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## The use of heat maps to explore perceived visual indicators of online fake news

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### Abstract

The study uses heat maps to explore visual indicators of online fake news as perceived by news consumers. Participants in this study were asked to browse through three separate documents, two of which contained fake news, which they were not made aware of. After browsing the three documents, participants were asked a series of questions via a questionnaire relating to the three articles' content. These answers, in combination with the participants' combined heat map data, were analysed to determine what participants consider as visual indicators of online fake news. Participants attempted to establish the source's credibility and evaluate the indicators provided in the articles. It appeared that the title, URL and website names were important indicators. In addition, images attracted attention, too many adverts were considered a red flag, and an organized layout with an author, date, sources, and secure website increases the credibility of the source.

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## 1. Introduction

Fake news, news that are intentionally false, can take on multiple forms and are spread via different platforms, such as social media, online documents and news websites, making it difficult to control [1]. Control of fake news is necessary as it can be used by propagandists to spread political messages or exert influence over individuals or society [2].

There are different ways to identify fake news. Some of these are automated techniques such as linguistic cue approaches with machine learning and network analysis [3] whereas other rely on human experts to do the fact checking [4]. Singh et al.[2] consider online news as multimodal – a combination of text and visual elements. They therefore consider a multimodal analysis based on textual and visual cues (specifically photos) in the detection of fake news as a more holistic approach. Machine learning is typically used in such an approach to automatically detect fake news [5].

Apart from images, some researchers consider website appearance as potential indicators of fake news. Castelo et al. [6], for example, examine the combination of linguistic style with website appearance to create topic-agnostic detection approaches including HTML mark-up information. In a recent study, Billard and Moran [7] report subtle differences between real and fake news websites based on a comparative visual analysis study of visual design features. They acknowledge that the study is explorative and identify a need to understand the audience reception of visual cues. In general, it appears that more human behavior analysis is needed to refine fake news detection methods [5].

Eye-tracking is a possible measurement instrument to gather data of online news consumers' reaction to websites' visual design features. Eye tracking can be defined as measuring a person's eye movements while they are performing a task [8]. Of the most common types of eye movements is saccadic eye movements; this is when a person's eyes focus on a certain point and then jump to a new location or area on which their eyes will fixate [9]. Eye-tracking has been used before to explore the fake news consumption behavior of social media users [5]. In the Simko et al [5] study, participants went through two rounds of eye-tracking: they had to read 12 social media articles before and after they were informed that some of them are fake. The focus was on user characteristics. For example, they found that less successful participants relied more on the social media feed than on the article itself. Another relevant study used eye-tracking to create an eye movement dataset on the perceived believability of online news [10]. Other studies employing eye-tracking are [11] who found that readers exhibit higher levels of confusion when reading fake news and a study [12] exploring user visual behavior when coming across fake news flags. None of the existing studies on eye-tracking and fake news consider online news consumers' identification of visual indicators of online fake news. This study focuses therefore on the use of eye-tracking, more specifically heat maps, to explore perceived visual indicators of fake online news. As such we intend to contribute towards the body of literature on the use of eye-tracking and fake news and a better understanding of the reaction of the audience of fake news on visual design elements.

## 2. Background

### 2.1. Fake news

Fake news is an elusive concept and several studies attempt to get a better grasp of the concept in order to understand and manage it better. For example, Tandoc et al.[13] provide a typology of scholarly definitions of fake news. This includes news satire, news parody, fabrication, manipulation, advertising and propaganda. Propaganda refers to news articles meant to further the agenda of a powerful individual or organization. Advertising includes 'clickbait' headlines, meant to entice the reader to a commercial cite. It also refers to articles in typical news format but meant to convince the reader to buy a product or participate in a scheme. Manipulation refers to the manipulation of photos and videos. Although reputable news outlets have strict rules regarding the manipulation of photos, no such rules hold for social media. Also, the creators of fabricated news can easily use such images to further their argument. Rubin et al. [14] define a more subtle category, "finger-pointing" which is not meant to deceive, but exhibits one-sidedness, partisanship and is not committed to unbiased reporting.

## 2.2. Credibility assessment of online fake news

When online news consumers try to identify fake news, they have to establish the veracity of news. In absence of fact-checking resources or skills, the next best thing is so examine the credibility of the news. Sitaula et al [15] assess credibility of online news from two broad perspectives: the *source* and *content*. Each of these are subdivided into further categories. *Source* refers here to the credibility of the news source, author and co-authors, whereas *content* credibility includes aspects such as sentiments, domain expertise, argumentation, readability, characters, words and sentence, and typos. These credibility cues are shortly explained below.

