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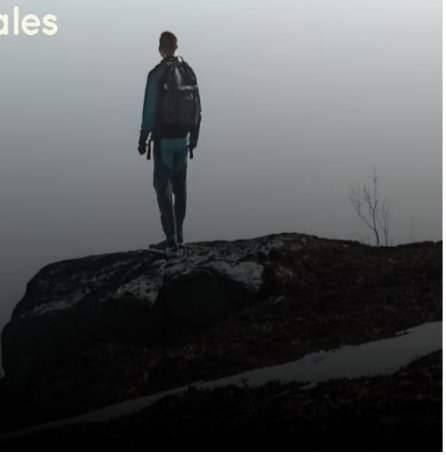

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IDENTITY OF BRANDS FOR BUILDING VISUAL NEUROCOMMUNICATION

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Abstract

The development of new technologies and the introduction of innovations in branding are associated with the construction of a system of visual neurocommunication, formed on the basis of predictive analytics, including neurophysiological data. In order to isolate the neurometrics, two experiments were conducted. The first is aimed at assessing the visual visibility of a territorial identity in a competitive environment based on an analysis of ascending stimuli, namely, color and shape. The second experiment was aimed at studying the effect of visual stimulus (logo) on visual attention, interest and memorability. The oculomotor behavior of 36 test subjects was recorded in an array of 791 data sets. According to the results of data processing, eleven metrics have been proposed that can be used as a practical toolkit for managing customer attention in an information-rich competitive environment. As a result of the work it is shown that the visual visibility of logos depends on their color, shape and location. Complicated colors attract more attention, they have 25% more fixations, and the subjects show the strongest interest during color transitions and gradient fills, the number of fixations on similar objects is 70% higher.

Keywords

Neuromarketing – Neurocommunications – Eye tracking study – Identity – Brands

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Introduction

The study of mechanisms for building visual neurocommunication based on neurophysiological methods of tracking decision-making and analysis of individual behavior is of particular interest in view of the development of new technologies and implementation of innovations in this area.

Currently, the neurocommunication market in Russia is at the stage of technological development. The companies engaged in this area are mainly engaged in commercial, rather than scientific, research. In foreign countries, there are dotted scientific studies regarding the perception of specific brands of trademarks. At the same time, such works are essential for understanding individual and social behavioral patterns, which can be formed on the basis of objective biometric indicators and presented in the form of neurometers. This is indispensable for shaping new strategies for branding development, especially in terms of creating tools for visual brand identification or identity development[1]. Broadly speaking, brand identity encompasses a set of graphical forms and principles for building visual communication united by a common semantic idea. Brand identification is systematized from two positions: visual-graphic language and style[2]. In this case, visual-graphic style predetermines the competitive identity of brands in terms of their visual attractiveness or significance. It results from the impact on such important mental processes in a person as attention, interest and memorability. In their turn, they are a trigger for the launch of effective communication, capable of influencing consumer behavior[3]. Issues related to subsequent individual and socially optimal decisions are reflected in the works of R. Thaler. His Nobel Prize in Economics in 2017 opened a new page in the series of studies of mechanisms responsible for the economic behavior of individuals[4].

Literature review

Eye tracking researches prevail at the formation stage of predictive analytics system formed on the basis of biometric data for neuromarketing studies of brand identic. These provide a comprehensive study of visual attention in the processing of information, which makes it possible to identify preferences and predict options for consumer choices. Studies of the very phenomenon of "attention" are conducted from different angles. In terms of psychology, visual attention is understood as a set of cognitive operations directed to select the appropriate information, and to filter out unnecessary information from oversaturated visual scenes[5]. However, there is another definition of this concept - a mechanism responsible for selection of information with preferential status[6].

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[1] J. M. Balmer, “Identity based views of the corporation: Insights from corporate identity, organizational identity, social identity, visual identity, corporate brand identity and corporate image”, Eur. J. Mark. (2008) Vol: 42 num 9/10 (2008): 879-906.

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[4] R. H. Thaler, Misbehaving: The making of behavioral economics (New York: Norton, 2015).

[5] S. A. McMains, Kastner Sabine. Visual Attention, 2009. Available at: https://link.springer.com/referenceworkentry/10.1007%2F978-3-540-29678-2_6344.

[6] H. Plassmann; T. R. Zoëga y M. Milosavljevic, “Branding the brain: A critical review and outlook”, Journal off Consumer Psychology num 22(1) (2012): 18-36.

Two types of processes stand out in psychology works: ascending (stimulated-driven) and descending (targeted). The first ones are related to the perception of information from the lower parts of the visual system (receptors) to the higher parts (cortical structures). The main task is to identify the most contrasting areas of the visual scene. The study of this very approach from the point of view of ascending attention began with the works of Koch C., Ullman S., in which the role of color and brightness of an object in its visual visibility was identified[7]. In 2000, the range of studies in this direction[8] was extended to include four leading color shades: red, yellow, green, and blue, as well as taking into account the value of color brightness and local object orientations (0°, 45°, 90°, and 135°). In addition to the above stimuli, flickering[9], movement[10], and contours[11] were later investigated.

The second process is the descending attention, which flows in reverse order (from higher to lower cortical parts). This is assumed to be due to a conscious purposeful action of the individual and depends on his experience and behavioral factors. The descending stimuli include: faces of people, animals, social interactions, cars, special signs and symbols that attract attention. It is difficult to draw a clear line between the ascending and descending systems because it depends largely on subjective factors such as individual perceptions of the individual[12]. Existing modern models of visual attention are based on the calculation of visual visibility maps[13]. They are implemented on the basis of two approaches: the formation of a computational model[14], taking into account the functioning of the human visual system as a whole. The second approach is related to the study of different parts of the image that are captured by observers, after which stimuli causing eye movement are identified[15]. The brand identity perception depends heavily on brand's popularity. Cognitive neurobiology and psychology describes it as "fluency" or ease of information processing. According to this process, familiar brands have a significant communication advantage, as they are recognizable[16], have an advantage in sales because of their high quality[17].

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[7] C. Koch y S. U. Ilman, “Shift in selective visual attention: towards the underlying neural circuitry”, Human Neurobiology num 4 (4) (1985): 219-227.

[8] L. Itti, Models of bottom-up and top-down visual attention: Doctor of Philosophy thesis. Pasadena. P.70-115. 2000.

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[11] T. N. Mundhenk y L. Itti, “Computational modeling and exploration of contour integration for visual saliency”, Biolo Cybern num 93 (3) (2005): 188-212.

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[17] A. Y. Lee y A. A. Labroo, “The effect of conceptual and perceptual fluency on brand evaluation”, Journal of Marketing Research (2004) num 41 (2): 151-165 y D. Novemsky y S. Schwarz, The Effect

Therefore, familiar stimuli are more visible and attractive and influence the level of commitment or loyalty to brands.

