Coll. Antropol. **34** (2010) 3: 819–827
Original scientific paper

Visual Aspects of Perception of Multimedia Messages on the Web through the »Eye Tracker« Method

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A B S T R A C T

Since the dawn of civilisation visual communication played a role in everyday life. In the early times there were simply shaped drawings of animals, pictograms explaining hunting tactics or strategies of attacking the enemies. Through evolution visual expression becomes an important component of communication process on several levels, from the existential and economic level to the artistic level. However, there was always a question of the level of user reception of such visual information in the medium transmitting the information. Does physical positioning of information in the medium contribute to the efficiency of the message? Do the same rules of content positioning apply for traditional (offline) and online media (Internet)? Rapid development of information technology and Internet in almost all segments of contemporary life calls for defining the rules of designing and positioning multimedia online contents on web sites. Recent research indicates beyond doubt that the physical positioning of an online content on a web site significantly determines the quality of user's perception of such content. By employing the »Eye tracking« method it is possible to objectively analyse the level of user perception of a multimedia content on a web site. What is the first thing observed by the user after opening the web site and how does he/she visually search the online content? By which methods can this be investigated subjectively and objectively? How can the survey results be used to improve the creation of web sites and to optimise the positioning of relevant contents on the site? The answers to these questions will significantly improve the presentation of multimedia interactive contents on the Web.

Key words: *perception, visual perception, perceptiveness, online perception, multimedia messages, online contents, information presentation on the Web, visual aspects of perception, »Eye tracker« method, user perception, offline perception, online perception*

Introduction

Ever since the Palaeolithic era and the drawings in the Altamira and Lascaux caves the mankind had an intrinsic need for visual transfer of information (Figure 1 and 2). At first they were primitively shaped drawings intended to explain the tribal hunting tactics or strategies of attacking the enemy. Such drawings were found on various localities worldwide. As the mankind developed, visual expression became an important part of evolution process on several levels – from existential and economic to the artistic level. However, there was always a question of the level of user reception of such visual information in the medium transmitting the information. Does physical positioning of information in the medium contribute to the efficiency of the message? Do the same rules of content positioning apply for traditional (offline) and online media (Internet)? What is the first thing observed by the user after opening the web site and how does he/she visually search the online content? By which methods can this be investigated subjectively and objectively? How can the research results be used to improve the creation of web sites and to optimise the positioning of relevant contents on the site? The answers to these questions will significantly improve the presentation of multimedia interactive contents on the Web.

Received for publication July 29, 2010

Fig. 1. Preserved drawings from Palaeolithic era, Lascaux Cave.

Information Technology and Perception of Visual Contents on the Web

With the introduction of hypermedia and multimedia, i.e. of Internet as a medium integrating these characteristics, the phenomenon of perception of audiovisual contents becomes a very relevant segment of the modern life. Considering the comparative advantages of the Web as a medium in terms of non-linear branching of information, data storage potentials and multimedia, one of the rather unexplored areas in the social aspect of information technology is the user perception of multimedia contents on the Web. Among many aspects of perception of multimedia visual stimuli in everyday life, the economic aspect of assessing the perception of recipients of such messages is nowadays prominent. That is, the better a certain piece of multimedia information is placed in terms of its visibility and position in the medium, the higher the certainty that it will be recognised by recipients, ultimately implying a higher marketing potential. As the average time of site visit of internauts searching the Web is extremely short (56 seconds), when placing multimedia messages and ensuring their visibility and perception it is crucial to ensure that such stimuli are placed on the site in a controlled manner, so that the user may notice, perceive and process (i.e. read or 'click') them in the shortest possible time[1]. In this context there are now methods available that allow us to anticipate and even suggest the user's interest and/or potential to perceive (read or 'click') an online content based on how such content is positioned on web sites. There are two approaches to measuring the level of perception of visual stimuli by internauts (Internet surfers), allowing for subsequent analysis of impact of multimedia messages: subjective and objective method. In subjective approach the questionnaire is used, where immediately after having perceived the offered visual content the internaut is presented with multiple choice questions and asked to check the answers related to the viewed online content, thus momentarily providing the information on the perception of his/her online observations. With this method there is the objective problem based on 'human factor', i.e. the respondent has a subconscious need to provide socially acceptable answers in the broadest sense, so that the results obtained in the survey are relativized to a certain degree, as they depend on the context of information content. The other method – objective method – may be divided into reactive and proactive method. In objective – reactive method the user is viewing the offered interactive online content. By subsequent listing of web-log files of his/her search and of the perception of visited web sites we get a very precise analytics of internaut's preferences. In this way we can learn how long he/she stayed on a specific web site, how many times he/she 'clicked' specific visual stimulus (image or alike), which key words he/she has entered into the search engine, etc. Although the objective-reactive method undoubtedly has high analytic potential, the objective-proactive method goes one step further. Unlike the previously mentioned method, this method enables us real-time processing of information provided by the user while viewing web contents, thus allowing us to monitor the response to visual stimuli at all times and to evaluate the internaut's interest in the online content being viewed. The objective – proactive method is conducted by means of 'Eye tracker' analytics[2], monitoring movements of respondent's pupils and correlating them in real time with visual architectonics of online content on the screen in front of the user. Such analytics provides us with a fully objective repreentation of internaut's perception of visual stimuli. Using objective result of 'Eye Tracker' survey we can very precisely design the appearance of web sites and guide the user's perception and interest intensity towards the information we want them to receive. To a certain degree we can also guide a dynamic process of users' perception of online content. Possibilities and potential of 'Eye Tracker' method are prominent especially in landing ('home') pages, where the internaut's perceptive navigation begins.

