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Neuromarketing Techniques for Software Usability Evaluation to Understand Motivations of Behaviors: an Integrated Perspective

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ABSTRACT

This report presents the results of a software usability study in a web environment for analytical purposes to be used by legal organizations. Eye tracker, facial expressions recognition and galvanic skin response (GSR) technologies, and the application of a questionnaire were used in an integrated way to understand the motivations of behaviors and corroborate the observations among the participants, to analyze these results and understanding of the user attention and detect attractive areas in the interface. The results show that the eye tracker made it possible to measure user attention and identify problem areas in the interface. On the other hand, facial expression recognition allowed us to analyze the user's emotions during the interaction, and the galvanic response of the skin allowed us to detect physiological changes associated with the user's experience. The results confirm the potential of neuromarketing techniques for software evaluation, and the value of these techniques increases to the extent of their use and interpretation.

Keywords: Neuromarketing; Software usability; Motivations; Behaviors; Legal organizations.

INTRODUCTION

Usability is crucial for web-based legal tool design since it can impact effectiveness and efficiency and improve user satisfaction when performing different tasks. Consequently, traditional usability evaluation techniques may need more precision and subjectivity in measuring the user experience. On the other hand, neuromarketing techniques reveal their potential for these purposes.

The neuromarketing research is relatively new compared with most fields. The Scopus database registered only 921 publications in the field, the first two dating from 2004 (The Lancet Neurology, 2004; Singer, 2004). Despite the novelty of the subject, joint research with different scientific disciplines has already been reported.

Specifically, the administrative sciences field reported only 291 publications, the first in 2006 (Grimes, 2006). Of this whole, 160 publications (55%) focus on theoretical analyses that seek to establish the conceptual foundations (Bulut & Arslan, 2020; Ramsøy, 2019), methodological (Agarwal & Xavier, 2015; Tinoco-Egas et al., 2020), legal (Revilla-Camacho et al., 2018), showing the relevance or viability of this field of research (Sharma & Nama, 2022), or delve into the crucial ethical connotations that these research field (Bulley et al., 2018; Luna-Nevarez, 2018).

Correspondingly, 123 publications (42%) show potential for practical applications that characterize neuromarketing. The objects of applied studies are diverse, with a predominance of research associated with tourism (Ladkoo, 2020; Savelli et al., 2022), online commerce (Moya & García-Madariaga, 2022), food consumption (Covino et al., 2021), marketing of beer or wine (Alvino et al., 2020; De Oliveira & Giraldi, 2019). Likewise, some researchers seek to establish differences by the multiplicity of variables such as gender (Pileliene & Grigaliunaite, 2017; Stefko et al., 2021) or age (Di Flumeri et al., 2016; Garczarek-Bąk et al., 2021).

Also, we observed changes regarding the type of stimulus and the sensations researched. Some studies reported the influence of music (Cha et al., 2020; Levrini et al., 2020), visual stimulation through the use of colors (Pileliene & Grigaliunaite, 2017; Norman Acevedo et al., 2015), or places lightning (Horská & Berčík, 2014), the use of smell (Cherubino et al., 2018), the generation or role of memory (Alonso Dos Santos et al., 2019) or the influence of the memory (Baldo et al., 2022).

A significant percentage of the published research shows the potential of the tools that facilitate the development of neuromarketing research. Eye-tracking studies (Pascucci et al., 2022; Zahmati et al., 2022) and electroencephalograms (Di Flumeri et al., 2016; Cherubino et al., 2016) are the most widely applied, followed by functional magnetic resonance imaging (fMRI) (Gómez-Carmona et al., 2022; Krampe ,2022) the analysis of facial expressions (Hammond et al., 2022) and the measurement of galvanic skin response (GSR) (Ohme et al., 2009; Xu et al., 2023).

This research presents the results of the software evaluation in a web environment through the combination of several neuromarketing techniques (eye-tracking, facial expressions analysis, and galvanic skin response) complemented with the application of a questionnaire that allows to confirm the results of the preceding techniques and to deepen in their potential causes.

DEVELOPMENT

Software usability is a group of techniques and methodologies applied to different web pages to analyze the user's comfort in navigating the page (Massaro et al., 2021). It has been studied since 1970 (Bouvard, 1970; Ohtawa et al., 1970). Since then, investigation in the field has been on the rise, highlighting researchers such as Nielsen and Molich (Nielsen & Molich, 1990; Norman Acevedo et al., 2015; Shneiderman, 2005).

Researchers like Ruiz et al. (2021) analyzed 472 articles published between 1982 and 2019 in which they initially identified 205 design principles. Through a process of analysis,

they established a set of 50 rules, and several can be evaluated with the help of neuromarketing techniques, among them:

- Make things visible
- Structuring user interfaces
- Provide visual cues
- Provide marked exits
- Iterative design to eliminate usability issues
- Speak the user's language
- Provide shortcuts
- Affordability
- Users involved in the design
- Recognition rather memory
- Allow users to customize the interface (preferences)
- Encourage exploration (predictable)
- Avoid frustrating the users
- Respond to user actions.

Hence, neuromarketing techniques are new tools proposed to evaluate the usability of software based on eye-tracking technologies, facial expression recognition, and galvanic skin response.

According to Gill and Singh (2022), the background of neuromarketing is associated with the advances in the domain of a group of researchers at Harvard University integrating different fields of knowledge, which allowed them to reach additional conclusions, changing the way psychology, neurobiology, economics, and other related disciplines study the decision-making process. The results allowed them to provide significant outcomes, such as the one that states our subconscious level is related to most of our decisions and choices.

