Exploring the experiential impact of online propaganda using eye-gaze and pupil dilation: A comparison across three ideological groups *

Mojtaba Heidarysafa[1], Sara Dalpe[2], Shelby Kiefner[2] Erfan Pakdamanian[1], Inki Kim[1,5], Donald E. Brown[1,3], and Janet I. Warren[2,4]

[1] Department of Systems & Information Engineering, University of Virginia, VA
[2] Institute of Law, Psychiatry, & Public Policy, University of Virginia, VA
[3] Data Science Institute, University of Virginia, VA
[4] Department of Psychiatry & Neurobehavioral Sciences, University of Virginia, VA
[5] College of Engineering, University of Illinois at Urbana-Champaign, Urbana, IL

Abstract. Our study explores the physiological reactivity of women to propaganda generated by far-right, far-left, and jihadist groups to promote radicalization and recruitment into organizations promoting extremist violence. The theoretical bases of the study derive from the writings of Chomsky and Ellul who explore the power of propaganda to engineer opinions according to specific doctrines while maintaining the illusion of independent thought. Our sample was comprised of 90 women aged 18 through 35 years who described themselves as being conservative, liberal, or Muslim. The first half of the sample participated in a series of three online search sessions designed to capture compelling images related to the radicalization of women. The second half of the sample underwent a single in-lab session which involved reviewing a sample of these materials while being monitored according to eye-gaze, heart rate, galvanic skin response, and emotional facial recognition.We found images of horrific violence prompted dilation of the pupils across all three study groups, suggesting the triggering of sympathetic and parasympathetic pathways to brain regions associated with cognitive and emotional processing. These findings are relevant to understanding the pathways through which violent propaganda stimulates specific areas of the brain possibly enhancing receptivity to further ideological content. In addition, our study provides a perspective for seeking to understand propaganda and the processes of recruitment scientifically using empirical measures of physiological response and reactivity.

Keywords: Eye-gaze · Pupil dilation · Propaganda · Radicalization.

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1 Introduction

Noam Chomsky contends that modern propaganda emerged in the early 20th century in the United States when Woodrow Wilson was elected President and determined he had to transform a pacifist country into a warmongering population ready to go to war to save the world. The Creel Commission, or the Committee on Public Information (1917-1919), was created to address this dilemma. Over a two-year period, the commission generated 75,000 volunteers, 7.5 million four-minute oration sessions, and a plethora of newsprint releases, posters, radio shows, telegraphs, movies, academic papers, and seminars, all designed to complement each other and to convey a shared support for the war effort. Chomsky described the success of these efforts in driving "a reluctant population into a war by terrifying them and eliciting jingoistic fanaticism" [4]

More recently, Charlie Winter [11] has used the writing of Jacques Ellul [5] to systematize the "half-truth, limited truth, and truth out of context," used by the Islamic State to recruit individuals to their belief system and to engender support for its emerging Caliphate. Winter argues that the immensity of the Islamic States propaganda machine has obscured a rational understanding of it, but that a close examination of it can help to reveal its underlying media strategy [11]. According to Ellul, these aims include the creation of a form of symbiosis between the media strategist and the consumer, which motivates the latter to willingly convey a predetermined version of events across public and private spheres. The content of the messages vary but they create a constant interplay structured on the lines of paired opposites. Importantly, all of these ideas and content are used to generate a participation by the individual, prompting them to engage in the transmission of the ideas and content while maintaining the illusion of experiencing and transmitting independent thought and believes [5].

These theoretical assumptions, paired with the disturbing efficacy of extremist propaganda at this time, serve as the impetus for our study. Specifically, we seek to build an empirical methodology for examining the ways in which propaganda generates physiological, emotional, and cognitive responses as a first step in developing a fuller understanding of effective countermeasures to it. This study is part of a larger research undertaking that is examining risk and threat assessment for extremist violence perpetrated by women. In the current study, we use physiological to determine the effect of propaganda on women who self-identify as conservative, liberal, or Muslim. We examine group differences in reactions to different propaganda series while also examining change over time as each woman moves from a review of neutral images to exposure to three different series of propaganda focused on far-right, far-left, and jihadist content.

