

## THERMAL INDICATORS AND THE "THERMOCHROMISM" EFFECT ORTHOPEDIC SHOES FOR CEREBRAL PALSY

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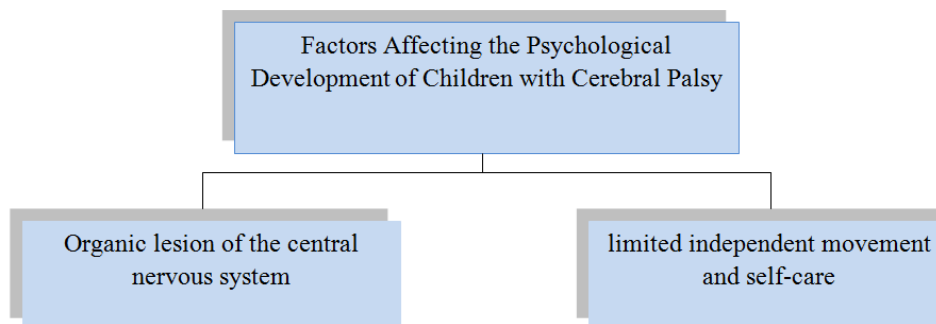
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**Annotation:** In the article the scientific direction for the rehabilitation of children with cerebral palsy disease. As a remedial solutions proposed to use color combinations and shoe materials thermoindicators to assess the patient's border states.

**Keywords:** footwear, orthopedics, cerebral palsy, thermoindicators, color correction.

Children with cerebral palsy are characterized by specific developmental delays. The mechanisms of these disorders are complex and are determined by both the timing and the severity and location of the brain damage. A significant number of studies by Russian specialists have been devoted to the problem of mental disorders in children with cerebral palsy. Factors influencing the psychological development of children with cerebral palsy are divided into two broad groups (Fig. 1).



**Fig. 1 – Factors influencing the psychological development of children with cerebral palsy**

The patient's psychological state is largely influenced by limited independent mobility and self-care. In this case, a disproportionate development of higher mental functions is characteristic. In some cases, there is a discrepancy between a satisfactory general level of abstract-logical thinking and insufficient spatial representations. Developmental deviations are also caused by the insufficient sociocultural experience of children with cerebral palsy [1-4]. Such children are vulnerable. Communication links with the outside world are disrupted or distorted.

A child's intelligence may correspond to age-appropriate norms, but their emotional sphere remains immature. Immaturity of the emotional-volitional sphere may partially persist into adulthood. Behavior is often accompanied by emotional instability, rapid fatigue, and motor disinhibition.

It should be noted that in children with cerebral palsy, negative emotions predominate over positive ones, which leads to overstrain of all body systems.

Issues of psychological assistance to children with cerebral palsy have been far from adequately addressed. The practical application of various psychotechnical techniques aimed

at patients is often used by psychologists and teachers without regard for the type of disease, the level of intellectual development, and the characteristics of the emotional-volitional sphere. The lack of clearly developed differentiated methods of psychocorrection for children with cerebral palsy, as well as the inappropriate selection of psychotechnical techniques, can negatively impact the quality of the mental development of the affected child.

It's important to stimulate positive emotions. Shoes can be used for this purpose. Their visual and tactile properties can help correct the patient's mental state.

Correction of motor and sensory disorders in children and adolescents with cerebral palsy should be considered as a complex system of rehabilitation interventions aimed at increasing social activity and developing intellectual processes that are consistent with the patient's mental and physical capabilities.

In the production of footwear and accessories, the most significant methods of intervention are the color scheme of the products and the tactile properties of the materials.

To create footwear that provides therapeutic benefits not only through its design but also through its visual appearance, it's important to consider the perception and impact of various colors on patients with cerebral palsy. It's essential to understand how color and its shade influence a child's psyche. Using this knowledge, it's possible to create footwear that satisfies the visual component of the product's therapeutic and preventative properties (Table 1).

Table 1

#### Characteristics of the impact of color on humans

1	2	3	4	5
Col	Healing properties		Excess	Compe nsation
	physical	psychological		
red	Stimulates all types of energy. Helps build physical strength. Increases heart rate. Stimulates brain activity. Increases productivity with short-term use. Improves appetite.	Helps focus, inspires confidence. Can cause joy or aggression	Causes irritability, overexcitement, and fatigue. Decreased attention span	Green
yellow	Stimulates the brain in cases of mental retardation. Stimulates the psyche to focus, harmony, and obedience. Improves appetite.	Improves mental ability, lifts mood, gives confidence, energizes. Enhances communication skills	Mental fatigue, headache.	purple