In studies of brand perception or visual prominence, conceptual and perceptual fluency factors need to be considered.

- Conceptual fluency is associated with descending visual attention stimuli. In its essence it is cognitive ease of perception of information and is used in framing studies when the task of searching[18] and prototypically is set[19].

- Perceptual fluency refers to ascending visual attention stimuli, as it is conditioned by the ease of perception of form, size or visual details of the objects under study[20].

Thus, ocular fixation on fugitive visual stimuli will appear earlier than on complex objects. This is due to the fact that less neural resources are spent on their processing, and, therefore, such brand identity will be easier to perceive.

In turn, interesting objects attract more attention if they are more visually significant. This conclusion is given in the works of Itti L., Koch S.[21], in which it is noted that, for subjects without search purposes and time constraints, ascending attention stimuli dominate and direct them according to interest[22]. The relationship between visual attention and subjective interest was revealed in the work of Christopher Michael, Stefan Mihalas, Derrick Parkhurst, Ernst Niebur[23]. When comparing the visual observability zones obtained from the Itti oculographic studies and the areas highlighted by the mouse, it is shown that there is a significant correlation between these areas. The studies by Chris Janiszewski found that repeated attention to an object increases the probability of its purchase[24], because the brand memorability already takes place. At the moment of making decisions, the first eye fixations are aimed at studying alternative but noticeable objects regardless of consumer preferences, and the subsequent ones will predetermine the choice.

Memorability studies are associated with an extensive block of scientific papers related to the analysis of consumer loyalty. During the development of brand identity, their memorability opens up possibilities for predicting the visibility probability of a visual object

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[24] C. Janiszewski; A. Kuo y N. T. Tavassoli, “The Influence of Selective Attention and Inattention to Products on Subsequent Choice”, Journal of Consumer Research. Forthcoming (2013).

using computer vision technologies[25]. The paper by Meur O. (Olivier Le Meur)[26] shows the direct correlation between visual attention and memorability, as well as the possibilities of its modeling depending on the visual image or content[27].

Studies of attention, memorability and interest are basic directions in neuromarketing. Taken together, they allow us to identify certain neurocognitive metrics that allow us to develop practical tools for managing consumer attention in an information-saturated competitive environment, to respond to consumer expectations and to predict possible reactions.

Research methodology

Experiment I. Evaluation of visual noticeability of a logo in a competitive environment based on ascending stimuli analysis.

The experiment is aimed to study visual noticeability of territorial logotypes in a competitive environment on the basis of eye tracking data, taking into account their color and shape.

Hypothesis 1: The logos with high visual noticeability will be detected earlier in a competitive environment and the number of fixations on them will be greater.

Design and stimuli. In order to test the first hypothesis, 12 territorial logotypes were chosen, which are objects for comparison. The visual stimuli were located in a circle and equidistant from the central point. In order to level out the impact of the stimulus location on the result, each logo was presented once in each sector (0°-45°, 45°-90°, 90°-135°, 135°-180°). Four color renderings were duplicated in black and white to eliminate the effect of color on eye fixation. In this experiment, a total of eight collages were shown.

Hypothesis 2. The level of visual noticeability of color and black-and-white images depends on the patterns of image viewing at presentation of stimulus material.

Design and stimuli. In order to test this hypothesis, five collages were prepared, including 12 logos, of which 50% were in one color and 50% were multicolored.

Experiment 2. Evaluation of the visual stimulus (logo) effect on visual attention, interest and memorability.

The purpose was to study visual attention, interest and memorability of logos.

This experiment was divided into two parts: the first was related to the study of visual attention to familiar and unfamiliar stimulated logos, and the second was to define visual attention to objects with high and low fluency depending on their shape and color.

[25] P. Isola; J. Xiao; D. Parikh; A. Torralba y A. Oliva, “What Makes a Photograph Memorable?”, IEEE Trans. Pattern Anal. Mach. Intell Vol: 36 num 7 (2014): 1469-1482.

[26] O. Le Meur y M. Mancas, Memorability of natural scenes: the role of attention, 2013. Available at: https://www.researchgate.net/publication/271554907_Memorability_of_natural_scenes_The_role_of_attention;

[27] Z. Bylinskii, “Intrinsic and extrinsic effects on image memorability”, Vision Research. 2015. Available at: https://web.mit.edu/zoya/www/docs/figrimProof.pdf y B. Zoya; P. Isola; C. Bainbridge; A. Torralba y A. Oliva, “Intrinsic and extrinsic effects on image memorability”, Vision Research. 2015. http://dx.doi.org/10.1016/ j.visres.2015.03.005.

At the same time, it was assumed that objects with high fluency are perceived as lighter, since their perception consumes less neural resources. Such visualizations included black and white images and lighter shapes.

Hypothesis 3. Familiar logos, in other words, with a high score of fluency will be detected earlier and the number of fixations on them will be greater.

Design and stimuli. There were prepared 5 collages consisting of 12 logotypes on each one, arranged in a circle and equidistant from the center. The four logos presented to the subjects were well recognizable.

Hypothesis 4: The logos with high visual noticeability and high scores of fluency will have a higher scores of memorability.

Design and stimuli. There was prepared a similar group of stimuli - 5 collages of 12 logotypes each, but 50% of them had light shape and 50% were complex. It should be noted that this group was black and white. The assessment of lightness or complexity of shape corresponded to the ability of the respondent with medium artistic ability to draw a logo by hand, taking into account the technical simplicity and comprehensibility of the geometric figure.

General procedure. Prior to the beginning of the experiment, the participants were explained the task and conducted a five-point calibration procedure. The participants were offered to view sets of their slides during 5000 ms without any task. This was done to detect reflex reactions of eye movement to visual stimuli. A randomization function was activated to show the slides. The participants of the experiments were 36 people (18 males and 18 females, 18 to 35 years old). All the participants were right-handed people with normal vision. Before starting the experiments, the participants gave their written consent to the processing of their personal data.

Equipment. The stimuli were shown on the monitor ThinkVision T24d-10 61B4MAT1EU, 60,9 cm (24") / IPS / 1920x1200 (16:10) / 300 cd/m2 / 1000:1, the working surface diagonal of the matrix 60,9 cm; frequency rate - 60 Hz. A stationary eye tracker VT 3 mini with a frequency of 250 Hz was used to obtain neurophysiological metrics.

The stimulus material was developed using Adobe Photoshop CS3 graphic program, where the size of logos and extension of 120 pixels/inch were corrected. The size of the stimulus material corresponds to the EventIde software, OGAMA (Open Gaze And Mouse Analyzer) 1920x1080. The obtained data was processed using the methods of economic and statistical analysis implemented in SPSS 17.0 software package and proprietary algorithms.

