Relationship between perceived self-reported trust in health information sources and ocular fixation in a sample of young adults: a secondary data analysis

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Abstract: Individuals use Internet for health-related issues to gather information and to share experiences and emotional support with other people who have similar medical problems. The easy access to information has sparked heated debate whether this converse urge to seek medical and health advice online is within the benefit of patients. In this research we set out to explore the relationship between self-perceived trust and visual interaction with medical websites, using eye tracking (ET) methods. The individual ocular reaction at 30-second exposure intervals to 20 health-related webpages was studied in 28 gender-balanced young adults by a Pro T60XL monitor device. The results showed a borderline strong statistically significant positive correlation (r=0.68, p=0.001) between logo fixations (LAOI) and self-reported trust rank. Websites that were ranked higher in terms of trust appear to be more likely to have a higher number of fixations on the logo. A moderate statistically significant positive correlation (r=0.526, p=0.017) was observed between fixations before the logo (FBL) and self-reported trust rank. Logos are a main point of ocular focus and are associated with higher trust. ET proves to be a useful assessment tool of behavioral patterns in searching online information.

Keywords: Eye movement tracking, Ocular fixation, E-health, Trust analysis.

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Introduction

Self-researching health information online is the third most popular Internet activity, after email and search engine utilization (Fox, Susannah, 2003). Individuals use the Internet for health-related issues to gather information and to interact with other people who have or had similar health problems to share experiences and to give or receive emotional support (Wildevuur & Simonse, 2015).

With the accelerated advance of modern technology, more and more people gain access to World Wide Web. The expanding usage of the internet and social media has provided exceptional circumstances for people to search for health and medical information online, which was not accessible to them in the past (Chen, Li, Liang, & Tsai, 2018). Also, the literature suggests that a possible explanation for the increase in online searching for health information has occurred due to patients perception that medical doctors do not offer them sufficient information or attention to make sensible health-related decisions on how they want to be taken care of (Xiao, Sharman, Rao, & Upadhyaya, 2014). Moreover, studies suggest that in some cases young people in particular are turning to the Internet rather than to a parent or family doctor to obtain health information and advice (Beck et al., 2014). Data collected in 2015 by the Pew Research Center shows that approximately 31% of cell phone owners and 52% of smartphone owners have used their phone to look up health or medical information (Dana Page, 2015). Currently, the situation may be further compounded by an increase in the sources of information that create more choices of medical information for the reader (Sieving, 1999).

This recent explosion of access to information due to Internet and mobile device usage has sparked heated debate whether this converse urge to seek medical and health advice online is within the benefit of patients (Desai, Yee, & Soman, 2016). According to an article published in the New England Journal of Medicine, information and knowledge do not equal wisdom, and it is too easy for non-experts to take at face value statements made confidently by voices of authority. The paper argues that medical doctors cannot be replaced by online information, as expertise and training places them in the best position to weigh information and to advise patients, drawing on their understanding of available evidence as well as their training and experience (Hartzband & Groopman, 2010). Making major medical decisions based on inadequate and incomplete health information may entail harmful results, such as incorrect diagnosis, delayed specific medical care and treatment (Sun, Zhang, Gwizdka, & Trace, 2019). Therefore, we concede that attention should be placed on credibility, reliability and content quality of health-related information sources.

Eye and gaze tracking are common research method used by researchers to study cognitive function, attention and other reading and learning behaviors (Rodrigues & Rosa, 2019). Besides diagnosing cognitive impairment and dementia, in medicine ET may be useful for investigating cranial nerve palsies, multiple sclerosis, autism, ADHD and for differentiating between Parkinson-plus syndromes (Harezlak & Kasprowski, 2017). Moreover, due to their affordability in recent decades, these methods have been increasingly used in many domains of research (Pretorius, Calitz, & van Greunen, 2005). Given
the previously described context of popularity in the case of health information websites, a number of scientific studies have explored the relationship between ocular fixation and the content and design of such sources, using eye tracking methods. The themes explored to this day on the topic revolve around age differences in website interaction and access, associations between website content type and levels of attention and other self-reported user-content relationships (Bergstrom, Olmsted-Hawala, & Jans, 2013; Djamasbi, Siegel, & Tullis, 2010; Sillence, Hardy, Medeiros, & LeJeune, 2016; Tullis, 2007).

For online health information to be effective, users must trust informational health websites. Self-reported factors that are responsible for driving and affecting users’ trust in health information websites and a method to measure these factors have been evaluated in recent decades by multiple researchers (Williams, Nicholas, & Huntington, 2003). To our knowledge, there is limited physiological insight available on what determines individuals to access certain sources of health-related online information using objective research methods.