With subsequent applications of these studies, the concept of neuromarketing was born. Lee et al. (2018) provided the most accurate definition as "the application of neuroimaging to marketing problems." Subsequent empirical research validates this claim: "Ads that created the best emotional reaction caused a 23% increase in market volume over the side effects of traditional promotional techniques" (Wilson, 2002).

According to Wilson (2002), every second, all senses can create an estimated 11 billion bits, while an individual can process only about 50 bits of that information, leaving most of the

data unnoticed. Under these conditions, sight has a profound influence on decision-making behavior.

Consequently, science has generally established three critical moments in acquiring, processing, and interpreting information. The sensory organs capture the information, the brain processes it, and finally, it is interpreted, provoking reactions in the test subject that receives the external stimuli. Although this occurs in micro fractions of time at the brain level, these three moments always occur in that hierarchy. Based on this logic, neuromarketing tests have been developed: some seek to study the information capture process, such as eye tracking; others study the information processing process, such as electroencephalograms or functional magnetic resonance imaging; and finally, others delve into the reactions that trigger responses such as galvanic sensations or facial expressions. Due to the complexity of the processes and the speed with which these three stages occur, it is only occasionally possible to perform tests that allow them to be separated, which are described below (Plassmann et al., 2012):

- Stage 1. Information gathering (Evidence: eye-tracking)
- Stage 2. Information processing (Evidence: electroencephalogram functional magnetic resonance imaging)
- Stage 3. Reaction to stimulus (Evidence: facial expressions galvanic sensations).

Regarding the first stage, Gill and Singh (2022) acknowledges that to delve into the consumer's reaction to different products or understand the patterns of gaze permanence in lifelike environments, specialized laboratories use "eye-tracking" or "eye-tracker," which is a valuable technique to analyze the places where people look, mainly when the eye fixes its attention on a certain point. Salabun et al. (2017) states that eye-tracking is also used with different equipment to measure cognitive response and generate synergy to obtain the latest insights, especially according to marketing communication and consumer behavior.

Pupil Labs (2016) expresses that this approach allows establishing answers to critical questions such as: What does this person feel? What are they interested in? How distracted or sleepy are they? What is their state of mental or physical health?

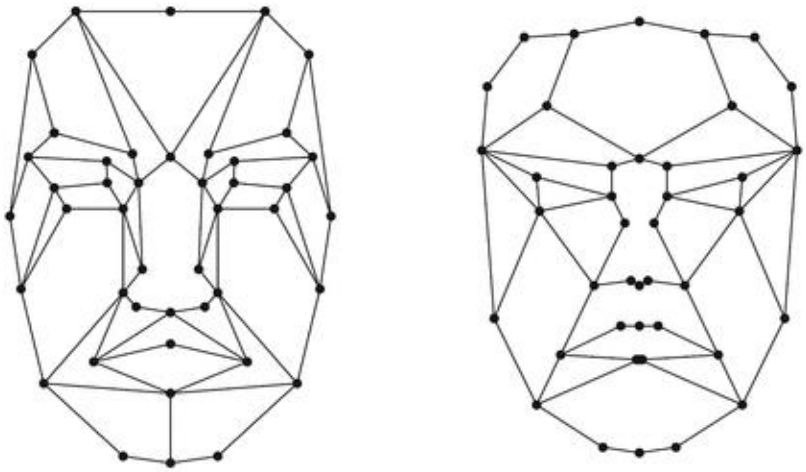
For the development of the second stage, techniques often used are Electroencephalogram (EEG), which directly measures the cortical activity of brain waves resulting from neurons communicating. Dynamic brain activity is captured as a voltage through the event-related potential (ERP), fixed in duration to particular stimuli, and presented as a function of time. From the stimulus generation (zero time), they monitor brain waves in response to the stimuli. Coşkun and Yücel (2021) applied EEGs to evaluate websites, finding

that colours, reference points, and the feeling of missing opportunities are essential to consumers.

Regarding the third stage, science has been developing new methodologies to understand the emotional reactions of subjects to stimuli by reading facial expressions, which are in the group of tests that are not neuroimaging and allow obtaining equally valuable inputs of information. In this sense, specialized software has been developed that incorporates face-reading algorithms with artificial intelligence based on the interpretation of millions of videos of faces. Academic experts provide the interpretation of faces and specialize in performing analysis of them and their emotions. In order to carry out these interpretations, the system fixes points on the face, such as the jaw, eyebrows, mouth, eyes, nose, or others, to reference the expressions. Figure 1 shows an example of how the system works.

Figure 1.

Fixation points for reading facial expressions



Note: Adapted from https://es.123rf.com/

Specialized software algorithms classify image frames into more general groups of reactions (positive, negative, or neutral) and identify emotions such as anger, attention, confusion, contempt, disgust, commitment, fear, joy, sadness, and surprise. With the correlation of these results, it is possible to infer stimuli or sections that may or may not help assess the objectives of the stimuli.

Studies based on skin reactions use galvanic skin response meters (galvanic skin response - GSR) through sensors that measure the electrodermal activity—establishing a physiological indicator that indicates a more significant amount of sweating, improving

electrical conductance (Moya et al. 2020), allowing to induce an emotional impact in real time of the stimuli.