Historical Development of Surveying Content Perception in the Medium and of »Eye Tracker» Method

In 19th century Louis Émile Javal[3,16] has researched the methods of reading and comprehending texts. The research showed that, when reading, the subjects often

Fig. 2. Preserved drawings from Palaeolithic era, Altamira Cave.


DANS, KÖN OCH JAGPROJEKT

På jakt efter ungdomars kroppsspråk och den "synkretiska dansen", en sammansmältning av olika kulturers dans, har jag i mitt fältarbete under hösten rört mig på olika arenor inom skolans värld. Nordiska, afrikanska, syd- och östeuropeiska ungdomar gör sina röster hörda genom sång, musik, skrik, skratt och gestaltar känslor och uttryck med hjälp av kroppsspråk och dans.

Den individuella estetiken framträder i kläder, frisyrer och symboliska tecken som förstärker ungdomarnas "jagprojekt" där också den egna stilen i kroppsrörelserna spelar en betydande roll i identitetsprövningen. Uppehållsrummet fungerar som offentlig arena där ungdomarna spelar upp sina performanceliknande kroppsbower

Fig. 3. An example of Javal's 'fixations' and 'saccades'.

needed to change the rhythm of following the text, so that they made pauses during reading. These pauses were named 'Javal's fixations', and they occurred in order for the subject to be able to more precisely process, i.e. understand the content of the read text.

In addition, the subjects have generally returned their eyes to the previously read text, also in order to better perceive it in the broader context. Javal has named such short retro-movements of subject's eyes 'saccades' (Figure 3).

Louis Émile Javal also investigated whether there is any correlation between the meaning of read words and short stops during reading, i.e. what 'triggered' the return of eyes to the previously read words (saccades)[4].

Edmund Huey continued similar research and designed a prototype of contemporary 'Eye Trackers' by using contact lenses with holes on the location of the pupil and measuring the shifts of dynamics and direction of watching in correlation with the text and/or drawn visual stimulus.

In the mid 1930's Guy Thomas Buswell and his study 'How People Look at Pictures' (1935) introduced new ideas into the research of how users perceive visual contents[6,16]. Buswell has designed the first device transmitting the dynamics of subject's eye movements during the perception of visual content – a forerunner of today's 'Eye Tracker'. He conducted the survey with 80 subjects who were connected to the then revolutionary device called AUPEM (»Apparatus Used for Photographing Eye Movement«) (Figure 4). All subjects were looking at Homer Winslow's painting »Stowing the Sail« (Figure 5). By analysing the obtained results a pattern was defined for the first time, i.e. a matrix suggesting the dynamics of visual content perception, that is, how the users are moving their eyes across the image aiming to perceive it as fast as possible, to cognitively process it and then to position this information in their mind (Figure 6).

In 1950' Buswell's research was continued in the papers of Russian scientist Alfred Lukjanovich Yarbus, who

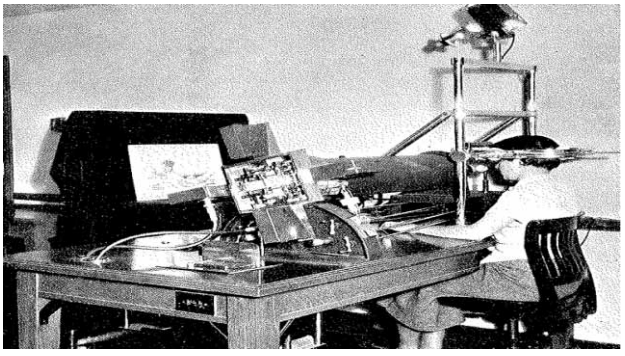

Fig. 4. Buswell's »AUPEM« – Apparatus Used for Photographing Eye Movement.

