Greenhouse-Geisser	84.279	1.587	53.102	78.779	.000	.300	125.030	1.000
	Huynh-Feldt	84.279	1.616	52.151	78.779	.000	.300	127.310	1.000
	Lower-bound	84.279	1.000	84.279	78.779	.000	.300	78.779	1.000
time * Study2	Sphericity Assumed	18.813	4	4.703	8.793	.000	.087	35.171	.999
	Greenhouse-Geisser	18.813	3.174	5.927	8.793	.000	.087	27.910	.996
	Huynh-Feldt	18.813	3.232	5.821	8.793	.000	.087	28.419	.997
	Lower-bound	18.813	2.000	9.407	8.793	.000	.087	17.585	.969
Error(time)	Sphericity Assumed	196.846	368	.535					
	Greenhouse-Geisser	196.846	292.026	.674					
	Huynh-Feldt	196.846	297.352	.662					
	Lower-bound	196.846	184.000	1.070					

a. Computed using alpha = ,05

Table 0.8

Tests of Within-Subjects Contrasts

Measure: Attitude

Source	time	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Para	Observed Power[a]
time	Linear	21.138	1	21.138	44.662	.000	.195	44.662	1.000
	Quadratic	63.141	1	63.141	105.847	.000	.365	105.847	1.000
time * Study2	Linear	14.348	2	7.174	15.158	.000	.141	30.317	.999
	Quadratic	4.465	2	2.232	3.742	.026	.039	7.484	.679
Error(time)	Linear	87.085	184	.473					
	Quadratic	109.761	184	.597					

a. Computed using alpha = ,05

Table 0.9

Levene's Test of Equality of Error Variances[a]

		Levene Statistic	df1	df2	Sig.
Attitude at time 1	Based on Mean	.742	2	184	.477
	Based on Median	.630	2	184	.534
	Based on Median and with adjusted df	.630	2	176.506	.534
	Based on trimmed mean	.671	2	184	.513
Attitude at time 2	Based on Mean	1.939	2	184	.147
	Based on Median	1.613	2	184	.202
	Based on Median and with adjusted df	1.613	2	177.960	.202
	Based on trimmed mean	1.881	2	184	.155
Attitude at time 3	Based on Mean	13.658	2	184	.000
	Based on Median	10.223	2	184	.000
	Based on Median and with adjusted df	10.223	2	163.048	.000
	Based on trimmed mean	13.071	2	184	.000

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.[a]

a. Design: Intercept + Study2

Within Subjects Design: time

Table 0.10

Tests of Between-Subjects Effects

Measure: Attitude

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	2622.544	1	2622.544	1112.796	.000	.858	1112.796	1.000
Study2	26.384	2	13.192	5.598	.004	.057	11.195	.853
Error	433.636	184	2.357					

a. Computed using alpha = ,05

Estimated Marginal Means

Table 0.11

1. Grand Mean

Measure: Attitude

		95% Confidence Interval	
Mean	Std. Error	Lower Bound	Upper Bound
2.166	.065	2.038	2.294

2. Main study

Table 0.12

Estimates

Measure: Attitude

			95% Confidence Interval	
Main study	Mean	Std. Error	Lower Bound	Upper Bound
Control	2.468	.113	2.246	2.690
Social consensus	1.954	.116	1.724	2.184
source bias	2.076	.108	1.862	2.290

Table 0.13

Pairwise Comparisons

Measure: Attitude

					95% Confidence Interval for Difference[b]	
(I) Main study	(J) Main study	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
Control	Social consensus	.514*	.162	.005	.123	.905
	source bias	.392*	.156	.039	.015	.769
Social consensus	Control	-.514*	.162	.005	-.905	-.123
	source bias	-.122	.159	1.000	-.506	.262
source bias	Control	-.392*	.156	.039	-.769	-.015
	Social consensus	.122	.159	1.000	-.262	.506

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 0.14

Univariate Tests

Measure: Attitude

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	8.795	2	4.397	5.598	.004	.057	11.195	.853
Error	144.545	184	.786					

The F tests the effect of Main study. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

3. time

Table 0.15

Estimates

Measure: Attitude

			95% Confidence Interval	
time	Mean	Std. Error	Lower Bound	Upper Bound
1	1.690	.044	1.604	1.777
2	2.641	.101	2.443	2.840
3	2.166	.080	2.009	2.324

Table 0.16

Pairwise Comparisons

Measure: Attitude

		Mean Difference			95% Confidence Interval for Difference[b]	
(I) time	(J) time	(I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	-.951*	.092	.000	-1.174	-.728
	3	-.476*	.071	.000	-.648	-.304
2	1	.951*	.092	.000	.728	1.174
	3	.475*	.060	.000	.330	.620
3	1	.476*	.071	.000	.304	.648
	2	-.475*	.060	.000	-.620	-.330

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 0.17

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Pillai's trace	.372	54.202[a]	2.000	183.000	.000	.372	108.405	1.000
Wilks' lambda	.628	54.202[a]	2.000	183.000	.000	.372	108.405	1.000
Hotelling's trace	.592	54.202[a]	2.000	183.000	.000	.372	108.405	1.000
Roy's largest root	.592	54.202[a]	2.000	183.000	.000	.372	108.405	1.000

Each F tests the multivariate effect of time. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = ,05

Table 0.18

*4. Main study * time*

Measure: Attitude

Main study	time	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Control	1	1.782	.076	1.632	1.932
	2	2.810	.174	2.466	3.154
	3	2.810	.138	2.538	3.083
Social consensus	1	1.616	.079	1.461	1.771
	2	2.397	.180	2.041	2.752
	3	1.849	.143	1.567	2.131
source bias	1	1.672	.073	1.527	1.816
	2	2.716	.168	2.385	3.047
	3	1.840	.133	1.577	2.102

Post Hoc Tests

Main study

Table 0.19

Multiple Comparisons

Measure: Attitude

Tukey HSD

					95% Confidence Interval	
(I) Main study	(J) Main study	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Control	Social consensus	.5137*	.16191	.005	.1312	.8963
	source bias	.3919*	.15619	.035	.0228	.7609
Social consensus	Control	-.5137*	.16191	.005	-.8963	-.1312
	source bias	-.1218	.15896	.724	-.4975	.2538
source bias	Control	-.3919*	.15619	.035	-.7609	-.0228
	Social consensus	.1218	.15896	.724	-.2538	.4975

Based on observed means.

The error term is Mean Square(Error) = .786.

*. The mean difference is significant at the ,05 level.

Homogeneous Subsets

Table 0.20

Attitude

Tukey HSD[a,b,c]

		Subset	
Main study	N	1	2
Social consensus	58	1.9540	
source bias	67	2.0759	
Control	62		2.4677
Sig.		.724	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .786.

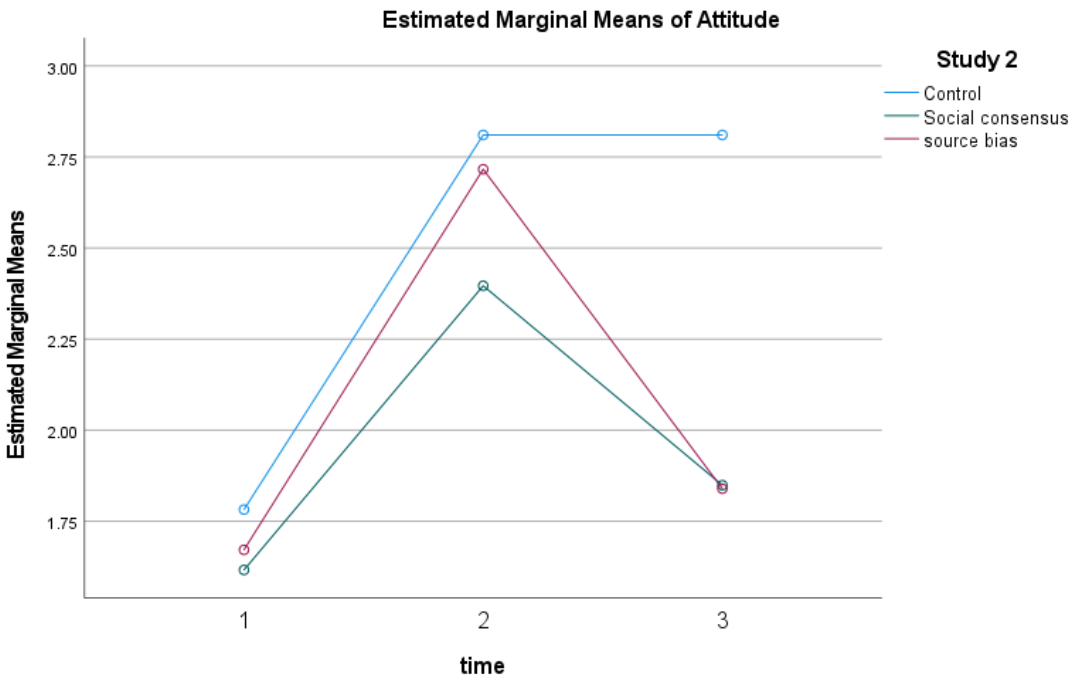
a. Uses Harmonic Mean Sample Size = 62.117.

b. The group sizes are unequal. The harmonic mean of the group sizes is used.

Type I error levels are not guaranteed.

c. Alpha = ,05.

Profile Plots



Annexure 8: Independent samples t-test for the main study attitude 3

Table 0.1

Group Statistics

	Main study	N	Mean	Std. Deviation	Std. Error Mean
Attitude at time 3	**Control**	62	2.8105	1.44906	.18403
	Social consensus	58	1.8491	.86341	.11337

Table 0.2

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% CI of Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	Lower	Upper
Attitude at time 3	Equal variances assumed	17.082	.000	4.377	118	.000	.96135	.21963	.52641	1.39628
	Equal variances not assumed			4.448	100.583	.000	.96135	.21615	.53254	1.39015

Independent Samples Effect Sizes

			95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Attitude at time 3	Cohen's d	1.20232	.800	.426	1.170
	Hedges' correction	1.21003	.794	.423	1.163
	Glass's delta	.86341	1.113	.698	1.522

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

Table 0.3

Group Statistics

	Main study	N	Mean	Std. Deviation	Std. Error Mean
Attitude at time 3	**Control**	62	2.8105	1.44906	.18403
	source bias	67	1.8396	.84578	.10333

Table 0.4

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% CI of Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	Lower	Upper
Attitude at time 3	Equal variances assumed	18.531	.000	4.690	127	.000	.97093	.20704	.56124	1.38062
	Equal variances not assumed			4.600	96.646	.000	.97093	.21105	.55203	1.38984

Independent Samples Effect Sizes

			95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Attitude at time 3	Cohen's d	1.17486	.826	.465	1.185
	Hedges' correction	1.18186	.822	.462	1.178
	Glass's delta	.84578	1.148	.748	1.541

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

Glass's delta uses the sample standard deviation of the control group.

