

## ECOLOGICAL SAFETY OF VISUAL PERCEPTION OF NATURAL AND ARTIFICIAL ENVIRONMENT

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Досліджено ландшафти міської екосистеми на прикладі міста Вінниці. Проаналізовано рівень відеоекологічної сприйнятливості та геопотенціальної стійкості території м. Вінниця, виявлено основні ризики для видимого природного та штучного середовища міста. Відеоекологічний аналіз урбосередовища спрямований на шлях визначення оптимізації візуальної сприйнятливості природного та штучного середовища в місті. *Ключові слова:* відео екологія, сакади, візуальне забруднення, фрактальне середовище, гомогенні поля.

**Экологическая безопасность визуального восприятия природной и искусственной среды.** Бондарчук О.В., Петрук В.Г., Цвенько О.О. Исследованы ландшафты городской экосистемы на примере города Винниц. Проанализирован уровень видеоэкологической восприимчивости и геопотенциальной устойчивости территории г. Винница, определены основные риски для видимой природной и искусственной среды города. Видеоэкологический анализ урбосреды направлен на определение оптимизации визуального восприятия естественной и искусственной среды в городе. *Ключевые слова:* видеоэкология, саккады, визуальное загрязнение, фрактальная среда, гомогенные поля.

**Ecological safety of visual perception of natural and artificial environment.** Bondarchuk O., Petruk V., Tsvenko O. The landscapes of the urban ecosystem are studied on the example of the city of Vinnitsa. The level of videoecological susceptibility and geopotential stability of the territory of Vinnitsa is analyzed, the main risks for the visible natural and artificial environment of the city are determined. The video-ecological analysis of the urban environment is aimed at determining the optimization of visual perception of the natural and artificial environment in the city. *Keywords:* videoecology, saccade automaticity, visual pollution, visual environment, homogeneous fields, landscape design.

Environmental security issues are of paramount importance today, but along with the main environmental problems (air quality, water pollution, increased noise and radiation), environmental importance is not less important - a permanent visible environment and its status stands on the sidelines.

The processes of urbanization, rationalization and industrialization have alienated us from visual perfec-

tion: the artificial environment has ceased to bring aesthetic pleasure and has generated a large number of social problems. The architecture of the last 50 years negatively affects the psycho-emotional state of a person. Really now in many cities the visual environment is dramatically changed: dark gray, straight lines and corners prevail, urban buildings are mostly static and have a large number of planes,

which negatively affects the visual processes.

**Urgency of the research.** The study of the ecological safety of visual perception of the natural environment and management of environmental risks of the technosphere is an urgent issue of the present, which is caused by the destruction of greenery, high level of contamination of the territory, the spread of uniform aggressive environments for visual perception of people, low level of architectural planning of cities and inadequate color saturation.

**Research results.** The human visual organ is a biological system designed to perceive light and receive environmental information through it. Actually, in many cities the visual environment has changed dramatically: dark gray color, straight lines and angles, urban buildings are predominantly static with many monotonous planes prevail, which negatively affects the visual processes of a person.

So, let us turn to the Saccade theory, which we use to explain the concept of the necessary qualitative susceptibility of the environment and its influence on the general psychoemotional state of a person [2].

Saccade (French for "strong push, jerk") is called the rapid movement of the eye, which is carried out spontaneously, that is, in automatic mode. Eyes continuously scan the visible surroundings, carrying around 120 Saccades per minute. The nature of Saccades passage is due to the activity of the central nervous system. Each person has its own mode of passing saccades, which is determined by three parameters: the interval between accades, their amplitude and orientation (Figure 1). Saccades follow an average interval of

0.2 ... 0.6 seconds with an amplitude of saccades changing in a large range, on average from 2 angular minutes to 15 angular degrees. The targeted saccades are practically in all directions, but, as a rule, their number is more in the horizontal plane. Depending on the external and internal conditions, the saccades have the property of change. If a person captures a view on any immovable object, it is also accompanied by several continuous, imperceptible movements of the eyes. They can be detected only with the help of special equipment. Without such micromovements, the visual organ does not perceive the image formed on the retina by the optical system of the eye. Also, the saccades create the necessary conditions for the visual system to estimate the magnitude, distance and the location of visible objects, that is, it is a component of the process of dynamic perception [1, 2, 3, 4].

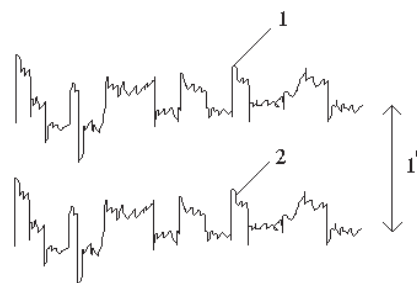


Fig. 1. A fragment of the recording of the coordinated movement of the eyes of the "saccades" type with the right eye fixed point: 1 - right eye, 2 - left eye [2]

So, after each saccade, the eye fixes any visual element, and the brain receives information about the seen from the photoreceptors, the brain calms down: there was a saccade, there was an element of the environment, the element was fixed. When the eye has practically

nothing to focus on, because the surrounding visual environment is only lines, corners, large transparent planes, then as a result of the eyes movements only the same time signals come to the brain and the brain is in a state of complete confusion. Such a visual environment is unacceptable for a person and his health, increasing the negative effect on the fundamental mechanisms of vision - a saccade automaticity, a binocular apparatus, convergence, and visual centers. Then the inverse relationship between the sensory and locomotor apparatus is disrupted [1, 4].