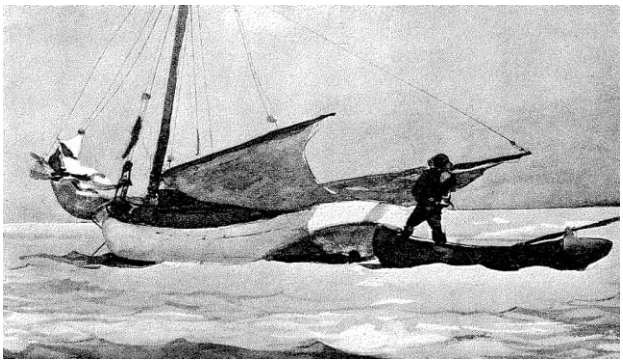

Fig. 5. Image »Stowing the Sail« by Winslow homer.

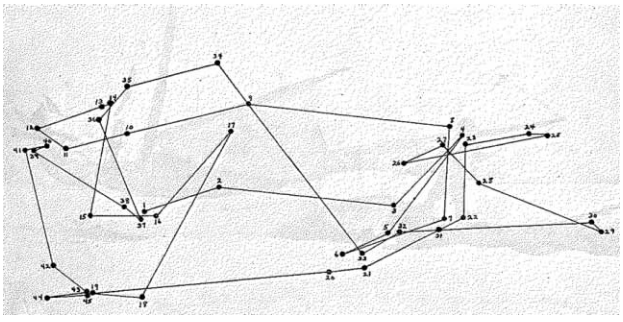

Fig. 6. Model of perception of the painting »Stowing the Sail« through matrix structure.

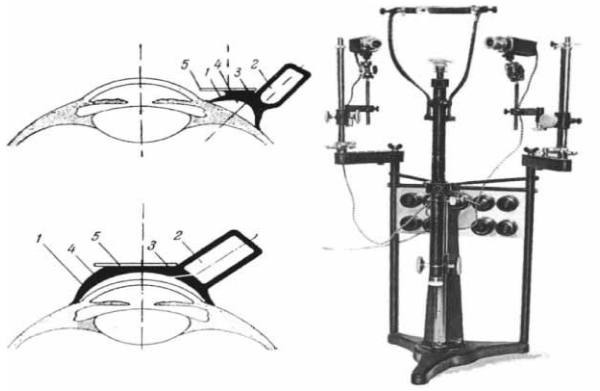

Fig. 7. Yarbus' machine for connection eye caps with the camera recording the results.

is considered to be one of the most quoted authors in this field at the time. Yarbus[7,16] took one step further then Buswell in searching the correlation between pupil movement dynamics when perceiving a visual content and level of subject's interest in that content. In his paper »Eye movements and Vision« (original title: *»Роль движений глаз в процессе Зрения«*) published in 1965 Yarbus has for the first time connected eye caps with the camera (Figure 7) and directly recorded (filmed) the content of subject's preferences in real time. In his work Yarbus took one step further, proving that the logics of dynamics and direction shifts of subjects pupil movements is in a direct connection with the subject's thinking on what he sees in front of him.

In this way Yarbus has confirmed the correlation between pupil movements conditioned by a visual stimulus, taking a step forward in contemplating the reasons for the frequency of repeated movements. His research has shown that there is a perceptive visual 'anchoring' in the experience of the presented content and that the subject viewing a visual unit – after having observed a detail of such unit – has the need to return to this visual unit. Only then the observed detail can become its place in the subject's cognitive process (i.e. this place can be found only in the context of the overall perceived content).

Here we have an interesting parallel to holistic theories, where only the entirely perceived content can assign the appropriate role to the observed detail. Yarbus' role was additionally significant because he was the first to notice the differences of visual matrix depending on the contextual content of a visual sensation.

In other words, he concluded that the dynamics and the matrix of pupil movement direction when the subject is observing visual stimuli is in direct connection with cognitive guidelines given to the subjects. The research[8,16] confirming this was conducted on the painting titled 'The Unexpected Visitor' (oil on canvas) by Ilya Repin (Figure 8). The subjects were given a task to freely study the painting by looking at it. Then in separate sessions they were asked to make following conclusions:

- What is the material status of the family presented in the painting?
- How old are the people in the painting?
- What clothes are they wearing?
- What were the members of the household doing before the visitor came?
- What is the disposition of people and objects in the room?
- How far is the man entering the room from family members in the room?

Fig. 8. Image »Unexpected Visitor«, oil on canvas painting by Liya Repin 1884. – 1888.