2 Prior Research

Pupillometry examines pupillary motility to understand the underlying cognitive and emotional processing associated with an individual's exposure to particular stimuli. Changes in pupillary dilation have been found to be correlated both

with cognitive effort and emotional state. This process is believed to occur as a result of stimuli being transmitted through sympathetic and parasympathetic pathways connecting the eye with brain regions associated with cognitive and emotional processing.
Some of the earlier research found that pupil dilation occurred when subjects viewed positive visual stimuli and contracted when they viewed aversive stimuli [8, 10]. Other research has suggested that participants' pupils dilated when viewing any emotionally arousing pictures, regardless of whether they were pleasant or unpleasant [3]. More recent research suggests that cognitive load tends to increase the dilation of the pupil while an overload of working memory and information processing is associated with a decrease in pupil diameter [6, 9]. Research comparing meditators from individuals who did not meditate found that while the two groups did not differ on the responses to positive and neutral images, negative images evoked a greater pupillary contraction and a weaker dilation in the meditating group. The meditating group also had a faster physiological recovery to baseline levels [10].

These findings, supported by the development of Tobii eye tracker [2] with iMotions software [1], have led to the development of clinical interventions designed to measure pupil dilation as a physiological proxy for cognitive activity and emotional processing, along with the assessment of medical disorders including Parkinsons disease, Major Depressive Disorder, and Autism Spectrum Disorder. Research concerning Human Computer Interfaces (HCI) also has introduced pupillometry along with galvanic skin response, eye tracking, and EEG to better understand unconscious processes among clinical populations in which verbal communications are dysfunctional and/or inadequate [6].

3 Methods and Materials

3.1 Experiment design & Sample

The sample for our study was made up of 90 women aged 18 through 35 years who self-identified as being conservative, liberal, or Muslim. In Stage 1 of the study, 45 of these women conducted three one-hour online sessions during which they were asked to identify material that they believed would be compelling in recruiting young women to extremist ideologies. The surface, deep, and dark web were used in these explorations [7]. Stage 2 of the study involved a different group of 45 women aged 18 through 35 years who attended a one-hour session in a research lab. Each session involved exposure to four series of materials, one neutral and three content-specific to three different extremist groups. Between each of the four sessions, each participant completed the Lab Session Inventory (LSI), a self-report measure that examined emotional reactions, propaganda-based cognitions, and general arousal to themes of emotional valence, arousal, and dominance. Before beginning the series, consent was obtained from each participant, and they were informed of the graphic nature of some images. Each subject was offered alternative materials if they were concerned about their own emotional reactions to graphic and provocative violence. Only the 40 subjects

using the primary experimental stimuli are included in the data analyses that follow.

3.2 Series Image Content

Examples of the four online stimuli are presented in Fig 1. The first image on the left is similar to one of the neutral photos we selected from the International Affective Picture System (IAPS) developed at the NIMH Center for the Study of Emotion and Attitude, University of Florida [3]. The remaining three images are actual images used in our sessions. Pupil dilatation and eye gaze were measured for a total of 22 stimuli and 70 areas of interest (AOI) marked within them. These images are rated on dimensions of emotional valence, arousal, and

Fig. 1: Example of image contents for each of four sessions.

dominance using a self-report completed by each participant between each of the four sessions.

3.3 Eye tracking and pupil measurement

Tobii eye tracker and Imotions software Pupil dilation and eye gaze for each of the 45 subjects were obtained using Tobii Pro eye tracker instrument. It collects data on location of eye gaze and pupil dilation through measurements collected approximately every eight milliseconds. During the experiment, subjects viewed images on a computer in a tent-like structure with consistent ambient light being maintained throughout the four sessions. These data were integrated through iMotions software with other physical measures for each area of interest and each stimulus slide, and also displayed visually as heat maps to allow for visual comparisons.

Areas of Interest (AOI) To monitor and analyze eye gaze patterns, each image from each session had Areas of Interest (AOIs) marked post-hoc. These are displayed in the red boxes outlined in the four stimuli images included in Fig 1. These areas were organized around general concepts, such as a block of text, a graphic, or a face.