Table 0.5

Group Statistics

	Main study	N	Mean	Std. Deviation	Std. Error Mean
Attitude at time 3	**Social consensus**	58	1.8491	.86341	.11337
	source bias	67	1.8396	.84578	.10333

Table 0.6

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% CI of Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	Lower	Upper
Attitude at time 3	Equal variances assumed	.043	.835	.063	123	.950	.00959	.15317	-.29360	.31277
	Equal variances not assumed			.062	119.697	.950	.00959	.15339	-.29413	.31330

Table 0.7

Independent Samples Effect Sizes

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Attitude at time 3	Cohen's d	.85400	.011	-.340	.363
	Hedges' correction	.85925	.011	-.338	.361
	Glass's delta	.84578	.011	-.340	.363

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

Glass's delta uses the sample standard deviation of the control group.

Annexure 9: Univariate tests for the main study attitudes 1-3

Univariate Analysis of Variance – Attitude 1

Table 0.1

Between-Subjects Factors

		Value Label	N
Main study	1	Control	62
	2	Social consensus	58
	3	source bias	67

Table 0.2

Tests of Between-Subjects Effects

Dependent Variable: Attitude at time 1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.864[a]	2	.432	1.207	.301	.013
Intercept	532.298	1	532.298	1487.056	.000	.890
Study2	.864	2	.432	1.207	.301	.013
Error	65.864	184	.358			
Total	601.563	187				
Corrected Total	66.728	186				

a. R Squared = .013 (Adjusted R Squared = .002)

Estimated Marginal Means

Table 0.3

1. Grand Mean

Dependent Variable: Attitude at time 1

		95% Confidence Interval	
Mean	Std. Error	Lower Bound	Upper Bound
1.690	.044	1.604	1.777

2. Main study

Table 0.4

Estimates

Dependent Variable: Attitude at time 1

			95% Confidence Interval	
Main study	Mean	Std. Error	Lower Bound	Upper Bound
Control	1.782	.076	1.632	1.932
Social consensus	1.616	.079	1.461	1.771
source bias	1.672	.073	1.527	1.816

Table 0.5

Pairwise Comparisons

Dependent Variable: Attitude at time 1

(I) Main study	(J) Main study	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.166	.109	.131	-.050	.382
	source bias	.111	.105	.295	-.097	.319
Social consensus	Control	-.166	.109	.131	-.382	.050
	source bias	-.055	.107	.607	-.267	.156
source bias	Control	-.111	.105	.295	-.319	.097
	Social consensus	.055	.107	.607	-.156	.267

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 0.6

Univariate Tests

Dependent Variable: Attitude at time 1

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	.864	2	.432	1.207	.301	.013
Error	65.864	184	.358			

The F tests the effect of Main study. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Univariate Analysis of Variance – Attitude 2

Table 0.7

Between-Subjects Factors

		Value Label	N
Main study	1	Control	62
	2	Social consensus	58
	3	source bias	67

Table 0.8

Tests of Between-Subjects Effects

Dependent Variable: Attitude at time 2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5.618[a]	2	2.809	1.490	.228	.016
Intercept	1299.930	1	1299.930	689.644	.000	.789
Study2	5.618	2	2.809	1.490	.228	.016
Error	346.827	184	1.885			
Total	1664.063	187				
Corrected Total	352.445	186				

a. R Squared = .016 (Adjusted R Squared = .005)

Table 0.9

1. Grand Mean

Dependent Variable: Attitude at time 2

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
2.641	.101	2.443	2.840

2. Main study

Table 0.10

Estimates

Dependent Variable: Attitude at time 2

Main study	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	2.810	.174	2.466	3.154
Social consensus	2.397	.180	2.041	2.752
source bias	2.716	.168	2.385	3.047

Pairwise Comparisons

Dependent Variable: Attitude at time 2

(I) Main study	(J) Main study	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Social consensus	.414	.251	.101	-.081	.909

	source bias	.094	.242	.698	-.383	.571
Social consensus	Control	-.414	.251	.101	-.909	.081
	source bias	-.320	.246	.196	-.806	.166
source bias	Control	-.094	.242	.698	-.571	.383
	Social consensus	.320	.246	.196	-.166	.806

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 0.11

Univariate Tests

Dependent Variable: Attitude at time 2

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	5.618	2	2.809	1.490	.228	.016
Error	346.827	184	1.885			

The F tests the effect of Main study. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Univariate Analysis of Variance – Attitude 3

Table 0.12

Between-Subjects Factors

		Value Label	N
Main study	1	Control	62
	2	Social consensus	58
	3	source bias	67

Table 0.13

Tests of Between-Subjects Effects

Dependent Variable: Attitude at time 3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.715[a]	2	19.358	16.354	.000	.151
Intercept	874.595	1	874.595	738.899	.000	.801
Study2	38.715	2	19.358	16.354	.000	.151
Error	217.791	184	1.184			
Total	1132.563	187				
Corrected Total	256.506	186				

a. R Squared = .151 (Adjusted R Squared = .142)

Estimated Marginal Means

Table 0.14

1. Grand Mean

Dependent Variable: Attitude at time 3

		95% Confidence Interval	
Mean	Std. Error	Lower Bound	Upper Bound
2.166	.080	2.009	2.324

2. Main study

Table 0.15

Estimates

Dependent Variable: Attitude at time 3

			95% Confidence Interval	
Main study	Mean	Std. Error	Lower Bound	Upper Bound
Control	2.810	.138	2.538	3.083
Social consensus	1.849	.143	1.567	2.131
source bias	1.840	.133	1.577	2.102

Table 0.16

Pairwise Comparisons

Dependent Variable: Attitude at time 3

					95% Confidence Interval for Difference[b]	
(I) Main study	(J) Main study	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
Control	Social consensus	.961*	.199	.000	.569	1.353
	source bias	.971*	.192	.000	.593	1.349
Social consensus	Control	-.961*	.199	.000	-1.353	-.569
	source bias	.010	.195	.961	-.375	.395
source bias	Control	-.971*	.192	.000	-1.349	-.593
	Social consensus	-.010	.195	.961	-.395	.375

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: Attitude at time 3

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	38.715	2	19.358	16.354	.000	.151
Error	217.791	184	1.184			

The F tests the effect of Main study. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Annexure 10: Main study Attitudes 1-3 Simple main effect for time

Table 0.1

Within-Subjects Factors

Measure: attitude

time	Dependent Variable
1	Attitude1
2	Attitude2
3	Attitude3

Table 0.2

Descriptive Statistics[a]

	Mean	Std. Deviation	N
Attitude at time 1	1.7823	.60307	62
Attitude at time 2	2.8105	1.44906	62
Attitude at time 3	2.8105	1.44906	62

a. Main study = Control

Table 0.3

Multivariate Tests[a,b]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Non cent. Parameter	Observed Power[d]
time	Pillai's Trace	.390	39.053[c]	1.000	61.000	.000	.390	39.053	1.000
	Wilks' Lambda	.610	39.053[c]	1.000	61.000	.000	.390	39.053	1.000
	Hotelling's Trace	.640	39.053[c]	1.000	61.000	.000	.390	39.053	1.000
	Roy's Largest Root	.640	39.053[c]	1.000	61.000	.000	.390	39.053	1.000

a. Main study = Control

Table 0.4

Mauchly's Test of Sphericity[a,b]

Measure: attitude

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[c] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.000	.	2	.	.500	.500	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Main study = Control; b. Design: Intercept Within Subjects Design: time c. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects[a]

Measure: attitude

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
time	Sphericity Assumed	43.700	2	21.850	39.053	.000	.390	78.105	1.000
	Greenhouse-Geisser	43.700	1.000	43.700	39.053	.000	.390	39.053	1.000
	Huynh-Feldt	43.700	1.000	43.700	39.053	.000	.390	39.053	1.000
	Lower-bound	43.700	1.000	43.700	39.053	.000	.390	39.053	1.000
Error(time)	Sphericity Assumed	68.259	122	.559					
	Greenhouse-Geisser	68.259	61.000	1.119					
	Huynh-Feldt	68.259	61.000	1.119					
	Lower-bound	68.259	61.000	1.119					

a. Main study = Control

b. Computed using alpha = ,05

Table 0.5

Tests of Within-Subjects Contrasts[a]

Measure: attitude

Source	time	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
time	Linear	32.775	1	32.775	39.053	.000	.390	39.053	1.000
	Quadratic	10.925	1	10.925	39.053	.000	.390	39.053	1.000
Error (time)	Linear	51.194	61	.839					
	Quadratic	17.065	61	.280					

a. Main study = Control

b. Computed using alpha = ,05

Tests of Between-Subjects Effects[a]

Measure: attitude

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Intercept	1132.694	1	1132.694	328.867	.000	.844	328.867	1.000
Error	210.098	61	3.444					

a. Main study = Control

b. Computed using alpha = ,05

Estimated Marginal Means

Table 0.6

1. Grand Mean[a]

Measure: attitude

		95% Confidence Interval	
Mean	Std. Error	Lower Bound	Upper Bound
2.468	.136	2.196	2.740

a. Main study = Control

2. time

Table 0.7

Estimates[a]

Measure: attitude

			95% Confidence Interval	
time	Mean	Std. Error	Lower Bound	Upper Bound
1	1.782	.077	1.629	1.935
2	2.810	.184	2.442	3.178
3	2.810	.184	2.442	3.178

a. Main study = Control

Table 0.8

Pairwise Comparisons[a]

Measure: attitude

					95% Confidence Interval for Difference[c]	
(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	Lower Bound	Upper Bound
1	2	-1.028*	.165	.000	-1.433	-.623
	3	-1.028*	.165	.000	-1.433	-.623
2	1	1.028*	.165	.000	.623	1.433
	3	.000	.000	.	.000	.000
3	1	1.028*	.165	.000	.623	1.433
	2	.000	.000	.	.000	.000

Based on estimated marginal means[a]

*. The mean difference is significant at the ,05 level.

a. Main study = Control

c. Adjustment for multiple comparisons: Bonferroni.

