SUNTEXT REVIEWS

SunText Review of Economics & Business
ISSN: 2766-4775

Open Access
Research Article
Volume 1:2

Pupillometry and Eye-Tracking in Product Evaluations: The Medical Doctor's Prescription

Cesar Salazar O*

Department of Business and Economics, University of Leon, Leon, Spain

***Corresponding author:** Cesar Salazar O, Department of Business and Economics, University of Leon, Leon, Spain; E-mail: ddecso [at] unileon [dot] es

Received date: 24 August 2020; **Accepted date:** 03 September 2020; **Published date:** 10 September 2020

Citation: Cesar Salazar O (2020). Pupillometry and Eye-Tracking in Product Evaluations: The Medical Doctor's Prescription. SunText Rev Econ Bus 1(2): 109.

DOI: https://doi.org/10.51737/2766-4775.2020.009

Copyright: © 2020 Cesar Salazar O. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Studying human behaviour when making economic decisions is important because they are biased by emotions and instincts. Our approach consists of contributing to the demonstration that non-rational brain processes do influence decision-making and that the study of human behaviour and its decisions should be involved with new technologies such as the eye tracker. This research focuses exclusively on the use and relevance of eye tracking within selective visual attention processes, in response to any marketing stimuli, such as exposure to brands of products known or unknown to the medical doctor. There is ample literature that supports that gaze fixations and pupil diameter are associated with cognitive and emotional processes, showing that large dilations in the diameter of the pupil are associated with positive choices, compared to small dilations in the diameter of the pupil that suggest negative choices. It was possible to establish that the diameter of the pupil acted as an emotional indicator before the presentation of a promotional video of a cream for the healing and treatment of skin wounds. Additionally, it was determined that gender is an explanatory variable for the difference in pupil diameters and that gaze travel and fixations in certain areas of interest, allow us to discover two important conclusions. The first being that the count of fixations together with their duration, are indicators of attention generated in that particular area, the second is related to the importance of the correct measurement of the diameter of the pupil that allows to establish if that fixation that produced attention, is due to an emotional response of acceptance or rejection.

Keywords: Credit Decision making; Human behaviour; Eye tracking; Pupillometry

Introduction

Human behavior and its complexity go beyond traditional observation techniques. Studying human behavior at the time of making economic decisions is important to adjust the offer of companies to the real needs and desires of customers [1,2]. But from the perspective of behavioural economics, human decisions are emotionally biased, how can you determine if the decision made is emotional, rational or a mixture of the two, and in what proportion? With which it is necessary to establish research methodologies consistent with this assumption. The purpose of this article is to determine whether the analysis of pupillometry is applicable to establish whether the decision made by individuals obeys an emotional or rational process. For this purpose, the eye-tracker technology, was applied in the laboratory work [3].

Theory Pupillometry

Based on the foundations of the school led by Kahneman and Tversky, where the decisions of human beings are biased by emotions and instincts, our approach consists of contributing to the demonstration that non-rational brain processes do influence decision-making. Of decisions and that the study of human behaviour and its decisions should be involved with new technologies such as the eye tracker. For this purpose, there is abundant literature that mainly raises how the dilation of the pupil in humans is associated with brain processes of approach / flight to external stimuli. Specifically, the diameter of the pupil is an indicator of measurement of the attention processes of the human being [4-8]. Additionally, there is ample literature that supports

that gaze fixations and pupil diameter are associated with cognitive and emotional processes [9]. On the other hand, for they also suggest that the increase in the diameter of the pupil is involved in the processes of visual attention. Therefore, large dilations in the diameter of the pupil are associated with positive choices, compared to small dilations in the diameter of the pupil that suggest negative choices.