Results of research

In the course of neuromarketing experiments a number of standard indicators of the subjects' eye motive behavior were measured: total time of fixation, number of fixations, duration of fixations (median and average value), average saccade length, its average velocity, length of connection between fixations, velocity of the eye path. This study consisted of four groups of visualization projects:

1. Perception visualization of only the territorial logos in a homogeneous competitive environment (K) was made in two options: color and black and white.

2. Visualization of thematically unrelated logos in order to study their color perception (C).

3. Visualization of the thematically unrelated logos as to their recognizability in black and white (B).

4. Visualization of the thematically unrelated logos in order to study the simplicity or complexity of their shapes (S).

These sets of indicators have been created to identify a range of neuromarketing metrics that allow to make recommendations regarding the neurocommunication promotion of territorial identity.

Eye motive behavior of 36 subjects was recorded in an array of 791 data sets. Indicators obtained from the eye tracker were recoded for processing, and labels were formed as segmented polygons. Comparison of average visualization indicators No.1 is presented in Table 1.

Table 1
Pairwise comparison of independent samples

Data set No.1	Slide No.1 Color	Slide No.1a Black and white
Gaze: fixations (count)	15,2000	15,5000
Gaze: fixations (count /ms)	2,7421	2,7973
Gaze: duration of fixations. Average (ms)	338,3023	214,8174
Gaze: duration of fixations. Median (ms).	277,9571	151,9306
Gaze: average saccade length (pixel)	193,4061	200,8635
Gaze: average saccade velocity (pixel)	1,7330	1,8027
Gaze: length of connection between fixations (pixel)	2707,6039	2640,2974
Gaze: path velocity of the view (pixels/ms)	487,5545	476,8624
Data set No.2	Slide No.2 Color	Slide No.2a Black and white
Gaze: fixations (count)	15,2500	16,3611
Gaze: fixations (count /ms)	2,7505	2,9582
Gaze: duration of fixations. Average (ms)	198,4567	197,4746
Gaze: duration of fixations. Median (ms).	140,2639	146,3472
Gaze: average saccada length (pixel)	215,5966	189,7302
Gaze: average saccade velocity (pixel)	1,7443	1,8399
Gaze: length of connection between fixations (pixel)	2762,3654	2797,5797
Gaze: path velocity of the view (pixels/ms)	498,1889	505,3926
Data set No.3	Slide No.3 Color	Slide No.3a Black and white

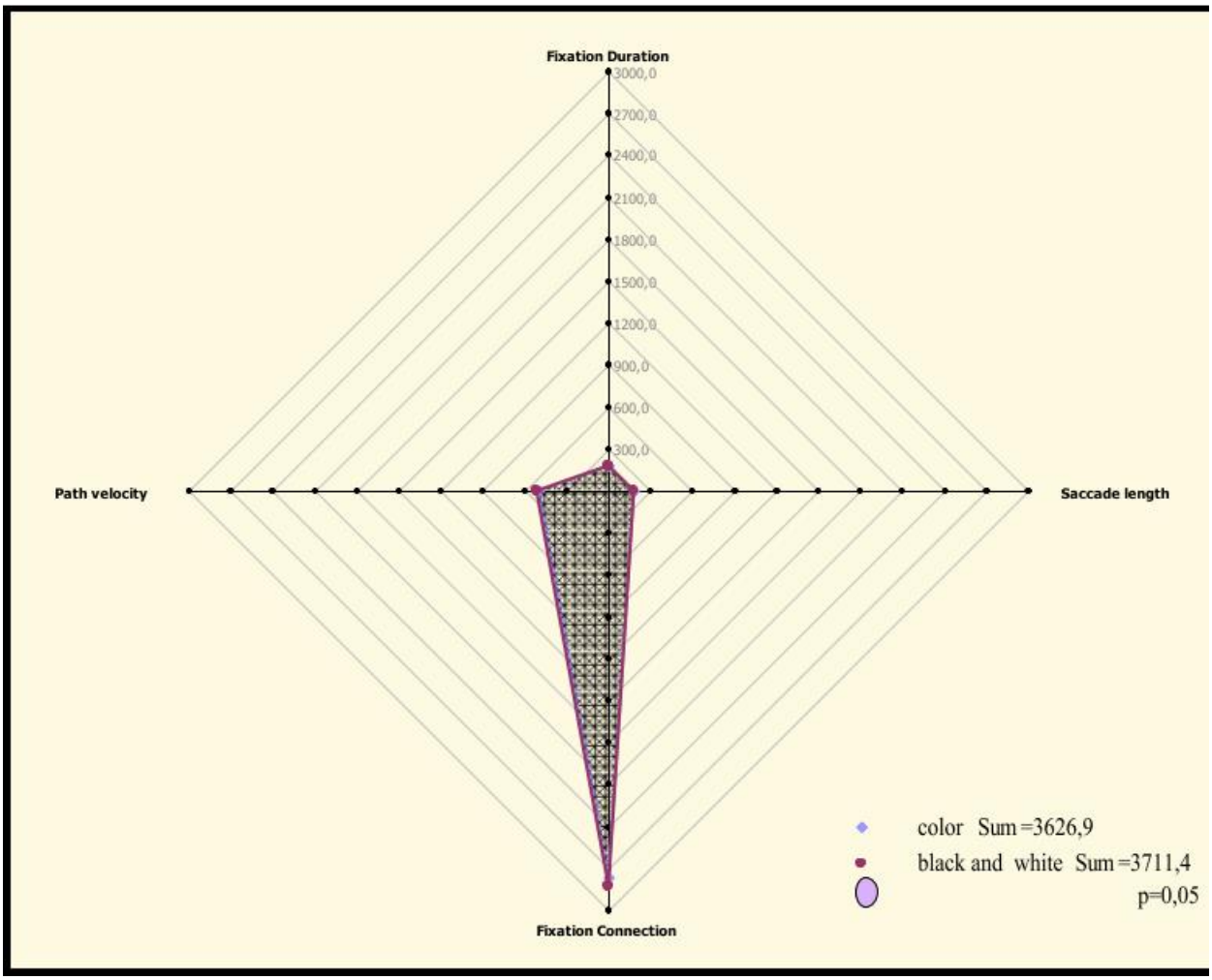
Gaze: fixations (count)	15,9714	16,6389
Gaze: fixations (count /ms)	2,8811	3,0036
Gaze: duration of fixations. Average (ms)	258,3810	189,6793
Gaze: duration of fixations. Median (ms).	208,3429	146,0139
Gaze: average saccada length (pixel)	167,5466	191,9834
Gaze: average saccade velocity (pixel)	1,8034	1,8006
Gaze: length of connection between fixations (pixel)	2545,0601	2807,5588
Gaze: path velocity of the view (pixels/ms)	458,9952	506,3983
Data set No.4	Slide No.4 Color	Slide No.4a Black and white
Gaze: fixations (count)	16,4286	16,6970
Gaze: fixations (count /ms)	2,9713	3,0187
Gaze: duration of fixations. Average (ms)	176,7276	183,1309
Gaze: duration of fixations. Median (ms).	131,4286	137,7121
Gaze: average saccade length (pixel)	180,5987	183,3833
Gaze: average saccade velocity (pixel)	1,6899	1,8227
Gaze: length of connection between fixations (pixel)	2769,3463	2832,1950
Gaze: path velocity of the view (pixels/ms)	500,2411	512,6999

Source: compiled by the authors.