Table 0.9

Multivariate Tests[a]

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Pillai's trace	.390	39.053[b]	1.000	61.000	.000	.390	39.053	1.000
Wilks' lambda	.610	39.053[b]	1.000	61.000	.000	.390	39.053	1.000
Hotelling's trace	.640	39.053[b]	1.000	61.000	.000	.390	39.053	1.000
Roy's largest root	.640	39.053[b]	1.000	61.000	.000	.390	39.053	1.000

Each F tests the multivariate effect of time. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Main study = Control

b. Exact statistic

c. Computed using alpha = ,05

Table 0.10

Descriptive Statistics[a]

	Mean	Std. Deviation	N
Attitude at time 1	1.6164	.56042	58
Attitude at time 2	2.3966	1.16325	58
Attitude at time 3	1.8491	.86341	58

a. Main study = Social consensus

Table 0.11

Multivariate Tests[a,b]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
time	Pillai's Trace	.405	19.052[c]	2.000	56.000	.000	.405	38.103	1.000
	Wilks' Lambda	.595	19.052[c]	2.000	56.000	.000	.405	38.103	1.000
	Hotelling's Trace	.680	19.052[c]	2.000	56.000	.000	.405	38.103	1.000
	Roy's Largest Root	.680	19.052[c]	2.000	56.000	.000	.405	38.103	1.000

a. Main study = Social consensus

b. Design: Intercept
Within Subjects Design: time

c. Exact statistic

d. Computed using alpha = ,05

Table 0.12

Mauchly's Test of Sphericity[a,b]

Measure: attitude

					Epsilon[c]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.871	7.724	2	.021	.886	.912	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Main study = Social consensus

b. Design: Intercept
Within Subjects Design: time

c. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 0.13

Tests of Within-Subjects Effects[a]

Measure: attitude

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
time	Sphericity Assumed	18.608	2	9.304	24.120	.000	.297	48.240	1.000
	Greenhouse-Geisser	18.608	1.772	10.503	24.120	.000	.297	42.735	1.000
	Huynh-Feldt	18.608	1.824	10.200	24.120	.000	.297	44.006	1.000
	Lower- bound	18.608	1.000	18.608	24.120	.000	.297	24.120	.998
Error(time)	Sphericity Assumed	43.975	114	.386					
	Greenhouse-Geisser	43.975	100.989	.435					
	Huynh-Feldt	43.975	103.993	.423					
	Lower-bound	43.975	57.000	.771					

a. Main study = Social consensus

b. Computed using alpha = ,05

Table 0.14

Tests of Within-Subjects Contrasts[a]

Measure: attitude

Source	time	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
time	Linear	1.571	1	1.571	4.731	.034	.077	4.731	.571
	Quadratic	17.037	1	17.037	38.774	.000	.405	38.774	1.000
Error(time)	Linear	18.929	57	.332					
	Quadratic	25.046	57	.439					

a. Main study = Social consensus

b. Computed using alpha = ,05

Table 0.15

Tests of Between-Subjects Effects[a]

Measure: attitude

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Intercept	664.368	1	664.368	404.804	.000	.877	404.804	1.000
Error	93.549	57	1.641					

a. Main study = Social consensus

b. Computed using alpha = ,05

Estimated Marginal Means

Table 0.16

1. Grand Mean[a]

Measure: attitude

		95% Confidence Interval	
Mean	Std. Error	Lower Bound	Upper Bound
1.954	.097	1.760	2.149

a. Main study = Social consensus

2. time

Table 0.17

Estimates[a]

Measure: attitude

			95% Confidence Interval	
time	Mean	Std. Error	Lower Bound	Upper Bound
1	1.616	.074	1.469	1.764
2	2.397	.153	2.091	2.702
3	1.849	.113	1.622	2.076

a. Main study = Social consensus

Table 0.18

Pairwise Comparisons[a]

Measure: attitude

					95% Confidence Interval for Difference[c]	
(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	Lower Bound	Upper Bound
1	2	-.780*	.134	.000	-1.111	-.449
	3	-.233	.107	.101	-.497	.031
2	1	.780*	.134	.000	.449	1.111
	3	.547*	.102	.000	.296	.799
3	1	.233	.107	.101	-.031	.497
	2	-.547*	.102	.000	-.799	-.296

Based on estimated marginal means[a]

*. The mean difference is significant at the ,05 level.

a. Main study = Social consensus

c. Adjustment for multiple comparisons: Bonferroni.

Table 0.19

Multivariate Tests[a]

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Pillai's trace	.405	19.052[b]	2.000	56.000	.000	.405	38.103	1.000
Wilks' lambda	.595	19.052[b]	2.000	56.000	.000	.405	38.103	1.000
Hotelling's trace	.680	19.052[b]	2.000	56.000	.000	.405	38.103	1.000
Roy's largest root	.680	19.052[b]	2.000	56.000	.000	.405	38.103	1.000

Each F tests the multivariate effect of time. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Main study = Social consensus

b. Exact statistic

c. Computed using alpha = ,05

Main study = source bias

Table 0.20

Descriptive Statistics[a]

	Mean	Std. Deviation	N
Attitude at time 1	1.6716	.62494	67
Attitude at time 2	2.7164	1.46480	67
Attitude at time 3	1.8396	.84578	67

a. Main study = source bias

Multivariate Tests[a,b]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
time	Pillai's Trace	.379	19.876[c]	2.000	65.000	.000	.379	39.753	1.000
	Wilks' Lambda	.621	19.876[c]	2.000	65.000	.000	.379	39.753	1.000
	Hotelling's Trace	.612	19.876[c]	2.000	65.000	.000	.379	39.753	1.000
	Roy's Largest Root	.612	19.876[c]	2.000	65.000	.000	.379	39.753	1.000

a. Main study = source bias

b. Design: Intercept
Within Subjects Design: time

c. Exact statistic

d. Computed using alpha = ,05

Table 0.21

Mauchly's Test of Sphericity[a,b]

Measure: attitude

					Epsilon[c]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.560	37.724	2	.000	.694	.704	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Main study = source bias

b. Design: Intercept
Within Subjects Design: time

c. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 0.22

Tests of Within-Subjects Effects[a]

Measure: attitude

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
time	Sphericity Assumed	42.180	2	21.090	32.902	.000	.333	65.803	1.000
	Greenhouse-Geisser	42.180	1.389	30.376	32.902	.000	.333	45.687	1.000
	Huynh- Feldt	42.180	1.409	29.937	32.902	.000	.333	46.357	1.000
	Lower-bound	42.180	1.000	42.180	32.902	.000	.333	32.902	1.000
Error (time)	Sphericity Assumed	84.612	132	.641					
	Greenhouse-Geisser	84.612	91.647	.923					
	Huynh- Feldt	84.612	92.992	.910					
	Lower- bound	84.612	66.000	1.282					

a. Main study = source bias

b. Computed using alpha = ,05

Table 0.23

Tests of Within-Subjects Contrasts[a]

Measure: attitude

Source	time	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
time	Linear	.944	1	.944	3.675	.060	.053	3.675	.472
	Quadratic	41.235	1	41.235	40.229	.000	.379	40.229	1.000
Error (time)	Linear	16.962	66	.257					
	Quadratic	67.650	66	1.025					

a. Main study = source bias

b. Computed using alpha = ,05

Table 0.24

Tests of Between-Subjects Effects[a]

Measure: attitude

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Intercept	866.157	1	866.157	439.779	.000	.870	439.779	1.000
Error	129.989	66	1.970					

a. Main study = source bias

b. Computed using alpha = ,05

Estimated Marginal Means

Table 0.25

1. Grand Mean[a]

Measure: attitude

		95% Confidence Interval	
Mean	Std. Error	Lower Bound	Upper Bound
2.076	.099	1.878	2.274

a. Main study = source bias

2. time

Table 0.26

Estimates[a]

Measure: attitude

			95% Confidence Interval	
time	Mean	Std. Error	Lower Bound	Upper Bound
1	1.672	.076	1.519	1.824
2	2.716	.179	2.359	3.074
3	1.840	.103	1.633	2.046

a. Main study = source bias

Table 0.27

Pairwise Comparisons[a]

Measure: attitude

					95% Confidence Interval for Difference[c]	
(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[c]	Lower Bound	Upper Bound
1	2	-1.045*	.172	.000	-1.467	-.622
	3	-.168	.088	.179	-.383	.047
2	1	1.045*	.172	.000	.622	1.467
	3	.877*	.142	.000	.528	1.225
3	1	.168	.088	.179	-.047	.383
	2	-.877*	.142	.000	-1.225	-.528

Based on estimated marginal means[a]

*. The mean difference is significant at the ,05 level.

a. Main study = source bias

c. Adjustment for multiple comparisons: Bonferroni.