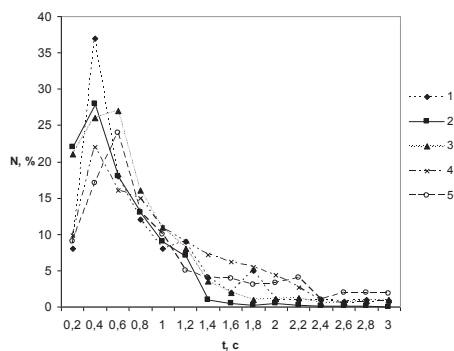


Fig. 2. Diagram of distribution of intervals between saccades under different conditions of contemplation: 1 and 2 - during fast sleep of children and adults, respectively (studied 470 and 2343 intervals between saccades, 7 and 3 target persons); 3 and 4 - fixation of the fixed and imaginary points, respectively (studied 2362 and 1215 intervals, 11 and 8 target persons); 5 - free contemplation of the picture (studied 2000 intervals, 5 target persons); on the axis of abscis - intervals between saccades,  $t, c$ ; on the ordinate axis - the number of measurements,  $N\%$  [2]

The idea of a saccade automaticity is a new direction in physiology, promising in the study of psychiatric and neurophysiological aspects of visual perception, diagnosis of a number of dis-

eases, etc. The distribution of intervals between saccades under different conditions of contemplation is presented in Figure 2 [2].

Distribution of the saccades amplitude for free human behavior in the environment is depicted in Figure 3 [2].

From the above figures we conclude that the interval between saccades is relatively constant under different conditions of contemplation, and the amplitude of saccades depends on the nature of the activity and during the free movement of a person in the environment varies in a wide range - up to  $30^\circ$ .

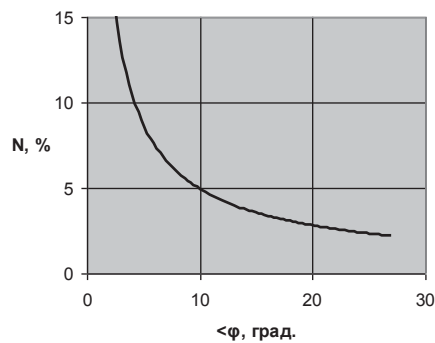


Fig. 3. Curve of amplitude distribution of saccades for free human behavior in the environment (along the axis of abscis - amplitude of saccades, angular degrees  $\phi$ , degrees, ordinate - number of measurements,  $\%$ ) [2]

The growth of the "artificial world" is manifested more remotely from natural standards and ideals, and as a result - more influence and transformation of the visible human habitat [5].

Under the visible environment it should be understood the environment, which a person perceives by the organs of vision in all its diversity. In general, the environment can be conventionally divided into natural and artificial. The natural visual environment fully corre-

sponds to the physiological norms of vision, since nature "adapted" the eye "to itself". An artificial environment is perceived quite differently. It increasingly differs from natural and in many cases contradicts the laws of visual perception of it by a person. Such an environment has created the problem of videoecology - a new scientific direction studying the aspects of visual perception of the environment, based on the theory of automatic saccades, which allows to explain and evaluate the negative impact on psycho-emotional health of a person [2, 6].

Since the visible environment is an environmental factor, one should pay attention to the fact that the person as a biological species was formed in certain natural conditions, where the corresponding color scale prevailed. However, the processes of urbanization, rationalization and industrialization have removed us from the visual ideal [6]. The structure of the color elements themselves has also changed, in which straight lines, straight angles, a huge number of large planes with a uniform color predominate.

The emergence of a large number of new same type of new developments and other less attractive constructions with simplified architectural planning is depressing for the residents of the city. In recent years, the appearance of modern cities is overwhelmed with European design. It is created not only by modern buildings of modern type, but also by annoying advertising, a continuous stream of fast-moving mostly gray or black foreign cars; in the architecture appeared buildings that meet the corporate aesthetics, but are completely devoid of a sense of national color [5, 8, 9].

Monotony, uniformity of geometrically correct and equally glazed buildings is the main reason for annoyance of citizens. Decorating buildings is not someone's whim or caprice. These are the necessary functional elements that should form the basis of the visual environment, without which full-fledged eye work is impossible [6].

If you compare two houses of different cultural epochs, it's easy to see how much they differ. This difference is: in the saturation with decorative elements - a small number of them in new constructions and much more and more perfect in the buildings of past centuries; in the structure of the elements - a lot of straight lines and sharp corners in the constructions of the new building and many corners and curves in old buildings; in the size of the planes - one large plane in modern and many small - in old buildings; in the silhouette of houses - a simplified silhouette of new buildings and diverse - in the old buildings [10].

