



How does the brain affect cardiovascular health?

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Abstract

In the article the mechanisms of stress response regulation by the brain are reviewed, as well as the data from a new study in this area, which was focused on a detailed analysis of brain activity changes in people with excessive cardiovascular stress response.

Keywords: brain, cardiovascular, reactivity, stress, psychosomatics, psychophysiology

1 Background

It is known that acute and chronic psychological stress launches a cascade of reactions in the body. Studies in physiological and pathophysiological effects of stress on the body began in the first half of the 20th century from the classical works of Walter Cannon and Hans Selye and have been actively continuing today.

Acute psychological stress leads to rapid cardiovascular reactions, including heart rate acceleration and increase in blood pressure. Such reactions evolutionary are enabling increased energy consumption to provide appropriate protective behavioral reactions such as fight or flight response.

However, not all people are the same in these reactions. Their power can vary in a rather wide range. Some individuals tend to over-respond to potentially stressful events with exaggerated metabolic and especially cardiovascular changes that do not match the strength of the stressor. Unlike others, following individuals are at increased risk of developing hypertension, rapid progression of atherosclerosis and death from cardiovascular causes [1].

2 Mechanisms of cardiovascular reactivity

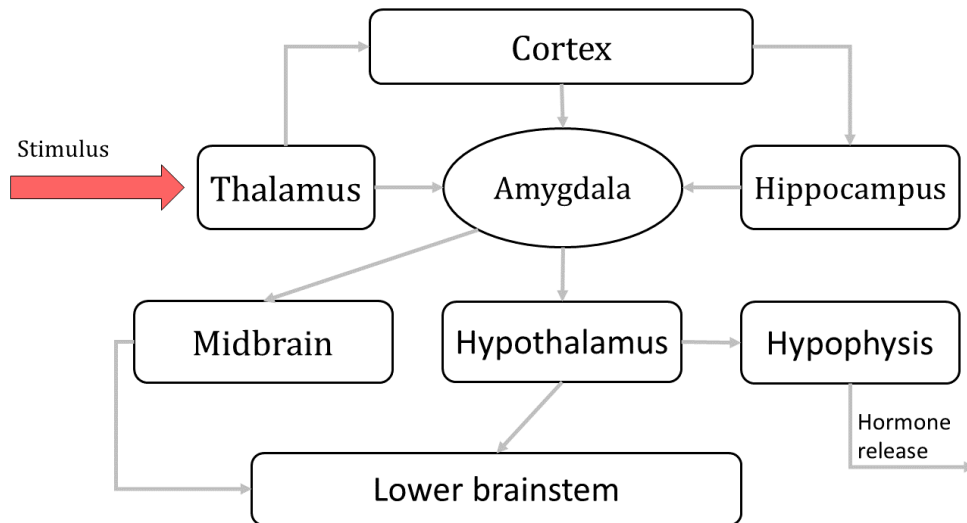
Changes in the cardiovascular system under acute stress (acceleration of the heartbeat, increased pressure, etc.) are due to changes in the autonomic nervous system, which innervates many organs including the heart and blood vessels. Stress is usually accompanied by increased activity of the sympathetic nervous system and reduction - parasympathetic.

Conventionally, the brain cardiovascular regulation of the body under the stress can be divided into upper and lower levels. It involves cortex, subcortical structures (limbic system), shown in Figure 1, the centers of autonomic regulation in the brain stem, shown in Fig. 2. Besides the autonomic nervous system, the response is also provided by the hypothalamic-pituitary-adrenal axis, shown in Fig. 1 (from the hypothalamus).

3 New data

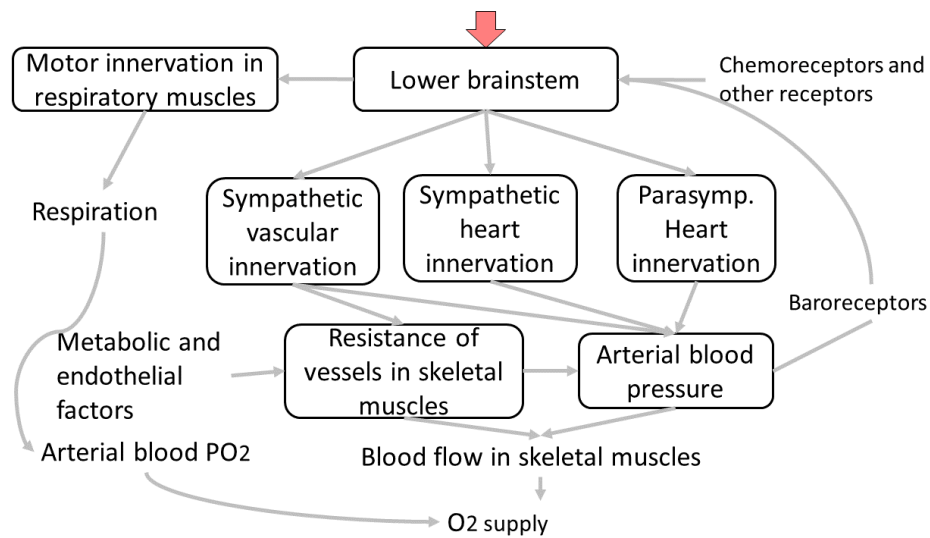
In the new study, researchers from the Pittsburg University, USA, conducted a detailed evaluation of the pathological