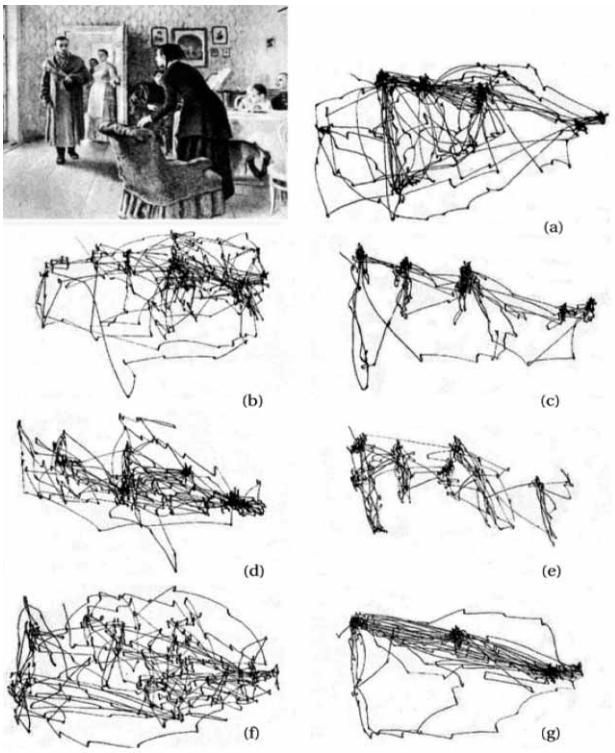

Fig. 9. Socio – cognitive matrix perceptive models of the painting »Unexpected Visitor«.

So, each viewing session has in a different way engaged the observatory principle of viewing mechanics in subjects, i.e. the perception of information from the thematic fable of the painting. The research results were very interesting; the dynamics and sample scope matrix of viewing the painting has radically changed depending on the questions that the subjects needed to answer (Figure 9).

This has confirmed Yarbus' hypothesis that the perception of visual content is directly determined by the information we are seeking to gain from the said visual content.

In 1970 Hans Werner Hunziker[13,16] used glass plate with drawn visual stimulus that was presented to the subject. Whilst the subject was viewing the visual, Hunziker would film with an 8 mm camera from the opposite side of the plate, in order to capture the subject-object relation as precise as possibly and to establish how the subject (examinee) perceives the object (visual). Hunziker's work – especially the study[14] titled »Plastizität als Faktor der Spannungsüberwindung in Denkaufgaben« (»Flexibility of closure as a factor of tension reduction in visual problem solving«) represents a breakthrough in the research, as the object perceived is no longer a work of art or a text, but a simpler visual riddle or problem to be solved.

By comparing the results of problem solving with the way the riddle was perceived, he established a correlation between the subject's visual perception and their intelligence. The peculiarity of Hans Werner Hunziker is the fact that he was the first scientist to anticipate the synergy between behaviourism and basic postulates of Gestalt psychology while studying visual aspects of human perceptivity.

The research of the connection between the content of the read word and the rate of user perception was continued by Just and Carpenter[15,16] in 1980. They recorded pupil movements in 14 students who were given the task to read 15 sentences abstracted from Times and Newsweek magazines. The survey results showed that the subjects have made pauses in their pupil movements during reading at 67.8% words in the average. In 83% of pauses in reading the words on which the subjects paused were contextually significant for comprehension of the sentence and/or text, and only 38% of pauses related to 'functional' words, i.e. words connecting sentences and not crucial for comprehension of the content.

The result of Just and Carpenter's research was named »Eye – mind Hypotesis[16]«, and it suggests that the subject's pupil is fixated on any word for the duration of the cognitive process of retrieving the content of such word and bringing it into the context with the entire text.

Nowadays research of visual perception is inconceivable without modern Eye Trackers, and they all have one common feature: they operate according to the principle of measuring the diameter of eye's rotation field in all directions. There are several types of Eye Trackers. The first type looks as contact lens with embedded mirror or magnetic field sensor. This sensor is connected with a measuring instrument that is recording each shift of the lens, i.e. pupil, and feeds the data into the central server (Figure 10).

The second model is »Dual Purkinje Eye tracker« using reflections from the front of the cornea and back of the lens. In this way, according to the light negative principle, an insight into the lens movement dynamics is obtained in controlled conditions (Figure 11).

The third model is the EOG Model, the most sophisticated model that measures electric potentials using special electrodes placed around the eyes. This method provides the most precise results, as it uses software with advanced mathematical algorithms in order to obtain maximal precision of end results (Figure 12).

