Fake News Attitude Recognition: How Users' Behavioral and Implicit Components Change Based on Conscientiousness and Visual Attention

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ABSTRACT

We live in a world where we can access a very large amount of information through the use of the Internet, but not all the info we take in is real. Propaganda, misinformation and disinformation have been used throughout history to influence public opinion. (Lazer et al., 2017). The problem related to fake news is often accompanied by people's propensity to search for news on any website or social rather than on institutional and/or certified sites. Fake news can have a huge important impact on people's behavior and they can become a weapon in conflicts between countries. Cognitive Warfare (CogWar) is a very important issue because it focuses on influencing humans' cognitive processes and thus their actions. Although technologies can monitor news trends and recognize real news from the fake ones, still little is known about individual characteristics of users and how they relate to news. Our study aimed to profile behaviors and personality traits most likely to believe fake news to mitigate the phenomenon and impact of misinformation, hence the effects of CogWar. In particular, we investigated the variation of visual attention and level of conscientiousness, openness and emotional stability based on the propensity to believe in fake news. We performed this study where Implicit reaction time (IRT) and visual behavior (Eye Tracker) were employed during the observation of fake and real news. The results suggest that when people believed fake news, they are less conscientious and pay more attention to the visual elements of a news story (images). In contrast, when people are able to recognize the fake news, they are more conscientious and look first at the source of a piece of news than the previous ones.

1.0 INTRODUCTION

The online spreading of fake news (and misinformation in general) has been recently identified as a major issue threatening entire societies. Fake news has been argued to be a by-product of virtual space and may be used in harmful ways to push agendas (Flintham et al., 2018), similar to propaganda (Tandoc et al., 2018). Much of this spreading was enabled by new media formats, namely social networks and online media sites (Brockinton et al., 2022). There are several dangers to fake news, including both subversive and overt uses of deceptive information to manipulate members of the public, either domestically or internationally (Bradshaw & Howard, n.d.). The difficulty in recognizing concrete information from an invented one makes it difficult to trust a source and often the impact that Fake News have in everyday life is relevant. Indeed, Fake News and its dissemination have important repercussions in very sensitive areas such as the political balance between countries (Sindermann et al., 2021). Cognitive Warfare (CogWar) refers to activities designed to influence people's mental states and behaviors, therefore it is vital to develop countermeasures to mitigate its impact, especially with the rapid advancement of information and communication technologies (Hung et al., 2022). It is important to distinguish cognitive warfare from information warfare; while the latter focuses on controlling the flow of information, the former aims to control the responses of individuals and groups to the presented information (Bernal et al.,2020). Information warfare targets human decision-makers, through online social media and offline interpersonal. It works at the epistemic and emotional levels (de Buitrago 2019; Serrano-Puche 2021). Compared to information warfare, cognitive warfare extends from focusing on media control to brain control; it depends more on neurological resources than just mass communication techniques (Avocat 2021). The cognitive warfare aims at acting on audience's mental states by using disinformation to appeal to existing fears and anxieties.

While the above studies offer valuable inputs to this emerging field, many significant issues remain unresolved. For example, we don't know how brain interacts with disinformation. To date, a great deal of investment is being made in technologies that can identify Fake News, but, at the same time, the means of creating a Fake News is becoming increasingly effective (Brockinton et al., 2022). We employed neuroscientific investigation methods (Simko et al., 2020) to analyze the implicit and explicit behavior of users during the fruition of Fake News and real news. The first aim of the study was to clarify whether individual characteristics are associated with tendencies to misclassify both fake and true news. The second aim was to identify whether there are implicit behaviors inherent in visual attention that can discriminate real

news from Fake News (Abdrabou et al., n.d.; Sindermann et al., 2017). In particular, we investigated the relationship to believe in news (fake or real) and visual behavior and traits of personality adopting human physiological behavior collected from eye gaze and IAT test as an indicator of the factuality of news is a promising research direction. Our hypothesis is based on the belief that Fake News triggers unconscious user behavior which can be captured using our technologies.