Comparison of visual perception indicators of territorial logos in a color and black and white environment allows to reveal that black and white images are perceived as more complex, with an average of more fixations, and their duration is 37% lower than in color images. In this case, saccades are higher on black-and-white images than on color ones. Thus, we can highlight the following metric important in the development of territorial brand identity.

Metric 1. Black-and-white images of territorial logos are perceived as more complex, they hold a view and register more fixations and saccades.

At the same time, the greatest difference among all groups of indicators participating in this comparison is observed in terms of fixations (figure 1).



Source: own researches.

Figure 1
Differences in indicators between color and black and white logos.

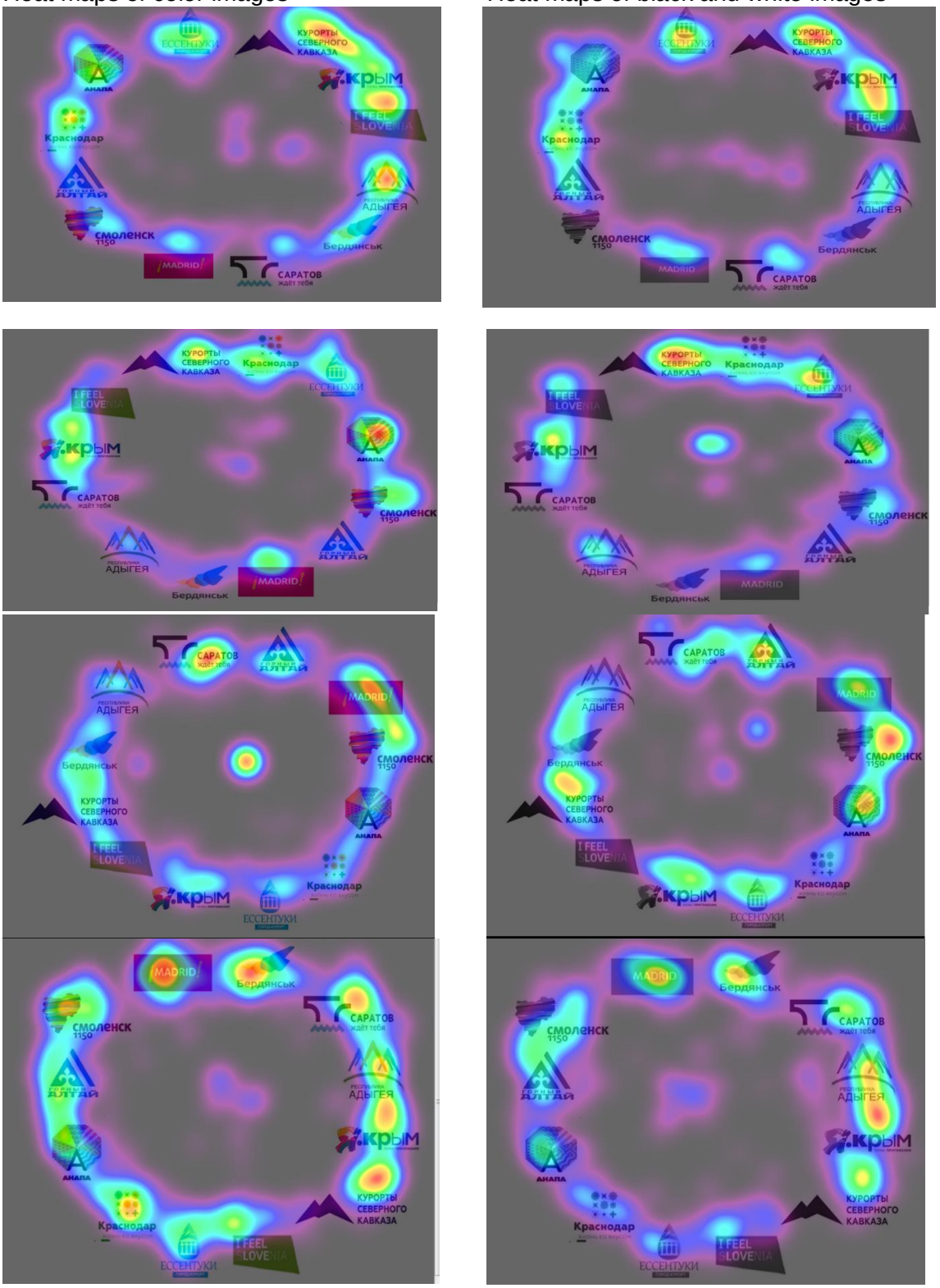
The polygonal object highlighted in Figure 1 is proportional to the duration of fixation, saccades and path velocities of the view.

Heat maps of the test participants' fixation are the result of the Gaussian function of each fixation point distribution[28]. Their location is associated with different cognitive processes. The work[29] shows that objects with high visual noticeability (Visual Saliency) are looked at earlier, longer and more often and this fact predetermines further consumer choice in competitive environment. Comparison of visual noticeability (Visual Saliency) of logos in a competitive environment in black and white and color version is shown in Figure 2

[28] O. Spakov, D. Miniotas, "Visualization of Eye Gaze Data using Heat Maps", Electronica and electrical engeneering num 2 (74) (2007): 55-58.
[29] M. Mormann; R. Towal y C. Koch, "What the Eye Does Not Admire the Brain Does Not Desire: How Visual Properties of Product Packaging Affect Consumer Attention and Choice Available at SSRN", 2015. Available at: https://ssrn.com/abstract=2709187 DOI 10.2139/ssrn.2709187

Heat maps of color images

Heat maps of black and white images



Source: own researches

Figure 2
Comparison of heat maps of territorial logos in color (left) and black and white (right) versions

The shape of the object[30], its location[31] and brightness[32] play a special role. The analysis of submitted data shows that there is a dependence between the color of a logo, its contrast and location on the number of fixations. At the same time, the zone of its localization depending on the angle of vision plays the most important role. One and the same logo is more visible in the area of 0°-45°, while the area of 90°-135°, as a rule, does not cause significant visual attention. Therefore, the density of fixation in the area of 90°-135° is 32% lower than the average visual stimulus.

