

# Research on the effects of sympathetic and parasympathetic nervous on emotions

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**Abstract:** Emotions play a crucial role in human life, not only affecting our psychological state, but also closely related to our physical health. The sympathetic and parasympathetic nervous systems, as important components of the human autonomic nervous system, play a crucial role in the generation and regulation of emotions. This paper deeply explores the physiological functions of the sympathetic and parasympathetic nervous systems and their impact on human emotions through the organization and analysis of existing academic achievements, aiming to provide theoretical basis for further understanding the physiological mechanisms of emotions and developing effective emotion regulation methods.

## 1. Introduction

Emotions are an important manifestation of human psychological activity, reflecting our feelings and reactions towards the external world. Positive emotions can improve our quality of life and work efficiency, while negative emotions may lead to psychological and physical illnesses. Therefore, understanding the mechanisms of emotion generation and regulation is of great significance for maintaining human physical and mental health.

The sympathetic and parasympathetic nervous systems, as important components of the human autonomic nervous system, play a crucial role in maintaining physiological balance. In recent years, an increasing number of studies have shown that these two nervous systems not only participate in physiological regulation of the human body, but are also closely related to the generation and regulation of emotions. However, the mechanisms by which the sympathetic and parasympathetic nervous systems affect human emotions are not fully understood at present. Therefore, this study aims to explore the impact of sympathetic and parasympathetic nervous systems on human emotions through the organization and analysis of existing academic achievements, providing a theoretical basis for further understanding the physiological mechanisms of emotions and developing effective emotion regulation methods.

## 2. Physiological function analysis of sympathetic nervous system

The sympathetic nervous system originates from the thoracolumbar segment of the spinal cord, and its fibers are widely distributed, almost dominating all organs and tissues in the human body. The sympathetic nervous system mainly promotes the release of adrenaline and noradrenaline from the adrenal medulla for bodily regulation. Through neural and hormonal regulation, when the sympathetic nervous system is excited, it can cause a series of physiological reactions in the human body, including:

Cardiovascular system: accelerates heart rate and enhances myocardial contractility, thereby increasing cardiac output; At the same time, it constricts blood vessels, raises blood pressure, and prioritizes the distribution of blood to important organs such as the brain, heart, and muscles to meet energy needs under stress.

Respiratory system: causes bronchial smooth muscle relaxation, expands airways, increases lung ventilation, and ensures that the body can take in more oxygen during stress.

Digestive system: Inhibits gastrointestinal peristalsis and secretion of digestive fluids, reduces digestive activity, and transfers energy from the digestive system to other organs and systems that need to respond more urgently.

Urinary system: reduces renal blood flow, reduces urine production, and helps preserve water in the body.

Eye: dilates the pupils, increases the amount of light entering the eye, and enhances visual sensitivity.

In terms of metabolism, it promotes the breakdown of liver glycogen and fat, increases blood sugar and free fatty acid levels, and provides more energy to the body.

Body temperature regulation: can cause the contraction of skin blood vessels and reduce surface heat dissipation; Simultaneously promoting sweat gland secretion, regulating body temperature through sweating.

Muscle system: Enhance muscle contraction and excitability to prepare the body for exercise.

The above reactions help the human body cope with emergency situations and improve its ability to cope with stress.

### **3. Physiological function analysis of parasympathetic nervous system**

The parasympathetic nervous system originates from the brainstem and sacral segment of the spinal cord, and its fibers are mainly distributed in internal organs such as the digestive, respiratory, and urinary systems. The parasympathetic nervous system mainly promotes the release of acetylcholine to regulate the body. Through neural and hormonal regulation, when the parasympathetic nervous system is excited, it can cause a series of physiological reactions in the human body, including:

Cardiovascular system: Contrary to the sympathetic nervous system, it slows down heart rate, weakens myocardial contractility, lowers blood pressure, and puts the heart and blood vessels in a relatively relaxed state.

Respiratory system: Causes bronchial smooth muscle contraction, narrows the airway, reduces lung ventilation, and adapts to the oxygen demand of the body in a quiet state.

Digestive system: stimulates gastrointestinal peristalsis and secretion of digestive fluids, promotes the digestive process, and uses energy for the body's recovery and maintenance of normal physiological functions.

