Factors affecting the emotions of Moscow Metro passengers

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1. Introduction

A modern developing city is a city that not only has jobs, good healthcare, educational facilities and other opportunities to meet the needs of its population, but also a comfortable, safe, positive environment that continues the relationship between man and nature. The amount of time humanity has had to live in a modern city made of concrete and glass, and now with the introduction of digital technology, is too short compared to its original natural environment. Moscow is one of not many cities that has a high percentage of historic buildings and modern architecture. This trend has both positive and negative aspects. Urbanisation is gaining momentum, the needs of the population are growing, and there is no time to build pompous mansions with stucco, columns and white cornices on the facades. Speed of construction is preferred over its impact on urban architecture, much less on people's psycho-emotional state.

Doctor of Biological Sciences V.A. Filin, the founder of a new scientific trend - videoecology, studying the relationship between the environment and human vision, comes to the conclusion that our eyes perform phases of smooth and lightning-fast movements in the vertical and horizontal planes, and in the horizontal plane the eye movement is automatic. After each of these phases our eye must stop on something, fixate. If this does not happen, the eye begins to move chaotically, and one experiences unpleasant sensations.

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The architecture of past times was lavishly decorated, natural materials were used, the rule of the golden ratio was taken into account, and the complex outline of the building's layout, etc. All this created additional accents for the eye and the perception of architecture had a positive effect on human mental health.

Development of technical progress and urbanisation led to cheapening of facade decoration and simplification of its volumetric and spatial composition, the human focus of vision began to disperse. In Moscow, it has been possible to combine the historical environment and new construction with some degree of success. For example, people are given the opportunity to see historic mansions, manors, churches, and new architectural projects, such as Moscow City.

The bigger and faster a city develops, the more urgent the question of public transport infrastructure and passenger transport becomes. The underground is a complex system of interconnected structures, from above-ground concourses to deep underground station halls, passageways and tunnels, as well as the transport-trains themselves. The connection between the underground space and the surface space is made by means of vestibules, which can be: free-standing structures, integrated into the building, combined with underground passageways. They are 'inviting' facilities and also serve as a guide to passenger flow.

The underground also plays an urban-forming role. New housing estates, shopping centres and other cultural and social spaces are being built around new metro stations.

It is no longer possible to imagine a major metropolis without underground public transport—the metro. It is the fastest, most comfortable and safest form of passenger transport. However, being underground is a stressogenic factor for people and can cause negative emotions, conditions affecting health. The solution to this issue is the intelligent design of stations and suggestions for emotional self-regulation for citizens while on the underground.

Relevance of the topic of reconstruction and subsequent new design of metro stations, lobbies and other facilities that meet the requirements of the future city, as well as the identification and consideration of psychophysical factors that negatively affect the psychoemotional state of a person in the metro, will allow to carry out preventive health maintenance and formulate recommendations to preserve the emotional health of passengers, consistent with the ideas about safety and comfort of being in an urban environment.

The aim of the work is to collect data for further development of proposals for the reconstruction of existing and new buildings of the Moscow metro and the formation of recommendations for the emotional self-regulation of citizens and employees of the metro.

Such recommendations will meet the requirements of the human-centred approach for building a positive city of the future.

We have no right to give up on the past, and we cannot fail to step into the future. The process is irreversible. We are rushing down the time stream into a future which cannot be predicted with any precision. But we can use the knowledge, experience, theoretical and practical groundwork of predecessors and contemporary scientists to create a controlled, positive, comfortable and environmentally harmonious urban environment. The responsibility for this lies with each and every one of us.

Such an ambitious goal can only be realised with an anthropocentric approach, in which people's well-being and health are regarded as a fundamental value. Of course, the pursuit of such an approach is virtually doomed to be hampered by economic, ideological and other constraints.

Among the many works devoted to the creation of a healthy urban environment, the most interesting for us are those that are consistent with the notion of salutogenesis.
Experiencing negative emotions creates a negative background for human life activity. In addition, the psycho-emotional state is influenced by the object environment, which architects and builders have exploited for thousands of years.