Metric 2. Logo perception index is the ratio of time and density of fixation of allocated AIO to total time and density of viewing the whole visual stimulus.

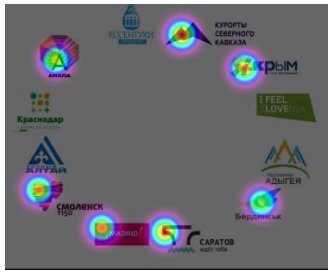
In its essence, the proposed perception index shows the importance of a particular area of interest (AIO). Fixations are directly related to the information content of the area and its visibility, these features should be taken into account when developing advertising products. It should be noted that attention is an important factor influencing the decision making process[33]. At the same time, fixation patterns should be considered in combination with their duration, which allows studying cognitive mechanisms in the process of attention distribution[34].

The study of visual attention is connected with the beginning and duration of fixation. It is known that synaptic delay of nerve impulse passing through the optic nerve to the brain is about 200 ms.[35]. Therefore, this time is rightly considered to be prethreshold, involuntary, because the localization of the point element in the visual field in this period is not controlled by the brain. Figure 3 studies the evolution of the participants' attention according to different time limits.

200 ms

300 ms

400 ms



600 ms

[30] V. Folkes y S. Matta, "The Effect of Package Shape on Consumers Judgments of Product Volume: Attention as a Mental Contaminant", Journal of Consumer Research num 31 (2004): 390-401.
[31] X. Deng y B. Kahn, Is "Your Product On the Right Side? The 'Location Effect' on Perceived Product", Journal of Marketing Research num 46 (6 (2009): 725-738.
[32] M. Milosavljevic; V. Navalpakkam; C. Koch y A. Rangel, "Relative Visual Saliency Differences Induce Sizable Bias in Consumer Choice", Journal of Consumer Psychology num 22 (2012): 67-74.
[33] J.R. Bettman, An Information Processing Theory of Consumer Choice. Reading. MA: AddisonWesley.1979.
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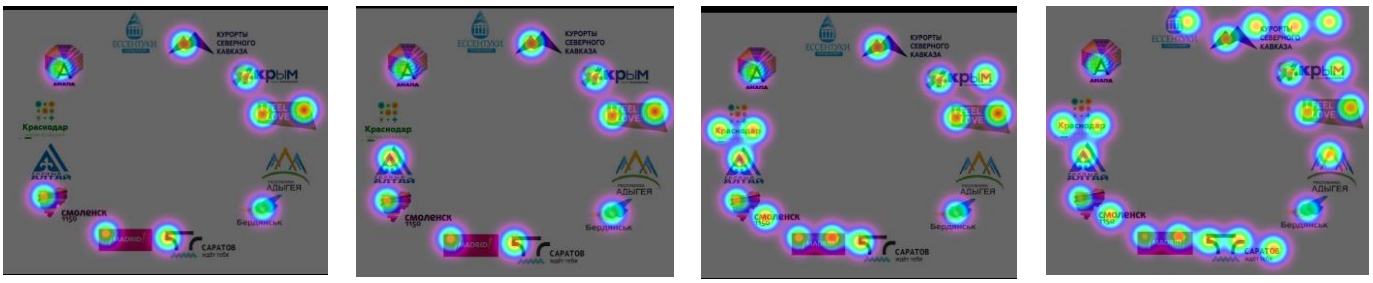
[35] W. Graf y H. Krueger, "Ergonomic evaluation of user-interfaces by means of eye-movement data", Proceedings of the third international conference on human-computer interaction. Elsevier Science Inc. P.659-665. 1989.



800 ms 1000 ms 1500 ms 2500 ms

Source: own researches

Figure 3
Evolution of attention

According to the data presented above, it can be seen that it took 2500 ms to study the stimulus material completely, and the first re-fixation began to be observed from 800 ms. After the neuromarketing experiment, we asked the participants which of the presented logotypes they remembered. The processed results of this survey and their correlation with the data presented above showed that fixations of less than 300 ms are not encoded in memory and, consequently, are not memorized[36]. In accordance with this, the following metric can be distinguished.

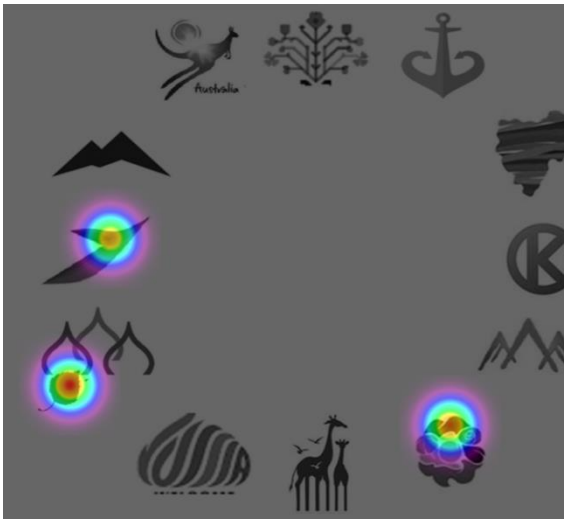
Metric 3. Refixation (repeated fixations) is the ratio between the number of the participant's appeals to the visual stimulus for the whole period of viewing, starting from 800 ms, to the total duration of fixations on the element during the whole period of its viewing.

In this way, it is possible to identify which elements of visualization are studied during the entire period of stimulus presentation. Definition of these time limits is important for understanding the memorability of advertising logos and the possibility of their placement on the boards along the transport arteries, where the time of their visibility is extremely limited by the speed of movement.

