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ANALYSIS OF COLORED OPTICAL ILLUSIONS FIELD THROUGH IRRADIATION FIELD

Abstract: *In this paper by using the principles of design irradiative field deals with the influence of color (wavelength) and brightness take as object optical illusion that it can cause a person perceiving.*

Keywords: *optical illusion irradiative field of physiological optics, wavelength, brightness, diffuse reflection coefficient.*

Statement of the problem. Optical illusion is an error in visual perception, which caused inaccurate correction processes the visual image and physical causes. The study of optical illusions requires study of optics, physiology of vision, psychology and psychophysics of vision.

Optical illusion is a powerful tool that allows the designer to get a certain effect in the construction of the object. Analysis of the various causes that affect the optical illusions will further the ability to analyze and manage the use of illusion when designing objects design.

Review and study of illusions requires a clear classification into: bad vision, illusion of color, contrast distort, contour illusion, the illusion of depth perception and size, the illusion of motion and stereo illusion.

The study and explanation of the illusion in terms of physiology, physiological optics and psychophysics will allow reasonable approach to the use of a particular type of illusion in design.

Analysis of recent research and publications. Research in the field of visual illusions and perception of scientists engaged Bardin KV [1] GE Ruuber [5] Logvynenko AD [4] R. Arnheim [7]. In the works of these scholars addressed the visual perception of different objects, the effect of the brightness and color of an object in its perception. In [2] examined the impact of physical parameters of the object, such as: hue, brightness, light level on the perception of the object. Not discussed are the impact parameters above object to those optical illusions that he can create with his perception of the man.

Goals of the Article. Identify the impact of color and brightness take as object to his optical illusions created by using the principle of building irradiative field.

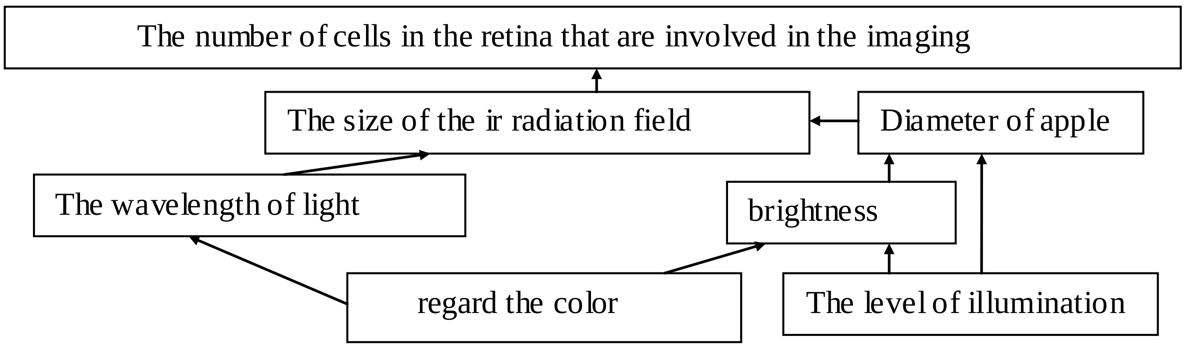
The main part. Several colored optical illusions may be explained in terms of the effects of irradiation.

At present there are several concepts of the phenomenon of irradiation (from Lat. Irradio - illuminates emit): 1. This feature of which is that bright objects appear larger and darker - less (by V. Sharonov [6]) 2. This spread of excitation and inhibition in the central nervous system (by IP Pavlov, EB Babsky, AA Zubkov [3]), and 3. to study Ruubera GE irradiative field is a hypothetical energy field that appears in the emergence of foci of excitation in the retina under the influence of waves of light.

Based on the foregoing definitions of the phenomenon of irradiation formed following provisions: the image of the object on the retina does not have a clear path and dissipates the emergence irradiative field caused by the rays of light that are reflected from the object perceived; irradiative field intensity is determined by the parameters of the light wave and physiology view.

That is the source that causes irradiative field is a light wave that is reflected from the object take as and the environment in which the field is spread retinal cells. Light wave is characterized by a length and frequency. Also, the perception of an object is an important indicator of the amount of light that falls on the retina, the light level that object.

So the irradiative field (areas of retinal excitation) depends on the physical parameters of the light wave and the level of illumination of the object. And the size of the zones of excitation, in turn, affects the number of retinal cells involved in the perception (circuit in Ill. 1).