The regulation of emotions is essential for adaptive behaviour and mental health. He investigates the effects of different emotion regulation strategies on pupil dilation, skin conductance responses, and subjective emotional responses. These results indicate that the pupil diameter is modulated by emotional arousal, but is initially related to the extent of mental effort required to regulate automatic emotional responses [10].

that the diameter of the eye's pupil indexes the modulation of the state of arousal and responds to a wide variety of cognitive processes, including mental effort, attention, surprise, decision processes, decision biases, value beliefs. , uncertainty, volatility, exploitation / exploration, compensation or learning rate [11]. In the context of decision making, pupil dilation varies in contexts of uncertainty / certainty. When decisions are made in the absence of uncertainty, as in simple stimulus-response association tasks, the relationship between response and information gain is straightforward. In conditions of uncertainty, the situation is a bit more complex. Zenon highlights this observed relationship between reaction time and pupillary dilation, they are best modelled by repressors that span the entire reaction time period of the tests, rather than limited short pulses at the start of the stimulus. These findings suggest that the process from which pupillary dilation originates is maintained throughout the decision process. The pupil dilates when we make decisions and these fluctuations in pupil size reflect decision-making calculations during and after an election. Like most decisions in real life, they are guided by the results of previous elections. These results show that fluctuations in pupil size can provide detailed information on the calculations underlying value-based decisions and subsequent updating of value beliefs [12].

Eye Tracking

The rise of new technologies that allow human-computer interaction, known by its acronym in English as HCI -Human Computer Interaction, are becoming achievable for marketing, helping to control mismatches or errors in the results of consumer studies, which can also be substantially minimized with the application of these new technologies [13]. Within the great boom of new technologies and since the early eighties, the eye tracking process or eye tracking has been on the rise. Various fields of study cover the application of this tool, from neurological research to usability or experience research. This research focuses exclusively on the use and relevance of eye tracking within selective visual attention processes in response to any marketing stimuli, such as exposure to brands of products known or unknown to the doctor. Taking into account the above, it is pertinent to clarify how HCI helps us to capture data on eye movements. In this case, these are two simple things, but they are usually confused [14]. The Eye-tracking is the software with which the data obtained by the Eye-tracker are processed, which is the hardware in charge of directing recording the eyes. The Eye-tracker's job is to record these types of movements at actual speeds and accelerations. The human eye is a large detection sensor that moves at almost imperceptible speeds [15,16]. Its field of view is not that extensive, it is a relatively small field composed of an ellipse one hundred and eighty degrees (horizontal), versus 130 degrees (vertical). The precision of the human visual field is less than two degrees, which has been called the foveal focus area and is the one that concentrates or focuses the main visual field, followed by the parafoveally area that concentrates between two and five degrees of visual acuity and it ends with an area greater than five degrees that is called the peripheral area. In this sense, it can be said that when human beings want to see or focus with precision, they do so in the foveal area and if they want less precision, they move to the parafoveally area and then to the peripheral area. In order to focus our vision on something of our interest, two types of eye movements come into action, saccades and fixations [17,18]. The fixations are responsible for placing the retina on a stationary target to process it and the saccadic is the movement whose main task is to stabilize the eye in order to focus or “stabilize” the retina. They are extremely fast movements measured in milliseconds.

Two eye-tracking measures that can be used to study cognitive development and plasticity: pupil dilation and spontaneous blink rate [19]. Gaze analysis, which can reveal the current focus of attention as well as cognitive strategies, pupil dilation is modulated by the locuscoeruleus-norepinephrine system of the brain, which controls arousal and physiological attention, and has been used as a measure of subjective difficulty of homework, mental effort, and neural gain [20]. The spontaneous blink rate correlates with dopamine levels in the central nervous system, and may reveal goal-directed behaviour and learning processes. Eye tracking has largely occupied brain imaging research as a way to study the mechanisms underlying behaviour. How visual monitoring has been and could be extended to study cognitive development. For visual monitoring, the use of eye-trackers are necessary. The eye-tracker is the Hardware in charge of directing recording the eyes. Your job is to record these types of movements at real speeds and with realistic accelerations. Visual tracking, sampling rates ranging from 25 to 2000 measurements per second, meaning that the fastest trackers achieve temporal resolution of less than milliseconds, similar to the Davidson