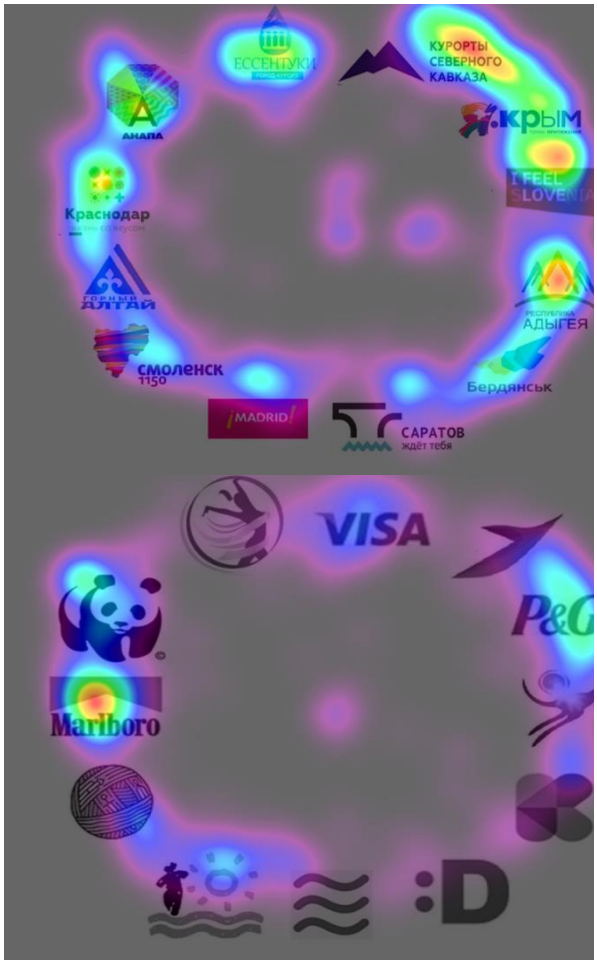
Studies of stimuli at the sub-sensory perception level provide some evidence that subthreshold semantic signals are recorded by the sensory system and encoded at the subconscious level, which according to some data[37] may have a serious impact on their further presentation. A comparison of logo visualizations at the sub-sensory and sensory levels is shown in Figure 4.

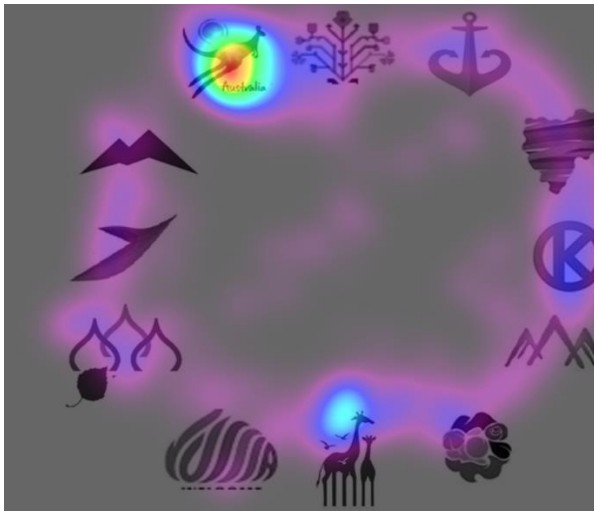
[36] M. Mancas y O. Le Meury, Memorability of natural scenes: the role of attention // Conference paper September, 2013. Available at: http://people.irisa.fr/Olivier.Le_Meur/publi/2013_ICIP/Mancas_ICIP_2013.pdf; DOI:10.1109/icip.2013.6738041.
[37] H. Shiffman, Sensation and Perception. SPb. 2003.

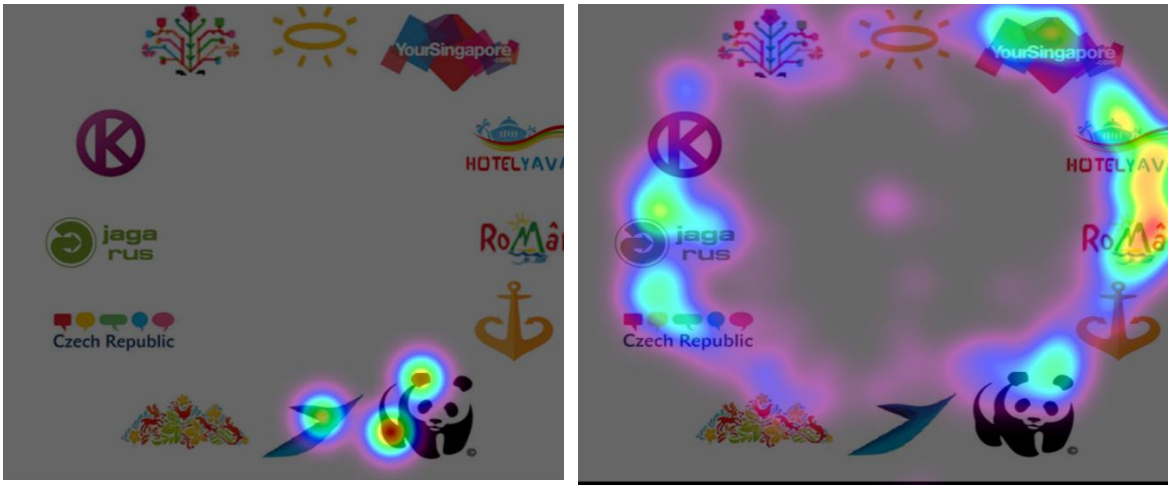
200 ms



5000 ms







Source: own researches

Figure 4
Comparison of perception levels of territorial logos

An expressed tendency is that the logos that have attracted attention on the unconscious level, have become uninteresting on the conscious level. One can see psychoanalytic symbolism in fixations for 200 ms and its displacement from the circle of conscious fixations. An indirect indicator of attention can also be the time before the first fixation and its very duration in the area of interest (AIO).

Metric 5. Memorability of visual elements depends on the total time of fixation minus fixations of up to 300 ms.

The second group of visualizations is related to the assessment of color perception of logos in a thematically unrelated environment. The difference between general neurophysiological indicators: fixations, saccades, etc. in a uniform and diverse stimulus material is on average 33% for all indicators. This allows us to conclude that when solving applied economic problems and obtaining reliable conclusions, the stimulus material should be selected thematically homogeneously. This is confirmed in scientific papers on contextual difference of the presented images[38]*.* The study of simple and complex colors is based on the assumption that it is simple to have one color (on the white background of the stimulus material) and complex to have more than 1 color. The results of our experiment show that fixations on complex color are up to 25% more than on simple and had longer duration of perception. Most of the participants were attracted by color transitions and gradient filling of logos, fixations on such objects increased by 70%. This observation is confirmed in the theory of color *[Benty, 2004].* Classical design widely used this technique, as it has long been known that people like the most natural gradients of color: rainbows, sunsets, sunrises, rather than a homogeneous palette.

Metric 6. Evaluation of color contribution to visual attention can be done by comparing the fixation time per 1 color divided by the total time of visual stimulus viewing.