Ill. 1. The scheme, which reflects factors that affect the number of cells involved in the imaging

To calculate the size of the field is used irradiative one-dimensional transfer function of an ideal optical system of the eye:

$$\begin{cases} O(f) = \begin{pmatrix} \frac{2}{\pi}(\arccos(u) - u\sqrt{1-u^2}) \\ 0 \end{pmatrix} ; & (1) \\ u = \lambda \cdot a^{-1} \cdot d \cdot \nu , & (2) \end{cases}$$

where λ - wavelength for spectral color or overwhelming wavelength for not spectral color, and - the pupil diameter, d - the distance from the lens to the retina (Optical axis), ν - frequency.

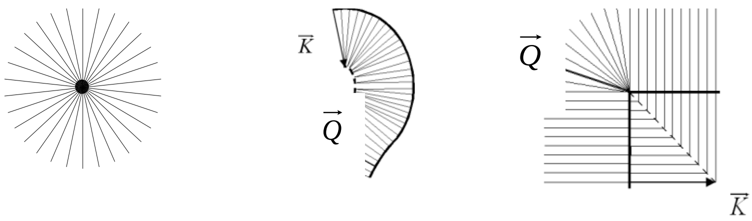
The point object of the system converts into concentric rings Fraunhofer (in terms of the scattering function - PST). These two concepts can be identified with the concept of the field of irradiation. Painting PST (irradiative field) consists of a central peak R_1(Airy circle) and secondary maxima are calculated with equations 3 and 4.

$$R_1 = \beta_1 \frac{\lambda}{a} = 1{,}22 \frac{\lambda}{a} ; \qquad (3)$$

$$R_2 = \beta_2 \frac{\lambda}{a} = 2{,}44 \frac{\lambda}{a} , \qquad (4)$$

where R_1 - radius of the first circle scattering; R_2 - radius of the second circle scattering; β_1, β_2 - factors that define the radii of the scattering in the diffraction pattern with regard to the degree of attenuation.

Irradiative field extends radial from the point of excitation foci (Ill. 2), or forms of concentration and scattering area for any curved contour that is perceived.



Ill. 2. Spread the irradiation field (scattering - K and concentration - Q).

According to physiology, the process of forming an optical image on the retina is similar to the process of interference of light diffraction by a round hole. A formula for calculating the radius of the diffraction rings similar to formulas (3) and (4).

Based on the wording irradiative field by GE Ruuberom [5] and IP Pavlov follows that the field intensity should decrease with increasing distance from the source of excitation. The degree of attenuation of irradiation will determine the size of the field due to the number of rings scattering, which is limited to the field. To establish the degree of attenuation of the field using a formula that expresses the intensity attenuation of the interference pattern in the diffraction of light by circular aperture (pupil):

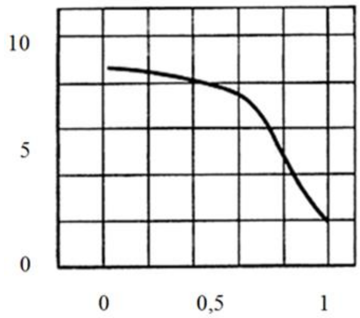
$$U(\Theta) = U_0 \left[\frac{2U_1\left(\frac{ka \sin\Theta}{2}\right)}{\frac{ka \sin\Theta}{2}} \right] \qquad (5)$$

where $U(\Theta)$ - the intensity of illumination of the retina at a point determined by the angle Θ; k - order scattering pattern.

Equation 5 establishes the fact that the level of light in the second ring of the Fraunhofer R_2 is $U(\Theta)\, R_2 \approx$ 2% of the illumination at point U_1 drop beam. According to the formula (5) the abstract constructs a graph shown in

Ill. 3. Shown dynamic schedule distribution of light intensity in Fraunhofer rings without consideration wavelength. According to the formula 5 and the graph in Ill. 3 size irradiation field will be limited of the other dissipation ring.

According to the formula 1, 2, 3 and 4, it follows that the diameter of the pupil affects irradiative right through the light level. Illumination in turn affects the level of brightness of the object. Graph of the diameter of the pupil of the perceived brightness of the object shown in Ill. 3. This graph obtained from experimental data SI Vavilov [3].



Ill. 3. Dependence changes in diameter pupils to increase brightness

According to the data shown in the graph in Fig. 3 By The formula, which allows to establish a link between pupil diameter and level of brightness:

$$a = 1{,}24(\log_{0{,}9} L)\ , \qquad (6)$$

where a - pupil diameter (in mm), L - brightness, which is in the range of 0 - to 1 USD (Standard unit).