METHODOLOGY

For the development of the investigation, the researcher attended the following steps:

Step 1. Description of the software

Judit Inteligencial Judicial is a legal-tech tool that offers information on judicial procedures in Ecuador from 2016 to 2021, incorporating data analytics retrieved from the information published in the Judicial Function System, seeking to identify patterns, trends, and statistically significant relationships, allowing to improve legal argumentation, refine strategies, facilitate decision-making and personalization of legal services.

This information is the most valuable asset that the tool has. It required the creation of a "web scraping" code, which raised 80 GB of information from judicial processes, which go through an algorithm of information classification that allows transforming all the cases raised into relevant statistics, having so far processed information from more than 36 million actions grouped into 1.3 million judicial processes, classified into 1377 matters. At this time, the mining process continues running. This way, it can contain and analyze a significant percentage of Ecuador's judicial processes and cases.

The first module, Analytics, generates a first statistical approach to the judicial situation in Ecuador. It has graphs with the available information, the leading causes, and the geographical distribution.

The following module is about legal cases, which allows the generation of information on law according to the type of judicial process. It has a filter module that allows anyone to define the information that will be displayed. It presents the graphs of judges' acting times, trends in judgment, filters by the court, and information in PDF documents on the actions of the different legal procedures.

The court module generates information on jurisprudence according to territorial parameterization. To comply with this function, it has an information filter section, which, once applied, allows viewing time information, trends in judgment, and obtaining information in PDF documents.

The following module, Judges, focuses on collecting information from a particular judge. Once this is selected, it displays contact information and the option to filter the details

of their actions based on a period at the user's convenience. Subsequently, it will display statistical information similar to the previous modules.

Step 2. Measurement development

Selecting measurements available in the software Imotions used for capturing information and parametrizing test subjects' reactions. The experiment does not consider brain processing measurements. Additionally, a questionnaire was applied to verify the validity of the previous results and delve into the causes of the observations made. Table 1 summarizes the instruments employed and the indicators related to each one.

Table 1.

Instruments and indicators used

Stage	Instrument	Indicators
Data collection	Eye tracker	Fixations and gaze points Saccades Time spent (dwell time) Heatmaps Fixations sequences
Generated reaction	GSR	Peaks of emotional arousal Spikes per minute Average Peak Amplitude
	Facial expressions	Emotions detected Time by emotions
Post-processing	Questionnaire	Appreciation Complexity Relevant information Information assessment Recommendations

Step 3. Determination of the sample for analysis

The experiment considered a convenience sample of six study subjects. All are linked to the law field of study (two are law students and four are legal professionals), equally distributed among students, recently practicing lawyers, and lawyers with more than 15 years of experience. The study participants were three men and three women, with an average age of 32.6 years. The oldest participant is 49, while the youngest is 22 years old. To encourage participation, a raffle for prizes was held for the participants. Informed consent was guaranteed, and the confidentiality of the individual identification data of the participants was guaranteed.

Step 4. Gathering data

Before starting the experiment to gather data, we explained the software's purpose, characteristics, and structure to the participants. They were allowed to navigate freely for 5 minutes. Subsequently, each participant has to fulfill the following tasks:

Task 1: In the analytics module, determine the following:

- What is the process that is the second most analyzed?
- In 2016, which process had the most extended average duration?

Task 2: In the legal cases module, obtain information from the following legal procedures:

- Topic: Legal protection
- Practice: Family, woman, childhood, and adolescence
- Filter by Azuay province
- Filter by Guayas province
- Get the PDF of one of the process outcomes of the filter application.

Task 3: In the court module:

- Obtain information for the province of Pichincha, Quito canton, specialized Court of the Family, Childhood, Adolescence, and Adolescent Offenders, Provincial jurisdiction.
- Obtain information for the province of Manabí, Manta canton, and the Court of Criminal Guarantees of Manta.
- Get the PDF of one of the process outcomes of the filter application.

Task 4: In the judge module:

- Filter at least two judges.
- Get the PDF of one of the process.
- Outcomes of the filter application.

While the participants complete the tasks, their interaction will be recorded in front of a monitor configured to access the web page under evaluation. It is essential to mention that when the test subject was interacting freely on the web page, the time the stimulus was considered "asynchronous," meaning that the free navigation and the execution of the assigned tasks were not performed simultaneously. Once the test subjects finished the tasks, they responded to a questionnaire designed in three parts, with 13 aspects related to the platform's usability.

General evaluation of the tool (a Likert evaluation scale):

- How would you rate your experience using the tool?
- Is the tool easy to use?

- Did the tool have been easier to use or more precise? Which elements and why?
- How useful do you encounter the information provided by the tool?
- Do you consider it an efficient and effective tool to carry out your tasks?

Module evaluation. Rate each of the modules on a scale of 1 to 5 on each of the following attributes:

- Easy to use
- The usefulness of the information
- Information graphics
- PDF reports (PDF generation)
- What would you recommend to improve the module?

Willingness to foster its use:

- Would you recommend the tool?
- Why would you do it?

Step 5. Information processing

We gather data by utilizing specialized software to infer stimuli or sections that may or may not be helpful to the user. In addition, the galvanic skin response meter (GSR) data is correlated. It is a sensor that measures the electrodermal activity of the skin to induce an emotional impact in real time of the stimuli.

A timestamp tag was used as the unit of analysis. It allows us to determine the module the user is navigating, helping to discriminate the data retrieved from the gaze sensor, facial expressions, and electrodermal activity peaks and presenting each result. As part of the evaluation throughout the completion of the tasks, time was considered as another indicator of the software's functionality. We assume it has a good design if the user gains skills during the experience and completing tasks. Therefore, the time spent should decrease. Additionally, we use the information from the processed questionnaire.