Table 0.28

Multivariate Tests[a]

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Pillai's trace	.379	19.876[b]	2.000	65.000	.000	.379	39.753	1.000
Wilks' lambda	.621	19.876[b]	2.000	65.000	.000	.379	39.753	1.000
Hotelling's trace	.612	19.876[b]	2.000	65.000	.000	.379	39.753	1.000
Roy's largest root	.612	19.876[b]	2.000	65.000	.000	.379	39.753	1.000

Each F tests the multivariate effect of time. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Main study = source bias

b. Exact statistic

c. Computed using alpha = ,05

Annexure 11: Kruskal Wallis Test on Attitude 4

```
NPTESTS
  /INDEPENDENT TEST (Attitude4) GROUP (Study2TwoWeek)
  /MISSING SCOPE=ANALYSIS USERMISSING=EXCLUDE
  /CRITERIA ALPHA=0.05  CILEVEL=95.
```

Nonparametric Tests

Table 0.1

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of Attitude at time 4 is the same across categories of Survey after 2 weeks.	Independent-Samples Kruskal-Wallis Test	.256	Retain the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

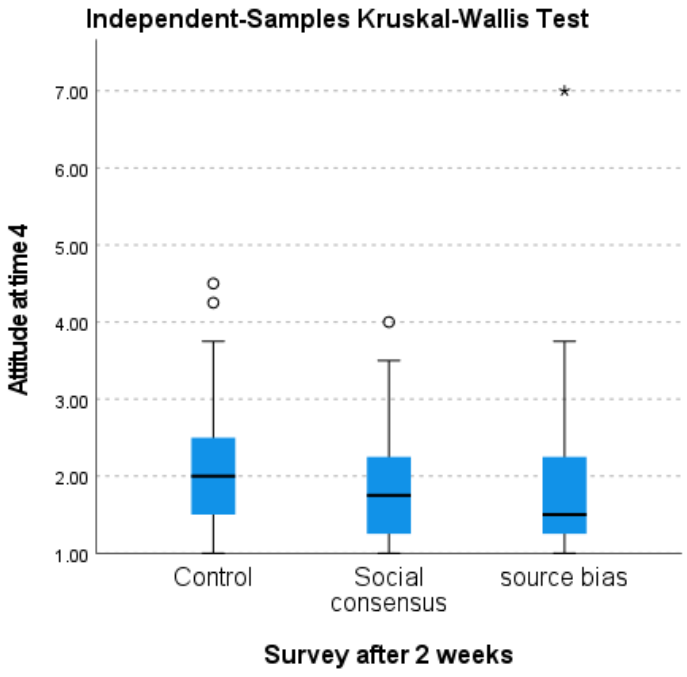
Independent-Samples Kruskal-Wallis Test
Attitude at time 4 across Survey after 2 weeks

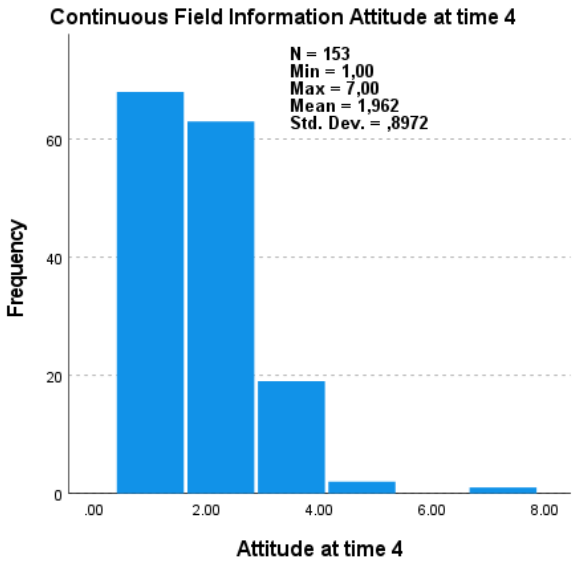
Table 0.2

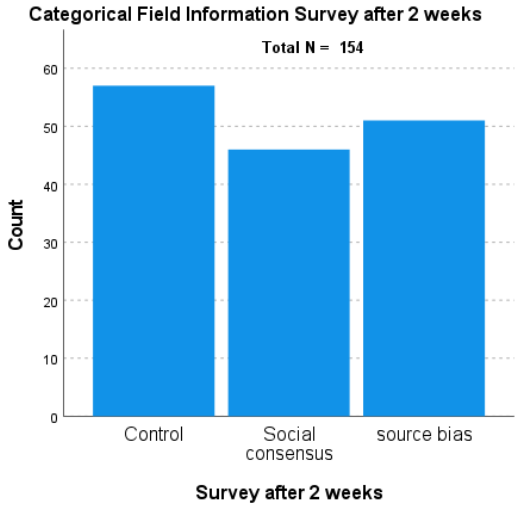
Independent-Samples Kruskal-Wallis Test Summary

Total N	120
Test Statistic	2.723[a,b]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	.256

a. The test statistic is adjusted for ties.
b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.








```
MEANS TABLES=Attitude4 BY Study2TwoWeek
  /CELLS=COUNT MEDIAN.
```

Means

Table 0.3
Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Attitude at time 4 * Survey after 2 weeks	120	64.2%	67	35.8%	187	100.0%

Table 0.4

Report

Attitude at time 4

Survey after 2 weeks	N	Median
Control	46	2.0000
Social consensus	40	1.7500
source bias	34	1.5000
Total	120	1.8750

Annexure 12: Kruskal Wallis Test on Attitude 5

```
MEANS TABLES=Attitude5 BY Study2ThreeMonth
  /CELLS=COUNT MEDIAN.
```

Means

Table 0.1

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Attitude at time 5 * Survey after 3 months	94	50.3%	93	49.7%	187	100.0%

Attitude at time 5

Survey after 3 months	N	Median
Control	35	1.7500
Social consensus	29	1.5000
source bias	30	1.5000
Total	94	1.5000

```
NPTESTS
  /INDEPENDENT TEST (Attitude5) GROUP (Study2ThreeMonth)
  /MISSING SCOPE=ANALYSIS USERMISSING=EXCLUDE
  /CRITERIA ALPHA=0.05  CILEVEL=95.
```

Nonparametric Tests

Table 0.2

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of Attitude at time 5 is the same across categories of Survey after 3 months.	Independent-Samples Kruskal-Wallis Test	.368	Retain the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

Independent-Samples Kruskal-Wallis Test

Attitude at time 5 across Survey after 3 months

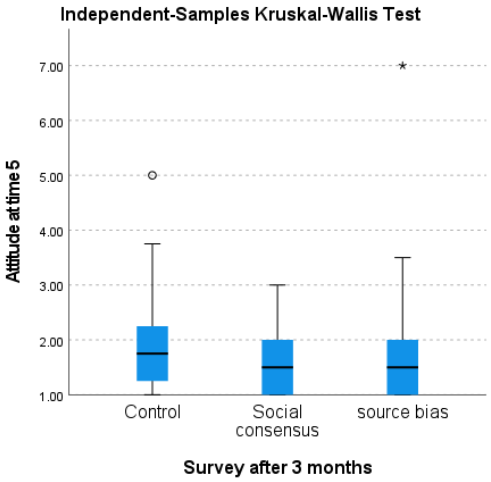
Table 0.3

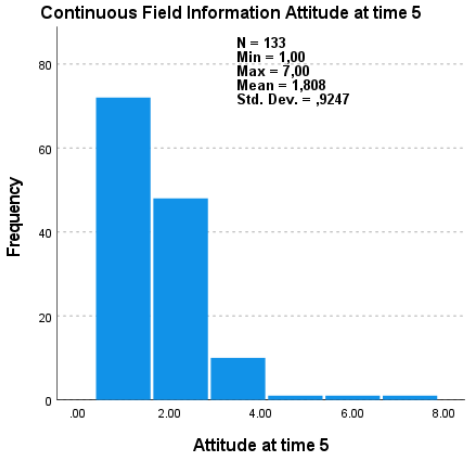
Independent-Samples Kruskal-Wallis Test Summary

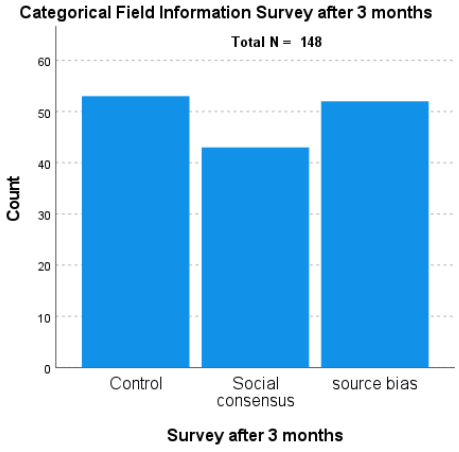
Total N	94
Test Statistic	2.001[a,b]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	.368

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.


Independent-Samples Kruskal-Wallis Test
Attitude at time 5
7.00
6.00
5.00
4.00
3.00
2.00
1.00
Control
Social consensus
source bias
Survey after 3 months


Continuous Field Information Attitude at time 5
N = 133
Min = 1,00
Max = 7,00
Mean = 1,808
Std. Dev. = ,9247
Frequency
80
60
40
20
0
.00
2.00
4.00
6.00
8.00
Attitude at time 5


Categorical Field Information Survey after 3 months
Total N = 148
Count
60
50
40
30
20
10
0
Control
Social consensus
source bias
Survey after 3 months

Annexure 13: Repeated measures ANOVA on Attitudes 1 - 5

General Linear Model

Table 0.1

Within-Subjects Factors

Measure: attitude

time	Dependent Variable
1	Attitude1
2	Attitude2
3	Attitude3
4	Attitude4
5	Attitude5

Between-Subjects Factors

		Value Label	N
Survey after 3 months	1	Control	34
	2	Social consensus	29
	3	source bias	27

Descriptive Statistics

	Survey after 3 months	Mean	Std. Deviation	N
Attitude at time 1	Control	1.7353	.65117	34
	Social consensus	1.6207	.50718	29
	source bias	1.7222	.68054	27
	Total	1.6944	.61326	90
Attitude at time 2	Control	2.7500	1.60963	34
	Social consensus	2.4224	.92607	29
	source bias	2.4074	1.33580	27
	Total	2.5417	1.33358	90
Attitude at time 3	Control	2.7500	1.60963	34
	Social consensus	1.7672	.66792	29
	source bias	1.6667	.67937	27
	Total	2.1083	1.22075	90
Attitude at time 4	Control	2.0662	.94410	34
	Social consensus	1.6897	.58879	29
	source bias	1.9907	1.23934	27
	Total	1.9222	.95668	90
Attitude at time 5	Control	1.9485	.88715	34
	Social consensus	1.5948	.57637	29
	source bias	1.9074	1.26177	27
	Total	1.8222	.94158	90

Table 0.2

Box's Test of Equality of Covariance Matrices[a]

Box's M	121.765
F	7.304
df1	15
df2	11604.145
Sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.[a]