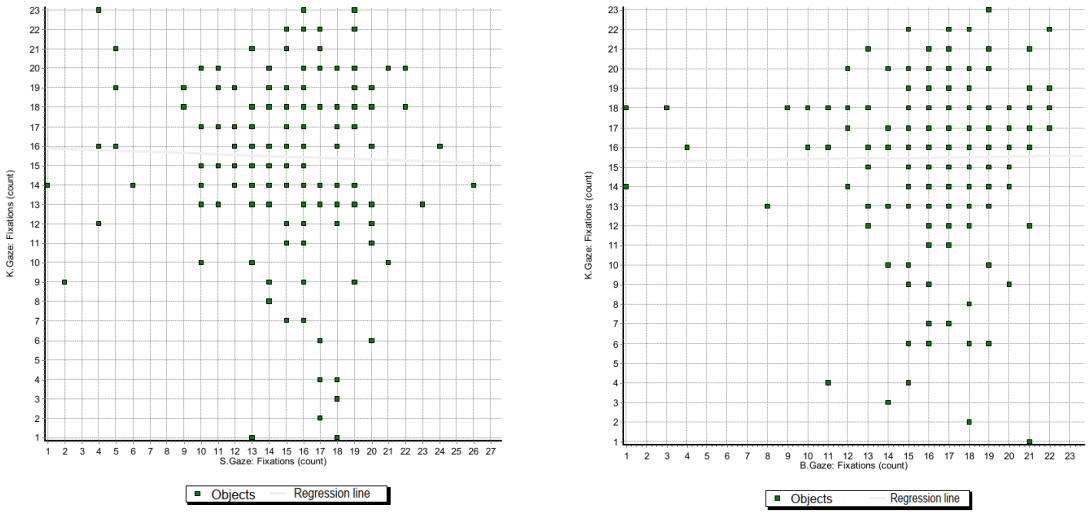
As a result of the experiment it was shown that the same logo has different fixations in the color spectrum: red color- average of 39 units, blue color - 55 units, and orange color - 57 units.

[38] Z. Bylinskii, “Intrinsic and extrinsic effects on image memorability” Vision Research. 2015. Available at: https://web.mit.edu/zoya/www/docs/figrimProof.pdf

The third group of visualizations on the consideration issue of familiar and unfamiliar logos in a heterogeneous environment allowed to reveal that the number of fixations is comparable to the complexity of the studied object. Familiar logos had on the average 29.7 fixations, while unfamiliar logos had 19.8 fixations, which is 32% higher.

Metric 7. The level of object complexity is determined by the frequency of fixation on the logo (AIO) in relation to the total fixation on the slide and the number of returnable saccades in the area of interest.

The focal similarity of scanning paths by the participants of all the visualization groups we studied revealed that the largest number of saccades was caused by black and white slides, where only the form was examined for its simplicity or complexity. Regression analysis of black and white objects of group B (recognizeability study) and group S (simple or complex shape study) show that the simple shape is characterized by an increase in saccades, while the recognizeability task on the contrary forms a larger number of fixations. At the same time, the data spread in regression analysis makes up groups: S (10-20 fixations) and B (14-21 fixations).



Source: own researches

Figure 5
Regression analysis of visualizations (shape) S and (memorizing) B

The study of familiar and unfamiliar logos showed that the number of fixations is related to the complexity of the studied object's shape. The works of Anuj K. Shah, Daniel M. Oppenheimer[39] demonstrated that complex and easy information directly affects the fluency of information perception.

According to the data of the conducted experiment, light shapes give on the average 13.56 units, and complex 48 fixations, which allows to conclude that their number on complex objects was 3.5 times higher. The lowest number of eye fixations was observed on a wave, and the highest number of fixations was observed on a star and diverging objects, respectively.

[39] A. K. Shah y D. M. Oppenheimer, "Easy does it: The role of fluency in cue weighting", Judgment and Decision Making Vol: 2 num 6 (2007): 371-379.

At the same time, it was found that the shape of the presented logo does not affect its further memorization. In part, this conclusion echoes the work of Isola P.[40], which proves that there is no direct relationship between attention and memorization. Thus, after the end of the experiment, the respondents could not recall any of the forms presented in the stimulus material. At the same time, the longest saccades and the smallest number of fixations were registered compared to all other stimulus material. Thus, we can conclude that memorability is associated with high level functions.

Metric 8. The level of interest in a visual object is measured by the ratio of fixations to saccades.

This is explained by the fact that the perception of a whole image (collage) is quite difficult, so the choice of priority zones of interest is made selectively. This occurs in the process of interaction between two mechanisms - open attention based on the saccadic movements of the eyes and decision-making based on the awareness of interest in certain parts of the collage. As a result, this is reflected in the figure of eye movements[41] of the participants, which corresponds to three different attention processes: from bottom to top - the process is exogenous, involuntary, and independent; from top to bottom - the process is endogenous, caused by higher cognitive factors, in particular interest, which is slower, more complex, and subconscious, and the third - perceived interest is associated with endogenous attention and conscious decision-making[42].

To assess the level of perception of form in the classical design, such an indicator as prepositional density of the object is used. We believe that it can also be used in the neuro study of visual objects.

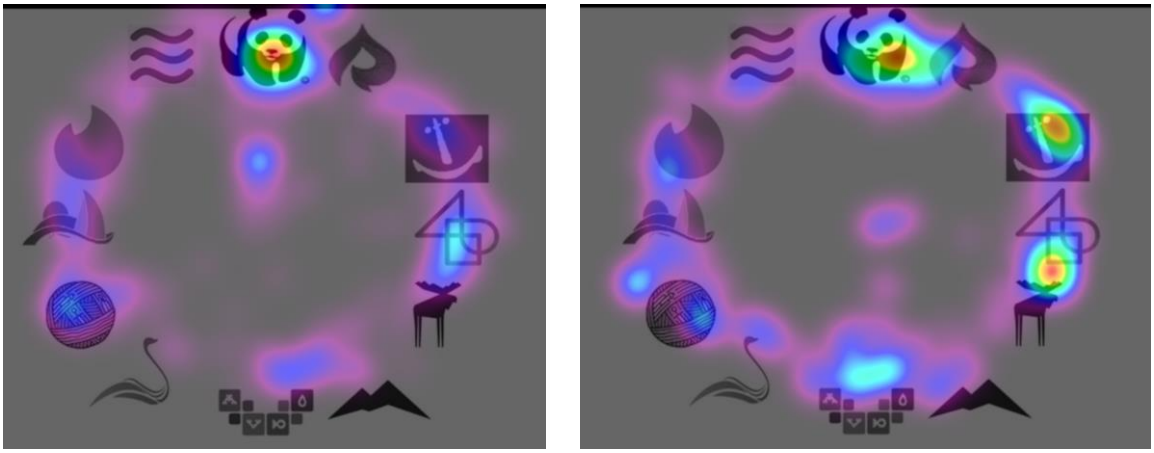
Metric 9. Propositional density[43] of the logo is the ratio between the number of semantic characteristics embedded in the shape and the number of its elements. It is desirable, however, to have more sense and fewer elements.

In its essence it is the amount of information per element's unit or ratio between invisible and visible meaning. As for variety of forms and their visual significance, they can be estimated with the following metric.

Metric 10. The variety of the logo shape is determined by the variety of fixations on unique elements fixed by the participants during the whole viewing period. At the same time, fixation on certain elements is estimated by the number of times when it occurred on them.