Consequently, we set out to explore the relationship between self-perceived trust and visual interaction with online information sources (websites), using ET methods.

**Methodology**

The study is a secondary data analysis conducted based on the original data of a larger study entitled *Trust assessment in medical and health web pages-similarities and differences between subjects investigated with eye tracking, neurology specialist and web trust indicators*, published on March 8th 2016 as a dissertation thesis. As all data used was anonymous, approval from the institutional review board was waived for this stage of analysis.

A total number of 28 gender-balanced young adults (ages 18-39) with ongoing or completed higher education degrees and intermediate or higher knowledge of English were initially recruited in this study as part of a snowball sample (with a total of 40 patients). Potential study participants with medical backgrounds were excluded in order to avoid any biases in relation to the perceived trust of certain websites. Information regarding internet usage and health-related searches was extracted from the original baseline demographic questionnaire. Eye tracking measurements were also collected from original recordings.
Criteria for website selection
The selection criteria for the web pages were based on the relevance to search behavior, the rationale being that Google presents the most relevant and high-quality search results against a particular search term. The process started with a broad search performed on informational keywords (average monthly searches, exact match only) on Google.com, Google.co.uk and Google Australia. From a total of 345 keywords, the top three positions in this search were Alzheimer (550,000 hits) followed by Dementia and Parkinson (both with 368,000 hits). In order to narrow the websites selection, in the second step composite keywords were selected to add specificity to the query.

Four categories were identified: stroke, migraine, epilepsy and dementia. The top pages in each section as returned by Google were finally used in the analysis (Appendix 1).

Eye tracking procedures
ET measurements for each participant were performed using a Pro T60XL monitor device (Tobii, Sweden) in a controlled environment (dark room, fixation of participant head, peripheral vision blinders and individual pre-calibration – figure 1). The experimental design was setup in the Tobii Studio software to assess individual ocular reaction at 30-second exposure intervals to 20 health-related webpages. After 30 seconds of exposure to each static page, the software automatically closed the browsing session and displayed a window with a single Likert scale assessment of self-perceived trust.

In the course of this procedure, the eye tracker measures characteristics of the subject’s eyes and uses them together with an internal, physiological 3D eye model in order to determine several gaze parameters. The examination began with the calibration process, during which each subject was asked to look at specific points on the screen (also known as calibration dots) while images of the eyes are collected and analyzed. The resulting information is then integrated in the eye model and the gaze point for each image sample is calculated. When the procedure is finished the quality of the calibration is illustrated by green lines of varying length. The length of each line represents the offset between each sampled gaze point and the center of the calibration dot (Figure 1).
The procedure is repeated from slide 1 to slide 20. The experiment took place for each subject in a live environment (live feed from the web), therefore there have been cases when a specific webpage failed to load. These events were marked in each patient observational file (Figure 2).
**Eye tracking indicators**

We defined two rectangular areas of interest (AOIs) that correspond to the logo and main header (title) of each webpage from the experiment, using Tobii Studio software. A metric called *Fixation before* was calculated for each AOI. This includes the total number of ocular fixations that have occurred before the first fixation on the AOI. *Fixation frequency* counts the total number of occurrences user fixes his attention on a specific point of the screen. According to Granka et al., fixations are “defined as spatially stable gaze time intervals of approximately 200-300 milliseconds, during which visual attention is directed to a specific area of the visual display” (Granka, Feusner, & Lorigo, 2008). Fixations were also used to calculate total counts for the two types of AOIs.

**Statistical analysis**

A total of 8 variables were included in the analysis: (1) Title AOI fixation total (TAOI), (2) Logo AOI fixation total (LAOI), (3) Non-AOI fixation total (NAOI), (4) Fixation before title (FBT), (5) Fixation before logo (FBL), (6) Self-reported trust rank (RANK) and corresponding totals (AOI TOTAL, FB TOTAL). Subject fixation scores indicated no significant outliers and relatively small standard deviations, hence added sums were used to consolidate subject level data for each website. The mean was used as an aggregate measure for self-reported trust ranks, and websites were used as a statistical unit for the analysis. After preliminary coding and data aggregation, descriptive statistics were performed to meet the assumptions for bivariate correlation analysis. Pearson correlations and corresponding nonparametric equivalents (Spearman’s rho) were performed for all variables included into analysis. Results were summarized using visualizations and tables. The analysis was performed using Office Excel 2016 (Microsoft) and SPSS Statistics v.23 (IBM) for all components.