2 Methods

In order to realise this goal, the method of source study for the subsequent design and refurbishment of the underground transport system is applied. The Moscow design experience is of particular interest because of its tendency to build not just a transport network for passenger transport but also a cultural and architectural heritage of the future. Such experience in the world practice is rare. The works of Y. V. Dubrovsky, A. K. Bratishchev, I. Kuznetsova, E. Troitskaya were analysed.

In megacities, the number of inhabitants is increasing, so the transport system largely determines the livelihoods of city dwellers. As a consequence, requirements and standards for station design are changing, and questions about improving passenger comfort and safety in the underground are being raised.

Alexander Bratishchev singles out the factors that influence the architectural and planning decisions of metro stations:

- socio-political (urban planning solution of the area, leading political ideology, decisions of authors and customers);
- economical and ecological;
- natural-climatic (condition of soil and soils, atmospheric precipitations, local landscape).

The core concept of the Moscow Metro is the formation of interchange hubs: combining different modes of public transport to move passengers comfortably and quickly. When designing new stations, it is important to rely not only on the functionality and durability of the building structure, but also on its architectural design. It is important to create a structurally sound space that is human-scale and has a positive impact on the psycho-emotional state of passengers. Avoid bright colours, lots of glossy and mirrored surfaces, excessive decorative designs.

For the expressiveness of underground structures, it is possible to use: the principle of asymmetry, which gives the architecture dynamism; composite materials in order to increase reliability, strength, durability, ease of installation and variety of textures.

Yuri Dubrovsky in his writings raises the problem of movement in architecture. In the system of underground structures, movement is carried out due to the ensemble structure of the underground station consisting of consistently arranged functional and thematic zones: lobby, passenger service area and the platform hall itself. Here the passenger movement is sequential and longitudinal, and in the central part of the building is transverse.

The practical part of the research was carried out by means of a questionnaire survey of Moscow residents of different age groups. The questionnaire consists of 22 questions and was provided in electronic format in Google form. The main purpose of the questionnaire: to identify factors affecting the psycho-emotional state of a person in the underground and on this basis to formulate recommendations for the prevention of negative consequences of being in the underground, for effective self-regulation in the process of movement under the ground.

The theoretical basis for the study of human emotions was formed by the works of A. Maslow, J. Plumper. The works of W. Gelpach on environmental psychology, P. Kidwell on the study of emotions in the city, E. Hall on proxemics were taken into account. The works of V. Abramchuk, N. Pavlov, A. Bronovitskaya, D. Golitsynsky, O. Grozman provided the theoretical basis for the study of experience in the design of metro stations.
In terms of our basic salutogenic approach, which has its origins in the organisation of a space of life that promotes health and recovery, the works of the author of the model, A. Antonowski, have been used. He experienced being in concentration camps. His experience of survival gave him an idea of shifting the emphasis from the causes of illnesses to the causes and possibilities of preserving health. The health-promoting architectural design of medical facilities was called salutogenic architecture, salutogenic design. Subsequently, Dilani proposed Psychosocially Supportive Design: physical space design neutralises anxiety, stress; Jan Golembiewski developed “Neuroscience of Salutogenic Design”, Ty Farrow developed “Method of Salutogenic Design”, Roger Ulrich developed “Theory of Supportive Design”[9].

An analysis of the publications available for study related to the evaluation of artificial light and colour environments shows the relevance of the topic of illumination of the human environment[14]. This is partly due to the development of technology (e.g. LED lighting, fluorescent lamps, incandescent lamps) to enable the organisation of workspaces. Relevant scientific research is being carried out to identify the parameters of the light and colour environment that affect the human body[15].

3 Results

The Moscow Metro has a strong potential and its development is accelerating. Even now, it is necessary to propose options to improve and modernise the underground transport network from the point of view of comfortable stay of passengers in it. The demand for underground public transport is extremely high: 7.54 million people a day[17]. This confirms the relevance of the study. Questions about the quality and comfort of passenger movement come to the fore. At the same time, we support the trend to develop the Moscow metro as an underground palace, which performs not only a transport role, but also socio-cultural, aesthetic, and health through a positive impact on human emotions.

A questionnaire was developed and tested, which was offered in an electronic format in order to realise the objective. The random sample consisted of 41 people. The sample turned out to be unbalanced in terms of the number of men and women who took part in the study (17.1% men, 82.9% women).