(1988) EEG. It is here where the use of high-tech devices (Eye-trackers) becomes relevant, which really record the movements of the eyes and do not de-calibrate in the face of sudden or involuntary movements of the head. After the data is captured by the eye-tracker, these data are analysed with a software called eye-tracking, which in synthesis what allows at least is to group and summarize the data of the fixations, saccades, coordinates and diameters of the pupils and blinking. Creating in the light of these data the traces or paths travelled by the eyes (Gaze Maps) or the areas where the vision or heat maps (Heat Maps) were mostly fixed. The relevance of using pupillometry as an indicator of emotional processes can be seen in the previous paragraphs. But for this purpose, it is also necessary to apply robust and precise eye-tracker technologies, with which the measurement of the pupil diameter is made easier, since it is a non-invasive technique, and more precise, with the configuration of the appropriate eye-trackers.

Method

It is important that the lighting conditions remain constant, because the pupil reacts to changes in lighting, and that this condition must be taken into account for the measurement of changes in it and to be able to explain the capture of the data as a reflection of the pupillary response to information processing. The present study is exploratory of a descriptive nature, due to the difficulty presented for the recruitment of study subjects, who in this case were medical professionals. 15 appointments were made by medical doctors who will work in areas where they have permanent contact with patients. Of the 15 doctors to study, eight were men and seven women. Seven were under 29 years of age, six were between 46 and 55 years old, one was between 29 and 39 years old, and finally a doctor over 55 years of age. The pupillometry test was carried out on an individual, closed space of four square meters of surface, with dim and constant light through two eco-halogen lamps. Additionally, the walls of the space used are opaque white, which prevents glare and glare. A 17 " monitor and the Eyeteeth company eye-tracker were used (60 Hz), was located 70 centimetres away from each of the participants. Each participant obtained a calibration of both eyes greater than 80%. The resolution of the monitor used was 1366 x 768 pixels. At one minute and six-second-long video was projected on this monitor, showing the presence of a topical cream for the treatment of burns and skin ulcers. The software used to analyse the data obtained with the eye-tracker was the Mangold Vision 4.0 eye-tracking. Each one of the participants was informed before the test what it consisted of and a brief explanation of the eye-tracker, which is a non-invasive technology without any risk to the individual's visual health. For the analysis of the data obtained by the eye-tracker, the attachment aggregation method was used. This method creates groups around anchor points. For this, at least 3 coordinates must be found that were recorded within the defined distance from each other (Cluster size) and have at least a minimum fixation at the moment these three points are found, all points within this area they are added to a single group. Those results can be read as real life fixation points and all values outside of those areas will be ignored. With this method, 1032 aggregated records were finally obtained.

He was told that a video of one minute and six seconds would appear. At the end of it, a questionnaire automatically appeared on the screen, with questions regarding the content of the video. The questionnaire data was captured through the CAWI application of the company Tesi [21-23].

Results

Figure 1 shows the AOIs or predefined areas of interest for data analysis. There are five areas of interest determined a priori: those located in the center of the screen that go from attribute one to attribute three, in the area of attribute number one appeared the brand of the product and the following sentence: "Bioengineering applied to the healing of wounds". For attribute number two, images of cells, chains of cells, and the like were constantly appearing. For attribute number three it appeared: "Greater granulation tissue, appearance, color and elasticity similar to normal" and "Wounds, Burns, Skin Ulcers". The fourth area of interest was located in the upper left corner of the screen, where the product brand would continually appear, and the area of interest located in the lower right corner of the screen, where the laboratory logo always appeared. Pharmaceutical manufacturer of the product to be evaluated. The product evaluated was a topical cream for the healing of skin wounds due to burns. In this article, neither the brand nor the name of the laboratory is presented, for reasons of privacy of this data (Figure 1).