**Results**

The study sample reported an average of 2.35 hours of daily internet usage. Almost three quarters of subjects browse the Internet for 2 or more hours, mainly from a personal computer (26 out of 28 subjects). Half of study participants declared that they have no previous experience in browsing medical websites. Despite this answer, 78.5% argued that they had searched for specific medical information on the web in the previous 6 months. In total, 35,100 fixation points were detected for all 20 websites (mean=1755, SD=248), averaging 1254 points for each study participant. An important proportion of fixation points (mean=92.2%) were NAOI counts, while logo and title AOIs accounted for a minority of the total, accounting for 2.2% and 5.6%, respectively.
The websites received self-perceived trust marks ranging from 1 to 5 (mean=3.52, SD=0.422). A borderline strong statistically significant positive correlation (r=0.68, p=0.001) was found between logo fixations (LAOI) and self-reported trust rank. Websites that were ranked higher in terms of trust appeared to be more likely to have a higher number of fixations on the logo (Figure 3).

A moderate statistically significant positive correlation (r=0.526, p=0.017) was also observed between fixations before the logo (FBL) and self-reported trust rank. It appeared that study subjects had more fixations on trusted websites before fixating on the logo AOI. The remaining correlations explored in the analysis were unremarkable. These are available for consultation in Appendix 3.

**Discussion and conclusions**

The main objective of this study was to understand the relationship between self-perceived trust and visual interaction with online information sources (websites). To our knowledge, this is an original attempt to describe the physiological manifestations of underlying drivers of trust in health information websites using ocular fixation. The scope of our analysis, although limited by the design of the original study, we feel is a good
starting point for focusing the conversation on involuntary factors that influence preference.

This, in turn may aid in delivering our previously stated resolution for patient-oriented health information sources (credibility, reliability and content quality), by tailoring specific components and content. Tailoring refers to “any of a number of methods for creating communications individualized for their receivers” (Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008). Scientific evidence has shown that approaching behavior change by means of individualization leads to larger intended effects of health communications (Kullgren et al., 2016; Vlaev, King, Darzi, & Dolan, 2019). The key research gap that may be addressed using our approach is knowing “what to tailor for”.

A methodological issue regarding website selection for the analysis was that over the course of the initial study, Google updated its core search algorithm. The so-called “Quality Update” focuses on providing users with the best possible content. From a different perspective, this update rewards the sites that are focused on improving user experience and pushing quality content. It is difficult to determine if the sites originally selected for the study were affected or not in terms of page ranks. Further investigation and similar comparisons will provide new insights on the issue of trust, undoubtedly highly correlated with content. Ideally, the change in the Google algorithm should reflect an optimization of the search engine results based on the core relevance and quality of the websites.

Unsurprisingly, one of the most consistent findings of this secondary data analysis are that graphical elements, in this case the webpage logo is attractive as explored in terms of eye movement, in line with existing literature (Buscher, Cutrell, & Morris, 2009; Yesilada, Jay, Stevens, & Harper, 2008). In the case of our analysis, we consider LAOIs attractive because they present high fixation levels, similar to the page title.

An interesting result is the positive correlation between overall fixation counts for logos and perceived self-reported trust. A possible explanation for this outcome is that long and multiple fixation on graphical elements either trigger recognition of a memorable element (hence perceived trustworthy) or focus attention on the acquisition of knowledge related to the underlying task at hand, which is marking the level of trust in all websites (Bayram & Duygu Mutlu Bayraktar, 2012; Bylinskii, Borkin, Kim, Pfister, & Oliva, 2017). Identity in the digital world means that someone has agreed to trust an association between a name and a key pair, because he or she has directly verified it or trusts an intermediary element (Parry, 2009).

Conversely, a paradoxical finding of the correlation analysis is the positive association between fixation before logo AOI and trust. Following the previously described narrative of importance of graphical elements, a negative correlation would be expected, especially if the logo is recognizable to the subject. Nevertheless, results from our sample indicate
that websites rated with higher trust scores have larger counts of fixation before reaching the logo. We believe that a possible explanation for this result is that website elements are perceived instantly peripheral, as opposite to central (fixative) vision in the case of an easy task, such as identifying a familiar graphical image. Hooge and Erkelens have found that search is more selective and efficient when the selection task is easy or when fixations are long-lasting. Subjects of their research did not increase their fixation durations when the peripheral selection task was more difficult. Only the discrimination task affected the fixation duration. The study confirms our hypothesis that the time available for peripheral target selection is determined mainly by the discrimination task (Hooge & Erkelens, 1999). If fixation count is an acceptable proxy indicator for time, this phenomenon might explain our result.

