ИНФОРМАТИКА

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СУБЪЕКТИВНЫЕ АСПЕКТЫ ВОСПРИЯТИЯ ЦИФРОВЫХ ИЗОБРАЖЕНИЙ

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SUBJECTIVE ASPECTS OF DIGITAL IMAGES PERCEPTIONS

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Аннотация. Приведены результаты исследования субъективных восприятий цифровых изображений. Предложена модель цифрового изображения на макро-, микро- и информационном уровнях, а также дано описание опросника для изучения психофизиологических эффектов восприятий цифровых изображени и другие факторы, влияющие на субъективное восприятие.

Ключевые слова: *цифровые изображения*, *психофизиологическое воздействие*, *анкетирование*.

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Abstract. The subjective perception of digital images were investigated. A digital image model at the macro, micro and information levels was proposed, and a description of the questionnaire for the study of the psychophysiological effects of digital images was given. In addition, other factors that affect subjective perceptions were also introduced in this paper.

Keywords: *digital images*, *psychophysiological impact*, *questionnaire.*

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Introduction

Due to the development of microelectronics and computer technology, digital images have entered our daily life from aerospace, medical and other fields. Big data research shows that more than 50% of the information people receive in daily life comes from digital images, such as screens, TVs, computers and smart phones, which affect people's physiology and psychology while transmitting information.

A digital image is an information model described according to ISO/IEC 19794-5 [1] by a two-dimensional representation of the brightness and texture of an object under certain lighting conditions, a discrete-continuous structure consisting of a finite number of elements (pixels) each of which has a geometric reference to the displayed object and its state in time. Digital images display symbols, graphics, coordinates, static and dynamic, primary and secondary, protected and unprotected information, categorized by features such as number of degrees of freedom, color depth, graphic type, information provided, playback mode, number of layers, etc. At the macro level, the digital image has a non-point primary emitter, which is potentially dangerous in terms of unwanted visual effects, such as “flashes” with hazardous class of A, AA, AAA, areas of uncomfortable brightness, etc. At the microscopic level, a digital image is a discrete continuous object with an ordered structure of a finite number of elements, each of which is independently assigned color, intensity, and other characteristics; and according to GOST R 52872-2019, this is “content brought to the user through his senses using a user application, often not requiring compliance with the standard.” At the information level, a digital image is a content that carries a semantic and psycho-emotional load, described through an ensemble of states in the space of random events by families of orthogonal matrices and undirected graphs through data arrays and real functions *img I*(*x*,*y*) [2]:

$$img = I(x,y) = \begin{bmatrix} I(0,0) & \dots & I(0,W-1) \\ \dots & \dots & \dots \\ I(H-1,0) & \dots & I(H-1,W-1) \end{bmatrix},$$

where *W* and *H* are the width and height of the image.

As people spend a lot of time interacting with digital images on computers, smartphones and televisions, their subjective perception issues are affected by the World Health Organization (WHO), International Standardization Organization (ISO), International Telecommunication Union (ITU), International Color Union (ICC), etc. At the same time, the developed normative documents are based on the results of psychophysical experiments aimed at understanding the aspects of safety and ergonomics in terms of the preferred dynamic range of brightness, viewing conditions and time.

Recommendations on viewing conditions and viewing environments are given by ITU [3], and specifications by ICC [4].

1 Experimental method – Questionnaire

In October 2021, the authors compiled a questionnaire in Russian, English and Chinese to study the psychophysiological perceptions of digital images. The purpose of the study is the formation of biological reference intervals used in the future to design a favorable light environment. The questionnaire is hosted on the cloud https://docs.google.com/forms/d/e/1FAIpQLSd8R5J5JsTak-KbYOBJA53-pz3IHBIfpbQUz_sTJYLJZT_pVfA/viewform and includes the registration area indicating age, gender, geographic region, profession, which are used as factors of biological reference intervals.

The questionnaire contains 35 questions, for example, “What devices do you interact with most during the day?” , “How often do you have problems with insomnia?”, “What content do you prefer to use during your free time while at home?”, “How much time do you usually spend interacting with the TV while at home?”, “How often do you wake up at night for no apparent reason and have difficulty falling asleep?”, “Do you take normal breaks when interacting with a computer?”, “In what kind of light environment do you work at a computer?”, “Do you have complaints about poor health?”, “ How often do you notice numbness and pain in the hand, back pain, dry eyes, headaches; neglect of personal hygiene, eating near a computer?”, “Does working with a computer cause eye irritation (itching, burning, feeling of sand under the eyelids?”, “Do you have visual impairment (nearsightedness, farsightedness, astigmatism)?”, “How do you prefer to communicate with close people or friends?”, “How often is there an actualization or threat of loss of friendships and / or family relations, academic success due to frequent work at the computer (staying online)?”, “How often do you neglect family, social responsibilities and studies due to frequent work at the computer (being online)?”, “Do you feel the need to return to the computer to improve your mood or avoid life problems?”, etc.