Table 0.3

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
time	Pillai's Trace	.396	13.754[b]	4.000	84.000	.000	.396	55.016	1.000
	Wilks' Lambda	.604	13.754[b]	4.000	84.000	.000	.396	55.016	1.000
	Hotelling's Trace	.655	13.754[b]	4.000	84.000	.000	.396	55.016	1.000
	Roy's Largest Root	.655	13.754[b]	4.000	84.000	.000	.396	55.016	1.000
time * Study2ThreeMonth	Pillai's Trace	.377	4.940	8.000	170.000	.000	.189	39.517	.998
	Wilks' Lambda	.633	5.399[b]	8.000	168.000	.000	.205	43.188	.999
	Hotelling's Trace	.564	5.855	8.000	166.000	.000	.220	46.843	1.000
	Roy's Largest Root	.535	11.363[c]	4.000	85.000	.000	.348	45.451	1.000

a. Design: Intercept + Study2ThreeMonth
Within Subjects Design: time

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

d. Computed using alpha = ,05

Table 0.4

Mauchly's Test of Sphericity[a]

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	.449	68.374	9	.000	.709	.752	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept + Study2ThreeMonth
Within Subjects Design: time
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Contrasts

Source	time	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
time	Linear	1.173	1	1.173	3.379	.069	.037	3.379	.444
	Quadratic	15.212	1	15.212	20.936	.000	.194	20.936	.995
	Cubic	16.163	1	16.163	25.479	.000	.227	25.479	.999
	Order 4	4.555	1	4.555	18.427	.000	.175	18.427	.989
time * Study2ThreeMonth	Linear	.824	2	.412	1.187	.310	.027	2.373	.254
	Quadratic	7.161	2	3.581	4.928	.009	.102	9.856	.795
	Cubic	.499	2	.249	.393	.676	.009	.786	.112

	Order 4	5.665	2	2.832	11.457	.000	.208	22.915	.992
Error(time)	Linear	30.203	87	.347					
	Quadratic	63.213	87	.727					
	Cubic	55.191	87	.634					
	Order 4	21.507	87	.247					

a. Computed using alpha = ,05

Table 0.5

Tests of Within-Subjects Contrasts

Measure: attitude

Source	time	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
time	Linear	1.173	1	1.173	3.379	.069	.037	3.379	.444
	Quadratic	15.212	1	15.212	20.936	.000	.194	20.936	.995
	Cubic	16.163	1	16.163	25.479	.000	.227	25.479	.999
	Order 4	4.555	1	4.555	18.427	.000	.175	18.427	.989
time * Study2ThreeMonth	Linear	.824	2	.412	1.187	.310	.027	2.373	.254
	Quadratic	7.161	2	3.581	4.928	.009	.102	9.856	.795
	Cubic	.499	2	.249	.393	.676	.009	.786	.112
	Order 4	5.665	2	2.832	11.457	.000	.208	22.915	.992
Error(time)	Linear	30.203	87	.347					
	Quadratic	63.213	87	.727					
	Cubic	55.191	87	.634					
	Order 4	21.507	87	.247					

a. Computed using alpha = ,05

Table 0.6

Levene's Test of Equality of Error Variances[a]

		Levene Statistic	df1	df2	Sig.
Attitude at time 1	Based on Mean	1.205	2	87	.305
	Based on Median	.450	2	87	.639
	Based on Median and with adjusted df	.450	2	79.055	.639
	Based on trimmed mean	1.025	2	87	.363
Attitude at time 2	Based on Mean	5.079	2	87	.008
	Based on Median	2.705	2	87	.073
	Based on Median and with adjusted df	2.705	2	72.632	.074
	Based on trimmed mean	4.381	2	87	.015
Attitude at time 3	Based on Mean	19.813	2	87	.000
	Based on Median	10.428	2	87	.000
	Based on Median and with adjusted df	10.428	2	51.054	.000
	Based on trimmed mean	17.423	2	87	.000
Attitude at time 4	Based on Mean	2.524	2	87	.086
	Based on Median	1.426	2	87	.246
	Based on Median and with adjusted df	1.426	2	56.311	.249
	Based on trimmed mean	1.998	2	87	.142

Attitude at time 5	Based on Mean	1.520	2	87	.224
	Based on Median	.975	2	87	.381
	Based on Median and with adjusted df	.975	2	51.823	.384
	Based on trimmed mean	1.116	2	87	.332

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.[a]
a. Design: Intercept + Study2ThreeMonth
Within Subjects Design: time

Table 0.7

Tests of Between-Subjects Effects

Measure: attitude

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	1788.059	1	1788.059	546.320	.000	.863	546.320	1.000
Study2 Three Month	15.739	2	7.870	2.404	.096	.052	4.809	.473
Error	284.744	87	3.273					

a. Computed using alpha = ,05

Estimated Marginal Means

Table 0.8

1. Grand Mean

Measure: attitude

		95% Confidence Interval	
Mean	Std. Error	Lower Bound	Upper Bound
2.003	.086	1.832	2.173

2. time

Table 0.9

Estimates

Measure: attitude

			95% Confidence Interval	
time	Mean	Std. Error	Lower Bound	Upper Bound
1	1.693	.065	1.563	1.823
2	2.527	.142	2.245	2.808
3	2.061	.119	1.825	2.298
4	1.916	.101	1.715	2.116
5	1.817	.099	1.619	2.015

Table 0.10

Pairwise Comparisons

Measure: attitude

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.834*	.123	.000	-1.187	-.481
	3	-.369*	.101	.005	-.660	-.077
	4	-.223	.088	.132	-.477	.031
	5	-.124	.083	1.000	-.365	.116
2	1	.834*	.123	.000	.481	1.187
	3	.465*	.073	.000	.256	.674
	4	.611*	.123	.000	.258	.964
	5	.710*	.129	.000	.338	1.081
3	1	.369*	.101	.005	.077	.660
	2	-.465*	.073	.000	-.674	-.256
	4	.146	.100	1.000	-.143	.435
	5	.244	.106	.239	-.062	.551
4	1	.223	.088	.132	-.031	.477
	2	-.611*	.123	.000	-.964	-.258
	3	-.146	.100	1.000	-.435	.143
	5	.099	.106	1.000	-.208	.405
5	1	.124	.083	1.000	-.116	.365
	2	-.710*	.129	.000	-1.081	-.338
	3	-.244	.106	.239	-.551	.062
	4	-.099	.106	1.000	-.405	.208

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Pillai's trace	.396	13.754[a]	4.000	84.000	.000	.396	55.016	1.000
Wilks' lambda	.604	13.754[a]	4.000	84.000	.000	.396	55.016	1.000
Hotelling's trace	.655	13.754[a]	4.000	84.000	.000	.396	55.016	1.000
Roy's largest root	.655	13.754[a]	4.000	84.000	.000	.396	55.016	1.000

Each F tests the multivariate effect of time. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = ,05

3. Survey after 3 months

Table 0.11

Estimates

Measure: attitude

Survey after 3 months	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	2.250	.139	1.974	2.526
Social consensus	1.819	.150	1.520	2.118
source bias	1.939	.156	1.629	2.248

Table 0.12

Pairwise Comparisons

Measure: attitude

(I) Survey after 3 months	(J) Survey after 3 months	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
Control	Social consensus	.431	.205	.114	-.068	.930
	source bias	.311	.209	.418	-.198	.820
Social consensus	Control	-.431	.205	.114	-.930	.068
	source bias	-.120	.216	1.000	-.648	.408
source bias	Control	-.311	.209	.418	-.820	.198
	Social consensus	.120	.216	1.000	-.408	.648

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Table 0.13

Univariate Tests

Measure: attitude

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	3.148	2	1.574	2.404	.096	.052	4.809	.473
Error	56.949	87	.655					

The F tests the effect of Survey after 3 months. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

Table 0.14

*4. Survey after 3 months * time*

Measure: attitude

Survey after 3 months	time	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Control	1	1.735	.106	1.525	1.946
	2	2.750	.230	2.294	3.206
	3	2.750	.193	2.367	3.133
	4	2.066	.163	1.741	2.391
	5	1.949	.161	1.629	2.269
Social consensus	1	1.621	.115	1.393	1.849
	2	2.422	.249	1.928	2.917
	3	1.767	.209	1.352	2.182
	4	1.690	.177	1.338	2.041
	5	1.595	.174	1.248	1.941
source bias	1	1.722	.119	1.486	1.959
	2	2.407	.258	1.895	2.919
	3	1.667	.216	1.237	2.097
	4	1.991	.183	1.626	2.355
	5	1.907	.181	1.548	2.266

Post Hoc Tests

Survey after 3 months

Table 0.15

Multiple Comparisons

Measure: attitude

						95% Confidence Interval	
	(I) Survey after 3 months	(J) Survey after 3 months	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Tukey HSD	Control	Social consensus	.4310	.20451	.094	-.0566	.9187
		source bias	.3111	.20856	.300	-.1862	.8084
	Social consensus	Control	-.4310	.20451	.094	-.9187	.0566
		source bias	-.1199	.21637	.845	-.6359	.3960
	source bias	Control	-.3111	.20856	.300	-.8084	.1862
		Social consensus	.1199	.21637	.845	-.3960	.6359
Dunnett T3	Control	Social consensus	.4310	.20378	.112	-.0714	.9335
		source bias	.3111	.22539	.430	-.2424	.8646
	Social consensus	Control	-.4310	.20378	.112	-.9335	.0714
		source bias	-.1199	.16999	.859	-.5399	.3001
	source bias	Control	-.3111	.22539	.430	-.8646	.2424
		Social consensus	.1199	.16999	.859	-.3001	.5399

Based on observed means.
The error term is Mean Square(Error) = .655.