2.0 MATERIALS

2.1 Inclusion Criteria

Participants were recruited through online platforms and by invitation at "La Sapienza" University's Industrial Neuroscience Laboratories. The experimental sample was created by admitting anyone who was at least 18 years old and able to speak and read Italian. All research participants were between the ages of 25 and 40. The final number of participantssample that carried out the study was N = 18 (11 females, 7 males; mean age = 32, SD = 7). All participants were students or researchers recruited as volunteers from the University of Rome "La Sapienza". Inclusion criteria were the absence of knowledge about the stimuli, absence of major neurological and psychiatric pathologies, normal or corrected vision. Informed consent was obtained from each participant on paper, after the study explanation, as well as the consent for recording and employing videographical material. The experiments were conducted following the principles outlined in the Declaration of Helsinki of 1975, as revised in 2000. The experiments have been approved by the Ethical Committee of Sapienza University, as reported in the Institutional Review Board Statement. All the data were pseudorandomized to prevent any association with the participants' identities. The order of the experimental stimuli was randomly assigned to participants. Informed consent was obtained from all participants prior to the start of the experimental sessions. We asked participants not to tell others what they saw until after they completed all stages of the research. In addition, an important objective of our study was to conduct it in an ecologically valid remote setting, mimicking real-life interaction with social media. To this end, we also chose software that can be easily installed on laptop and smartphone.

2.2 Stimuli

The stimuli were eight (8) images, four of which contained real news and the remaining with fake news. Each image remained on the screen for 22 seconds. Each participant was free to visually explore the stimuli. We used a Facebook's post reproduction made by Adobe Photoshop. Users were provided with 8 posts (1920 * 1080) structured exactly like a Facebook post. Each post was structured as a headline, a text section, an image (were which "Like" and "Comment" call-to-actions were visible), a hashtag section, and the news source. Each stimulus is described here below:

- Image 1 (News): This post reports the news of the introduction of crocodile meat into the Italian market.
- Image 2 (News): This post reports on the introduction of four phones inside a prison through the use of a drone.
- Image 3 (News): This post reports on the firefighters' intervention to get two guys off a roof when they had gone there to be alone.
- Image 4 (News): This post reports on the failure of a plane to take off because of a swarm of bees.
- Image 1 (Fake): This post reports the news of the opening of a hotel by soccer player Cristiano Ronaldo.
- Image 2 (Fake): This post reports news of earthquake alert in the Canary Islands due to Teide volcano activity.

- Image 3 (Fake): This post reports the news of blogger David Puente's arrest for indecent exposure in a public place.
- Image 4 (Fake): This post reports on the death of a child after being run over by TV presenter Enrico Mentana.

2.3 Eye Tracker

The Tobii Sticky online platform is a device through which images or videos can be administered and the user's visual behavior recorded through the user's PC webcam (smartphone or tablet). Eye tracking offers the opportunity to observe behaviors that contribute to decision-making both consciously and unconsciously. Eye movements can indicate subconscious behaviors and decision-making when observing stimuli that may not be self-reported by the participant. It is important to distinguish these unconscious behaviors from methods, such as surveys, interviews, and focus groups that describing what users have experienced on a conscious level (Orquin & Holmqvist, 2019). In this study, Areas of Interest (AOIs) were used to indicate pre-defined areas on social media examples that we thought participants would look at. An online webcam-based eye-tracking system was chosen for this research. In other words, the participants' computer webcam together with the Tobii Sticky solution allowed us to better replicate a realistic scenario (Hummel et al., 2017). For eye tracking to accurately track eye movements, the algorithm must be calibrated to each participant. This information was then used to calculate the gaze data. Calibration is vital to ensure accuracy of the data collected. Excessive head and eyes movement and other participant behaviors jeopardize the usability of their sessions. Once the calibration was completed, the stimuli were presented.