In practice, the perception of the same stimulus material is noticeably different between males and females, experts and non-experts, representatives of different age groups, etc. (Figure 6).

[40] P. Isola; J. Xiao; A. Torralba y A. Oliva, “What makes an image memorable?”, IEEE Conference on Computer Vision and Pattern Recognition (CVPR). P. 145-152. 2011.
[41] C. M. Masciocchi; S. Mihalas; D. Parkhurst y E. Niebur, “Everyone knows what is interesting. Salient locations which should be fixated”, Journal of Vision Vol: 25 num 9(11) (2009):1-22.
[42] U. Engelke y P. Le Callet, “Perceived interest and overt visual attention in natural images Signal Processing”, Image Communication num 39 (2015): 386-404.
[43] W. Lidwell, More with Less, 2009. Available at: http://research.avenues.org/wp-content/uploads/files/morewithless.pdf. DOI: 10.1145/1620693.1620711



Males Females

Source: own researches

Figure 6

Comparison of heat maps of fixation on objects with low and high level of consistency

Thus, males and females have different fixation schemes. Peculiarities of human perception are in the center of behavioral economics research, which explains the formation of behavioral heuristics on decisions made[44]. Among the objects presented in the figure there was one object that equally attracted attention of all participants. It seems to be an object of high congruence (consistency). The congruence level estimation is a basic one for understanding the perception of visual content by different groups. That is why obtaining fixations of increased duration on such objects can be used for diagnostics of visualization objects complicated for perception or their elements.

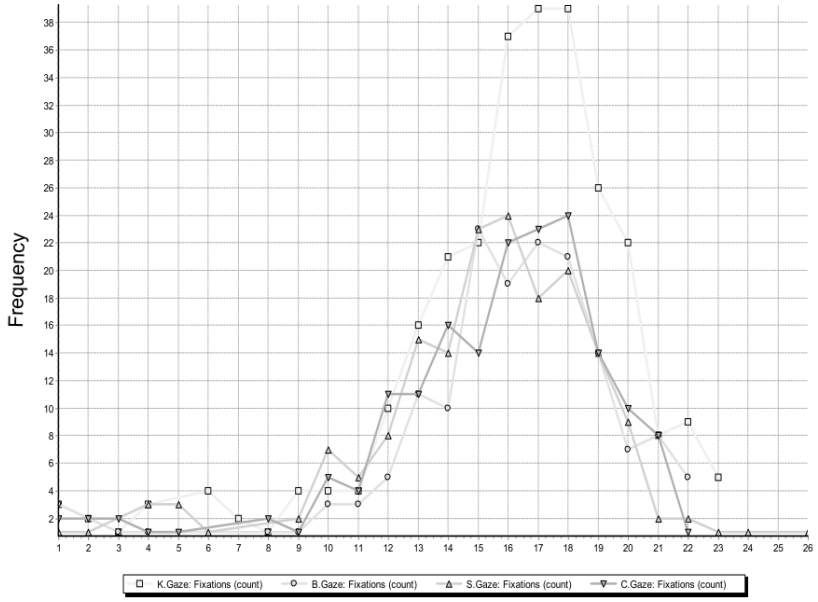
Metric 11. Fixation congruence index is a ratio of participants' fixation on separate elements of visualization by one or several socio-demographic features.

A high congruence index shows that the presented content or visual stimulus has aroused interest in all groups, and therefore is universal. On the contrary, a low congruence index shows that the visual symbolism is aimed at only one group. This is important for marketing brand positioning, namely, to understand which target group the promotion is aimed at. Consistency of observers is used in studies[45] to quantify behavioral patterns and identify metrics of similarity.

The results of a final comparison of the four visualizations are shown in Figure 7.

[44] A. V. Belyanin, "Richard Tyler and behavioral economics: from laboratory experiments to nudging practice", Voprosy Ekonomiki num 1 (2018): 5-25.

[45] M. Burch; N. Konevtsova; J. Heinrich; M. Hoeferlin and D. Weiskopf, "Evaluation of traditional, orthogonal, and radial tree diagrams by an eye tracking study", IEEE TVCG num 17 (12) (2011): 2440-2448.



Source: own researches

Figure 7

Frequency of fixation on the four visualizations of the logos: C. Gaze - competitive environment; K. Gaze - simple and complex colors; B. Gaze - familiar and unfamiliar logos; S. Gaze - simple and complex shapes.

The highest number of fixations in this study was on logos presented in a homogeneous competitive environment, so it can be assumed that they were the most interesting for the participants, the lowest was observed on black and white shapes of thematically heterogeneous logos. The proposed system of neuromarketing metrics for brand identity assessment can be used as a complex method based on objective neurophysiological parameters and allows to form a block of applied recommendations for logo designers and marketing specialists.

Conclusion

The hypotheses put forward in the work allowed us to come to the following conclusions:

1. Visual noticeability of the logos depends on their color, shape and location. Complex colors attract more attention, they have 25% more fixations, and the strongest interest among participants is revealed at color transitions and gradient filling, the number of fixations on such objects is 70% higher. When preparing and designing logos, a special role is played by their localization depending on the angle of vision. The most viewable area is from 0°-45°, while the area of 90°-135°, as a rule, does not cause significant visual attention. The density of fixation in the area of 90°-135° is 32% lower than the average visual stimulus.

2. Noticeability of color and black-and-white images depends on the ratio of fixation and saccades when the stimulated material is presented. It was found that visual perception of logos in black and white was more complicated, on the average more fixations were made on such objects, and they were viewed less (duration was 37% lower than on colored images).

3. Familiar logos were detected earlier and the number of fixations on them was on average 32% higher than on unfamiliar ones. At the same time, it has been proved that a simple shape is characterized by an increase in saccades, while a recognition task, on the contrary, generates a larger number of fixations. This leads to the conclusion that the number of fixations is connected with the complexity of the studied object shape, as there are 3.5 times more fixations on complex logos.

4. High visual noticeability and fluency of logos has a good estimation of memorability. It was shown that the stimulus material is studied completely at 2500 ms, and the first refixations were observed at 800 ms. It was found that the logos, which attracted attention on an unconscious level, were not interesting on a conscious level. One can see psychoanalytic symbolism in fixations at 200 ms and its displacement from the circle of conscious fixations. The objects, which attracted attention during the first 300 ms, have not been remembered.

In conclusion, it should be noted that this experimental work allowed to obtain new evidence on oculomotor reactions to territorial identity. Objectification of the test participants' eye movement data according to the proposed technique provides an opportunity to successfully create visually significant logos taking into account visual fixations on their semantic forms in the chain of mnemonic processes related to mastering of central and peripheral visual information.

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