We further discuss several limitations. First, the study is limited by its cross-sectional design and limited size. Secondly, the complexity of ET procedures has yielded non-usable data points. This in turn has prompted the necessity for data aggregation at website level, as opposite to patient level. A per patient analysis is required in order to assess the homogeneity and hence reliability of observations. The exploratory nature of our hypothesis requires confirmation by a longitudinal approach and a causative regression model. Stratification is required based on patient demographic information. Sample age range should be extended to include children and older adults, in order to increase generalizability of results. Additionally, a number of specialists from medical and non-medical areas may also be examined using eye tracking in order to set benchmarks for content tailoring. Finally, confounder control should be implemented in the analysis by including measures of content and subject homogeneity.

In this paper, progress was made in understanding physiological trust indicators and the dynamics of online trust with a specific focus on medical webpages and user search behavior for health-related online information. By extrapolating the patterns found in this study, future research should focus on applying this framework to various fields of public health, and even to other industries in order to raise their trust markers.

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## Appendix 1

List of websites included in final analysis

| No. | Pathology | Link |
|-----|-----------|------|
| 1   | Stroke    | http://www.strokeassociation.org/STROKEORG/WarningSigns/Stroke-Warning-Signs-and-Symptoms_UCM_308528_SubHomePage.jsp |
| 2   | Stroke    | http://www.stroke.org/understand-stroke/recognizing-stroke |
| 3   | Stroke    | http://www.stroke.org/we-can-help/survivors/stroke-recovery |
| 4   | Stroke    | http://www.nlm.nih.gov/medlineplus/ency/article/007419.htm |
| 5   | Epilepsy  | http://www.epilepsy.com/learn/epilepsy-101/what-happens-during-seizure |
| 6   | Epilepsy  | http://www.webmd.com/epilepsy/guide/epilepsy-symptoms-types |
| 7   | Epilepsy  | http://www.epilepsy.com/ |
| 8   | Epilepsy  | http://www.ninds.nih.gov/disorders/epilepsy/epilepsy.htm |
| 9   | Dementia  | http://www.alzheimers.net/difference-between-alzheimers-and-dementia/ |
| 10  | Dementia  | http://www.healthline.com/health/alzheimers-disease/difference-dementia-alzheimers#Connection1 |
| 11  | Dementia  | http://www.alz.org/alzheimers_disease_stages_of_alzheimers.asp |
| 12  | Dementia  | http://www.webmd.com/alzheimers/guide/alzheimers-dementia |
| 13  | Migraine  | http://www.everydayhealth.com/headache-migraine-pictures/8-home-remedies-for-headaches-and-migraines.aspx |
| 14  | Migraine  | http://www.mayoclinic.org/diseases-conditions/migraine-headache/basics/definition/con-20026358 |
| 15  | Migraine  | http://www.medicalnewstoday.com/articles/148373.php |
|   |   |   |
|---|---|---|
|16 | Migraine | http://www.healthline.com/health/migraine/causes-of-chronic-migraine |
|17 | Stroke | http://emedicine.medscape.com/article/324386-overview |
|18 | Migraine | http://emedicine.medscape.com/article/1142556-overview |
|19 | Stroke | http://www.sailorswithdisabilities.com/album/144/MackayStrokeRecoveryGroup/ |
|20 | Migraine | http://www.understandmigraines.org/migraine-review/theories-about-migraine-causes |
Appendix 2

Descriptive statistics for variables included in analysis, aggregated by websites.