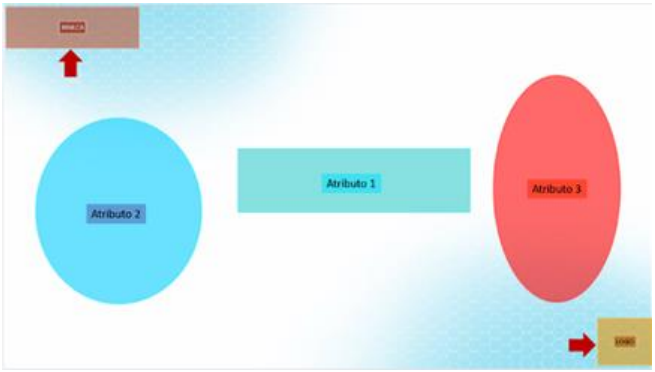

Figure 1: *Areas of Interest.*

Figure 2 shows the four heat maps or heat maps as a result of the eye tracking tests applied to the men participating in the study. These heat maps reflect the specific moments where the greatest focus of attention was generated in the video. In maps number one and two it is observed that the highest count of gaze fixations

occurred for attribute number one and to a lesser extent for attribute number three. At these specific moments in the video there were no reinforcement phrases towards the product. In map number three, the fixation trend towards attributing one continues, and for attribute three, attention is already focused on the explanatory text or argumentation about the healing benefits of the product. In map number four, attention is strongly focused on the healing effect of the cream, that is, an attribute number one (Figure 2).

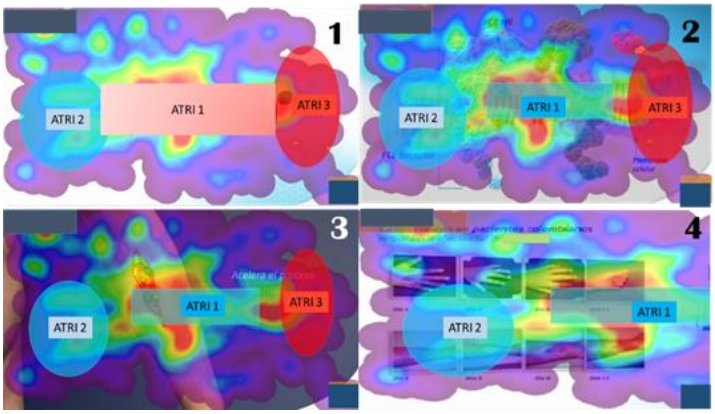

Figure 2: *Heat maps for men.*

Figure 3 shows the four heat maps or heat maps made to the women participating in the study. These maps reflect the specific moments where the greatest focus of attention was generated in the video. The resulting heat maps are similar to the behaviour of the gazing for the group of men, with a similar tendency towards great attention to the demonstration of the effectiveness of healing cream, chosen in attribute number one of map number four (Figure 3).

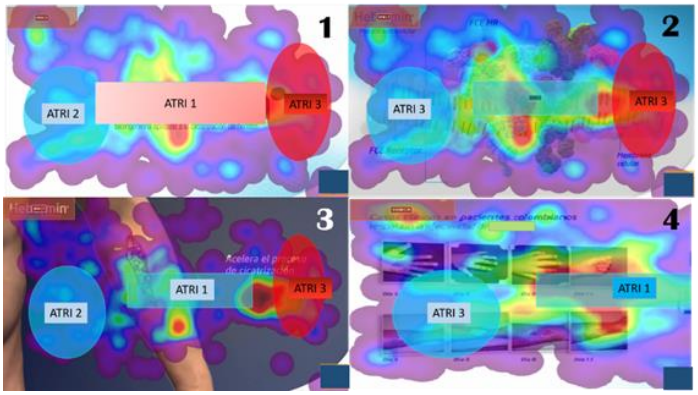

Figure 3: *Heat mas for female.*

Now, observing in figure 4 the distribution of absolute frequencies by gender, of each one of the AOIs from the heat maps or heat maps of figures one and two, attribute number one obtained the highest number of aggregated fixations, followed by attribute three and two. The brand and logo areas present low counts of added fixations, and of the latter two, the pharmaceutical company logo did not attract the attention of the study participants (Figure 4).