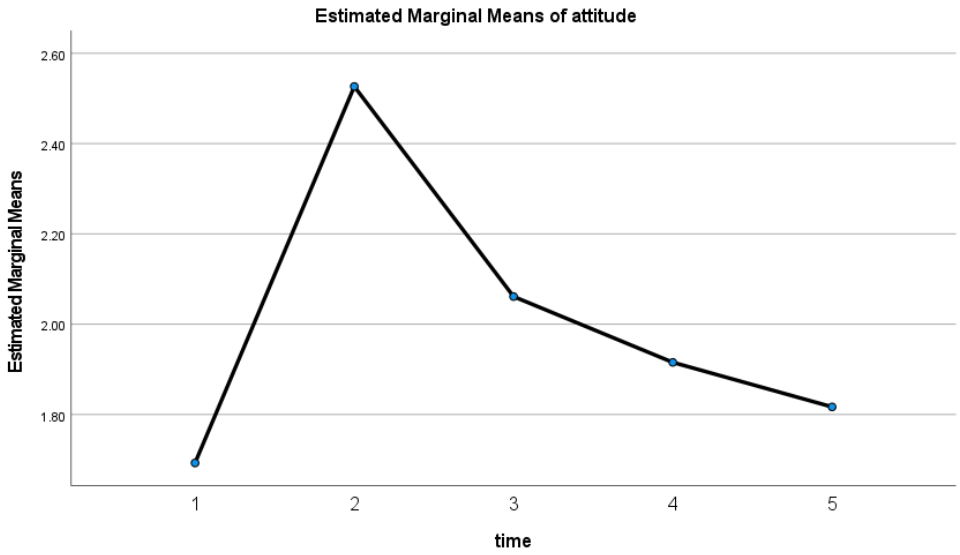
Homogeneous Subsets

Table 0.16

attitude

			Subset
	Survey after 3 months	N	1
Tukey HSD[a,b,c]	Social consensus	29	1.8190
	source bias	27	1.9389
	Control	34	2.2500
	Sig.		.106

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = .655.
a. Uses Harmonic Mean Sample Size = 29.723.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = ,05.



Profile Plots

Annexure 14: Main study assumption testing of data for the two way mixed ANOVA

Assumptions 1-3 of the two-way mixed ANOVA

Since each participant in our study was measured on the same continuous scale (representing the dependent variable i.e. attitudes) on three occasions at different time periods, and there are two independent variables that were categorical (social consensus and source bias), the first three assumptions of the two-way mixed ANOVA were met i.e. (a) a continuous dependent variable; (b) between-subjects factor that is categorical with two or more categories; and (c) one within-subjects factor (time) that is categorical with two or more categories.

Assumption 4 - Outliers

The fourth assumption for a two-way mixed ANOVA is that there should be no significant outliers in any cell of the design. Since Outliers have potential to increase the estimated sample variances, resulting in a decreased F statistic with an increased chance of a type I error, it is vital that they are identified and managed appropriately (Pallant, 2016). The next section discusses the tests for outliers and the management thereof in more detail.

Test for Outliers.

Outliers were detected via the studentized residuals output of the mixed ANOVA analysis. Values greater than + 3 and lower than -3 were considered outliers (Laerd Statistics, 2015b). On attitude 1, there were three participants identified as outliers. These were cases 46, 83 and 111 with SR values of +5.33; +4.49; and +3.40 respectively. Comparison of their respective scores at different times showed that they were still influenced by the vignette as they have moved closer to the climate denier end of the spectrum. Participant 46 attitude mean score went from 5.5 to 6.25 and because the participant was in the control group, remained at 6.25 for the period under evaluation. Participant 83 was in the social consensus group and their attitude mean score moved from 4.75 to 5.5 and stayed at 5.5 at time 3. Further inspection of these participant's mean attitude scores revealed that their initial attitudes were initially higher relative to other participants in the study. Participant 111 was in the social consensus group and was also influenced by the vignette, with attitude mean score moving from 4.00 to 4.75 between times 1 and 2.

At time point 2, there was one outlier (case 116) with a studentized residual of +3.06. This participant's initial attitude mean score was 2 (close to a climate change proponent) and it went to a 6.75 (climate denier) after reading the vignette.

At time point 3, there were four participants identified as outliers using studentized residuals. These were cases 129, 25, 15 and 83 with SR values of +4.27; +3.06; and +3.06 and +3.02 respectively. The first three were similar to case 116 mentioned above where the participants had moved from one extreme to the other, aligned with the position established in the vignette. The fourth was the same participant 83 identified at timepoint 1. Case 129 did not behave in the expected manner with attitude mean scores moving from 1.00 to 5.50 to 7.00 at times 1, 2 and 3.

Pallant (2016, p. 64) report that some authors recommend removal of all extreme outliers, while others change the values to less extreme ones. Pallant (2016) instead compared the sample mean to the 5% trimmed mean and because the values were similar they opted to retain those cases. In our study, none of the outliers had originated from an incorrect data entry, and they were all within the range of expected values. In all cases, the delta between times 2 and 1 was positive. However a review of the descriptive statistics table revealed skewness and kurtosis values that exceeded the -2 and +2 range considered acceptable (DiStefano & Hess, 2005; Javier, 2015). Removal of cases 46, 83 and 129 brought the skewness and kurtosis values to within acceptable range. The descriptive statistics before and after removal of these three cases are captured in Table 4.5.2.1.1 and 4.5.2.1.2 respectively.

Table 0.1
Descriptive statistics before removal of outliers

Attitude	N	Min	Max	Mean	Std. Dev	Variance	Skewness		Kurtosis	
	Stat	Stat	Stat	Stat	Stat	Stat	Stat	SE	Stat	SE
time 1	190	1,00	5,50	1,7237	0,69339	0,481	1,900	0,176	**5,964**	0,351
time 2	190	1,00	6,75	2,6974	1,42023	2,017	0,941	0,176	0,272	0,351
time 3	190	1,00	7,00	2,2289	1,27432	1,624	1,514	0,176	**2,126**	0,351

Valid N (listwise) 190 ; SE = Standard Error

Table 0.2

Descriptive statistics after removal of outliers

Attitude	N	Min	Max	Mean	Std. Dev	Variance	Skewness		Kurtosis	
	Stat	Stat	Stat	Stat	Stat	Stat	Stat	SE	Stat	SE
time 1	187	1,00	4,00	1,6912	0,59896	0,359	1,107	0,178	**1,230**	0,354
time 2	187	1,00	6,75	2,6484	1,37654	1,895	0,973	0,178	0,473	0,354
time 3	187	1,00	6,50	2,1644	1,17434	1,379	1,433	0,178	**1,937**	0,354

Valid N (listwise) 187; SE = Standard Error

The boxplot after removal of the three outliers is shown in Figure 4.5.2.1.1.

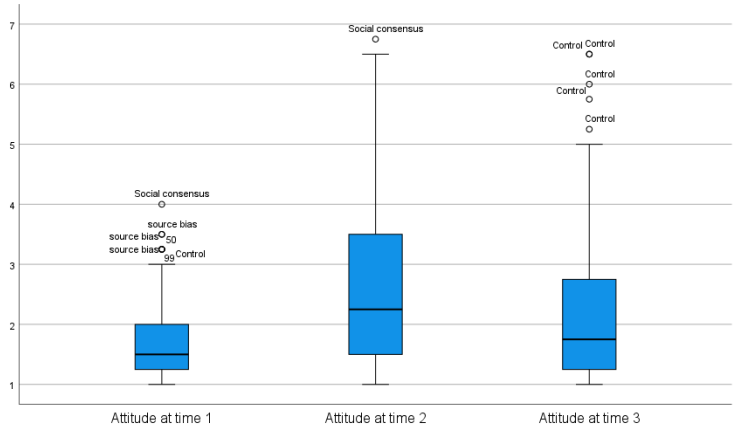


Figure 0-1 Boxplot for Study 2 Attitudes 1, 2, and 3 after removal of outliers

This reduced the sample size to 187.

Assumption 5 Normality checks

Normality checks were done using the Shapiro-Wilk test of normality. The null hypothesis for the Shapiro-Wilk test is that a variable is a normally distributed representation of population, and it is rejected if $p < .05$. The results from the descriptive statistics performed on attitudes 1 to 3 indicated that data was not normally distributed, with significance < .05 in all cases. Figure 4.5.3.1 shows the normality plots for the three groups at time 1. Figure 4.5.3.2 and 4.5.3.3 show the same for times 2 and 3 respectively. It is evident that the plots are positively skewed as was the case in the pilot study (see Annexure 6).