Analysis of Results Obtained by »Eye Tracker« Method and Conclusions

Content perception in conventional (offline) media such as radio, television and press is significantly different from the perception of the online (Web) contents. Considering the specific features of Internet in terms of the approach to information presentation, internauts are gradually changing their previous 'offline' perception of

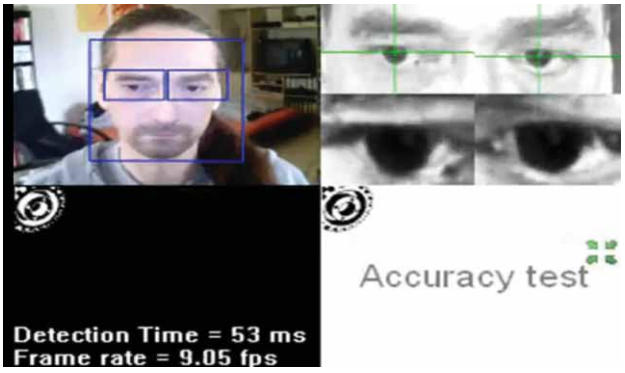

Fig. 10. Installed »eye tracking« sensor connected with measuring instrument recording lens shifts and feeding the data into the central server.

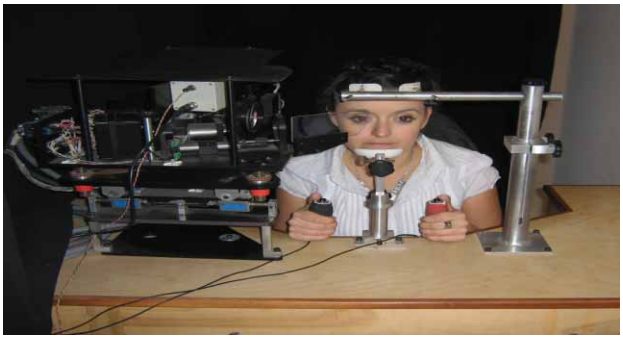

Fig. 11. »Dual Purkinje Eye tracker« operating according to the principle of reflection of lights positioned in front of the lens and behind the lens.

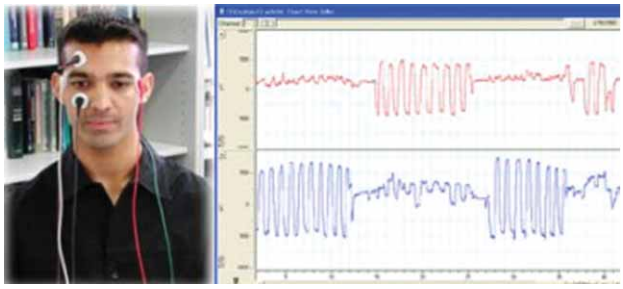

Fig. 12. EOG »Eye tracker« model.

contents and are adjusting to the new medium (Figure 13).

In this context the results of surveys obtained by Eye Tracker method provide extremely useful information for media development and for methods of positioning the online information. By means of derived schematic model this information can clearly show how the internauts perceive the level of importance[17] of contents offered on web sites, i.e. what is the first to catch their attention when searching web sites (Figure 14 and 15).

Results obtained by Eye Tracker method[18] are most commonly presented by 'heat map'. The red areas on the heat map indicate the areas of highest intensity, i.e. highest frequency of 'visual contact' between the user and the multimedia content on the web site. In other words, the red fields on the image show the content observed by the most subjects, i.e. locations of proactive interaction with the user in the context of offered content (the user acted proactively by clicking on the link or reading the text). In this context a phenomenon of internauts' 'impatience' should be noted: it is significant that the positive user perception is rapidly decreasing with each transition to a new line of the web site (Figure 16 and 17).

Fig. 14. Schematic representation of the dynamics of user perception of online Home page viewing.

Orange transitions suggest the decreased high intensity of high frequency of perception. It is interesting that the orange fields in the heat map are almost as a rule situated on the edges of red fields (Figure 18). This is indicative of the existence of perceptive reflex in internauts, i.e. of the need to view the contents positioned on the left or on the right side of the contents marked as most attractive for users.

This part of research results can be compared with the previously mentioned Javal's 'fixations' and/or 'saccades', confirming the need to perceive a broader context of the content presented, for the purpose of better perception of individual specific pieces of information. Such perceptively deductive approach indicates that there are certain links with holistic theories, where the sense of the whole determines the relation to/perception of the components.