Urinary system: increases renal blood flow, promotes urine production and excretion of waste.

Eye: Narrows the pupils, reduces the amount of light entering the eye, and protects the retina.

In terms of metabolism, it promotes insulin secretion, lowers blood sugar levels, and is beneficial for energy storage and utilization.

Reproductive system: In males, it can cause penile erection; In women, it can promote vaginal lubrication and participate in the regulation of reproductive function.

The above physiological reactions help the body maintain normal physiological functions, promote recovery and rest.

The sympathetic nervous system and parasympathetic nervous system interact in maintaining physiological balance in the human body. The sympathetic nervous system and parasympathetic nervous system are functionally opposed to each other, jointly maintaining physiological balance in the human body. Under normal circumstances, the two are in a dynamic equilibrium state to adapt to different physiological needs- For example, in a quiet state, parasympathetic nervous system activity dominates to maintain normal physiological functions of the body; Under stress, sympathetic nervous system activity is enhanced to improve the body's ability to cope with stress.

### **4. The impact of sympathetic and parasympathetic nervous systems on emotions**

Many studies have shown that sympathetic nervous system excitation is closely related to emotional arousal. When people are in emotional states such as anger, fear, and tension, the sympathetic nervous system quickly excites, causing physiological reactions such as increased heart

rate, elevated blood pressure, and rapid breathing. When emotionally excited, the human body secretes large amounts of adrenaline and noradrenaline, which further stimulate the sympathetic nervous system and enhance its excitability [1].

Although this emotional stress response can have a certain protective effect on the human body itself, long-term or excessive sympathetic nervous system excitation may have a negative impact on emotions, leading to anxiety disorders, stress-related diseases, and so on.

The activation of the parasympathetic nervous system is closely related to emotional relaxation. When people are in a calm, happy and other emotional state, the parasympathetic nervous system will be excited, causing physiological reactions such as slow heart rate, low blood pressure, and stable breathing. When emotions are relaxed, the human body secretes neurotransmitters such as acetylcholine, which can promote the excitation of the parasympathetic nervous system and enhance its regulatory effects. Parasympathetic nervous system excitation can also promote digestion, improve sleep, and other physiological functions, which also help people maintain a good emotional state. [2]

Therefore, dysfunction of the parasympathetic nervous system has a negative impact on emotions, leading to depression, insomnia, and so on.

The sympathetic nervous system and parasympathetic nervous system interact in emotion regulation to maintain balance. The two will have different antagonistic effects in different emotional states. When dealing with stress, the sympathetic nervous system first excites, triggering the body's stress response; Subsequently, the parasympathetic nervous system plays a regulatory role, reducing the degree of stress in the body and restoring it to a normal state. During emotional relaxation, parasympathetic nervous system activity dominates, maintaining normal physiological functions of the body; When emotions are aroused, the sympathetic nervous system is stimulated, enhancing the body's ability to cope with stress.

It is this balance mechanism that keeps people's emotions fluctuating within a controllable range and maintains a healthy state. [3]

## **5. The specific mechanisms of sympathetic and parasympathetic nervous systems in regulating emotions**

The specific mechanisms by which the sympathetic and parasympathetic nervous systems regulate emotions involve multiple levels, including physiological, psychological, and nervous system interactions.

The sympathetic nervous system (SNS): The sympathetic nervous system is primarily responsible for activating the body's stress response in the "fight or flight" response. It prepares the body for emergency situations by increasing heart rate, blood pressure, respiratory rate, and blood sugar levels. This physiological activation state helps individuals respond quickly to external threats, but excessive activation may lead to increased anxiety and stress [4].

The parasympathetic nervous system (PNS) is responsible for restoring the body to a relaxed state in non emergency situations. It promotes rest and recovery of the body by lowering heart rate, blood pressure, respiratory rate, and blood sugar levels. The activation of the parasympathetic nervous system helps alleviate stress and anxiety, and promotes emotional stability.

In emotional regulation, the roles of these two systems can be reflected through various mechanisms:

Cognitive control and emotion regulation: Studies have shown that the prefrontal cortex plays a crucial role in emotion regulation, particularly through cognitive reappraisal strategies to regulate emotional responses [5]. This process involves a top-down emotional regulation mechanism, which involves cognitive intervention to change the evaluation and interpretation of emotional stimuli, thereby affecting emotional experiences.