2 Results and discussion

2.1 *Results of questionnaire survey*

The proportion of men and women participating in this questionnaire is similar, and the age span is wide, ranging from 15 to 63 years old, from different countries or regions, different occupations (mainly students).

Through the questionnaire survey, the following conclusions can be drawn:

1. Smartphones are the most-used electronic devices of the day; next is laptops, then TVs. (From questions 2-7, Figyure 2.1, 2.2)/

2. Computers make up a large proportion of people’s daily lives (17), while TV is no longer a necessity and most people do not even watch it (16), as shown in Figure 1.3.

3. People prefer dynamic content (12, 14), as shown in Figure 1.4, but for possible visual and mental fatigue, the form of digital images has less influence and the content has more influence (35), in Figure 1.5.

4. People prefer to work in bright environments (20), as shown in Figure 1.6.

5. Communication with relatives and friends is mostly face-to-face, and normal and frequent using of computer may lead to irregular work or breaks, but currently does not cause social problems (26–29), as shown in Figure 1.7.

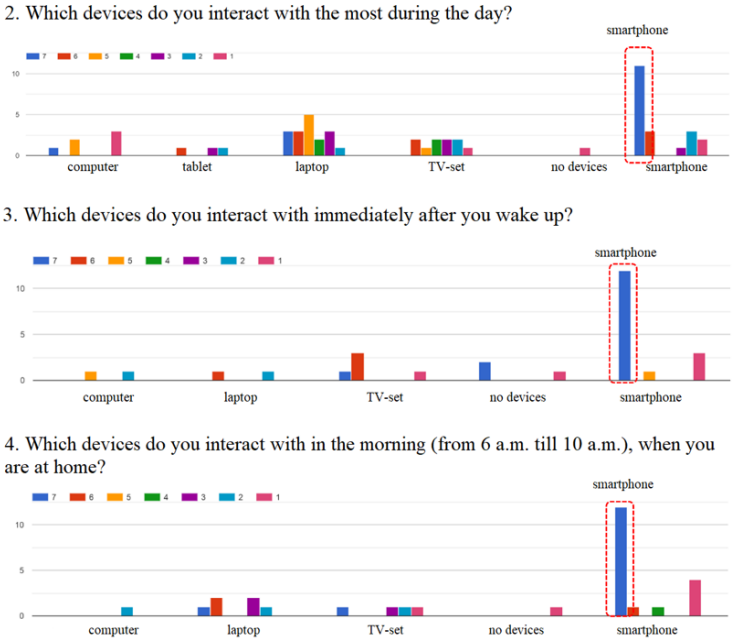


Figure 2.1 – The results of questions 2–4 in questionnaire survey

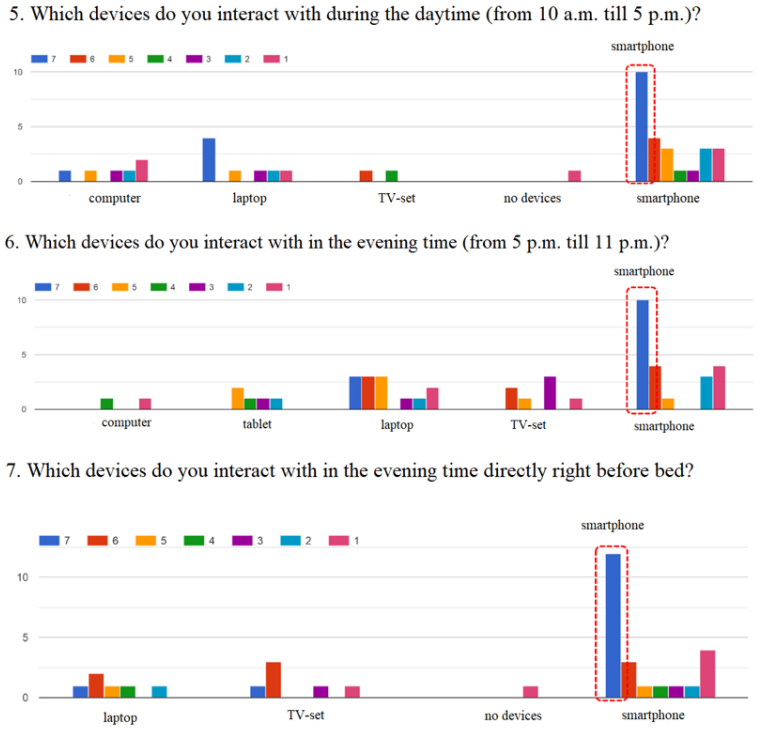


Figure 2.2 – The results of questions 5–7 in questionnaire survey

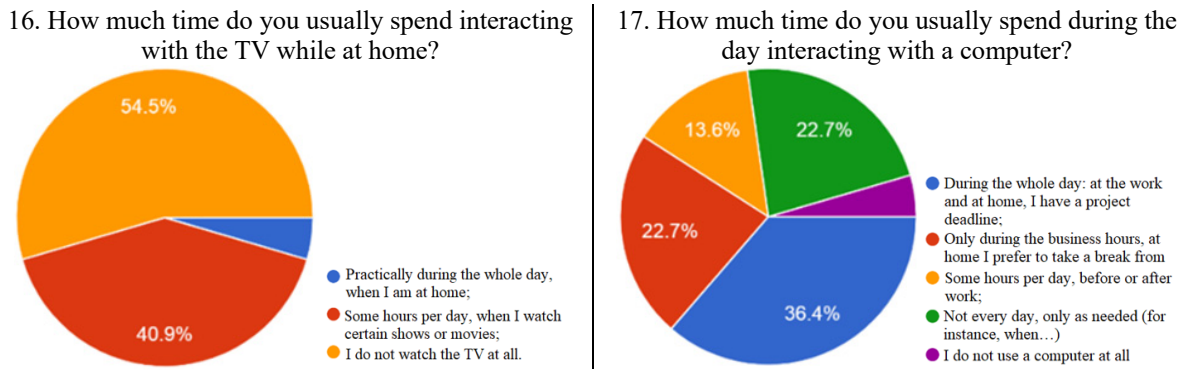


Figure 2.3 – The results of question 16 (spend interacting with th TV) and 17 (interacting with a computer) in questionnaire survey