The heat map continues towards yellow fields representing lower occurrence of proactive perception of multimedia contents situated on these locations (as can be

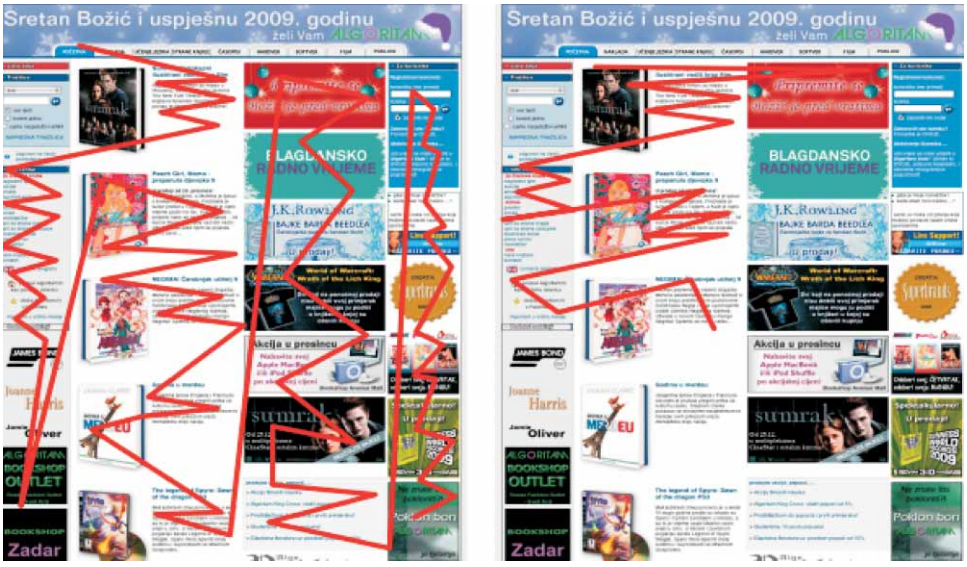

Fig. 13. On the left: schematic representation of multimedia content perception in the way in which offline (printed) media are perceived; on the right: actual dynamics of online content perception

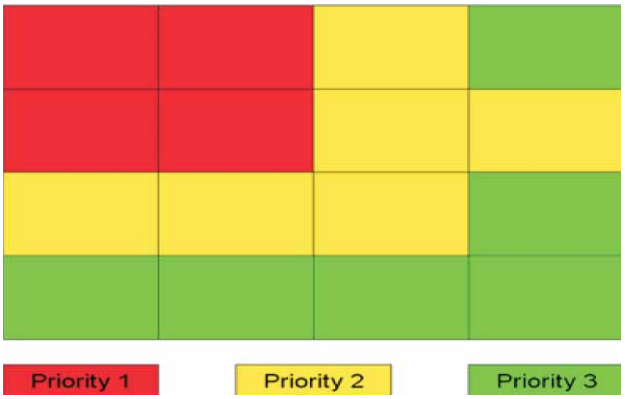

Fig. 15. Graphical representation of main perceptive quadrants on web sites.

seen in the illustration). This means that the internauts have noticed the contents in yellow fields, but they did not click these contents so often or did not dwell on them (which would suggest reading, i.e. proactive perception of the contents in question).

Heat map sections in green and shades of blue suggest low frequency of content perception by the user. What should be noted here is that the level of perception of multimedia contents on web sites is rapidly dropping from the centre of the page towards the bottom of the page. Such results undoubtedly indicate that these positions on a web site are unattractive, as opposed to positions marked red, orange and yellow. Therefore, despite the attractiveness of offered multimedia content, the contents located on 'blue' positions are doomed to lower interest level (Figure 19). Note: certain software versions of Eye Tracker software have heat map feature with three colours only (red, yellow and blue), but decoding of results is identical.

The research resulted in a number of interesting conclusions suggesting the following:

Internet users generally stay shortly at one web site and it is therefore crucial to precisely position the multimedia content on the site, to ensure that these contents will be proactively perceived by the users (meaning: click on the link or keeping eyes longer on a certain position, which is indicated by red colour on illustrations, suggesting that the internaut has read the text).