As the irradiation field extends on both sides of the contour of the object, or the arm to a point object in all directions, the formula for calculating the irradiation field is a dual radius $R_{2.}$

Based on formulas (4) and (6) an equation that determines the size of the field irradiative given the influence of the wavelength and brightness of the perceived object. In this formula also takes into account the diffuse reflection coefficient of the material δ:

$$D = 2R_2 = 2\frac{2{,}44\lambda}{1{,}24\delta(\log_{0{,}9} L)} \qquad . (7)$$

Using the formula 7 article author received them irradiation size fields for all spectral colors (from violet to red), which have different levels of brightness. The data obtained in the calculation are summarized in Table 1.

As the data Table 1, maximum size of the field is irradiation object color which has a wavelength λ ≈ 680 nm, which corresponds to red.

Table 1

Dimensions D irradiation fields for different values of the wavelength and the diameter of the pupil and the reflection coefficient at δ = 0,5

Color		violet	blue-violet	blue	light-blue	green	yellow	orange	red-orange	red
a	*L*	λ, nm								
		380	430	465	487	530	580	596	620	680
1.5	1	0.25	0.28	0,302	0.317	0.345	0.378	0.39	0.403	0.44

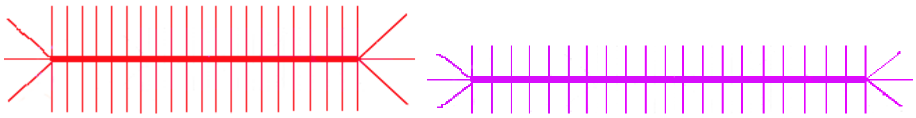
2	1	0.186	0.21	0.227	0,238	0,258	0,283	0,291	0,302	0.33
2.5	0.95	0,148	0,168	0,182	0.19	0.207	0.226	0.233	0.242	0.27
...	...	...	...	...	...	...	...	...	...	...
8	0.5	0,046	0,053	0,057	0,059	0,065	0,071	0,073	0,076	0.08
8.5	0.2	0,044	0,049	0,054	0,053	0,061	0,067	0.069	0,071	0.08
		Size of irradiation field D (nm)								

The minimum irradiation field is purple with a wavelength $\lambda \approx 380$ nm. Compared with the irradiation field line red field which creates a purple line will be approximately 1.8 times less than an equal brightness - the formula 8.

$$\frac{D_{ЧЕР}(a_1,\delta_1)}{D_{Ф}(a_1,\delta_1)} = 1{,}8 \qquad (8)$$

where a 1, δ 1 - the value of the diameter of the pupil and the coefficient of diffuse reflection material, the same for the two comparable colors.

Example correlations in size irradiation fields of purple and red line objects shown in Ill. 4.



a *b*

Ill 4. Iirradiation field that creates a spectral red line (a); Irradiation field spectral purple line (b)

This ratio in size irradiation field is valid only for the spectral colors.

Conclusions. Through calculation and construction irradiation fields may explain the optical illusion whereby the light-colored objects appear larger than dark-colored objects. The presented formula makes it possible to compare and get a numeric expression ratio of the image on the retina of one color to another.

Prospects for further research. Later irradiation should consider the size of these fields are not spectral colors and reveal the mutual influence of two adjacent fields irradiation of multi-colored objects.

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<u>Аннотация</u>

Бессарабова Е.В. Анализ цветовых оптических иллюзий при помощи иррадиационного поля. *В работе с помощью принципов построения иррадиационных полей рассматриваются вопросы влияния цвета (длины волны) и яркости воспринимаемого объекта на оптические иллюзии, которые способен он вызывать у воспринимающего человека.*

<u>Ключевые слова:</u> оптические иллюзии, иррадиационное поле, физиологическая оптика, длина волны, яркость, коэффициент диффузного отражения.

<u>Анотація</u>

Бессарабова О.В. Аналіз колірних оптичних ілюзій за допомогою іррадіаціонного поля. *у роботі за допомогою принципів побудови іррадіаціних полів розглядаються питання впливу кольору (довжини хвилі) та яскравості сприймаємого об'єкта на оптичні ілюзії які він здатен викликати у сприймаючої людини.*

<u>Ключові слова</u>: оптичні ілюзії, іррадіаційне поле, фізіологічна оптика, довжина хвилі, яскравість, коефіцієнт дифузного відбиття.