The monotony of the architectural space generates such a phenomenon as the "sadness of new cities", which is characterized by an increased morbidity of inhabitants in the new urban areas, where the living conditions are objectively much better than those in which the settlers lived before. Obviously, this phenomenon is caused by mistakes in urban planning, the absence of past close contacts between residents, separation from the usual socio-psychological environment. The environment has acquired homogeneous features [2].

Multipanel construction has become a major and determining factor in creating the image of our cities. The widespread use of this method of construct-

ing buildings greatly changes the image of our cities and the problem of visual perceptibility of the environment becomes more and more acute. In the urban environment, there are many homogeneous visible fields, which, in particular, create monotonous facades of houses, where prevailing bare concrete walls prevail. When looking at such a wall there is no eye to "catch" after the next saccade. If a person is close to such a wall at a distance of 40 meters, then it limits the view from all sides (along the horizontal line -  $20^\circ$  -  $30^\circ$ , and on the vertical line -  $40^\circ$  -  $45^\circ$ ), while the vast majority of saccades (86% ) has an amplitude of up to  $15^\circ$ , and for 1 second the eye perceives 2 to 3 saccades. This means that when looking at a person on such a surface within just 3 seconds before it there is a 6 to 9 saccades, like a monotonous wall, where there are no elements for fixing the look. This situation can be compared to a feeling when a person makes another step and feels a solid foundation under the feet. Only in this case, on the contrary, the eyes for about 3 seconds about 10 times "fall into the abyss". It is easy to imagine how unpleasant this situation is that inevitably leads to a feeling of discomfort [2, 3, 6].

Consequently, the facades of buildings create homogeneous fields in urban conditions when used in the construction of solid panels of a large size. No less disturbing is the use of large window frames. The facade of the house made of glass and the asphalt covering is a man-made non-oriented space. In such an environment, the amplitude of the saccades increases 3 to 5 times, that is, the automaticity of the saccades moves to a search mode. The search mode in the meantime also leads to an

undesirable result, as a building from a distance of 30 meters covers the sight at  $80^\circ$  [3, 4].

The visible environment in which a lot of monotonous elements are concentrated is called an aggressive environment. An example of aggressive visible fields are giant "book-houses", where through a rich number of identical elements the human eyes are trapped in a geometric structure. Long look at such a structure, you can not admire it because of the fact that the eye has nothing to stop. The aggressiveness of the visible environment dramatically increases with additional noise exposure. It has been established that rhythmization of signals entering the inputs of two basic sensory systems of a person (sight and hearing) leads to an increase in aggressiveness. According to VA Filin [6], in this case signals from "aggressive fields", consisting of identical elements and from mechanisms with a monotonous movement (escalators, elevators, wheels, conveyors) get to the visual input, and on the auditory input from rhythmic music, and rhythmic sensory signals can provoke epileptic seizures.

The environment with a wide variety of elements in the surrounding space is called a comfortable ecological visual environment. The presence of curved lines of different thicknesses and contrasts, the outlining of the silhouette, the diversity of the color range, thickening and rarefaction of visible elements and their different remoteness, fractality of structures are characteristic features of a comfortable visible environment in which the vision mechanisms operate in the optimal mode.

Let us consider the example of saccades automaticity. When a person is in the forest, then for any amplitude of

saccades, their orientation and intervals, there will always be enough elements for fixation. If the view stops at a certain element, then the amplitude of the saccades is reduced to a minimum. A person at this time rests, look narrowly at something or something does not pay attention, whereas the saccades automaticity works in its own mode with a better orientation and the inherent interval [2, 11].

In a comfortable environment from the point of view of videoecology, the retina photoreceptors work in the same optimal mode. At the same time, for example, the visible forest environment is the most comfortable for the binocular apparatus, since there are a sufficient number of pronounced contours and images from the right and left eyes, easily merge into a single image in the cerebral cortex, creating harmony and comfort for the person.

### Conclusions

To create a comfortable visual environment it is necessary:

- to prevent the appearance of aggressive and homogeneous visual fields in urban environments, and, where they are, to get rid of them through landscape design, landscaping, colouristics;

- to prevent the appearance of large planes in architecture, to strive for differentiation and diversification;

- to be guided in cities by principles of permaculture and biomicry;

- to diversify the silhouettes of buildings with various architectural ornaments (towers, rotundas, attics) and multi-storey parts (mezzanine);

- to avoid aggressive man-made elements (huge posters on houses, big boards, supports of electric power lines, etc.);

- to limit the growth of the number of storeys of buildings by the height of trees, to saturate the urban environment with diversity;

- to organize an integrated green zone of the city, the main idea of which should be to bring the city closer to the nature of its natural zone;

- to attract advanced international experience and to maintain interest and research in the field of folk customs, traditions of accomplishment [7, 10].

Thus, a comfortable videoecological environment creates favorable conditions for the work of physiological vision mechanisms. A properly organized artificial environment must approach the nature-like and fractal forms.

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