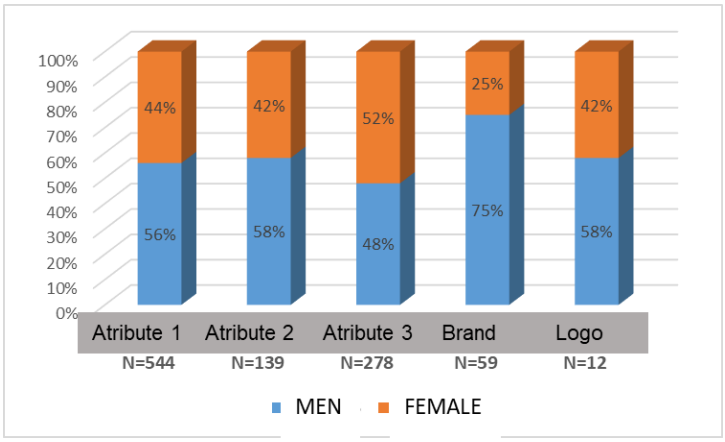

Figure 4: *Frecuencies by gender.*

Descriptively, some incidence of the gender variable can be seen in each of the areas of interest under study. In this sense, we proceeded with the ANOVA analysis to clarify whether both the gender variable and the area of interest variable, influenced the behaviour of the pupil diameter of the participants. In order to complement this analysis, Figure 5 provides the aggregate distribution of fixations in relation to the diameter of the pupil observed in men and women. The diameter of the pupil for men and women ranges from approximately three to seven millimetres. The data distribution for both men and women does not fit the normal curve. With an average diameter of the pupil smaller in men than in women. This suggests that the process of fixation and attention was greater in women than in men, because the diameter of the pupil in women is greater than in men (Figure 5).

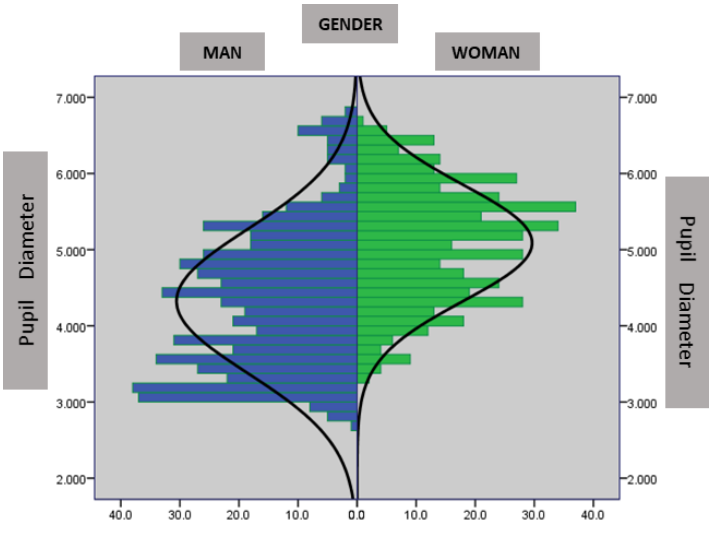

Figure 5: *Normal test.*

Continuing the analysis of the incidence of the gender variable and particularly the category of women, it is pertinent prior to any confirmatory analysis, to apply the normality test for the pupil diameter through the Shapiro Wilks contrast, this contrast yielded a significance of 0. 000 with 1032 degrees of freedom and its statistic of 0.982. Checking what was stated in the previous paragraph of the absence of normality in the data of the variable pupil diameter.

Having determined the absence of normality, the analysis of variance (ANOVA) was applied, in order to determine if there were significant differences in two groups of independent variables. These groups were the gender variable and the areas of interest AOIs. Duration time (Fixation) and pupil diameter were chosen for the variables to be contrasted. Before proceeding with the analysis of variance, the Levine test of equality of variances was requested for the two variables to be contrasted. In relation to the independent variable Gender and the variable time of duration, the statistic was 14,565 with significance 0.000. In turn, for the variable pupil dilation, the Levine statistic was 23.046 and significance 0.0000. Allowing to establish for both cases the non-equality of the variances for each of the effect variables. Now, for the independent variable areas of interest, the same contrast was repeated, yielding 4.716 as Levine's statistic and significance as 0.001. Since the diameter of the pupil the statistic has been 2.571 and significance was 0.037. Likewise, it can be asserted that the data from the contrasted variables do not present equal variances. Knowing the results of the tests for the assumption of the equality of the variances, the Games-Howell test is chosen as the contrast statistic, which allows the results of the statistics to be contrasted under the assumption of difference in the variances (Table 1).