### *Source credibility*

Sitaula et al. [15] found that the URL plays a role in the identification of fake news but the absence of the http prefix does not signify fake news. In addition, it is also important to determine the author(s) of the article. The credibility of articles without any authors is questionable but the author name is not necessarily helpful as fake names can be used. Author's affiliations can give some insight about the author's credibility. Interestingly, Sitaula et al. [15] found that real news often has more than one author. In their study the median number of authors for fake news is 0 and that of real news, 2.

### *Content credibility*

**Sentiment cues:** The authors found that although there is a slight difference in sentiment between real and fake news (fake news tend to be more emotional), this is a weak indicator of credibility.

**Domain expertise:** From the research there are indications that the use of signal words and expert sources increase credibility of news.

**Argumentation:** The findings from this study slightly support the idea that the occurrence of hyperlinks and URLs within the article increase credibility of online news. Similarly, they found that real news tend to use more numbers as evidence.

**Readability:** The findings indicate that fake news is more readable than real news.

**Characters, Words and Sentences:** It was found that the length of fake news articles are typically shorter than real news and that real news more often employ the use of special characters.

**Typos:** The findings show that the presence of typos can be an indication of fake news.

## 2.3. Credibility signals in visual elements of online fake news

Rubin [16] believes that the visual clues for fake news on social media is minimal. Similarly, by analyzing the stylistic conventions of news websites as a genre, Billard and Moran [7] came to the conclusion that fake news websites have the same look and feel as real news websites. However, when looking closer, they found stylistic variations between websites. The legacy news websites follow printed papers' stylistic features, whereas what they call digital-native news websites borrow ideas from blogs and other digital media. Digital-native websites often target audiences with certain social and political ideologies similar to what [14] call "finger pointing" news. Digital-native websites are often busier and use more bold colours, to name but a few stylistic differences. Some fake news websites mimic real digital-native websites but also have some more nuanced stylistic differences. For example, bold colours are used, and more prominently featured photographs are used, but different from real digital-native websites, these photos are likely to be stock photos, heavily edited and including photo collages. Such online websites often have more advertisements [7].

## 3. Research method

An experiment was conducted where participants were asked to read three separate articles on a 24-inch computer screen. Two rounds of eye-tracking were done as explained below.

### 3.1. First round of eye-tracking

To begin with the eye-tracking process, participants were given one minute to browse through each of three articles. The time limit was an attempt to take the focus away from the fact that they were being observed. After one minute, they were told to click on the next tab (the next article) in the Google Chrome web browser. Of the three articles the participants were given to browse through, two contained fabricated content (fake news) and one was a legitimate news article. After the participants had browsed through all three the articles, they were asked to answer a short questionnaire with questions grouped in two sections. The purpose of this was to ascertain their motivations and reasoning behind the movement of their eyes, as these are subconscious movements. Section one of the questionnaire focused on the perceived visual appeal of each article and how that influenced their interest in the article.

### 3.2. Second round of eye-tracking

After the participants had finished section one of the questionnaire, they were told to scroll to section two, where they were told that one or all of the articles they had read contained fake news. Section two of the questionnaire asked them specifically if they thought an article was fabricated or legitimate with reasons. Participants were then asked to go back to the article in question before answering the questions to obtain the necessary eye tracking data needed in round two. The idea behind a second round of eye tracking was to see which visual aspects the participants prioritized when they looked at the articles a second time to differentiate between fake news and legitimate news. Their eyes were monitored for the first 15 seconds only, to determine their preference of visual cues of credible information. This is in line with the identification of preference formation when looking at an online document [17]. The articles included advertisements on the sides of the screen, pictures throughout the article as part of the content, the content of the article itself and many other irrelevant aspects, such as the Windows toolbar.

### 3.3. The articles

A summary of the three articles is given in Table 1.

Table 1. Summary of the three articles.