2.4 Implicit Association Test (IAT)

The Implicit Association Test (IAT) is an indirect measure based on the subject's reaction time to a stimulus during a process of comparing two or more stimuli. A stimulus appears on the monitor and the participant is asked to rank it as quickly and accurately as possible. Each time a stimulus appears on the monitor, the respondent must return it to the reference category. If the stimuli that appear on the screen are most associated with a category in the participant's mind, the response time to categorize it will be shorter. The strength of association is measured by comparing the speed of categorization of superordinate category members under two different sorting conditions. In line with the basic tenets of associative and representational learning theories, the IAT is based on the assumption that it should be easier to give the same behavioral response (pressing a key) to strongly associated concepts than to weakly associated concepts (Greenwald et al., 1998b). The IAT returns a score, the D-Score, which can be positive (max +2) or negative (max-2), which indicates the direction and strength of people's internal beliefs about biases, emotions, and unconscious thoughts. A positive score indicates an association of *targetA* with *attributeA* and *targetB* with *attributeB* (compatible combination). A negative score indicates an association of *targetA* with *attributeB* and *targetB* with attribute (noncompatible combination). The translation of the score into a preference or attitude thus depends on how real-world categories are assigned to these 4 groups. For this study, three different IATs tested the extent to which participants associated self vs. others with (a) emotionally stable vs. emotionally labile (indicating emotion stability), (b) open-minded vs. rigid minded (indicating openness), (c) conscientious vs. not conscientious (indicating Conscientiousness) (Dentale et al., 2014, 2016; Schnabel et al., 2008; Steffens & König, 2006). Three items were selected as to-be-sorted stimuli for each of the concepts. The stimuli representing the target categories are 5 per category for a total of 10 items of each trait. Specifically, for the positive pole of Emotion Stability we have "emotional stable" (safe, balanced, calm, confident, stable) and for the negative pole "emotional labile" (insecure, changeable, nervous, touchy, emotive). Specifically, for the positive pole of Conscientiousness we have "conscientious" (organized, timely, careful, precise, constant) and for the negative pole "not conscientious" (disorganized, unreliable, careless, negligent and chaotic). Specifically, for the positive pole of Openness we have "open-minded" (learned, curious, creative, spirited, inventive) and for the negative pole "rigid minded" (uneducated, bored, uncreative, naïve, conventional).

2.0 PROCEDURE

The research was performed remotely. Firstly, participants filled out a brief questionnaire to collect information about their gender, age and course of studies/job position. After responding to the scale, participants were redirected to the Tobii sticky platform via links. They were then instructed about the new task and the gaze recording started. The first step was calibration. Participants were asked we calibrated the eye tracker at the beginning of the experiment using a standard 9-point calibration (the user followed the movement of a blue circle toward these nine points by following it solely with his gaze). After this phase, the different news were shown one at a time to participants. After every two pictures, participants were asked (via an on-screen question) to indicate whether they thought the news they had just seen was true or false. Participants were then redirected to the IAT execution. For this study, we used the classic methodology of the IAT by making a modification in defining the categories/attributes. Before taking the test, the participant were asked to enter his or her first and last name as stimuli that will represent the "Me" category in the test. With this procedure, the participant had the opportunity to quickly identify and become familiar with the category representing the self (Grumm & von Collani, 2007). In each IAT trial, there were 4 categories: two to represent "me" and "other" and two target categories for the traits of personality. Thus, the items in the "me" category were the first name and surname entered by the participant, while for the "other" category they were random. Instead, for the target categories we had the opposite poles for each personality trait analyzed such as; for *Emotional Stability*, the two opposite poles were: "Confident" and "Emotional", while the attributes were defined by the categories representing "me" and "others" for each test. For *Conscientiousness*, the two opposite poles were "responsibility" and "irresponsibility", while the attributes were the same for each test. For *Openness*, the two opposite poles were "open minded" and "rigid minded". The IAT procedure requires respondents to identify stimulus items and categorize them into one of four superordinate categories by pressing the corresponding button. The target categories were located one at the top right and one at the top left of the screen. A stimulus appeared in the centre of the screen and the participant was asked to classify it as quickly and accurately as possible. Each time a stimulus appeared on the monitor, the respondent had to return it to the reference category by pressing the 'E' key for the top left category and, the 'I' key for the top right category. The test comprised several trials in which attributes and categories were matched and mixed (Nosek et al., 2005).