Table 1: *ANOVA.*

Tests of Normality						
	Kolmogorov-Smirnov			Shapiro-wilk		
	Statistic	df	sig.	Statistic	df	sig.
Duration time	0.162	1032	0	0.784	1032	0
Pupil Diameter	0.048	1032	0	0.982	1032	0

Table 1 shows the results of the ANOVA tests for the independent variables gender and AOIs. The gender variable affects the two contrasted variables (Time of duration of fixation and pupil diameter), with level p <0.05, however, for the independent variable AOIs, it only affects the differences in the variances of the variable "Pupil diameter". Additionally, the Games-Howell test (Partial eta squared column of table number one), of non-equality of variances being very low in the score, only allows us to clarify that the independent variable gender affects the two independent variables more strongly than the variable AOIs. Having determined that the gender variable affects the behaviour of the pupil diameter and the areas of interest (AOIs), and as a descriptive complement to the ANOVA analysis, the correspondence analysis is presented in order to identify the closest associations between the categories. Of the AOI variable and the categories of the variable "Pupil diameter". Given that the variable "Pupil diameter" has the characteristics of a continuous variable, it was transformed into an ordinal variable, converting these values to "z" values with mean 0 and deviation 1. Values greater than one deviation were named as "Dilated Pupil", values between 0 and 1, were assigned the category "Normal pupil" and values lower than 0, it was called with the category "Pupil in contraction". Through this method a new ordinal variable with three categories was created. For the correspondence analysis procedure, SPSS 22 was used. Assigning the independent variable "AOIs" in the column categories and the new variable "Pupil Dilation" in the row categories. Table 2 shows the results of the correspondence analysis, observing that the dimension number one represents 95.5% of the total variation and the dimension number two represents only 4.5% (Table 2).

Table 2: *Dimensions of the correspondence analysis.*

Summary								
Dimension	Singular value	Inertia	Chi square	Sig.	proportion of Inertia		Confidence singular value	
					Accounted for	Cummulative	Standard deviation	Correlation 2
1	0.158	0.025			0.995	0.995	0.03	-0.028
2	0.34	0.001			0.045	1	0.03	
Total		0.026	27.052	0.001a	1	1		
a. 8 degrees of freedom								

In table number three, we can see the relative contributions of each of the categories of the column and row variables to the two dimensions that represent the associations or correspondences between them. Dimension one that collects or represents 95.5% of the total variation, is loaded first by the category "Dilated Pupil" followed by the category "Contracted Pupil". In the categories of

the variable AOIs, attributes three and two, respectively, contribute the most to this dimension, followed by attribute one and the product brand. For dimension number two, which represents 4.5% of the total variance, it corresponds to the category "Normal pupil" and the logo of the pharmaceutical laboratory (Table 3).

Table 3: *Relative Contributions.*

Variable	Code	D1	D2
Pupil	Contraction	93.62611	6.37359
Diameter	Normal	11.5468	88.45359
	Dilated	99.7319	0.26587
Areas of Interest AOIs	Attribute 1	89.5288	10.4489
	Attribute 2	96.88145	3.11754
	Attribute 3	99.3691	0.63136
	Brand	91.38765	8.61399
	Logo	63.34464	36.65255

Observing the correspondence map of figure number six and taking into account the relative correspondence of dimension one (D1), we see the closeness of attribute three and the brand of the product, with the "Dilated Pupil" and attribute two moves away of attribute three and without correspondence with the size of the pupil. This could mean that the brand and attributes featured in focus area number three generated more attention than attributes one and two, along with the pharmaceutical company logo (Figure 6).