Users have a different psychology of perceiving information on web in comparison with the information obtained by other (conventional) media. Web contents are visually perceived by initial 'scanning' of the site, and not by reading (as is the case in printed media). This is because the user is accustomed to the fact that most information on the subject he or she is interested in will not be obtained by reading the related text on the site (as this text is in most cases only informational trigger), but through hyperlinks within the text offering links to additional, often more attractive and more comprehensive contents providing details on the information initially

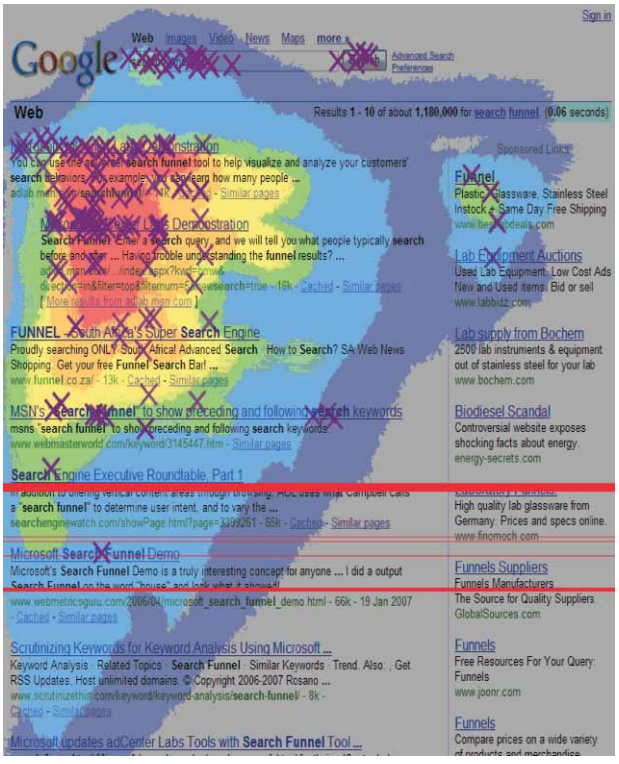

Fig. 16. Google Eye – Tracker »Heat map« and user's perceptive reaction with marked locations of 'saccades'.

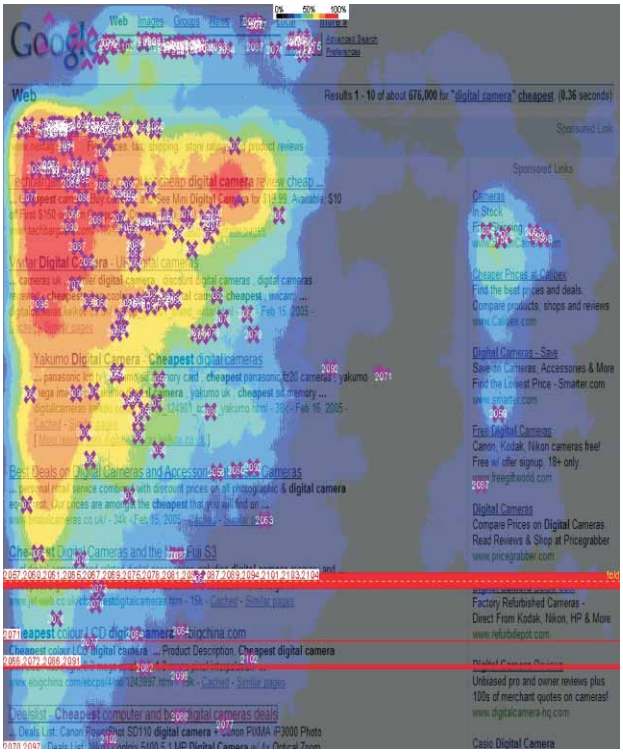

Fig. 17. Google Eye – Tracker »Heat map« and user's perceptive reaction with marked locations of žsaccades' including additionally »Eye tracker« positions (red lines with markings).

Fig. 18. Points of highest (red) and decreased high intensity (orange) of perception of the web site content.

Fig.20. Eye Tracking Reading Pattern; three parallel web sites with clearly observable F pattern of dispersion of multimedia online content.

found on the home page. Therefore the user who was attracted by basic information on the subject of his/her interest wants to find out more and instinctively searches for links in the text, in order to find the sources of detailed information.

Perceptive »F« sample suggests a geometrical dispersion matrix of proactive perception of online content. In simpler terms, the shape of the letter »F« is the fastest description of positions of multimedia documents on a web site that are as a rule observed and used by the users. Surveys employing Eye Tracker method showed that the highest frequency of user proactivity were recorded on the 32% of initial positions from the first line of the site. According to Nielsen[17], very high frequency was also recorded on 15% of lines within the upper third of the page, whereas the interest in multimedia content is rapidly decreasing if such content is situated in the lower half of the web site. If represented graphically, this dispersion of user interest would be shaped as letter F (Figure 20).

It can also be concluded that the position of multimedia content on web sites directly determines their visibility and their active use. The level of user's interest for such content is rapidly dropping with the square value of the distance from initial lines.