The duration of the IAT is approximately 4-5 minutes.

3.0 SOFTWARE AND TEST: METRICS AND SCORE

3.1 Eye Tracker Metrics

Of the users' visual behavior, several metrics were recorded that could describe the distribution of visual attention during the search:

- Time to first fixation: The average amount of time it takes for a respondent to see an AOI. Respondents that do not see the AOI will not be included in the statistics. Calculation: For all participants who have at least 1 fixation which overlaps in time and space for at least a sub-period of this AOI, calculate the elapsed time from the onset of the stimulus to the start time of the first fixation where it overlaps with the AOI. Participants who do not see the AOI are removed from the calculation. If an AOI starts after the beginning of the stimulus, fixations which are located inside the AOI before it starts or after it ends are not counted.
- Fixations count: The amount of total fixations inside the AOI. Calculation: For all fixations, if the fixation overlaps the AOI in x and y and in time for at least a sub-period of the fixation, increment the number of fixations for this AOI. The greater the number of fixations the more attention the user has paid to a given area.

- EyeBall: Percentage of how many of the respondents that saw the stimulus actually saw the AOI. Calculation: number of participants fixating on this AOI divided by total number of participants who saw this stimulus. This metric describes which areas, on average, attract the most attention from a user group.
- Time Viewed: The average amount of time that a respondent spends on an AOI. If the respondent did not see the AOI, they are not included in the statistics. Calculation: The sum of the (end - start) sub-periods of times for each participant where the fixation overlaps the AOI in X and Y and time for a least a sub-period of the fixation for all participants with the result divided by the number of total participants who had at least 1 fixation within the AOI. If a participant did not see the AOI, they are not included in the statistics.

All data were processed anonymously, and no records were obtained through the use of the webcam (the eye-tracking device only returns gaze coordinates within the screen).

3.2 IAT Score

The IAT score indicates how well a candidate associates himself or herself with the positive or negative pole of the personality trait under analysis. Specifically, for each trait of personality we had a negative and positive pole. In terms of *Emotional Stability*, the emotional sphere encompassed two opposite poles: *self-confidence* and *emotional lability*. This test indicates how emotionally stable, dominant and confident each participant is. This dimension identified people who tend toward psychological well-being, good anxiety management and adaptive coping strategies. In contrast, the opposite pole is represented by vulnerability, insecurity and emotional instability. Thus, this dimension identified people who tend toward psychological distress, excessive rumination or anxiety, and maladaptive coping strategies. As far as *Conscientiousness*, the opposite poles included *responsibility* and *irresponsibility/impulsiveness*. This test indicated how responsible a candidate is in achieving planned goals. *Conscientiousness*, in fact includes perseverance, thoroughness and industriousness, self-control and self-discipline. People with high levels of conscientiousness are responsible, organized and hardworking, although they may be at risk of perfectionism. Those with low levels of conscientiousness may show spontaneity but may also tend toward unreliability and carelessness. Finally, for *Openness*, the opposite poles were *Original* and *Traditionalist*. This test indicated how intellectually open a candidate is to new experiences. Open-mindedness denotes receptivity to new ideas and experiences, willingness to embrace new demands and challenges, and the ability to align without conforming. People with high levels of open-mindedness are able to adapt their thoughts and attitudes to changes that occur, seek a variety of experiences, and are comfortable with the unfamiliar. Those with low levels of open-mindedness prefer familiar habits, people and ideas while finding uncomfortable unanticipated circumstances. Positive scores describe a creative, flexible and unconventional attitude; in contrast, negative scores indicate a mindset that is more restricted to novelty and change. The *D-score* was interpreted on various levels that describe the intensity of association. The higher the numerical value is, the greater the association is. In particular, the intensity levels of the score can be the following ones:

- +0.15 to +0.35 slight association: participant identified poorly with the positive pole.
- 0.35 to 0.65 moderate association: participant identified moderately with the positive pole.
- 0.65 to 0.95 medium-high association: participant identified very much with the positive pole.
- 0.95 and above strong association: participant strongly identified with the positive pole.
- -0-15 to +0.15 neutrality: in this case the participant did not identify with the positive or negative pole but tended to take mostly neutral attitudes.
- -0.15 to -0.35 slight association: the participant identified little with the negative pole.
- -0.35 to -0.65 moderate association: participant identified moderately with the negative pole.

- 0.65 to -0.95 medium to high association: participant identified very much with the negative pole.
- -0.95 and below strong association: participant strongly identified with the negative pole.

3.2 Statistical Analyses

The eye-tracker data were computed for each stimulus (news). Two different analyses were performed. In one analysis, all the stimuli (both real and fake news) were considered. For the second analysis, only fake news was considered. In both analyses, for each participant we split the news in two category depending if the participant correctly classified the news as fake or real. For each eye-tracker measure, we averaged the data related to all the correctly classified news. The same was done for the wrongly classified news. After this procedures, for each participant and for each eye-tracker measure we had a value for correct responses and a value for wrong responses (none of the participants classified all the news either correctly or wrongly). Statistical analysis was then performed comparing the eye-tracker measures of each participant related to correct versus wrong response. Distribution of the data was checked using Kolmogorov-Smirnov test, In case normal distribution was confirmed parametric paired t-test was adopted, otherwise non-parametric paired t-test was adopted. Given that the IAT tests were performed only once at the end of the experimental procedure, for each participants it was weighted considering the number of correct and wrong response. This means that if a participant correctly classified half of the news, the IAT scores were weighted equally between correct and wrong response. Also in this case, for each participant we ended up with one value of IAT for correct response and one value for wrong response. Again, normal distribution was checked and parametric or non-parametric t-test was performed accordingly. All the statistical tests were performed after normalizing separately the data of each participant and measure as a z-score.

4.0 RESULTS

4.1 Fake and Real News

4.1.1 Time To First Fixation: Source

We analyzed users' eye-tracking behavior in relation to the recognition of fake and real news. Specifically, we focused on the relationship between eye behavior and news (fake and real), and the relationship between personality traits and Fake News. We created two groups by dividing the 8 stimuli (4 for fake and 4 for real news) for each subject as: *Correct*, when the stimulus had been recognized (fake news recognized as fake and, real news recognized as real) and, *Wrong* when the stimulus had not been recognized (Fake News considered real; real news considered as fake). We investigated differences between the behavior recorded when the nature of the post had been recognized (real or fake) and the behavior recorded when the nature of the post had been misinterpreted (considered in the analysis as an error). The results showed that there was a significant difference in TTFF (Time To First Fixation) between users who had correctly recognized the nature of the post and those who had not made a mistake. The TTFF inherent in the Region of Interest "source" was significantly lower in those who had recognized the nature of the post than in those who had not make a mistake ($p = 0.02$). The scores were normalized before statistical comparisons were made. Figure 1 shows the data just described.

4.2 Fake News

After this analysis involving all stimuli, we performed a second analysis considering the two groups: real or fake stimuli. In these analyses, we investigated the relationship between ocular behavior and fake news recognition and the relationship between personality traits and fake news recognition. We did not find any significant difference within the group of real posts, therefore we have reported only the ones related to the fake ones.