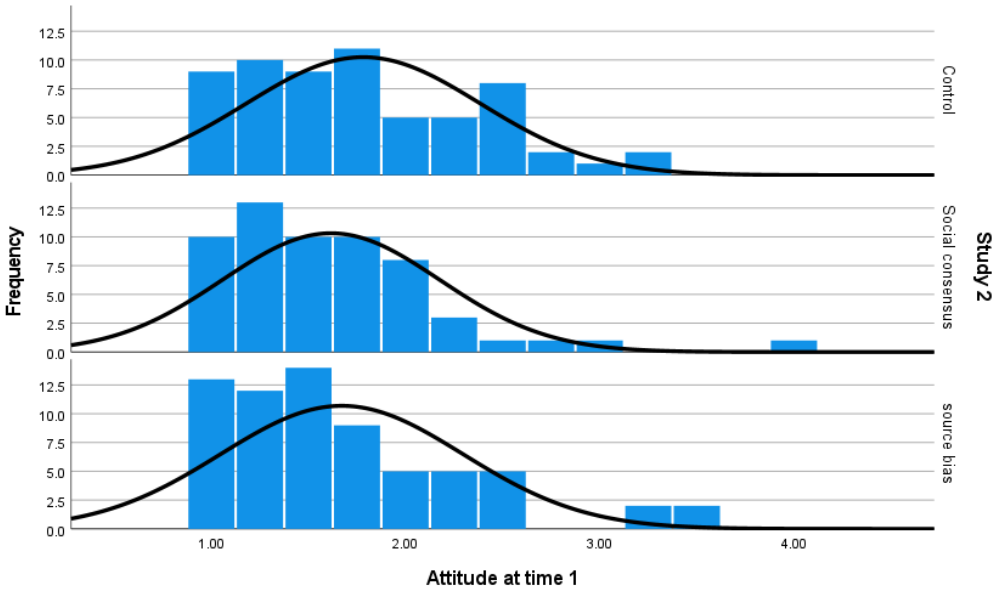


Figure 0-2 Normality plots for attitudes at time 1

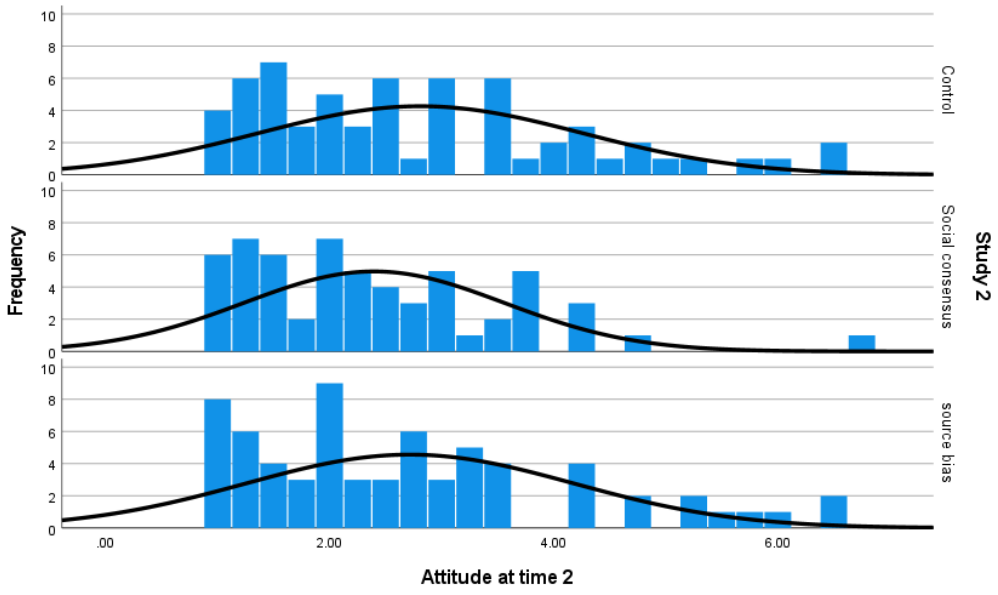


Figure 0-3 Normality plots for attitudes at time 2

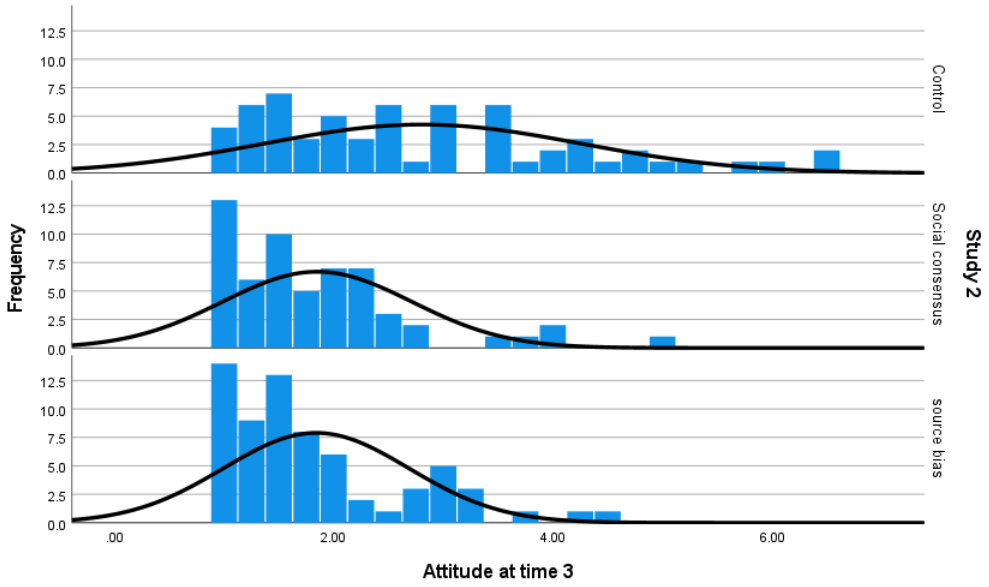


Figure 0-4 Normality plots for attitudes at time 3

In the pilot study, data was transformed using the square root methodology and it was found that there were no significant differences between the output of the original data and the transformed data (See Annexure 6). Most statistical techniques are reasonably robust to violations of normality for sample sizes greater than 30 (Pallant, 2016, p. 208). Data transformation is also a divisive topic with diametrically opposing views on the subject (Pallant, 2016, p.96). Based on findings from the pilot study, data for the main study was not transformed since the sample sizes are similar and substantially bigger than the threshold of 30 as established by Pallant (2016).

Although the normality assessment failed the Shapiro-Wilk test, normality checks based on attitude scores as well as on studentized residuals using Normal Q-Q Plots, found attitudes 1; 2 and 3 to be normally distributed, thus complying with the 5th assumption of a two-way mixed ANOVA. The results are captured in table 4.5.3.1.

Table 0.3
Estimated Distribution Parameters

		Studentized Residual for		
		Attitude1	Attitude2	Attitude3
Normal Distribution	Location	-.0474	-.0349	-.0542
	Scale	.86792	.97118	.90985

The cases are unweighted.

Figures 4.5.3.4 to 4.5.3.9 displays graphically the normal Q-Q plots for both attitudes 1 to 3 as well as the corresponding studentized residuals.

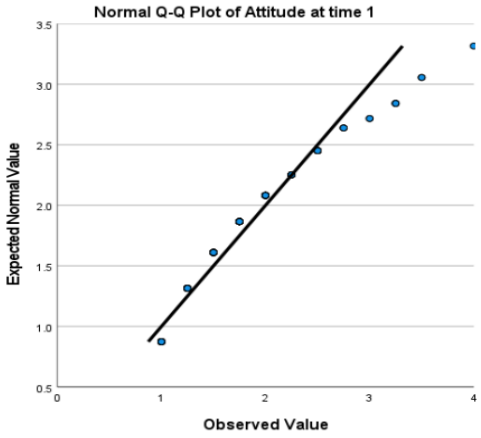


Figure 0-5 Normal Q-Q plot for attitude 1

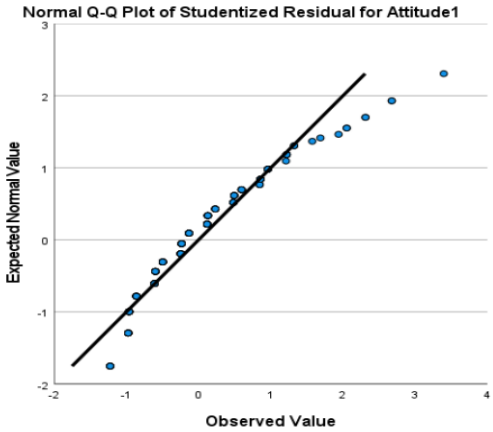


Figure 0-6 Normal studentized residual plot for attitude 1

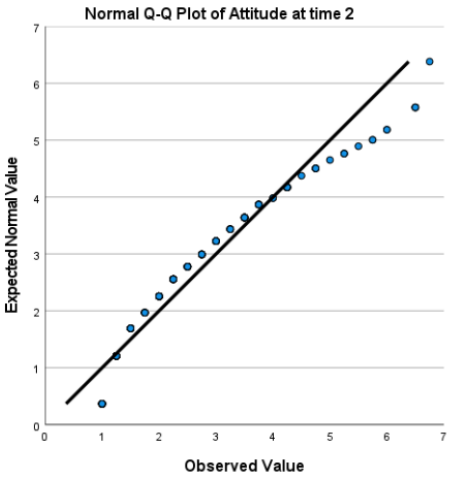


Figure 0-7 Normal Q-Q plot for attitude 2

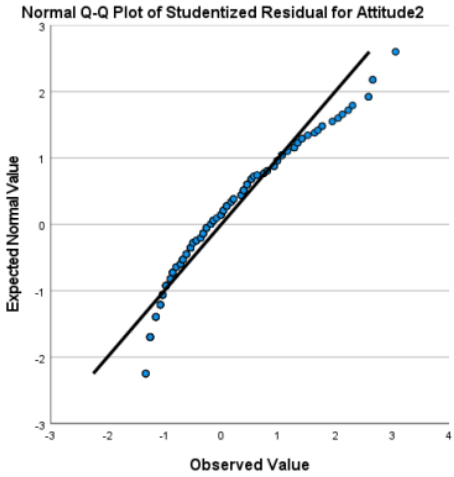


Figure 0-8 Normal studentized residual plot for attitude 2

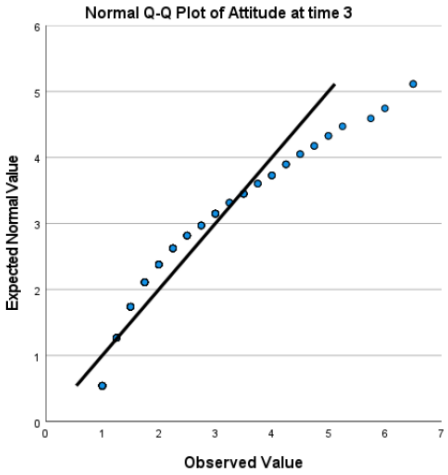


Figure 0-9 Normal Q-Q plot for attitude 3

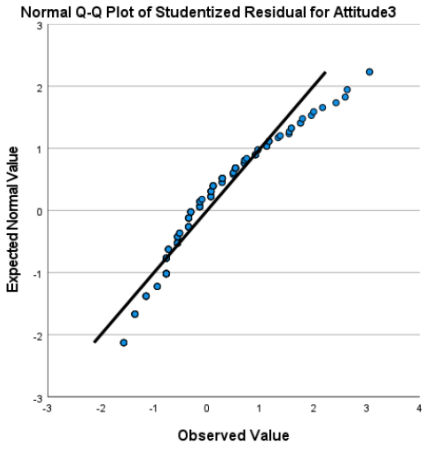


Figure 0-10 Normal studentized residual plot for attitude 3

Assumption 6 Homogeneity of variances

The 6th assumption to be met in conducting a mixed two-way ANOVA is to test for homogeneity of variances, which tests whether the variance in scores is the same for each of the three groups. This assumes that if samples obtained are from populations of equal variances, parametric tests would produce similar variability scores for each of the groups. The ANOVA F test is fairly robust to violations of this assumption when sample sizes are approximately equal i.e. largest / smallest <1.5 (Pallant, 2016). The Levene's test is used to establish equality of variances with a targeted significance level greater than .05 confirming that the test is not significant, i.e. the groups are homogenous. The results of the analysis are as captured in Table 4.5.4.1.