| No. | TA-OI | LAO | NA-OI | FBT | FBL | TOT_A | TOT_W | TOT_F | Rank_avg |
|-----|-------|-----|-------|-----|-----|-------|-------|-------|----------|
| 1   | 95    | 84  | 1329  | 155 | 246 | 179   | 1508  | 401   | 3.79     |
| 2   | 91    | 21  | 1833  | 194 | 108 | 112   | 1945  | 302   | 3.11     |
| 3   | 59    | 80  | 1886  | 112 | 85  | 139   | 2025  | 197   | 3.75     |
| 4   | 55    | 30  | 1041  | 118 | 46  | 85    | 1126  | 164   | 3.29     |
| 5   | 81    | 33  | 1843  | 171 | 80  | 114   | 1957  | 251   | 3.25     |
| 6   | 33    | 89  | 1734  | 174 | 161 | 122   | 1856  | 335   | 4.32     |
| 7   | 70    | 31  | 1712  | 140 | 193 | 101   | 1813  | 333   | 3.71     |
| 8   | 126   | 32  | 1565  | 279 | 482 | 158   | 1723  | 761   | 3.93     |
| 9   | 148   | 96  | 1620  | 116 | 427 | 244   | 1864  | 543   | 4.04     |
| 10  | 63    | 59  | 1531  | 107 | 130 | 122   | 1653  | 237   | 3.71     |
| 11  | 88    | 83  | 1627  | 55  | 212 | 171   | 1798  | 267   | 3.86     |
| 12  | 70    | 12  | 1735  | 118 | 19  | 82    | 1817  | 137   | 2.64     |
| 13  | 88    | 73  | 1662  | 223 | 104 | 161   | 1823  | 327   | 3.07     |
| 14  | 72    | 36  | 2130  | 210 | 82  | 108   | 2238  | 292   | 3.36     |
|   |     |     |     |     |     |     |     |     |
|---|-----|-----|-----|-----|-----|-----|-----|-----|
| 15 | 125 | 64  | 1789| 215 | 77  | 189 | 1978| 292 |
| 16 | 64  | 35  | 1622| 426 | 195 | 99  | 1721| 621 |
| 17 | 37  | 57  | 1637| 82  | 15  | 94  | 1731| 97  |
| 18 | 135 | 37  | 1510| 160 | 71  | 172 | 1682| 231 |
| 19 | 67  | 63  | 1314| 190 | 184 | 130 | 1444| 374 |
| 20 | 72  | 48  | 1278| 186 | 331 | 120 | 1398| 517 |
| SUMS| 1639| 1063| 3239| 8  | 3431| 3248| 2702| 35100| 6679| 70.57|
| AVG | 81.09| 53.15| 1619.9| 171.5| 162.4| 135.1| 1755| 333.95| 3.52|
| SDEV| 31.08| 24.98| 245.4| 7| 80.42| 127.8| 6| 41.261| 247.92| 166.48| 0.42|
Appendix 3

Bivariate two-tailed correlations for study variables.

| Study variables | RANK | TAOI | LAOI | NAOI | FBT | FBT | TOT_A | TOT_W | TOT_FB |
|-----------------|------|------|------|------|-----|-----|-------|-------|--------|
| RANK            |      |      |      |      |     |     |       |       |        |
| *Corr. Coeff.* | 1    | -.009| .676**| -.058| -.258| .526*| .403  | .010  | .279   |
| Sig. (2-tailed) |      | .971 | .001 | .808 | .273 | .017 | .078  | .968  | .233   |
| TAOI            |      |      |      |      |     |     |       |       |        |
| *Corr. Coeff.* | -.009| 1    | .072 | .017 | .116 | .469*| .797**| .149  | .416   |
| Sig. (2-tailed) |      | .971 | .762 | .943 | .627 | .037 | .000  | .529  | .068   |
| LAOI            |      |      |      |      |     |     |       |       |        |
| *Corr. Coeff.* | .676**| .072 | 1    | -.061| -.286| .274 | .660**| .049  | .072   |
| Sig. (2-tailed) |      | .001 | .762 | .798 | .221 | .243 | .002  | .837  | .764   |
| NAOI            |      |      |      |      |     |     |       |       |        |
| *Corr. Coeff.* | -.058| .017 | -.061| 1    | .090 | -.252| -.024 | .986**| -.150  |
| Sig. (2-tailed) |      | .808 | .943 | .798 | .707 | .284 | .919  | .000  | .528   |
| FBT             |      |      |      |      |     |     |       |       |        |
| *Corr. Coeff.* | -.258| .116 | -.286| .090 | 1    | .238 | -.086 | .075  | .666** |
| Sig. (2-tailed) |      | .273 | .627 | .221 | .707 | .312 | .718  | .755  | .001   |
| FBL             |      |      |      |      |     |     |       |       |        |
| *Corr. Coeff.* | .526*| .469*| .274 | -.252| .238 | 1    | .519* | -.163 | .883** |
| Sig. (2-tailed) |      | .017 | .037 | .243 | .284 | .312 | .019  | .492  | .000   |
| TOT_AOI         |      |      |      |      |     |     |       |       |        |
| *Corr. Coeff.* | .403 | .797**| .660**| -.024| -.086| .519*| 1     | .142  | .357   |

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|       | Sig. (2-tailed) |       |       |       |       |       |       |       |       |       |
|-------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| TOT_WEB | .078 | .000 | .002 | .919 | .718 | .019 | .549 | .122 |
|       | .010 | .149 | .049 | .986** | .075 | -1.13 | .142 | 1 | -0.089 |
| TOT_FB | .968 | .529 | .837 | .000 | .755 | .492 | .549 | .708 |
|       | .279 | .416 | .072 | -1.15 | .666* | .883* | .357 | -0.089 | 1 |
|       | .233 | .068 | .764 | .528 | .001 | .000 | .122 | .708 |