Bottom up emotional processing: Emotions can also be processed in a bottom-up manner, that is, emotional reactions directly triggered by sensory input. In this case, the sympathetic and parasympathetic nervous systems respond to emotional stimuli by regulating the physiological state of the body, such as adapting to changes in emotional states by altering heart rate and breathing

patterns.

The role of the neuroendocrine system: The hypothalamic pituitary adrenal axis (HPA axis) serves as a bridge connecting the central nervous system and endocrine system, and also plays an important role in regulating emotional responses. The activity of the HPA axis is influenced by the sympathetic nervous system and can affect the secretion of hormones such as cortisol, which further affect emotional states [6].

Therefore, the sympathetic nervous system and parasympathetic nervous system participate in regulating emotional responses by interacting with multiple regions in the brain, such as the prefrontal cortex and amygdala, as well as by regulating the neuroendocrine system.

## **6. Improving anxiety and depression symptoms by enhancing parasympathetic nerve activity**

Through the above argument and analysis, it can be concluded that the sympathetic nervous system and parasympathetic nervous system dynamically balance and control people's emotional states through interaction. This process is accompanied by changes in people's physiological states, which in turn can affect their emotional states. Therefore, inhibiting the excessive activity of the sympathetic nervous system and enhancing the activity of the parasympathetic nervous system is an effective method to improve anxiety and depression.

Specific operational methods include:

Deep brain stimulation: According to the latest research, deep brain stimulation technology has been used to treat refractory anxiety disorder. This treatment method targets the anxiety center located in the lateral ventricle, rapidly inhibiting anxiety related neurons and immediately relieving anxiety symptoms under various stress conditions without causing acute or chronic side effects [7].

Exercise: Studies have shown that acute aerobic exercise is associated with significantly reduced levels of anxiety. After exercise, the relative activation of the left frontal lobe area increases, which may help reduce anxiety [8]. Therefore, regular aerobic exercise may help enhance parasympathetic activity and improve anxiety symptoms.

Moxibustion stimulation of amygdala: In studies of post-traumatic stress disorder (PTSD), upregulation of the neuropeptide Y system through bilateral amygdala stimulation has been shown to alleviate anxiety components [9]. Although this is a study targeting PTSD, it also indicates that anxiety related behaviors and physiological responses can be regulated through specific neural stimuli.

Drug therapy: Although traditional benzodiazepines have limited their use in chronic anxiety disorders due to their side effects, selective serotonin reuptake inhibitors and serotonin/norepinephrine reuptake inhibitors have become effective alternative treatments of choice [10]. In addition, neurosteroids, as a new class of drugs, are currently under research, revealing new regulatory sites and mechanisms of action, providing insights into the pathophysiology of certain anxiety disorders.

Non invasive brain imaging technology: Combining system level discovery platforms with personalized medical methods based on non-invasive brain imaging can significantly promote the development of more effective therapies. This method can help identify and adjust a wide range of receptor targets that can produce sedative effects.

## **7. Conclusion**

The excitement of the sympathetic nervous system is closely related to emotional excitement. During emotional states such as anger and fear, the sympathetic nervous system rapidly excites, causing physiological reactions. However, long-term or excessive excitement may lead to negative effects such as anxiety disorders. The activation of the parasympathetic nervous system is closely related to emotional relaxation. When the parasympathetic nervous system is in a calm, happy and other emotional state, it is excited, promoting physiological function improvement and helping to maintain a good emotional state. Its dysfunction may lead to depression, insomnia, etc. The sympathetic and parasympathetic nervous systems interact and maintain balance in emotion

regulation.

The physiological phenomenon caused by the excitement of the sympathetic and parasympathetic nervous systems triggered by emotions will enhance the current emotions, which means that changes in physiological phenomena will also have a reverse impact on emotions. Therefore, by inhibiting the excessive activity of the sympathetic nervous system and enhancing the activity of the parasympathetic nervous system, anxiety and depression symptoms can be improved, including deep brain stimulation, exercise, moxibustion stimulation of the amygdala, drug therapy, and non-invasive brain imaging techniques.

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