green	Promotes recovery in medical facilities. Reduces pain. Calms the nervous system. Reduces irritability. Lowers high blood pressure, alleviates migraines and neuralgia. With long-term use, it causes a sustained increase in performance.	Calms and reduces stress. Stimulates interest in exploring the world around us and learning, increases self-esteem and confidence. Brings courage, peace, and meditation.	It's boring. Dark green is depressing.	red
turquoise	Stimulates immunity and promotes muscle relaxation	Enhances the feeling of peace	Stubbornness and peremptoriness	Pink
orange	Increases heart rate. Improves appetite. Increases performance with short-term exposure.	Uplifts the mood. Stimulates creative thinking. Creates a feeling of well-being and joy, liberates the senses.	Absent-mindedness	navy blue
purple	Purple is used for meditation, enhancing physical performance, and relieving headaches. It has a positive effect on the heart, blood vessels, and lungs. It increases stamina. It also reduces physical activity and productivity.	Enhances intuition and empathy. Promotes harmony and peace.	A feeling of fear. Light violet – dreaminess. With prolonged exposure causes depression and anxiety.	yellow
navy blue	Lowers blood pressure, improves sleep, relieves joint pain. Effective for neuralgic pain. Reduces appetite. Sharply reduces activity and emotional stress. Reduces vital processes, normalizes breathing and pulse.	Helps in learning new things. Induces a state of contemplation and reflection. Awakens the imagination.	Dark blue evokes melancholy, depression, despondency, and self-doubt. It promotes fatigue and oppression.	yellow
blue	Relieves stress and headaches. Lowers blood pressure. Calms. Slightly reduces activity. Relaxes.	Relieves fear, depression, and anxiety. Reduces agitation and neutralizes tension.	It evokes a feeling of alienation and coldness.	Pink

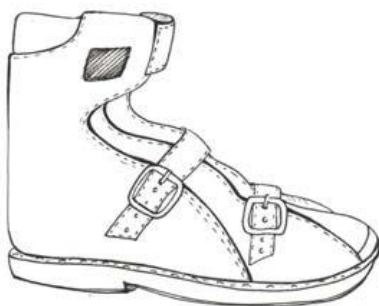
This means using colors that compensate for the specific needs of children with cerebral palsy, and designing footwear to suit their temperament.

Therefore, when designing footwear for children with cerebral palsy, it's important to consider not just the appearance but also the nature of the condition and the patient's mental state, thereby monitoring and regulating the child's emotional state. Corrective color schemes have been proposed. For example, for excited children, it's best to choose colors that neutralize their activity. These could include shades of yellow, green, purple, and blue. For apathetic, shy, and inactive children, on the contrary, colors and shades that encourage action, such as red or orange, are recommended.

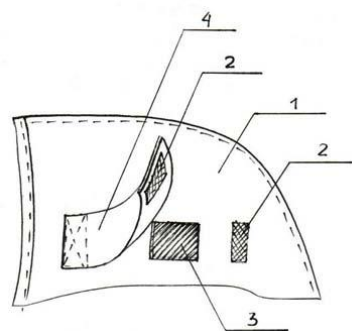
Children's temperament influences their excitability. When agitated, a child with cerebral palsy experiences increased sweating and fever, and their abstract and logical thinking is inhibited.

It is possible to detect these critical moments by using temperature-indicating films in orthopedic shoes. Liquid crystal-based temperature-indicating films, which allow body temperature to be determined, are considered an innovative approach in medicine. The unique optical properties of liquid crystals can be used for functional diagnostics of the feet, visualizing temperature fields and measuring temperatures. Cholesteric liquid crystals are useful for detecting pathological abnormalities. In a liquid crystal coating, the temperature distribution or surface friction on the model is determined using color. The technique for using liquid crystals is quite simple: the temperature range must be taken into account. The liquid crystal coating must not disturb the thermal field of the surface being examined, and the thermal field measurement rate must be less than the time constant of the liquid crystal [3]. The liquid crystal temperature indicator must be directly adjacent to the object being examined, i.e., the lower extremity.

Children with cerebral palsy have higher foot temperatures than healthy children, due to constant muscle and ligament tension, increased blood flow, and the constant wearing of shoes. Temperature-indicating films can be successfully used to detect abnormalities in the foot, and measurements using them are considered innovative technologies. Through scientific and technical research at BSTU, in collaboration with the prosthetic and orthopedic company Prado-N, footwear models with temperature indicators for children with cerebral palsy have been developed (Figs. 2, 3).



**Fig. 2 – Sample of summer orthopedic footwear with a temperature indicator**



**Fig. 3 – Layout of the protective strap for the temperature indicator for winter boots:**

- 1 – Upper; 2 – Velcro fastening;**
- 3 – Temperature indicator window;**
- 4 – Protective strap**

It's worth noting that winter footwear should include a strap to protect the temperature indicator from low temperatures.

Innovative development of corrective footwear is possible using the "thermochromism" effect. For example, a passive child wears red shoes to be active. As soon as he becomes nervous, the shoes automatically turn blue. Creating leather with a color-changing coating is a breakthrough technology for treating children with cerebral palsy.

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