Article	Title	URL	Type	Summary
Article 1	Breaking: There is no FDA-approved COVID vaccine in the US and here's the proof	<a href="https://dailyheadlines.com/breaking-there-is-no-fda-approved-covid-vaccine-in-the-u-s-heres-the-proof/">https://dailyheadlines.com/breaking-there-is-no-fda-approved-covid-vaccine-in-the-u-s-heres-the-proof/</a>	Fake news (finger pointing)	Sassy Liberty from Daily Headlines argues that after analysis of FDA papers, it is clear that there is no FDA approved COVID vaccine. Social media (Twitter) posts and videos are provided as evidence.
Article 2	SPECIAL REPORT: AB de Villiers from fastest ODI century to fastest-growing billionaire	<a href="https://madumarketing.com/4na7bd89/?P">https://madumarketing.com/4na7bd89/?P</a>	Fake news: Advertisement	The article is meant to convince readers to participate in the Blue Forex scheme and it uses a well-known SA sportsman as example of a successful investor.
Article 3	Spectacular natural choreography: How the ocean put on a show of blue bioluminescence around False Bay and Hermanus	<a href="https://www.dailymaverick.co.za/article/2021-10-17-spectacular-natural-choreography-how-the-ocean-put-on-a-show-of-blue-bioluminescence-around-false-bay-and-hermanus/">https://www.dailymaverick.co.za/article/2021-10-17-spectacular-natural-choreography-how-the-ocean-put-on-a-show-of-blue-bioluminescence-around-false-bay-and-hermanus/</a>	Legitimate news	This article was published in the Daily Maverick and reports on a natural phenomenon illuminating the waters of the popular coastal South African towns, False Bay and Hermanus.

### 3.4. The participants

This study had a sample size of 20 participants, which is acceptable for eye-tracking studies [18]. Of these 20 participants, 10 were still students and the other 10 were alumni. Students ranging from 18 to 29 years participated in the eye-tracking experiment. They represented both genders, where 65% of the participants were male and the remaining 35% were female. All the participants were familiar with social media and online documents.

### 3.5. Eye-tracking – Heat maps

The hardware that was used to conduct the eye tracking for this study was a Tobii X120 device. This eye-tracking device was placed at the bottom of a 24-inch Samsung monitor. Eye trackers' consistency of measurements and accuracy are tested and retested, and the results indicate a low measurement error [19]. Through the eye-tracking process, heat maps are generated from participants' eye movements. The heat maps show what participants' eyes are fixed on. Heat maps show a bright red or orange colour for areas on which they fixated intensely, and a green colour where their eyes did not intensely fixate on a particular location, but only glanced at it for a short duration. Areas with no colour (red, yellow or green) show areas on which their eyes never focused [20].

All the participants' heat maps were combined into one heat map, indicating which areas on the articles participants found most appealing or indicated the most interest in, whether it be conscious or sub-conscious.

## 4. Findings

In this section, the results from the interpretation of the heat maps and questionnaires are integrated to present the findings. The visual aspects that the participants considered as fake news cues are discussed using [15] categories given in section 2.2:

### 4.1. The source

From the heat maps, it was clear that participants were interested in identifying the source of the article after being made aware of the possibility of fake news. The heat maps showed increased eye movements towards the website name (evident in the heat maps of Articles 1 and 3), the author name (Articles 2 and 3) and the URL (all three articles). Figure 1 demonstrates the result of the combined heat maps for one screen from Article 2.

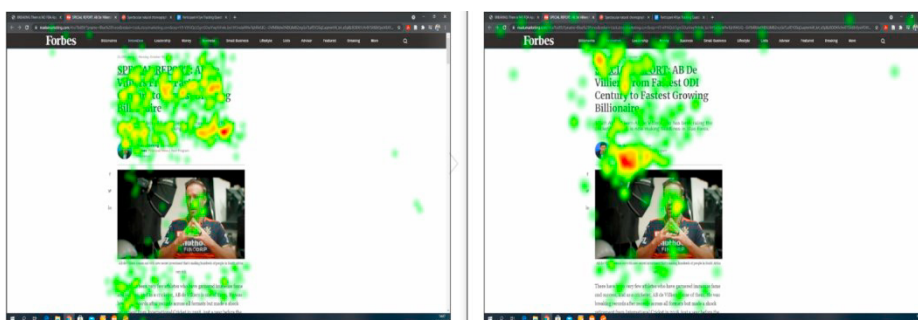


Fig. 1. Article 2 – increased focus on the title and author.

The images of Article 2 shows a shift of focus towards the URL and increased interest in the author (just above the image). The analysis of the questionnaire results confirm the importance of identifying the source. One participant pointed out that the name of the Website did not match the URL making it suspicious: “I think Article 2 is fake because the URL is from madumarketing.com instead of Forbes, which is shown on the screen”. “I think Article 3 is legitimate because the URL corresponds with what is Daily Maverick.” The absence of sources, dates and authors are clearly considered suspect by the participants: “I think article 2 is fake because no sources were mentioned, and no date was

published...”. “I think [Article 3] is legitimate because it has a date of publication, an author and it has references to links, contact details and the website is secured.”