Pupil Data Pre-processing Before starting the analysis, missing data were addressed using the iMotions outputs. For pupil dilation, missing data were represented as a -1 value. In these instances, we used linear interpolation to replace these missing values. Moreover, iMotions provides pupil diameter (in mm) for the left and right eyes separately. In order to obtain the pupil diameter, we obtained the mean of these two values for each raw data record. To normalize pre-existent individual differences in pupil size in the neutral setting, we obtained each participants mean pupil diameter when viewing all of the neutral images and used this to create a pupil baseline for each participant. We then subtracted these values from our experiment values to find the relative change of pupil diameter in each AOI for each participant based upon their unique baseline. Finally, we normalized these changes by dividing the difference to the pupil baseline diameter.

$$Normalized\ Pupil\ Change = \frac{pupil\ diameter - pupil\ baseline}{pupil\ baseline} \tag{1}$$

We aggregated these pupil changes in each of our AOIs for each participant. A negative value represents a general pupil contraction and a positive value reflects a mean pupil dilation on a particular AOI. For the time spent on each AOI, we counted the number of recorded gazes of a participant in an AOI and normalized the score according to the total number of records in our AOIs for each participant. iMotions provides a convenient visualization based on the amount of time that subjects spend on different areas of each stimuli. These heat maps can be generated both for each individual or a group

4 Results

4.1 Pupil Dilation

The data presented below in three separate bubble graphs reflects mean pupil dilation for each of the 40 subjects across the three stimuli series including

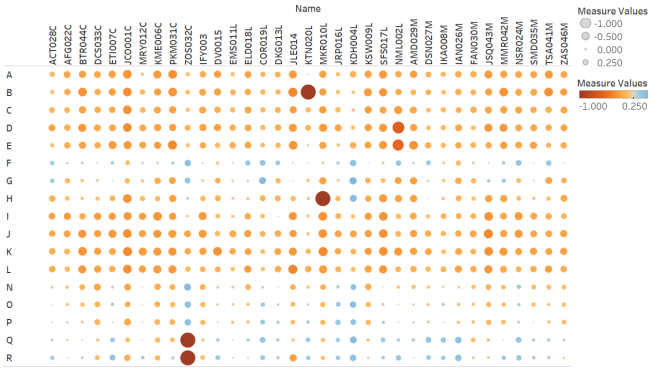

Fig. 2: Normalized Pupil dilation to 6 jihadist images and 18 jihadist AOIs

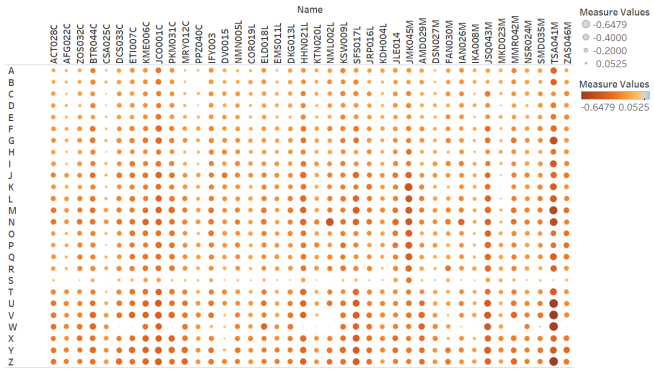

Fig. 3: Normalized Pupil dilation in 8 far-right images and 26 far-right AOIs.

Jihadist, far-right and far-left content. These data are presented as pupil dilation captured when viewing each of the Areas of Interest (AOI) contained in the 6 Jihadist images, 8 far-right images, and 8 far-left images. The first bubble graph reflects individual differences and group differences on the responses to various jihadist stimuli. In general as reflected by the gold circles (reflecting negative values), all 40 participants demonstrated pupil contraction when viewing jihadist propagandas as compared to when viewing neutral images. However, this general pattern of contraction was inverted for images reflected above as F, G and H, and P, Q and R. The F-G-H collection of AOIs contained a combination of religious sayings, which give the appearance of having come from the Qur'an, along with the scarf-wrapped young ISIS fighter carrying a large semi-automatic weapon. The P-Q-R collection of AOIs included images that reflected the preparation and aftermath of the beheading of Allen Henning by a black clad masked man with the ISIS flag flying behind the two men. Figure 3 involves pupil dilation to 8 far-right images and 26 far-right AOIs. There are three patterns conveyed by the bubble graph above. The first involves relatively less mean contraction across the various participants in response to AOIs A, B, C, D and E. AOIs A-B refer to a website with a hooded figure pointing, as seen historically in military advertisements, with the caption, Loyal White Knights, Klu Klux Klan, Wants You! AOIs C-D-E-F-G contain a photo of the KKK during the incident in Charlottesville, Virginia, with written notation explaining that the KKK is a family-like organization that supports God-fearing common folks, who feel obliged by the Bible to keep races separate. The third and most extreme reaction pattern can be observed in the participants' responses to AOI "S" This involved consistently less contraction, and in some instances, dilation of the pupils over the neutral baseline of each participant. The "S" AOI captures a dated photo of a deceased African-American man hanging by a noose in a wooded area.