Figure 1: The brain regulation of the cardiovascular system under stress, upper level.



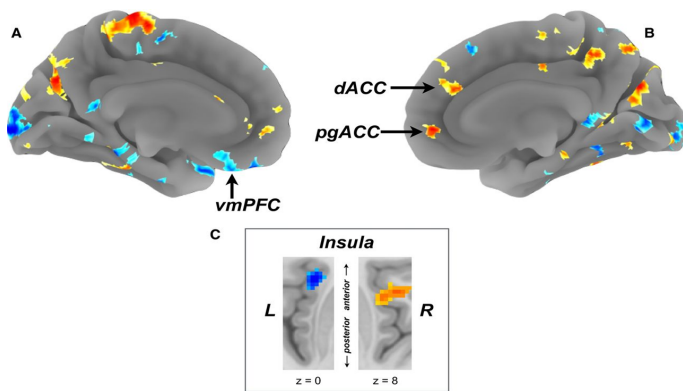
* Most of all sensory signals except those from the olfactory system are passing through the thalamus, which performs integrative role. In addition to the autonomic nervous system adaptation to the acute and chronic stress is provided by hypothalamic-pituitary-adrenal axis.

Figure 2: Brain regulation of the cardiovascular response to stress, lower level.



* Physiological feedback mechanism connection is provided through different receptors that are found in certain parts of vessels and heart.

Figure 3: Changes in the brain in patients with excessive cardiovascular reaction to stress [2].



* Blue - reduced activity, yellow and red - increased activity. vmPFC - ventromedial prefrontal cortex, ACC - anterior cingulate cortex, (L- insula in left hemisphere, R- insula in right hemisphere).

mechanisms of excessive response to stress in predisposed individuals [2]. In theory, this could allow developing effective methods for cardiovascular diseases prevention.

The total sample included 310 persons aged 30-51 years. Individuals underwent detailed examination using functional MRI and blood pressure assessment at baseline and during the potentially stressful event. As stressors researchers used a special battery of tests, which is available on the official website of the Pittsburgh University. It can not only provide the necessary level of stress and but to assess its impact on cognitive functioning.

Thus, scientists had a chance to evaluate the brain function at rest and during stress using neuroimaging and special tests. Also separately were measured changes in blood pressure as a marker of cardiovascular reactivity to a stressor.

According to the results in patients with a predisposition to excessive cardiovascular responses were recorded differences in patterns of brain activation in such regions as the ventromedial prefrontal cortex, anterior cingulate cortex and insula (Fig. 3).

Medial prefrontal cortex is a zone of the brain in the frontal lobe, which, in this case, provides a cognitive assessment of stressor. It is important in a conscious patient's assessment of potential stress factors in terms of significance

in the particular situation.

Anterior cingulate cortex - a brain area that is part of the limbic system, involved in the formation of emotions. In this case, it integrates incoming information about the stressor from the thalamus (it receives almost all sensory signals from the senses) and from the cortex. This area of the brain is closely associated with motivation and emotional learning.

The insula is a brain area located in the deep layers of the cerebral cortex, on the border between the frontal, temporal and parietal lobes. It performs a variety of functions in the brain associated with the conscious processing of information, including perception, movement control, self-awareness and a variety of cognitive functions.

4 Conclusion

So in the survey was found patterns of the brain associated with excessive cardiovascular reactivity to stress. There is a decrease in activity (compared with healthy individuals) in the medial prefrontal cortex and the left insular cortex, responsible for the conscious processing of information and increased activity in the anterior cingulate cortex and the right insular cortex that processes most of the unconscious emotional information.

A deeper understanding of these processes can give impetus to the creation of new or improving old methods for prevention and treatment of psychosomatic disorders associated with impairments in the cardiovascular system.

References

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