RESULTS

Eye tracking

According to the description of the methodology, the results are presented below:

Analytics module: We identified three points of gaze concentration: the graph of the number of legal cases per year, the number of legal cases by province, and the word cloud with the top 10 most dealt cases by the Ecuadorian justice system. The territorial distribution of the processes also caught the participants' attention based on the interest generated by the

information. Many of them clicked on the provinces, waiting to display information by province, which suggests that developers could add this functionality.

In this module, the experiment required identifying the process with the most prolonged average duration in 2016, represented in the final graph of the analytics page, called "Average duration per subject/year." However, the gaze did not focus on the expected area of interest with the correct answer. The outcome could be interpreted as a lack of clarity in the graph and, consequently, could lead to confusion.

Legal causes module: In this case, the gaze concentration suggests a greater diversity in the points of attraction. In the section on statistical analysis, the sight concentrates on the pie graph legends, which implies an interest in these results. The section on topics with more resolutions by trends in judgment shows an apparent concentration of gaze related to the Western reading pattern, from left to right, focusing on the left graph. The right one shows less relevance due to the influence of the prior analysis. In the heading of "courts with the most verdicts ruled", the results reveal a certain level of relevance. The results also indicate the need to improve the data reporting due to a functionality failure associated with the territorial map of Ecuador and its update.

The analysis of cases by province and the sex of the judge also showed a high level of gaze concentration. On the other hand, the information regarding the distribution of cases by year was not a point of interest. The evolution of the rulings classified by their trends in judgment was another area of interest, especially in the females.

Court module: The gaze tends to be less focused and concentrated in fewer places. However, it is relevant to analyze the duration of the legal cases, the trends in judgment in favor of the defendant, the number of processes per year, and the judges who handed down the most rulings.

Judges module: The result indicates that the attention was on the institutional information displayed for any judge. The section that most attracted users' attention was those on processes by topic and culmination state, which implies that knowing the prominent matters dealt with by the judge is relevant information. Another section that focuses attention is the cases with the most resolutions classified by the ruling trends, repeating attention to the data that allows analyzing the trend in favor of the offended party ruling. The rest of the sections showed little influence of gaze concentration.

Facial expressions

The observed results are expressed according to the percentage of time and the expression demonstrated (see Table 2).

Table 2.

Percentage of total exposure time at the marker with facial expressions detected

Module	Anger	Sadness	Disgust	Fear	Contempt	Joy	Surprise	Commitment	Attention
Analytics	0.04	0.34	0.02	0.21	0.00	0.48	1.06	4.72	91.02
Cases	1.45	0.66	0.07	4.11	0.14	1.20	0.67	13.40	93.27
Court	0.29	0.20	0.14	1.61	2.15	0.58	0.00	17.07	99.18
Judge	0.00	0.46	0.00	0.00	0.00	0.00	0.00	1.99	95.49
Average	0.43	0.29	0.13	1.01	0.25	1.56	0.48	8.83	95.71

As expected in a usability experiment with a new website, the primary emotion was attention. Overall, this was demonstrated for 95.7% of the exposure time, followed by the emotion called engagement, recorded for 8.83%. The rest of the emotions are at most 2% of the time, so their registration and study are not significant.

To the previously exposed emotions, the software has an algorithm that analyzes whether the detected emotion is positive, negative, or neutral. The results reveal that the neutrality of attention and commitment is the most frequent, recording it 98% of times. The positive and the negative have similar and insignificant numbers (See Table 3).

It is crucial to indicate that it is relevant that the positive emotion has exceeded the negative in the course of the experiment, which implies satisfaction during the interaction designed for this situation, which allows us to infer that the user felt comfortable exploring the web page, and the information displayed caught the attention of users, generating a value perception.

Table 3.

Positive, negative, or neutral emotions detected in facial expressions analysis

Module	Positive	Negative	Neutral
Analytics	0.39	0.66	98.95
Cases	1.97	1.11	96.77
Court	2.13	0.99	96.49
Judge	0.00	1.36	98.07
Average	1.41	1.18	97.42

Note: Percentage of total exposure time.

Galvanic Skin Response - GSR

The results of this analysis allow us to indicate the number of exaltations peaks each module can generate and their intensity. Based on the results (See Table 4), there are few peaks. However, these are important to analyze because they will corroborate the type of emotion generated by the new software.

Table 4.

Overall Results by Experiment Marker for GSR

Module	Peak count	Average Peaks per minute	Average Peak Amplitude
Analytics	59	2.07	0.03
Cases	29	2.37	0.07
Court	18	1.81	0.07
Judge	2	2.55	0.07
Average	18.29	2.21	0.06

It is critical to indicate that the analytical function has the highest number of peaks; however, it is also noteworthy that as the experiment participants became more familiar with web browsing, the number of peaks decreased, as did the average time spent browsing each of the modules to complete the assigned activities.

The results of the average peak amplitude indicate the same behavior in the modules except for the analytical one, which was relatively lower. It is also due to the many peaks recorded and participants spending more time in this module. Therefore, the longer the time, the less intensity of emotions showed when discovering new functionalities. Table 5 shows the behavior in time of each measurement and task.

Table 5.