Figure 4 summarizes pupil dilation to eight images associated with far-left propaganda and the 27 AOIs identified in them. It reflects a generally higher rate of pupil contraction in relation to each participants baseline measure across the

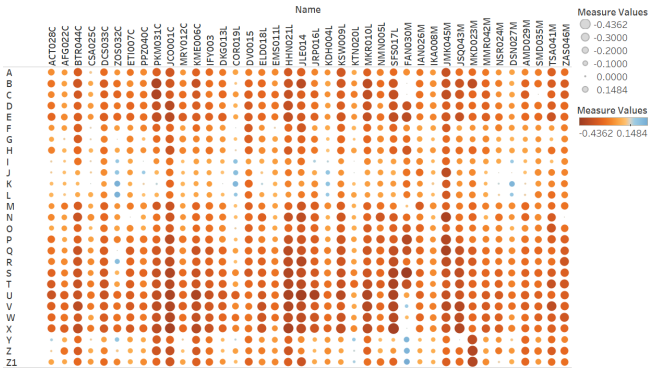

Fig. 4: Normalized Pupil dilation in 8 far-left images and 27 far-left AOIs.

majority of the AOIs. However, despite this general trend, we found there were two images that evoked less constriction and in some instances pupil dilation. These included responses to AOIs I, J, K, and L and in another collection made up of OAIs Y, Z, and Z1. The first I-J-K-L collection involves a well-organized, official-looking, British resistance image with an anti-fascists group marching with a large banner and the stated goal of "smashing racism by 2018." The collection of AOIs designated as Y, Z, and Z1 involved a march with a banner stating that the "only good fascist is A DEAD ONE" followed by the image of a police officer being set on fire while marching with other officers in riot gear.

4.2 Heat Maps

We examined the eye-gaze location of our participants based upon the time that each participant spent looking at each AOI. A normalized example is given in the bubble graph for the jihadist series of images in Fig 5. As illustrated above,

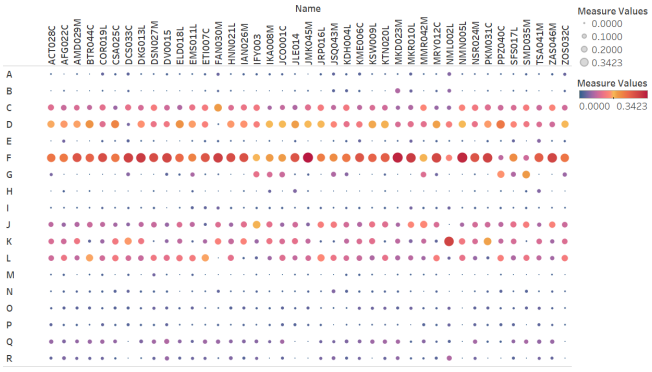

Fig. 5: Normalized Eye-gave time on each AOI containing jihadist propaganda.

the AOI labelled F captured the most seconds of attention for all of our participants. The F AOI involved six paragraphs of material located on the left side of the page written to convey that the content was derived from the Quran. The content referenced battles between the Muslim and Crusaders in Dabiq, an engagement in battle of the best people on Earth, and comments asserting that a third of the believers who die in battle will be viewed as martyrs by Allah.

These three images reveal differences across the three groups of participants with different strategies for reading the text and different degrees of interest in examining the facial features of the masked ISIS fighter.

Fig. 6: Conservative-only, liberal-only, and Muslim-only participants heatmaps (from left to right).