In this survey, it was revealed that respondents use the Moscow metro more often between 17 and 21 hours (Figure 1), spending on average between 1 and 2 hours on the way (Figure 2). We were surprised that when asked “How often do you use the metro?” 31.7% of the respondents answered “several times a month” (Figure 3). We hypothesised that city dwellers use the metro much more often. This result may be related to the mass shift to remote working against the backdrop of the recent epidemiological situation. In addition, the results are explained by the peculiarities of the sample. 

![Figure 1](image1.png)

**Fig. 1.** What time do you usually use the subway?
What is the average amount of time per day you spend on the subway?

How often do you use the subway?

Also, 76.9% of respondents answered that it did not matter to them which train to travel on: with or without noise insulation. However, when asked to write down 3 significant negative factors, noise was a frequent answer. 82.9% of respondents said they don't pay attention to the specifics of the lighting on the underground. 63.4% do not have a feeling of lack of fresh air.

According to the respondents, the negative emotions and conditions in the metro are caused by cramped (close proximity and a large number of unfamiliar, unpleasant people), dirt, lack of fresh air and noise.

It should be noted that many respondents show in their responses a high degree of adaptability to negative factors affecting people in the metro. These factors include lack of sunlight (82.9% do not pay attention) (Figure 4) and noise (56% do not pay attention) (Figure 5). For us, this is a negative signal, as the availability of internet and chargers was identified as a comfort criterion for travelling in the underground, rather than daylight, sunlight. Sunlight is essential and one of the main conditions for a healthy metabolism in the body, the disruption of which leads to illness. It turns out that passengers are not aware of this. They cope with negative conditions mainly through external tools: headphones, social media, internet, books, etc. Only 2 responses from the sample (5%) show the ability to engage internal resources to normalize the psycho-emotional state while travelling in the metro. These are different variants of self-regulation. For example, “concentrating on yourself” and “distracting your attention”.

As for the architectural and artistic design of stations, almost all respondents noted that they pay attention to the decorative decorations of metro stations and facilities. This shows that passengers are aware of the importance of the metro’s architectural aesthetics and beauty as a need.
Returning to the issue of reconstruction of the concourses of the fifth phase, which were combined with underground passages in order to save money (metro station Babushkinskaya, metro station Mendeleevskaya, metro station Sviblovo, metro station Oktyabrskoye Pole, etc.), it makes sense to recall a utilitarian approach in the process of metro construction. Moscow was expanding and it was necessary to quickly and cheaply fit metro infrastructure into the city. However, this solution was applied not only in the developing and under construction bedroom communities, but also in the historical centre of the city. An example is the Polyanka metro station.

In order to protect the underground from flooding, the crossings are covered with "glass boxes", which structurally consist of glass inserts, metal frame and concrete, which does not meet the requirements of the modern and developing city. These structures should be addressed to the environment and serve as a reference point for navigating passenger flows, and most importantly: carry a thematic architectural load. As mentioned above, the metro is also a meeting place for people. As a consequence, it is advisable to include comfortable waiting areas in future projects. It is better to isolate such areas from the mass transit areas. Squares in front of underground station lobbies should have free access to the lobby, direct the passenger flow by means of small architectural forms, green areas, diverse paving of the square.
4 Discussion

The need to improve the design principles of underground structures is demonstrated by the survey results. Respondents continue to experience negative conditions due to noise, crowding and lack of sunlight.

The problem of increasing noise pollution in the underground can be solved by reducing the reverberation time (sound attenuation) of arriving rolling stock by covering vaults with ribbed suspended structures [3].

We can't let sunlight into the station, but we can trick the brain with artificial lighting (example: Zyablikovo station). Thanks to the lighting in the vaults of the station it creates a feeling of windows.

Concerns in shaping a safe and comfortable metro environment are caused by the economic, ideological and other constraints mentioned in the introduction. This is a traditional hotly debated issue, which continues to this day: emotional health is the basis of human health in general, but the economic benefit can only be felt in the long term. Moreover, these benefits are indirect. Investments in human health capital are rarely accepted in practice.