Participants considered too many advertisements as a red flag. This showed that the source has a vested interested and caused distrust. “The first article with all the adverts made me think it was ‘fake news’ and not from a legitimate source.” “I think [Article 1] it is fake - it had way too many adverts and did not look like it came from a credible source.” In general, when participants picked up a vested interest, they tend to classify the article as fake: “Another forex pitch. I have encountered a lot of those before but this one was slightly different since they used a well-known popular face and sportsman”; As much as I enjoyed the second article I think it’s fake because they lack evidence and they are trying to sell a product where AB de Villiers is the frontman or guru of the scheme.”; “After reading the article (3) again, I think it is fake. At the bottom of the page it has a section where it asks you to ‘support daily maverick’ with a link that I assume will take you to enter your banking details.”

#### 4.2. The content

The participants scanned important parts of the content such as the title (evident in the heat maps of Article 1 and 2) of the article and evidence for the argument provided such as images.

*Images.* Figure 2 shows the increased focus on images in a screen of Article 2.

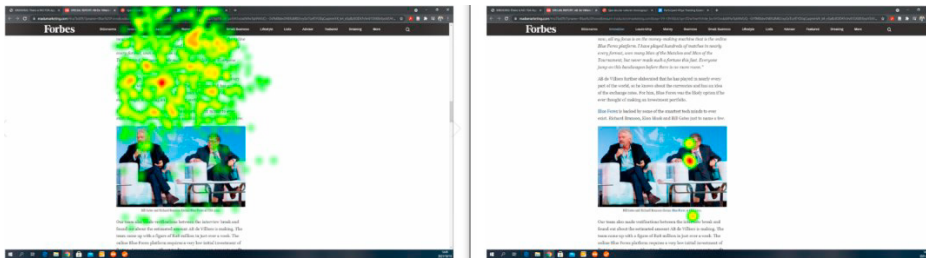


Fig. 2. Article 2 – increased focus on the image with Bill Gates and Richard Branson

The results of the questionnaire confirmed the role that images play in the identification (or not) of fake news. One participant considered the picture of Richard Branson and Bill Gates as support for the legitimacy of Article 2 (which is fake): “I think the article is true because of the credibility and reputation that Forbes (the publisher) holds. There are also clear pictures of well-known international billionaires who are affiliated with the Blue Forex programme.”

#### *Scientific evidence*

Apart from images, participants looked for other credible evidence provided in the text, such as scientific evidence. One participant mentioned: “I think [Article 3] is true because the science and explanation behind what is happening and the reasons behind what we see sound credible”.

#### *Social media as sources*

Some participants considered Twitter and social media sources as unreliable (“[Article 2 is] fake. It has a lot of advertisement. Twitter sources. Social media sources are not the most reliable.”).

#### *Plausibility*

One participant believed Article 2 to be fake as it was “too good to be true.”

#### *Social media as corroboration*

After participants were made aware of the fact that some of the articles are fake news, they focused slightly more on the social media feeds and the comments section. It can be inferred that they looked for cues from other readers on the legitimacy of the article. Figure 3 shows the focus on the comment section of Article 2.

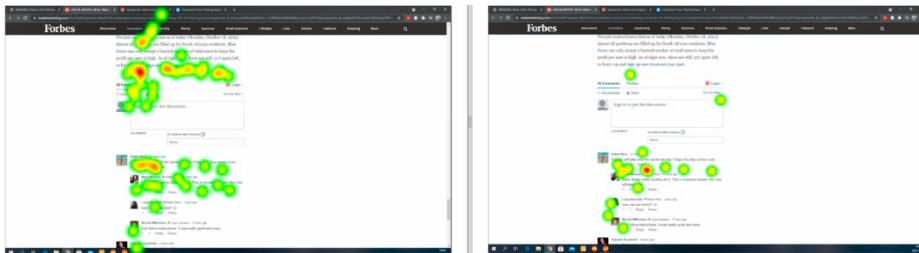


Fig. 3. Article 2 – increased focus on the image with Bill Gates and Richard Branson

#### 4.3. Page layout

From the participants' comments in the questionnaires, there is some evidence that the page layout of the article' websites played a role. For example, it was mentioned that Article 1 might be fake as "...it seems like there is a lot going on the website ... whereas Article 3 appeared legitimate as "... it has a date of publication, an author and it has references to links, contact details and the website is secured". Another participant mentioned that "Article 3 "seems way more organised, there is not a lot of clutter on the website." It was also interesting to note that when comparing the first and second round of heat maps of Article 3, there was a lot more focus on menu items. It appears that this contributes to the perceived well-organised layout of the page. (Figure 4).