Study of Contrast In line with Elluls assertion concerning the combining of opposites in the generation of effective propaganda, we sought to examine reactions to content designed to evoke different emotional and cognitive reactions. in Fig 7, we compare the eye gaze activity of our 40 participants to two images that were contained within the far- right series. This image, which involved a hanging from the 1889 prompted an increase in pupil dilation for all of our participants either through a lessening of the constriction or an actual increase in

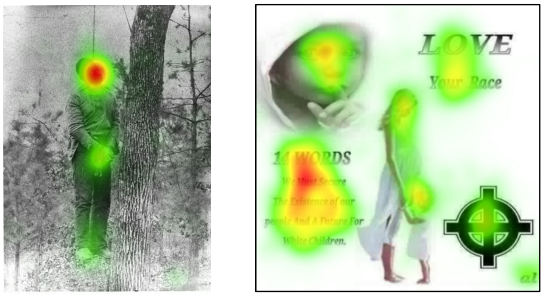

Fig. 7: Left:historical hanging of an African-American man Right: racially “pure” images of infant child and mother

dilation when compared to each individuals baseline measurements. In contrast, this image on the left, which included a blonde-haired pregnant woman holding her blonde-haired child both dressed in white, did not capture the primary attention of our participants. Rather, the image of the infant alone was immediately followed by a review of the 14 words, which focused on securing the safety of their white people and white children.

5 Conclusions

Our findings demonstrate that there are different types of content used in current-day propaganda that demonstrate an ability to capture the attention of Western-living young women aged 18 through 35 years, despite them differentially identifying themselves as being conservative, liberal, or Muslim. Embedded in these responses are different physiological responses to different images which have been associated through prior research with cognitive and emotional processing in the human brain. While these findings are too preliminary to argue for a science of propaganda, they do underscore the non-random use of different propaganda content, thereby opening the door to its scientific study.

Of interest was the consistent pupil dilation found among the majority of our participants to three different images of gruesome violence expressed within the context of jihadist, conservative and liberal ideologies. Despite their horrifying nature, or perhaps as a direct result of it, our participants demonstrated a significant pupildilation in relation to their individual baseline measurements. This triggering suggests that these images may serve a gateway function, creating a subliminal state of susceptibility to additional ideological information that are associated with it. This finding brings to mind Ellul's (19650 assertion):

"To be effective, propaganda must constantly short-circuit all thought and decision. It must operate on the individual at the level of the unconscious. He must not know that he is being shaped by outside forces . . . "(p.27).

These horrific images that the world finds so disturbing may constitute the precise short-circuiting necessary for individuals to by-pass their normal decision-making processes and find themselves experiencing a compelling attraction to ideas that would have previously been abhorrent to them.

Our findings also document Ellul's observation that the pairing of opposites can constitute a powerful ploy in the creation of effective propaganda. In terms of the ISIS propaganda, these contrasts are commonly observed yet seldom understood. Images of grotesque violence are often paired, at least for women, with images of female friendship, romantic intrigue, and the exciting participation in a new utopian life-style. The alt-right propaganda similarly combines despicable acts of racial violence with images of feminine purity; blonde-haired, blue-eyed infants and children; and the idea of an ideology that promotes family solidarity and conservative cultural values. The propaganda that we examined in this study was created for assimilation by women; this content might well be different for men, although likely containing the same pairing of opposite content and polarized emotional reactions to it.

Each of these observations has to be contextualized and interpreted with a clear appreciation of the limitations of our study. When examining the reactions of our participants, we had no comparable data that described young women's reactions to other types of stimulating material that was not propaganda-laden. Situationally, our experiment was conducted in a dimly-lit tent-like structure, but the lighting of the larger room where the participants completed the between-session survey was brighter, possibly evoking changes in pupil dilation unrelated to the initial calibration of each participant. The lumens emitted by our various images also varied. Perhaps most importantly, research on pupil dilation is still in its infancy,and while the dilation of the pupil in response to fight or flight responses has been widely verified, the correlation of these processes with arousal in specific areas of functioning within the brain has yet to be fully elucidated.

Despite these many caveats, our study provides support for further scientific study and argues for movement away from simple and repetitive expressions of dismay and horror, which as articulated by Chomsky, simply turns the media and the larger community into unwilling participants in the transmission of provocative,powerful and dangerous propaganda.

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