As for the lack of sunlight, daylight in underground stations and in tunnels and underground cars, we have yet to collect statistics. However, it is already clear that the prolonged absence of natural light interferes with the healthy functioning of the body. As already mentioned, the human eye is a complex organ. It is the only analyzer, in fact, part of the brain, which is moved outside. It is also the most active of the human senses. If our eyes were fixed, we could only discern another person's face from a distance of 3m and the complete human figure from a distance of 48m, which would make it extremely difficult to see in space. High visual acuity and head mobility cannot compensate for eye mobility functions, it is a pathway to disability. The basis of visual perception is automatic saccades ("saccade" from Fr. "clap a sail") - eye-motor reflex, rapid rhythmic synchronous eye movements. The eye constantly scans the surroundings, which is due to its automatism (like heart contractions, breathing). Saccadic automatism expands the visible space, creates conditions for systematic evaluation of the size, remoteness, and mutual location of visible objects, allows clarification of the visual picture twice a second, and ensures continuity of perception [16].

The design of a safe and comfortable visual environment implies the presence of a sufficient number of clearly visible objects that are covered by the human eye. These are object brightness (surface density of light intensity in a given direction, equal to the ratio of light intensity to the projection area of the luminous surface on a plane perpendicular to the same direction [5]), its size [20]), configuration (view, outline, image [20]), clarity (subjective evaluation of quality of reproduction and distinguishing fine details of images [19]).

Reflection in the cerebral cortex of individual qualities or properties of objects and/or phenomena is sensation as a mental cognitive process, based on the work of which the psyche is able to perceive, i.e. to create both holistic images of these objects / phenomena and a holistic image of the world. The whole range of signals available for reflection and processing by human senses, including vision, provides an opportunity to satisfy needs of all levels (according to A. Maslow's hierarchy of needs model [13]). When environmental conditions meet the conditions for the satisfaction of needs, a person is alive, healthy, feels safe, and is able to communicate constructively.

Environmental conditions can safely include light, both natural and artificial (abiotic factor). Light is defined by dictionaries as radiant energy (electromagnetic fluctuations in a certain wave range) perceived by the eye and making the surrounding world visible [2].
However, it is natural light, like air of a certain composition, that is biologically important for humans, as we know from school biology textbooks. This is how the body's metabolic processes work. Ultraviolet light stimulates the synthesis of vitamin D, which in turn affects the metabolism of calcium and phosphorus, so that the living organism grows, develops, stays active and able to work. Sunlight affects the endocrine system, sets the periodicity of circadian cycles, and triggers emotional states. Such influence of the sun on various biological parameters is studied within the framework of heliobiology, the founder of which is A.L. Chizhevsky [6].

It is worth noting that the process of visual perception as the basis for forming a picture of the world (which one takes as an objectively existing reality) has inextricably intertwined physiological and psychological aspects. This needs to be emphasised in the context of shaping a quality environment for people. Light designer I. Maurer rightly observes: "Bad light makes people unhappy". [24]. The interaction and mutual influence of the object environment and light will vary the picture of the world through the presence, degrees, combinations of shading, lighting, emerging shades, images ("Light always come from matter, is born in matter and, absorbed, disappears in matter"). [21]).

Sufficiency and uniformity of natural light reveals the potential of a complex environment that provokes the satisfaction of cognitive needs, and thus development in the broad sense of the word, and the preservation of health [12, 10]. D.E. Berline emphasised: "We need to pay attention to the signals coming from the environment", he highlighted 3 groups of stimulators (variables) of the human body:
1) psychophysical variables, including light;
2) environmental variables that ensure survival;
3) "collative" (comparative) variables. In addition to the environmental characteristic of complexity, Berline defined unusualness, "degree of puzzlement", and novelty (18).

We are convinced that it is possible to create and maintain lighting conditions that are in line with a health-preserving approach and meet all safety requirements, including mental health.

5 Conclusions

Intensive metro development is an inseparable concept with the city of the future. As a consequence, it is necessary to modernise the basic methods when designing new constructions and to consider the passenger's experience in the underground space when designing. In order to realise the task of forming proposals for the reconstruction, the future design of the stations is planned to apply the design method, taking into account the use of Archicad 24 and Lumion 12.0. As a projection for the next stages of this work we designate the psychophysical research of lighting in the underground.

References