Number of valid shots per experiment marker and accumulated time

Module	Aggregate time (milliseconds)	Average (milliseconds)
Analytics	2532894	422149
Cases	2081916	346986
Court	1209366	201606
Judge	254975	50995

As long as the user performs any task, the time required to complete them is shorter, which is evidence that the modules present a similar level of complexity and that the skills in using the software are on the rise if the users spend more time on it. It also confirms the existence of an intuitive navigation design.

Application of the questionnaire

As a general perception, the participants suggest easiness when managing the web page, the data reported interpretation, and executing the proposed tasks. Also, they declared that the data leak was immediate and provided essential information such as mail and telephone numbers appearing in the magistrate section.

It was possible to establish that the indicated deficiencies generally came from people of advanced age and high experience in the field who suggested showing the software to local institutions related to the domain.

Analytics module: It was recognized that some participants could not understand the graphics presenting the outcomes, establishing as a cause that the diameters of each circumference are similar. They recommended organizing the information by tabs and increasing the interaction using clicks on the graphs, allowing a deeper exploration of the information disaggregation and completing the search module for more specific cases based on the users' needs.

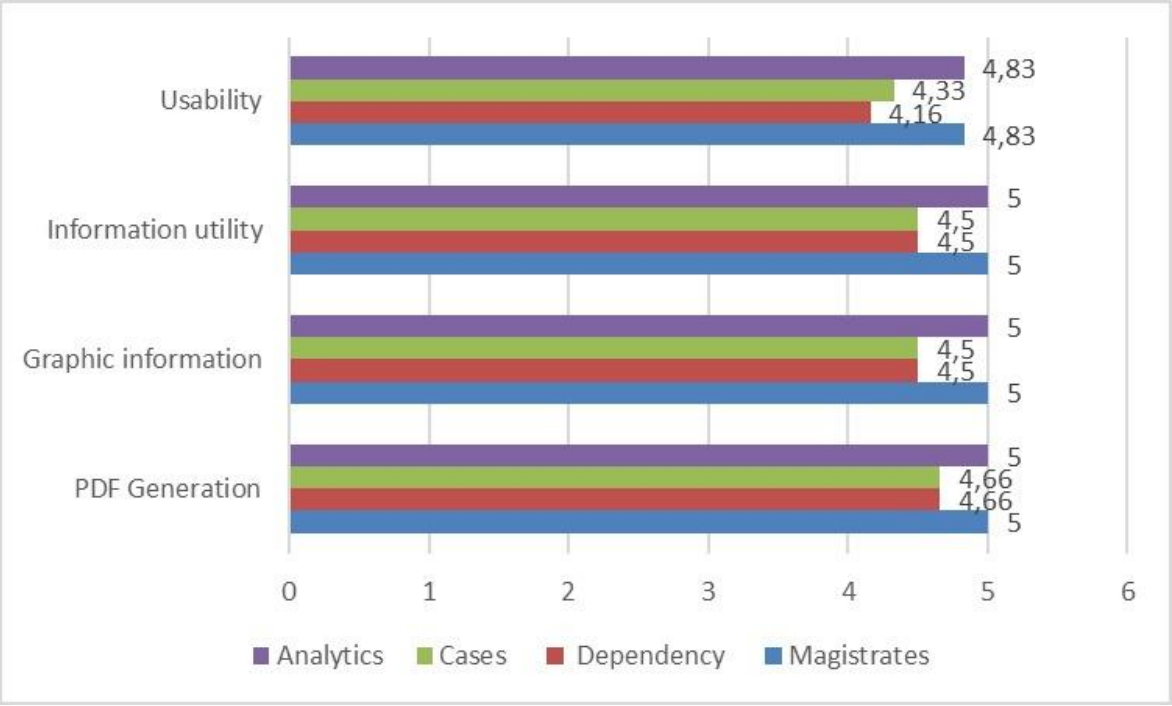
Judges module: Users recommended to include the comparison function between magistrates.

Cases and court modules: No suggestions for improvements.

As part of applying this technique, the performed evaluation of the different modules is summarized in Figure 2. As noticed, all modules present evaluations higher than 4 points. The attributes of the usefulness of information, graphic information, and PDF generation reached the highest rating in the judges and analytical modules. They are slightly lower in the remaining two. Ease of use was the attribute with the lowest evaluation.

Figure 2.

Module appraisal



The results achieved constitute one more contribution to the efforts related to evaluating

software usability (Norman Acevedo et al., 2015; Massaro et al., 2021; Nielsen & Molich, 1990; Shneiderman, 2005). The application of neuromarketing allows for an increase in the objectivity of the evaluations. The results of the analysis of gaze, facial expressions, and galvanic sensations corroborate previous research approaches (Pascucci et al., 2022; Zahmati et al., 2022; Hammond et al., 2022; Ohme et al., 2009; Xu et al., 2023; Gill & Singh, 2022; Sałabun et al., 2017). Similarly, the evaluation of the studied web page corroborates the results presented by Coşkun and Yücel (2021), who highlighted the role of colours, the reference point in software design (Moya et al., 2020).

The methodology described for evaluating software presents multiple applications in the managerial environment by allowing the evaluation of any software in advertising, management, or information. The evaluation of software based on neuromarketing techniques, on the one hand, allows for an increase in the objective nature of the evaluation and, on the other hand, to identify opportunities for improvements in the applied computer.