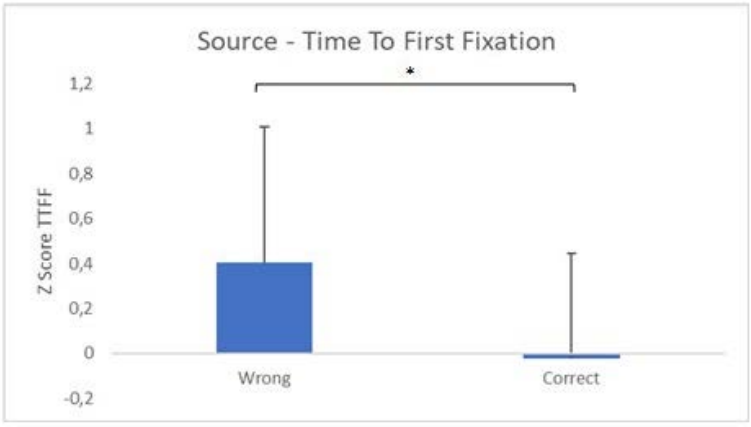

Figure 1. The users who took longer time to read the source of the posts did not recognise the correct nature of the news.

4.2.1 Number of Fixation

Specifically for the ocular behavior, we investigated how attention was distributed between users who were able to recognize Fake News as Fake and those who considered it to be real (Figure 2). It emerged that the number of fixations within the ROI Image was significantly higher in users who had made a mistake in recognizing the image as such ($p = 0.041$).

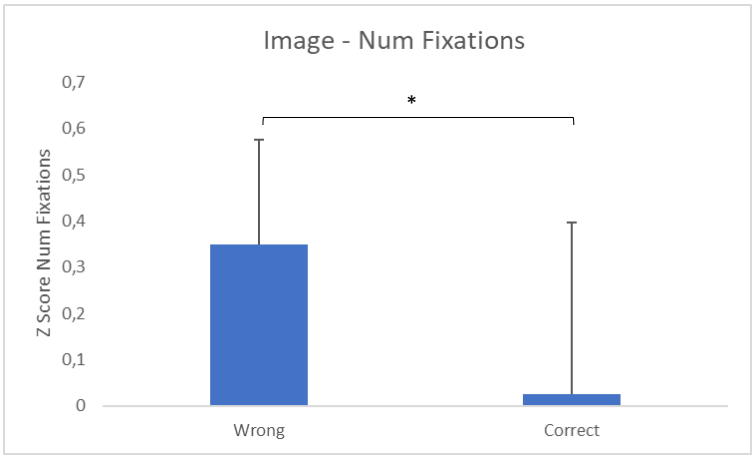

Figure 2. The users who spent longer time on the image, rather than other features of the posts, did not recognise the correct nature of the news.

4.2.1 Conscientiousness

Beyond that, we wondered whether there was a difference in personality traits when people recognize Fake News and when they mistakenly believe it to be real. Regarding the relationship between personality traits and recognition of fake news, we recorded significantly different values between levels of conscientiousness in those who recognized Fake news as Fake and those who regarded it as real. In fact, people reported a higher conscientiousness value when they recognized Fake news as Fake (Figure 3). Conversely, conscientiousness values were lower when at least one mistake was made in recognizing Fake news ($p = 0.047$).

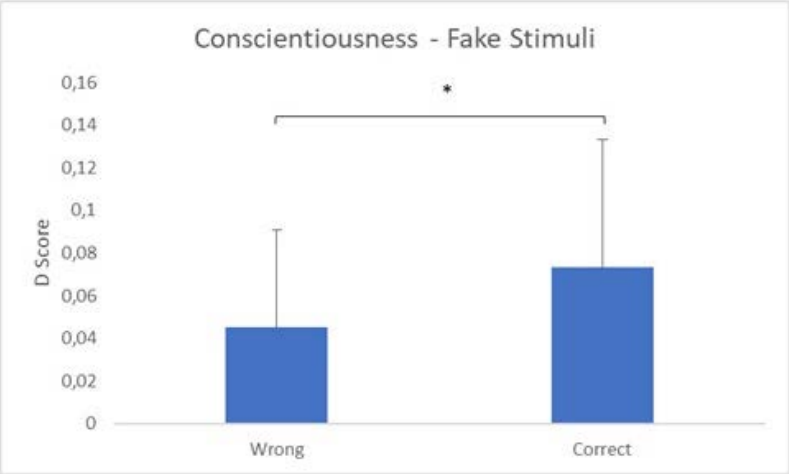

Figure 3. IAT Conscientiousness of users able to recognise the fake news was significantly higher than who did not.