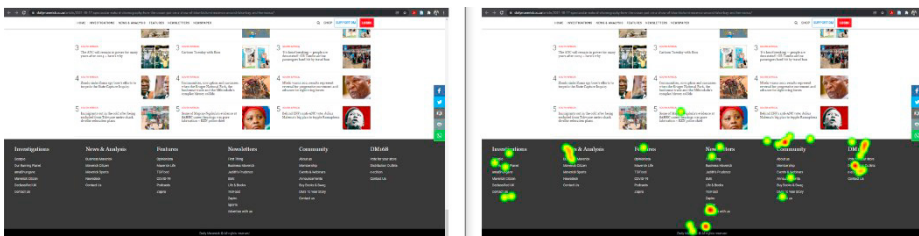


Fig. 4. Article 3 – increased focus on menu items and external links

#### 4.4. Prior beliefs, knowledge and experience

Although not confirmed by any heat maps, from responses to the questionnaire, it is clear that participants' own experience and knowledge play an important role in trust of the online information. Some students know the publication outlets: "I think article 3 is true because the science and explanation behind what is happening and the reasons behind what we see sounds credible. Additionally, I follow the Daily Maverick who published the article and they are a reputable source." Another student had a distrust in conspiracy theories: "I read further I was conflicted whether or not the content [of Article 1] is reputable and well informed or just another conspiracy or means to instill fear and confusion in society."

#### 4.5. Credibility and visual appeal

80% of participants believed Article 3 to be legitimate. Reasons given were the organized layout of the page, the necessary info on the source (the date, the author, references to links, contact details and a secure website) as well as the scientific evidence given. This is also the paper most students found visually most appealing (65%) because of the interesting colours in the images (the blue glow on the beaches) and the organized layout of the page. 60% of students believed Article 2 to be fake news. Participants mentioned the fact that the URL did not match that of Forbes, and that no sources were provided, no date, that it felt more like a sales pitch and "that it is too good to be true". Finally 55% of participants felt that Article 1 was fake news. The large number of advertisement, the 'conspiracy' style of the article, and the poor layout of the webpage were reasons provided. This was also the least visually

appealing paper to the participants (60%). Participants mentioned the number of adds and irrelevant content: “The first article had visuals that were not related to the content of the article, which made me uninterested in reading any further.” And “Furthermore, the changing font was a little annoying.”

## 5. Discussion

The findings show clearly that participants, once they are aware of the possibility of fake news articles, search for any signs of fake news. This study attempts to determine, using heat maps, what online news consumers consider indicators of fake news. This specific group of participants did credibility checks for the source (the URL author name and website name); they considered aspects of the content such as evidences in the form of images, sources and social media comments. In addition, for some the page layout played a role and too many advertisements raised suspicion. Sitaula et al [15] identified several credibility cues of fake news and Billard and Moran [7] identified some visual layout differences between real and fake news discussed in section 2.2 and many of these overlap with the indicators used by the participants. Furthermore, the experience and background knowledge of participants played a role as well in their veracity check. The length of eye-tracking recordings was limited to ensure that participants’ focus on visual aspects of the article. For that reason, this article does not report on linguistic or semantic cues of fake news.

## 6. Conclusion

This study shows that eye-tracking can be used to understand online news consumers’ behavior when evaluating news. The findings show that with increased media literacy the online news consumer can make more informed decisions regarding the veracity of news and their intention to share it. In addition, social media platforms can provide a checklist for veracity checking of online news. This study has some limitations. The group of participants are all graduated or are busy studying towards a degree. We can therefore assume that the participants have a high level of critical thinking skills, typically resulting from tertiary education. Having said that, there were still participants who believed the fake news : “when I noticed that he [AB de Villiers] is benefiting from forex, this again captivated my interest as one is hearing more about forex nowadays, so it is clearly something we need to get onboard with and learn more about”. In addition, other choices of articles could have resulted in different findings. The three articles that were chosen, were typical examples of real and fake news. Some fake news articles are good imitations of real news and readers will find it difficult to identify the fake news. In fact, one of the participant’s remark illustrates the increasing difficulty of online news consumers to identify fake news: “No, they might not be the entire truth, but no, I do not think they are fake”.

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