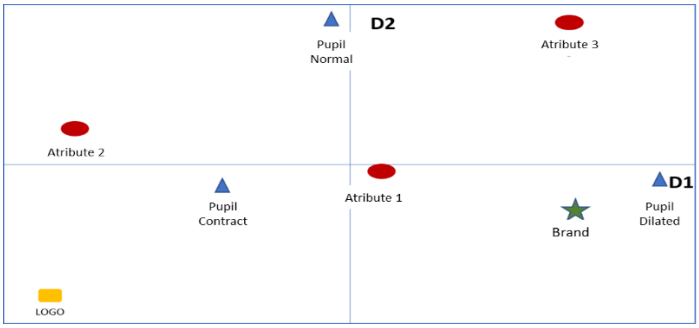

Figure 6: *Correspondences map.*

Next, the analysis of the verbal responses to the questions asked after watching the video is described, it is convenient to remember that asking a person to answer some questions together with the evaluation of each of the response items, is a process that activates system two or the rational brain proposed by Kahneman and Tversky. Here, the importance of comparing or descriptively comparing the responses obtained in the eye-tracking tests is highlighted against the verbal responses that are presented below. Table number four collects the answers to the question about the general opinion about the video, the data represented includes the mean and the coefficient of variation, obtaining the highest value for the category "Credible" and the one with the lowest coefficient of variation (Table 4).

Table 4: *Descriptive video analysis.*

	Mean	Coefficient of Variation
Shocking	5.267	24.3
Differentiated	5.333	25.2
New	5.6	28.5
Credible	6.2	13.9

In table number five, the averages and coefficients of variation of the responses obtained two sentences that collected the attributes represented within the areas of interest are presented. Being able to establish the interesting coincidence between the verbal responses and the fixations with their respective diameters of the pupil. The highest average is collected by one of the attributes located in area of interest number one, followed by attribute number one "Accelerates the healing process" (Table 5).

Table 5: *Attribute statistics.*

Frase	Mean	Coefficient of Variation
It is effective in managing wounds and skin ulcers.	5.993	23.4
It has bacteriostatic and bactericidal activity, protecting the affected area from possible infection.	6.8	6.1
Reduces wound evolution time.	5.867	30.8
Accelerates the healing process.	6.257	19.5
Provides a greater granulation fabric leaving skin with similar appearance, color and elasticity.	6.267	22.1

Finally, in table number six the doctors decided whether they would prescribe the product or not. 60% say they know the product, but had not prescribed it and would start to prescribe it.

Conclusion

Through the work carried out in this article whose main purpose was to determine if the analysis of pupillometry (Measurement of the pupil diameter) is applicable to establish if the decision made by individuals obeys an emotional or rational process.

Throughout the present investigation, the reasons why different authors have used the measurement of the pupil diameter (Pupillometry) in various areas of medical and psychological research were exposed, and its importance in establishing emotional reactions without the mediation of verbal responses. In this research, eye-tracking technology was methodologically combined with CAWI (Computer Assisted Web Interviewing) technology, which was in charge of capturing the verbal responses of the study participants. I was able to establish that the diameter of the pupil acted as an emotional indicator before the presentation of a promotional video of a cream for the healing and treatment of skin wounds. Additionally, it was determined that gender is an explanatory variable for the difference in pupil diameters and that gaze travel and fixations in certain areas of interest, allow us to discover two important conclusions, the first being that the count of fixations along with their duration, are indicators of attention generated in that particular area, the second is related to the importance of the correct measurement of the pupil diameter that allows to establish if that fixation that produced attention, is due to an emotional response of acceptance or rejection. With which it was also possible to contrast in this study that the verbal responses of the evaluated medical doctors did coincide with the findings of the pupillometry. At this point, it is of special interest that in future research the Human Computer Interface (HCI) tools can be combined with the traditional survey-type instruments. This combination allows enriching study findings with a broad application landscape. What is important is creativity in methodological designs for consumer research as opposed to applying a single data collection technique. With advances in computer storage and processing speed, such creativity and innovation is very achievable.