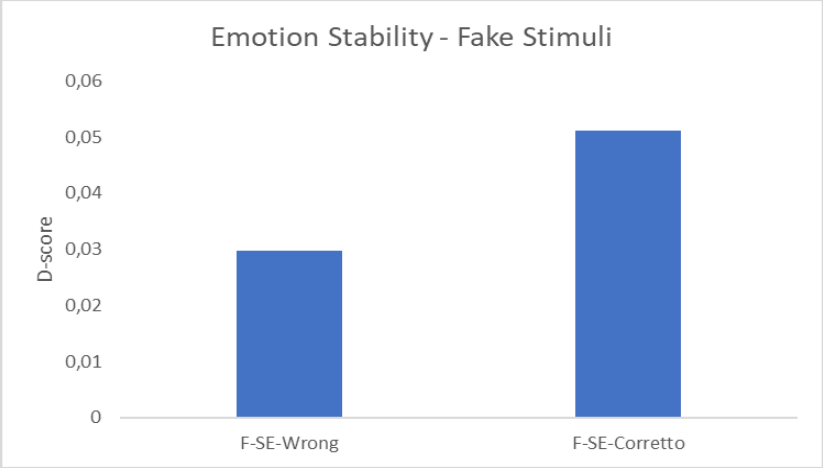

Figure 4. IAT Emotion Stability of users able to recognise the fake news was higher than who did not.

Regarding the emotional stability IAT, there were no significant differences between the groups but a trend ($p = 0.078$). People report greater emotional stability when they recognize Fake News than when it is not recognized (Figure 4). Instead, the IAT open-mindedness there are no significant differences between the wrong and correct groups.

5.0 DISCUSSIONS

The aim of the study was to explore whether a participants' personality traits can be used as features to characterize the influence on how participants discerned information. We focused on misinterpreting (*wrong*) or not (*correct*) stimuli regardless of their source (real or fake). The results show that there was a difference in the visual behavior of the two groups (wrong and correct). In particular, users who were able to recognize the nature of the posts looked at the source of the post or news earlier than those who made a mistake in evaluating it. It is well known that sources usually report information in an inaccurate and/or partial manner. The result of this metric can indicate how the source can be among the first elements sought to evaluate the reliability of news. Focusing on the fake news, we found that the number of fixations inherent

in the AOI "Image" describe how the image is able to capture the attention of the user. In other words, participants who did not recognize fake news as such spent longer time on the image itself while the attention of those who recognize the news as fake was distributed on other elements of the posts (e.g. *Title - Source - Post Text*). This result demonstrate how the most visible elements of a news are those to which more attention is paid in case of error in their interpretation. The practice of writing sensationalized or misleading headlines to attract people, with the help of images, seem to be confirmed by our results. Regarding the investigation of personality traits, an important role of traits emerged during the viewing of fake stimuli. The level of *Conscientiousness* is a variable that can determine the propensity to believe unreal (fake) news. In fact, the participants able to recognized correctly the fake news exhibited a IAT conscientiousness significantly higher than who did not. Additionally, a trend for the IAT Emotion Stability was observed for the participants reporting correct answers. Despite the promising results, we want to highlight some limitations of the study. Firstly, the number of the participants was small, therefore we will keep running the experiments to enlarge the number of participant and make the results more robust. Secondly, a more accurate user's characterization can be achieved by considering other data, like neurophysiological measures (brain activity, skin conductance, heart activity) and facial features. As a consequence, we will add these data in the next experimental protocol.

6.0 CONCLUSIONS

The results of the study have shown that users able to recognize if a news is real or fake initially look at the source of the news. Additionally, users who did not recognize fake news spent longer time in looking at the images in the news story than on the source, title, text. In terms of personality traits, when the users did not recognize fake news, they showed lower levels of conscientiousness and emotion stability.

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