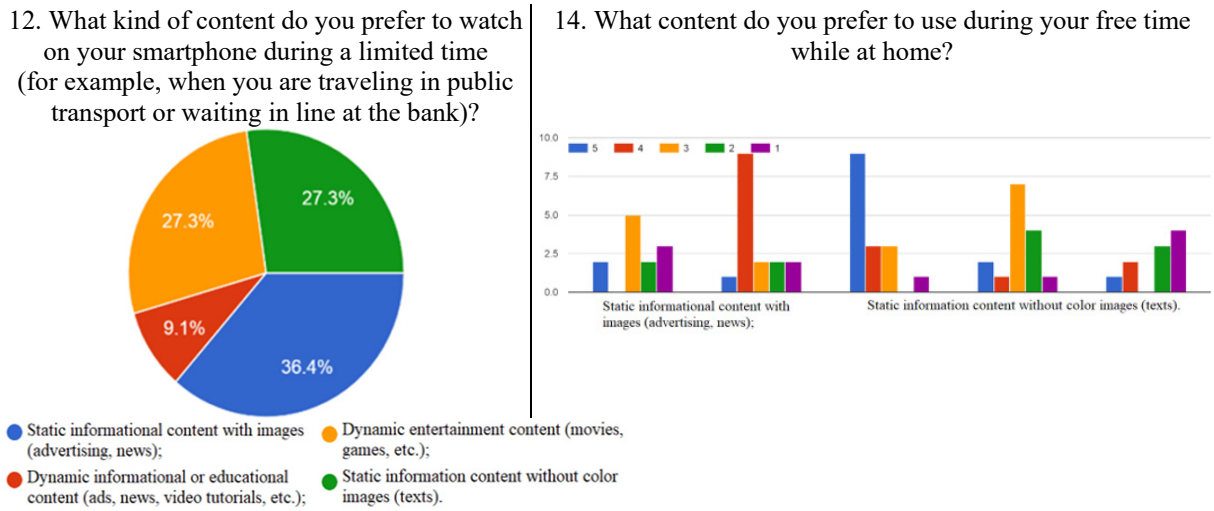


Figure 2.4 – The results of question 12 and 14 in questionnaire survey

35. What content makes you tired?

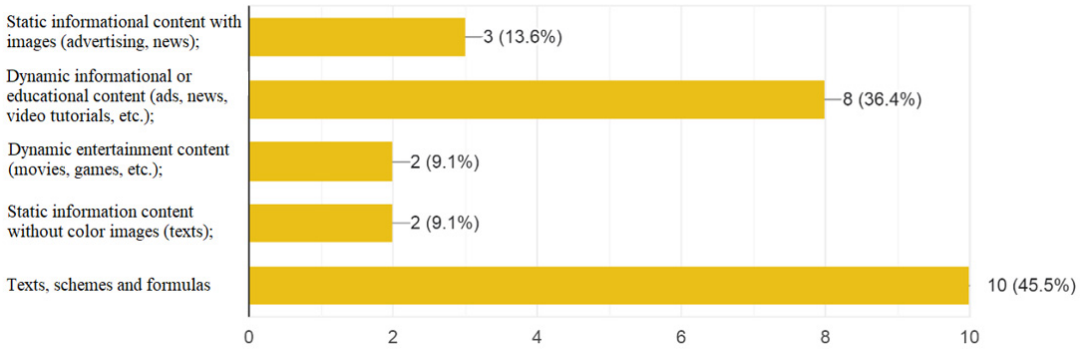


Figure 2.5 – The result of question 35 in questionnaire survey

20. In what light environment do you work with the computer?

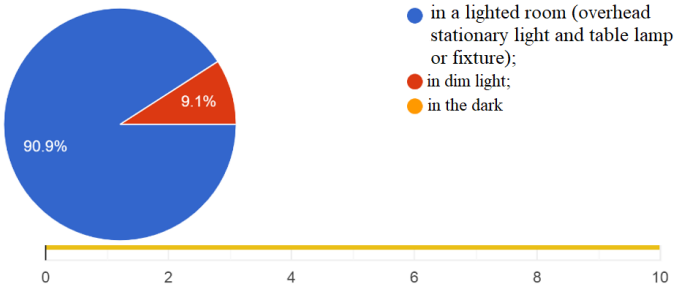
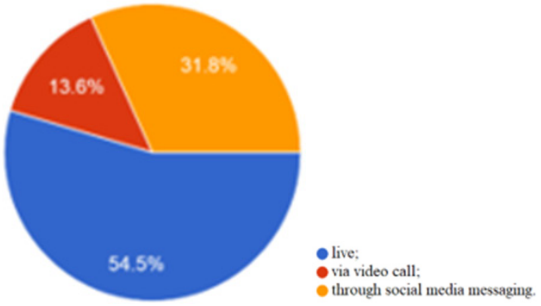
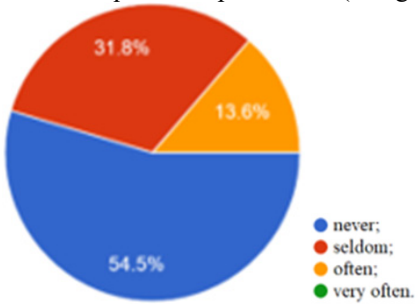


Figure 2.6 – The result of question 20 in questionnaire survey

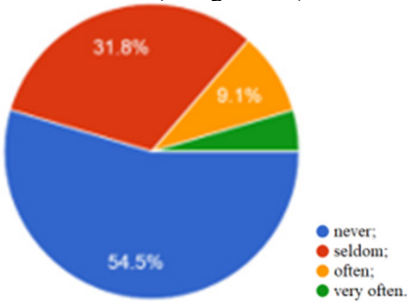
26. How do you prefer to communicate with loved ones or friends?



27. How often is there an actualization or threat of loss of friendships and/or family relationships, academic success due to frequent computer work (being online)?



28. How often do you neglect family, social responsibilities and studies due to frequent computer work (being online)?



29. Do you feel the need to get back to your computer to improve your mood or get away from life's problems?

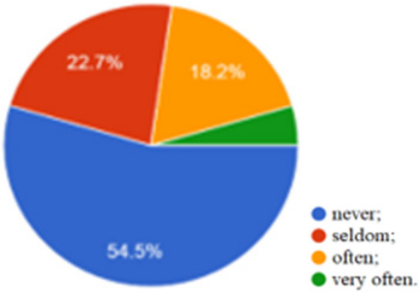


Figure 2.7 – The results of questions 26–29 in questionnaire survey

2.2 *Further discussion*

Other factors affecting subjective perception mainly include lens transmission spectra, spectral response curves, and photobiological rhythm factors.

The light transmission characteristics of eyes are mainly determined by the lens, and the difference in the transmission spectrum of eyes at different ages is also determined by the lens [5], [6]. It can be seen that with the increase of age, the transmission spectrum of the lens decreases continuously, and the blue light part decreases more than the red light. This is due to the fact that the anterior capsule of the lens continues to thicken with age, its mass and density continue to increase [7], and its optical path becomes longer and longer.

The photopic spectral response curve V(λ) adopts the data given by CIE in 1924, and its peak wavelength is at 555 nm. The circadian rhythm response function C(λ) adopts the data given by Gall et al., Germany, which is adopted by the German standard DIN V031-100: 2009 [8], and its peak wavelength is around 450 nm. Gall et al. [9] proposed the concept of photobiological rhythm factor to quantitatively evaluate the non-visual biological effects of light on the human body.

The impact of digital images on the human body is not only the adaptation or perception of vision, but also the impact on human circadian rhythms, including sleep, wake cycles, body temperature rhythms and hormone secretion rhythms. Currently, medical aspects related to the position of a person's head and neck when viewing content are relevant. The digitization of global society is causing the study of the impact of digital images to become multidisciplinary, bringing together the scientific community, manufacturers and regulators.

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