The results achieved are part of a set of limitations that must be taken into consideration. The research's limitations are related to evaluating software developed in a web environment, whose purpose is to present information related to legal knowledge. It would be advisable to apply the methodology described in web environments linked to sectors such as tourism and gastronomy. The sample size needs to be more extensive; consequently, the results should not be considered conclusive. From an integration perspective, the results would be more robust if the brain process measurements were carried out to analyze the information under evaluation from the application of electroencephalogram (EEG) or functional magnetic resonance imaging (fMRI) techniques.

CONCLUSIONS

The integrated analysis of the results of the different tests applied made it possible to confirm its general functionality and recognize opportunities for improvement. The main conclusion of the experiment indicates that the cases and judges' modules are the ones that have the most significant value for the user due to correlating the results of facial expressions, GSR, eye tracking with the final questionnaire and the assessment they gave to each module.

In the same way, the time reduction in the modules implies a rapid adaptation to the information displayed by the portal. The levels of attention and commitment observed show the utilitarian and functional nature of the web page. As a general conclusion, positive emotionality showed higher levels than negative, allowing us to infer high levels of satisfaction during the

designed interaction. These subconscious results correlate with those obtained in the data gathered from the experiment.

Maps and graphics showed a more remarkable power to attract attention. A tendency to review the information following the established sense of reading was corroborated.

It was also identified an implicit need for more significant interaction at the different levels of information reports, as well as increasing the existence of drop-down menus when information is required to be filtered, expanding the use of tabs with data sets to avoid overwhelming the user with diverse statistical data and incorporating more options for comparison between variables.

BIBLIOGRAPHIC REFERENCES

Agarwal, S., & Xavier, M.J. (2015). Innovations in consumer science: Applications of neuro-scientific research tools. In Brem, A. & É. Viardot (Eds), *Adoption of Innovation: Balancing Internal and External Stakeholders in the Marketing of Innovation* (pp. 25-42). Springer, Cham. https://doi.org/10.1007/978-3-319-14523-5_3

Alonso Dos Santos, M., Calabuig Moreno, F., & Crespo-Hervás, J. (2019). Influence of perceived and effective congruence on recall and purchase intention in sponsored printed sports advertising: An eye-tracking application. *International Journal of Sports Marketing and Sponsorship,* 20 (4), 617-633. https://doi.org/10.1108/IJSMS-10-2018-0099

Alvino, L., van der Lubbe, R., Joosten, R.A.M., & Constantinides, E. (2020). Which wine do you prefer? An analysis on consumer behaviour and brain activity during a wine tasting experience. *Asia Pacific Journal of Marketing and Logistics,* 32 (5), 149-1170. https://doi.org/10.1108/APJML-04-2019-0240

Baldo, D., Viswanathan, V.S., Timpone, R.J., & Venkatraman, V. (2022). The heart, brain, and body of marketing: Complementary roles of neurophysiological measures in tracking emotions, memory, and ad effectiveness. *Psychology and Marketing,* 39 (10), 1979-1991. https://doi.org/10.1002/mar.21697

Bouvard, J. (1970). Fourth Generation Software. The User's Prospective. *Honeywell Computer Journal,* 4 (2), 42-49.

Bulley, C.A., Braimah, M., & Blankson, F.E. (2018). Ethics, neuromarketing and marketing research with children. *International Journal of Customer Relationship Marketing and Management,* 9 (2), 79-95. https://doi.org/10.4018/IJCRMM.2018040105

Bulut, Y., & Arslan, B. (2020). The science behind neuromarketing. In Atli, D. (Ed), *Analyzing the Strategic Role of Neuromarketing and Consumer Neuroscience* (pp. 104-126). IGI Global. https://doi.org/10.4018/978-1-7998-3126-6.ch006

Cha, K.C., Suh, M., Kwon, G., Yang, S., & Lee, E.J. (2020). Young consumers' brain responses to pop music on YouTube. *Asia Pacific Journal of Marketing and Logistics,* 32 (5), 1132-1148. https://doi.org/10.1108/APJML-04-2019-0247

Cherubino, P., Cartocci, G., Modica, E., Rossi, D., Mancini, M., Trettel, A., & Babiloni, F. (2018). Wine Tasting: How Much is the Contribution of the Olfaction? In Nermend, K. & M. Łatuszyńska (Eds), *Problems, Methods and Tools in Experimental and Behavioral Economics. CMEE 2017. Springer Proceedings in Business and Economics* (pp. 199-209). Springer, Cham. https://doi.org/10.1007/978-3-319-99187-0_15

Cherubino, P., Trettel, A., Cartocci, G., Rossi, D., Modica, E., Maglione, A.G., Mancini, M., di Flumeri, G., & Babiloni, F. (2016). Neuroelectrical Indexes for the Study of the Efficacy of TV Advertising Stimuli. In Nermend, K. & M. Łatuszyńska (Eds), *Selected Issues in Experimental Economics. Springer Proceedings in Business and Economics* (pp. 355-371). Springer, Cham. https://doi.org/10.1007/978-3-319-28419-4_22

Coşkun, P., & Yücel, A. (2021). An Experimental Study on Consumers' Perceptions of Electronic Commerce Sites with EEG Method. *Süleyman Demirel Üniversitesi Vizyoner Dergisi,* 12 (29)m, 286-298. https://doi.org/10.21076/vizyoner.720686

Covino, D., Viola, I., Paientko, T., & Boccia, F. (2021). Neuromarketing: Some remarks by an economic experiment on food consumer perception and ethic sustainability. *Rivista Di Studi Sulla Sostenibilita,* 1, 187-199. https://doi.org/10.3280/RISS2021-001011