References

1. Eraslan S, Yesilada Y, Harper S. Identifying patterns in eye tracking scan paths in terms of visual elements of web pages. Springer Int Publishing. Switzerland. 2014; 8541: 163-180.
2. Erel H, Levy D. Orienting of visual attention in aging. Neurosci Biobehavioral Reviews. 2016; 60: 1-24.
3. Kahneman D. Maps of bounded rationality: psychology for behavioral economics. The American Economic Review. 2003; 93: 1449-1475.
4. Bayat A, Pomplun M. The influence of text difficulty level and topic on eye-movement behavior and pupil size during reading. 2016 2nd International Conference of Signal Processing and Intelligent Systems. 2016.
5. Ehlers J, Strauch C, Georgi J, Huckauf A. Pupil size changes as an active information channel for biofeedback applications. Applied Psychophysiol Biofeedback. 2016; 41: 331-339.
6. De Gee JW, Knapen T, Donner TH. Decision-related pupil dilation reflects upcoming choice and individual bias. Proceedings National Academy Sci. 2014; 111: 618-625.
7. Deltomme B. Instructed fear stimuli bias visual attention. Acta Psychologica. 2018; 184: 31-38.
8. Kiefer P, Giannopoulos I, Duchowski AT, Raubal M. Measuring cognitive load for map tasks through pupil diameter. In: proceedings of the ninth international conference on geographic information science. Springer Int Publishing. 2016.
9. Kahneman, Beatty J. Pupillary responses in a pitch-discrimination task. Perception Psychophysics. 1967; 2: 101-105.
10. Kinner V, Kuchinke L, Dierolf A, Merz C, Otto T, Wolf O, et al. What our eyes tell us about feelings: tracking pupillary responses during emotion regulation processes. Psychophysiol. 2017; 54: 508-518.
11. Zenon A. Eye pupil signals information gain. Proc Biol Sci. 2019.
12. Slooten VJ, Jahfari S, Knapen T, Theeuwes J. How pupil responses track value-based decision-making during and after reinforcement learning. Plos Computational Bio. 2018.
13. Meibner M, Musalem A, Huber J. Eye tracking reveals processes that enable conjoint choices to become increasingly efficient with practice. J Marketing Res. 2016; 53: 1-17.
14. James BW. The neural basis of visual attention. J Physiol. 2011; 589: 49-57.
15. Moss MFJ, Baddeley R, Canagarajah N. Eye movements to natural images as a function of sex and personality. PLOS ONE. 2012.
16. Pomplun M, Ritter H, Velichkovsky B. Disambiguating complex visual information: towards communication of personal views of a scene. Perception. 1996; 25: 931-948.
17. Courtemanche F, Leger PM, Dufresne A, Fredette M, LeMoyne E, Senecal S, et al. Physiological heatmaps: a tool for visualizing users emotional reactions. Multimed Tools Appl. 2017; 77: 11547-11574.
18. Salvucci DD, Goldberg JH. Identifying fixations and saccades in eye-tracking protocols. Palm Beach gardens. Florida, USA. 200.
19. Eckstein M, Carrillo GM, Singley M, Bunge A, Silvia A. Beyond eye gaze: What else can eye tracking reveal about cognition and cognitive development. Developmental Cognitive Neurosci. 2016; 25: 69-91.
20. Dhar S, Pradhan T, Gupta S, Routray A. Implementation of real time visual attention monitoring algorithm of human drivers on an embedded platform. Proceedings of the 2010 IEEE Students Technology Symposium. IIT Kharagpur. 2010; 3-4.

21. Davidson RJ. EEG measures of cerebral asymmetry: conceptual and methodological issues. Int J neuroscience. 1988; 39: 71-89.
22. Hubscher M, Moseley L, Martin B, Mcauley J, Skinner IW, Lee H, et al. The reliability of eye tracking to assess attentional bias to threatening words in healthy individuals. Behavior Res Methods. 2017; 1778-1792
23. Yuan L, Xu T, Yu C. Seeing is not enough for sustained visual attention, conference paper, department of psychological and brain sciences, and cognitive science program. Indian University Bloomington. USA. 2017.