Table 0.4

Levene's Test of Equality of Error Variances

		Levene Statistic	df1	df2	Sig.
Attitude at time 1	Based on Mean	.742	2	184	.477
	Based on Median	.630	2	184	.534
	Based on Median and with adjusted df	.630	2	176.506	.534
	Based on trimmed mean	.671	2	184	.513
Attitude at time 2	Based on Mean	1.939	2	184	.147
	Based on Median	1.613	2	184	.202
	Based on Median and with adjusted df	1.613	2	177.960	.202
	Based on trimmed mean	1.881	2	184	.155
	Based on Mean	13.658	2	184	.000

Attitude at time 3	Based on Median	10.223	2	184	.000
	Based on Median and with adjusted df	10.223	2	163.048	.000
	Based on trimmed mean	13.071	2	184	.000

At time point 1 (Attitude 1), the null hypothesis for equal variances was not rejected and the variances were equal $F(2,184) = .742$, $p = .477$. In other words, the assumption of homogeneity of variances was not violated.

At time point 2 (Attitude 2), the null hypothesis for equal variances was not rejected and the variances were equal $F(2,184) = 1.939$, $p = .147$. In other words, the assumption of homogeneity of variances was not violated.

At time point 3 (Attitude 3), the null hypothesis for equal variances was rejected and the assumption of homogeneity of variance was violated $F(2,184) = 13.658$, $p < .001$. An independent samples t-test was conducted to further understand this violation. The results are included in Annexure 8. It was found that there was homogeneity of variances for attitude scores for Social Consensus and Source Bias, as assessed by Levene's test for equality of variances ($p = .835$). However, the assumption of homogeneity of variances for attitude scores for the Control Group and Social Consensus was violated, as assessed by Levene's test for equality of variances ($p < .001$) with a large effect size as calculated by Cohens' d of .8. The assumption of homogeneity of variances for attitude scores for the Control Group and Source Bias was also violated ($p < .001$) with a large effect size as calculated by Cohens' d of .826. This is explained by the fact that the attitude scores for the Control Group at time 3 was a copy and paste of scores at time 2. Since ANOVA tests are quite robust when sample sizes are approximately equal, the violation of homogeneity of variances for attitude 3 was noted but not acted upon.

Annexure 15: The impact of participant self awareness on attitude changes

Participants were asked the following yes / no questions just before exposure to the discounting cues in the case of the two treatment groups, and at the end of the survey in the case of the control group.

> Reader's comments usually follow such articles. Do you believe that other readers would agree with the contents of the article?
>
> Do you believe that the author of this article is biased?

These questions were not asked in the pilot study, and due to a technical glitch the first 13 participants of the main study did not receive this question. This was fixed on Qualtrics and the remaining 177 participants responded to these questions. The responses to the first question was evenly split with 51 % of all respondents indicating that other readers would agree with the contents of the article and 49 % believing other readers would not. Since group 2 received discounting cues pertaining to user comments, this group was scrutinised further. A similar split was observed in group 2, with 28 participants believing that other readers would agree with the contents and 30 believing that other readers would not. These will be referred to as subgroup 1 and subgroup 2 respectively.

The change in attitude for group 2 participants was calculated on SPSS as the difference in attitude score before exposure to the discounting cues and after exposure to the discounting cues. The average change in attitude and standard deviation was then calculated on Excel, and the two subgroups were compared. The average change in attitude score for subgroup 1 was negative .536 with a standard deviation of .784. The average change in attitude score for subgroup 2 was negative .558 with a standard deviation of .757. Therefore, irrespective of participant's prior belief about how others would respond, the change in attitude between these two subgroups was the same after exposure to user comments uniformly berating the article.

Interestingly, the finding was different with regard to the second manipulation question asking whether participants believed that the author of this article is biased. In this case 113 respondents (64 %) believed that the author was indeed biased, while 64 (36 %) believed he was not. Since group 3 received discounting cues pertaining to source bias, this group was scrutinised further. The split within this group was similar to the larger sample with 43 participants believing that the source was biased and 24 believing that he was not. These will be referred to as subgroup 1 and subgroup 2 respectively.

The change in attitude for group 3 participants was calculated on SPSS as the difference in attitude score before exposure to the discounting cues and after exposure to the discounting cues. The average change in attitude and standard deviation was then calculated, and the two subgroups were compared. The average change in attitude score for subgroup 1 (the group believing the source was biased) was negative .866 with a standard deviation of 1.059. The average change in attitude score for subgroup 2 (the group believing the source was not biased) was negative .896 with a standard deviation of 1.303. As with group 2, irrespective of participant's prior belief about the source's bias, the change in attitude between these two subgroups was the same after exposure to discounting cues indicating source bias.

Annexure 16: Instrument reliability tests for main study – attitudes 1 to 5

Scale: attitude at time 1 reliability analysis

Case Processing Summary

		N	%
Cases	Valid	190	100.0
	Excluded[a]	0	.0
	Total	190	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.759	.777	4

Item Statistics

	Mean	Std. Deviation	N
Attitude 1 measure 1	2.24	1.061	190
Attitude 1 measure 2	1.82	.943	190
Attitude 1 measure 3	1.45	.826	190
Attitude 1 measure 4	1.38	.786	190

Inter-Item Correlation Matrix

	Attitude 1 measure 1	Attitude 1 measure 2	Attitude 1 measure 3	Attitude 1 measure 4
Attitude 1 measure 1	1.000	.361	.267	.295
Attitude 1 measure 2	.361	1.000	.628	.578
Attitude 1 measure 3	.267	.628	1.000	.663
Attitude 1 measure 4	.295	.578	.663	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Attitude 1 measure 1	4.65	4.884	.359	.142	.828
Attitude 1 measure 2	5.07	4.249	.658	.469	.643
Attitude 1 measure 3	5.44	4.703	.644	.530	.660
Attitude 1 measure 4	5.52	4.865	.638	.488	.668

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
6.89	7.693	2.774	4

Scale: attitude at time 2 reliability analysis

Case Processing Summary

		N	%
Cases	Valid	190	100.0
	Excluded[a]	0	.0
	Total	190	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.889	.891	4

Item Statistics

	Mean	Std. Deviation	N
Attitude 2 measure 1	3.26	1.688	190
Attitude 2 measure 2	2.83	1.735	190
Attitude 2 measure 3	2.39	1.599	190
Attitude 2 measure 4	2.31	1.526	190

Inter-Item Correlation Matrix

	Attitude 2 measure 1	Attitude 2 measure 2	Attitude 2 measure 3	Attitude 2 measure 4
Attitude 2 measure 1	1.000	.626	.491	.475
Attitude 2 measure 2	.626	1.000	.831	.777
Attitude 2 measure 3	.491	.831	1.000	.828
Attitude 2 measure 4	.475	.777	.828	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Attitude 2 measure 1	7.53	20.663	.571	.394	.927
Attitude 2 measure 2	7.96	16.877	.869	.768	.812
Attitude 2 measure 3	8.39	18.409	.824	.775	.833
Attitude 2 measure 4	8.48	19.341	.790	.711	.847

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
10.79	32.273	5.681	4

Scale: attitude at time 3 reliability analysis

Case Processing Summary

		N	%
Cases	Valid	190	100.0
	Excluded[a]	0	.0
	Total	190	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.906	.909	4

Item Statistics

	Mean	Std. Deviation	N
Attitude 3 measure 1	2.67	1.564	190
Attitude 3 measure 2	2.32	1.496	190
Attitude 3 measure 3	2.03	1.384	190
Attitude 3 measure 4	1.90	1.316	190

Inter-Item Correlation Matrix

	Attitude 3 measure 1	Attitude 3 measure 2	Attitude 3 measure 3	Attitude 3 measure 4
Attitude 3 measure 1	1.000	.671	.614	.570
Attitude 3 measure 2	.671	1.000	.859	.747
Attitude 3 measure 3	.614	.859	1.000	.827
Attitude 3 measure 4	.570	.747	.827	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Attitude 3 measure 1	6.25	15.394	.664	.462	.927
Attitude 3 measure 2	6.60	14.104	.858	.773	.852
Attitude 3 measure 3	6.88	14.844	.865	.816	.852
Attitude 3 measure 4	7.02	15.952	.790	.693	.880

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
8.92	25.982	5.097	4

Scale: attitude at time 4 reliability analysis

Case Processing Summary

		N	%
Cases	Valid	156	82.1
	Excluded[a]	34	17.9
	Total	190	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.856	.861	4

Item Statistics

	Mean	Std. Deviation	N
Attitude 4 measure 1	2.52	1.322	156
Attitude 4 measure 2	2.19	1.340	156
Attitude 4 measure 3	1.71	1.067	156
Attitude 4 measure 4	1.71	1.103	156

Inter-Item Correlation Matrix

	Attitude 4 measure 1	Attitude 4 measure 2	Attitude 4 measure 3	Attitude 4 measure 4
Attitude 4 measure 1	1.000	.602	.416	.562
Attitude 4 measure 2	.602	1.000	.694	.702
Attitude 4 measure 3	.416	.694	1.000	.671
Attitude 4 measure 4	.562	.702	.671	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Attitude 4 measure 1	5.60	9.789	.598	.407	.864
Attitude 4 measure 2	5.93	8.492	.793	.638	.775
Attitude 4 measure 3	6.42	10.606	.682	.553	.827
Attitude 4 measure 4	6.42	9.974	.760	.589	.796

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
8.12	16.482	4.060	4

Scale: attitude at time 5 reliability analysis

Case Processing Summary

		N	%
Cases	Valid	136	71.6
	Excluded[a]	54	28.4
	Total	190	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.874	.875	4

Item Statistics

	Mean	Std. Deviation	N
Attitude 5 measure 1	2.26	1.249	136
Attitude 5 measure 2	1.98	1.189	136
Attitude 5 measure 3	1.65	1.131	136
Attitude 5 measure 4	1.57	1.133	136

Inter-Item Correlation Matrix

	Attitude 5 measure 1	Attitude 5 measure 2	Attitude 5 measure 3	Attitude 5 measure 4
Attitude 5 measure 1	1.000	.657	.579	.656
Attitude 5 measure 2	.657	1.000	.589	.675
Attitude 5 measure 3	.579	.589	1.000	.659
Attitude 5 measure 4	.656	.675	.659	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Attitude 5 measure 1	5.21	9.068	.724	.531	.842
Attitude 5 measure 2	5.49	9.304	.738	.551	.835
Attitude 5 measure 3	5.82	9.884	.690	.489	.854
Attitude 5 measure 4	5.90	9.426	.771	.596	.823

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
7.47	16.073	4.009	4

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