De Oliveira, J.H.C., & Giraldi, J.M.E. (2019). Neuromarketing and its implications for operations management: An experiment with two brands of beer. *Gestao e Producao,* 26 (3). https://doi.org/10.1590/0104-530X3512-19

Di Flumeri, G., Herrero, M.T., Trettel, A., Cherubino, P., Maglione, A.G., Colosimo, A., Moneta, E., Peparaio, M., & Babiloni, F. (2016). EEG Frontal Asymmetry Related to Pleasantness of Olfactory Stimuli in Young Subjects. In Nermend, K. & M. Łatuszyńska (Eds), *Selected Issues in Experimental Economics. Springer Proceedings in Business and Economics* (pp. 373-381). Springer, Cham. https://doi.org/10.1007/978-3-319-28419-4_23

Garczarek-Bąk, U., Szymkowiak, A., Gaczek, P., & Disterheft, A. (2021). A comparative analysis of neuromarketing methods for brand purchasing predictions among young

adults. *Journal of Brand Management,* 28 (2), 171-185. https://doi.org/10.1057/s41262-020-00221-7

Gill, R., & Singh, J. (2022). A study of neuromarketing techniques for proposing cost effective information driven framework for decision making. *Materials Today: Proceedings,* 49 (8), 2969-2981. https://doi.org/10.1016/j.matpr.2020.08.730

Gómez-Carmona, D., Marín-Dueñas, P.P., Cano-Tenorio, R., Serrano Domínguez, C., Muñoz-Leiva, F., & Liébana-Cabanillas, F. (2022). Environmental concern as a moderator of information processing: A fMRI study. *Journal of Cleaner Production,* 369. https://doi.org/10.1016/j.jclepro.2022.133306

Grimes, A. (2006). Are we listening and learning? Understanding the nature of hemispherical lateralisation and its application to marketing. *International Journal of Market Research,* 48 (4), 439-457. https://doi.org/10.1177/147078530604800406

Hammond, R.W., Parvanta, C., & Zemen, R. (2022). Caught in the Act: Detecting Respondent Deceit and Disinterest in On-Line Surveys. A Case Study Using Facial Expression Analysis. *Social Marketing Quarterly,* 28 (1), 57-77. https://doi.org/10.1177/15245004221074403

Horská, E., & Berčík, J. (2014). The Influence of Light on Consumer Behavior at the Food Market. *Journal of Food Products Marketing,* 20 (4), 429-440. https://doi.org/10.1080/10454446.2013.838531

Massaro, A., Giannone, D., Birardi, V., & Galiano, A.M. (2021). An innovative approach for the evaluation of the web page impact combining user experience and neural network score. *Future Internet,* 13 (6). https://doi.org/10.3390/fi13060145

Krampe, C. (2022). The application of mobile functional near-infrared spectroscopy for marketing research – a guideline. *European Journal of Marketing,* 56 (13), 236-260. https://doi.org/10.1108/EJM-01-2021-0003

Moya, I., & García-Madariaga, J. (2022). Is a Video Worth More Than a Thousand Images? A Neurophysiological Study on the Impact of Different Types of Product Display on Consumer Behaviour in e-Commerce. In Martínez-López, F.J. & L.F. Martinez (Eds), *Advances in Digital Marketing and eCommerce. DMEC 2022. Springer Proceedings in Business and Economics* (pp. 300-306). Springer, Cham. https://doi.org/10.1007/978-3-031-05728-1_32

Moya, I., García-Madariaga, J., & Blasco, M.F. (2020). What can neuromarketing tell us about food packaging? *Foods,* 9 (12). https://doi.org/10.3390/foods9121856

Ladkoo, A.D. (2020). Neuromarketing and greenovation in festival and event tourism: The case of a small island developing state-Mauritius. In Gursoy, D., R. Nunkoo & M. Yolal (Eds), *Festival and Event Tourism Impacts* (pp. 221-233). Taylor and Francis.

Lee, N., Chamberlain, L., & Brandes, L. (2018). Welcome to the jungle! The neuromarketing literature through the eyes of a newcomer. *European Journal of Marketing, 52*(1–2), 4–38. https://doi.org/10.1108/EJM-02-2017-0122

Levrini, G., Schaeffer, C.L., & Nique, W. (2020). The role of musical priming in brand recall. *Asia Pacific Journal of Marketing and Logistics,* 32 (5), 1112-1131. https://doi.org/10.1108/APJML-04-2019-0231

Luna-Nevarez, C. (2018). An Exploratory Analysis of Consumer Opinions, Ethics, and Sentiment of Neuromarketing: An Abstract. *Developments in Marketing Science: Proceedings of the Academy of Marketing Science,* 79-80. https://doi.org/10.1007/978-3-319-66023-3_32

Nielsen, J., & Molich, R. (1990). Heuristic evaluation of user interfaces. *CHI '90: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* 249–256. https://doi.org/10.1145/97243.97281

Norman Acevedo, E., Quintana, H., & Ortegón Cortázar, L. (2015). Emotional arousal brands. A review of the color associated with stimulation of Logos in the context of neuromarketing. *Revista Espacios* 36 (19): 17.