Pursuant to research results it can be stated that the users generally do not make optimal choices when navigating to information they are searching for, nor do they scan the web site moving from one content to the other in a linear manner. The research results show that the users tend to be satisfied with the first acceptable choice. As soon as they find the content that they perceive as relevant for finding the needed information, they intuitively click. This can be explained by some logical postulates: Nielsen's research confirmed that the average time spent on the home page is 56 seconds. In this period of time the internaut wants to find as much as possible information and therefore proactively perceives even those contents that include only indications of required information. The users tend to search in this way, as they are aware that there is no 'penalty' for wrong assumption, i.e. that they can easily go back to the initial point of their search (home page).

In addition to proper positioning of multimedia online content, there is one more factor to be considered in ensuring the best possible perception of such content by the user: it is crucial to avoid annoying visual sensations such as 'violent' unwanted pop-up windows offering their content, blinking and flickering of texts or banners, movements across the screen, fake links after click, etc. John Boyd from Yahoo! and Christian Rohrer from eBay presented a large body of researches on how users perceive online advertising. Research on design elements with negative effect on users show that users are very adversely affected by such visual and other sensations (Table 1).

Clearly the research results provide many tips to web site creators, so that by precisely positioning information on the web site they can obtain a higher level of user perception and thus a stronger direct information impact.

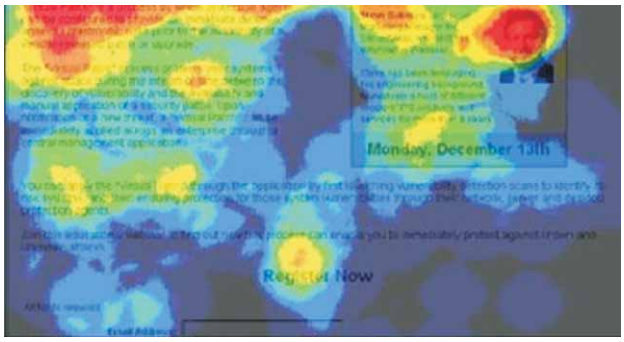

Fig. 19. Points of lowest (marked green and blue) perceived content on a web site.

TABLE 1
WEB SITE DESIGN ELEMENTS WITH ADVERSE IMPACT ON USER'S PERCEPTION OF MULTIMEDIA CONTENTS ON THE WEB SITE.

Design Element	Users Answering "Very Negatively" or "Negatively"
Pops-up in front of your window	95%
Loads slowly	94%
Tries to trick you into clicking on it	94%
Does not have a "Close" button	93%
Covers what you are trying to see	93%
Doesn't say what it is for	92%
Moves content around	92%
Occupies most of the page	90%
Blinks on and off	87%
Floats across the screen	79%
Automatically plays sound	79%

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VIZUALNI ASPEKTI PERCEPCIJE MULTIMEDIJALNIH PORUKA NA WEBU PUTEM »EYE TRACKER« METODE

SAŽETAK

Još od početaka civilizacije vizualna komunikacija je imala svoju ulogu u svakidašnjem životu. Tada su to bili primitivno oblikovani crteži životinja, piktogrami kojima se objašnjava taktika plemenskog lova na divljač ili strategije napada na neprijatelja. Evolucijom, vizualno izražavanje postaje važnim sastavnim dijelom komunikacijskog procesa i to na nekoliko razina, od egzistencijalne, ekonomske, pa sve do umjetničke. Ipak, svo to vrijeme nameće se pitanje razine korisničke recepcije takvih vizualnih informacija u mediju kojim se ta informacija prenosi. Je li fizička pozicija neke informacije u mediju doprinosi efikasnosti te poruke? Vrijede li ista pravila pozicioniranja sadržaja za klasične (offline) medije i za online medij (Internet)? Brzim razvojem informacijske tehnologije i Interneta u gotovo svakom segmentu suvremenog života javlja se potreba za definiranjem pravila oblikovanja i pozicioniranja multimedijskih online sadržaja na web stranicama. Nova istraživanja nedvojbeno pokazuju da mjesto fizičke pozicioniranosti nekog online sadržaja na web stranici u velikoj mjeri određuje kvalitetu percepcije tog sadržaja od strane korisnika. Korištenjem »Eye tracking« metode može se objektivno analizirati razina korisničke percepcije nekog multimedijskog sadržaja na web stranici. Što prvo korisnik uoči na web stranici kada je otvori i kako izgleda njegovo vizualno pretraživanje online sadržaja? Kojim metodama to možemo subjektivno, a kojima objektivno istražiti? Kako rezultatima istraživanja možemo unaprijediti kreiranje web stranica i optimizirati položaj relevantnih sadržaja na njoj? Odgovori na ta pitanja u velikoj mjeri će unaprijediti prezentaciju multimedijskih interaktivnih sadržaja na webu.