

Sympathetic neural mechanisms in the cardiac defense response

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Abstract:

The scientific approach to human emotions entails important methodological difficulties. Many of these difficulties can be solved by the development of adequate research paradigms together with the application of psychophysiological register techniques. Various studies show the influence that negative affect emotions like fear and anxiety have in human health. Heart affections are one of the most often health problems derived from an intense and continuous emotional activation. In order to know in detail the sympathetic mechanisms of influence on cardiovascular activity, we propose an experimental design of cardiac defense response (RCD) together with register of the pre-ejection period (PEP) obtained by impedance cardiography and electrocardiogram. The RCD is a well established paradigm of cardiovascular reactivity elicited by the unexpected display of an intense and short auditory stimulus (500 ms, 105 dB). The PEP measures the latency between the onset of electromechanical systole and the onset of left ventricle ejection, being a reliable index of beta-adrenergic activity on left ventricle.

Keywords: fear, anxiety, impedance cardiography, cardiac defense response, pre-ejection period.

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INTRODUCTION

Emotion is a complex phenomenon that is fundamental to psychology. Although emotions are part of everyone's daily lives and intuitively we all know what they are, it is not easy to come up with a formal, comprehensive definition of emotion. Even among scientists who specialize in the psychology of emotions, there has been and continues to be much debate about the scientific conceptualization and operationalization of emotion (James, 1884; Cannon, 1927). Undoubtedly one of the reasons for this lack of agreement is that as a subjective phenomenon, emotions are not an easy topic for an empirical study. However, over the past 25 years, several paradigmatic studies have provided a rigorous approach to emotion from a scientific point of view (Esteves, Dimberg and Öhman, 1994; Globisch, Hamm, Esteves and Öhman, 1999; Lang, Bradley and Cuthbert, 1990; Vila et al., 2007), enabling the study and conceptual integration of the phenomenon. The common element to these paradigms is that they are all based on psychophysiology, that is, the application of non-invasive techniques to measure the physiological changes that are produced in the human body when an emotion is experienced. These paradigms, along with the development of psychophysiological recording techniques, have contributed enormously to our knowledge of emotional experiences and their implications for human health (Ohmån and Mineka, 2001).

DISCUSSION AND CONCLUSIONS

Negative emotions and health. In terms of the advances in our knowledge of emotion, it is now widely accepted that the

principal function of emotions is to prepare individuals to take action (Lang, 1995). This preparation includes a series of physiological reactions that facilitate the optimal functioning of the organism: by mobilizing energy resources, the body assures that cells get the nutrients necessary for maximum performance. This increase in the physiological activation level and energy consumption is especially evident for negative emotions such as fear, anxiety and anger. Although there is an overwhelming quantity of literature on the adaptive function that negative emotions have had over the course of human evolution (Levenson, 1994), our current environment has changed drastically, especially in the industrialized countries. One of the consequences of these environmental changes is that what was once fundamental for survival has become a relic of natural situations from the past that have little or nothing in common with our current reality.

This level of physiological activation, which used to have an adaptive function and would only activate in specific situations in which an individual's physical integrity was in danger, is currently much more likely to become chronic, generating serious risks for people's health (Mayne and Bonanno, 2001). The physiological changes associated with emotions like anger and anxiety are precisely the ones that involve a greater risk to health (Consedine, 2008). Given that anxiety disorders are one of the psychopathological categories that bring the greatest number of people into psychologist offices, it is very important to find out how our organism reacts in these situations, and even more considering the negative implications that a high level of cardiovascular activation can have for our health if it occurs regularly over time (Mayne and Bonanno, 2001).

Sympathetic neural influences in the left ventricle. The body's main control system, which is also responsible for regulating heart activity, is the autonomous nervous system (ANS). The ANS is comprised of two subsystems that have "opposite" effects on the level of physiological activation: the SNS

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(sympathetic nervous system) increases activity while the PSNS (parasympathetic nervous system) decreases it. Traditionally it was thought that the two systems always acted in a reciprocal manner: when one activated a response, the other inhibited it and vice-versa. However, there is a large number of studies whose results do not fit this model. In the study by Bernston, Cacioppo and Quigley (1991), who brought together all of the data that had been previously overlooked, the activity of the SNS is conceived of as a two-dimensional space where the two subsystems can function not only in a reciprocal manner but also by simultaneously activating or inhibiting a response. Assuming this model thus requires that sympathetic and parasympathetic activity be measured separately as opposed to simply inferring them based on general cardiac activity.

The most rigorous methodological way to measure the influence of the SNS on the heart is by recording the activity of the left ventricle as it is innervated exclusively by sympathetic fibers. This monitoring can be done in a non-invasive way through the application of impedance cardiography that is synchronized with the electrocardiogram (Sherwood et al., 1990). The development and standardization of this technique originally designed by Kubicek, Karnegis, Patterson, Witsoe and Mattson (1966) allows different indexes of the sympathetic neural influences on the heart to be obtained. One of these indexes is the pre-ejection period (PEP), which is the time interval from the onset of ventricular depolarization (the moment when the electromechanical systole begins) until the opening of the aortic valve (the moment when the oxygenated blood begins to flow through the aortic valve). The shorter the interval, the higher the level of sympathetic activity on the left ventricle and vice-versa.

The application of this technique in the laboratory, within a research paradigm in the psychology of emotions such as the cardiac defense response (Vila et al., 2007), allows for precise information to be obtained on the degree of cardiovascular activity that depends on the influence of the sympathetic branch of the ANS. This integration model illustrates the importance of combining technological and conceptual advances with research paradigms, in a synergy that allows us to take one step forward in our knowledge of emotions and their health implications.

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