Ohme, R., Reykowska, D., Wiener, D., & Choromanska, A. (2009). Analysis of Neurophysiological Reactions to Advertising Stimuli by Means of EEG and Galvanic Skin Response Measures. *Journal of Neuroscience, Psychology, and Economics,* 2 (1), 21-31. https://doi.org/10.1037/a0015462

Ohtawa, H., Tuneoka, M., & Tsukada. W. (1970). Hitac-10. *Japanese Journal of Medical Electronics and Biological Engineering,* 8 (1), 18-26. https://doi.org/10.11239/jsmbe1963.8.18

Pascucci, F., Bartoloni, S., Ceravolo, M.G., Fattobene, L., Gregori, G.L., Pepa, L., Raggetti, G., & Temperini, V. (2022). Exploring the relationships between perception of product quality, product ratings, and consumers' personality traits: An eye-tracking study. *Journal of Neuroscience, Psychology, and Economics,* 15(2), 89-100. https://doi.org/10.1037/npe0000156

Pileliene, L., & Grigaliunaite, V. (2017). Relationship between spokesperson's gender and advertising color temperature in a framework of advertising effectiveness. *Scientific*

Annals of Economics and Business, 64 (Specialissue), 1-13. https://doi.org/10.1515/saeb-2017-0036

Plassmann, H., Ramsøy, T.Z., & Milosavljevic, M. (2012). Branding the brain: A critical review and outlook. *Journal of Consumer Psychology,* 22 (1), 18–36. https://doi.org/10.1016/J.JCPS.2011.11.010

Pupil Labs. (2016, september 23). *A short review and primer on eye tracking in human computer interaction applications*. http://arxiv.org/abs/1609.07342

Ramsøy, T.Z. (2019). Building a foundation for neuromarketing and consumer neuroscience research: How researchers can apply academic rigor to the neuroscientific study of advertising effects. *Journal of Advertising Research,* 59 (3), 281-294. https://doi.org/10.2501/JAR-2019-034

Revilla-Camacho, M.A., Cossío-Silva, F.J., & Mercado-Idoeta, C. (2018). Neuromarketing as a subject of legitimacy. In Díez-de-Castro, E. & M. Peris-Ortiz (Eds), *Organizational Legitimacy: Challenges and Opportunities for Businesses and Institutions* (pp. 105-119). Springer, Cham. https://doi.org/10.1007/978-3-319-75990-6_7

Ruiz, J., Serral, E., & Snoeck, M. (2021). Unifying functional User Interface design principles. *International Journal of Human-Computer Interaction,* 27 (1). https://doi.org/10.1080/10447318.2020.1805876

Sałabun, W., Karczmarczyk, A., & Mejsner, P. (2017). Experimental Study of Color Contrast Influence in Internet Advertisements with Eye Tracker Usage. In Nermend, K. & M. Łatuszyńska (Eds), *Neuroeconomic and Behavioral Aspects of Decision Making. Springer Proceedings in Business and Economics* (pp. 365-375). Springer, Cham. https://doi.org/10.1007/978-3-319-62938-4_24

Savelli, E., Gregory-Smith, D., Murmura, F., & Pencarelli, T. (2022). How to communicate typical–local foods to improve food tourism attractiveness. *Psychology and Marketing,* 39(7), 1350-1369. https://doi.org/10.1002/mar.21668

Sharma, D., & Nama, D.K. (2022). Demystifying the role of neuromarketing in creating value for the marketers. In Kaur, J., P. Jindal and A. Singh (Eds), *Developing Relationships, Personalization, and Data Herald in Marketing 5.0* (pp. 109-129). IGI Global. https://doi.org/10.4018/978-1-6684-4496-2.ch007

Shneiderman, B. (2005). Leonardo's laptop: Human needs and the new computing technologies. *CIKM '05: Proceedings of the 14th ACM international conference on Information and knowledge management*. Bremen, Germany: ACM Digital Library, 2005. https://doi.org/10.1145/1099554.1099555

Singer, E. (2004). They know what you want. *New Scientist,* 183 (2458), 36-37.

Stefko, R., Tomkova, A., Kovalova, J., & Ondrijova, I. (2021). Consumer purchasing behaviour and neuromarketing in the context of gender differences. *Journal of Marketing Research and Case Studies,* 2021. https://doi.org/10.5171/2021.321466

The Lancet Neurology. (2004). Neuromarketing: Beyond branding. *The Lancet Neurology,* 3 (2), 71. https://doi.org/10.1016/S1474-4422(03)00643-4

Tinoco-Egas, R., Juanatey-Boga, O., & Martínez-Fernández, V.A. (2020). Neuromarketing: Theoretical considerations and measurement tools. *Revista Venezolana de Gerencia,* 25 (90), 613-631. https://doi.org/10.37960/rvg.v25i90.32404

Wilson, T.D. (2002). *Strangers to Ourselves: Discovering the Adaptive Unconscious*. The Belknap Press of Harvard University Press.

Xu, Z., Zhang, M., Zhang, P., Luo, J., Tu, M., & Lai, Y. (2023). The neurophysiological mechanisms underlying brand personality consumer attraction: EEG and GSR evidence. *Journal of Retailing and Consumer Services,* 73. https://doi.org/10.1016/j.jretconser.2023.103296

Zahmati, M., Azimzadeh, S.M., Sotoodeh, M.S., & Asgari, O. (2022). Effects of Endorsers Popularity and Gender on the Audience's Attention to the Advertisement from a Neuromarketing Perspective: An Eye-Tracking Study. In Martínez-López, F.J. & L.F. Martinez (Eds), *Advances in Digital Marketing and eCommerce. DMEC 2022. Springer Proceedings in Business and Economics*. Springer, Cham. https://doi.org/10.1007/978-3-031-05728-1_29