Chapter 14
Virtual Reality Environments in Pain Management

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ABSTRACT

Pain is a distressing and subjective feeling that occurs in different intensities and may result from the stimulation of a nerve due to injury, illness, or emotional disturbance. This chapter aims to understand how VR can contribute to pain management. To this end, the authors will address topics such as: pain – types of pain and its consequences in everyday life, as well as ways to relieve it; virtual reality – what it consists of, its functionalities and components, as well as its application to health and well-being, its advantages and limitations; and virtual reality in pain management. It is intended to emphasize the importance of pain management for the daily lives of individuals and the consequent improvement in the quality of life of those who benefit from this type of intervention.

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INTRODUCTION

It is undeniable that, throughout life, we all experience some pain. Characterized as a sensory or emotional experience, pain is a distressing and subjective feeling that occurs in different intensities and may result from the stimulation of a nerve due to injury, illness, or emotional disturbance (Riva et al., 2011; Tait et al., 2009). More specifically, the International Association for the Study of Pain determines that this unpleasant experience is "associated with, or resembling that associated with, actual or potential tissue damage". It is a personal experience influenced by several unique and individual factors, which can translate into negative consequences, not only at the physical level, compromising the individual's functionality, but also the social and mental well-being (Merskey, 1994).

This reaction to harmful stimuli is regulated by non-nociceptive blocked mechanisms located in the spinal cord, as explained by the "gate control theory", allowing the increase or attenuation of perceived pain. It may also be due to distracting stimuli, which helps a harmful reduction of nociceptive neuronal signaling, attenuating perceived pain (Melzack & Wall, 1965; Triberti et al., 2014). In 2006, Luna considered that, as well as cardiorespiratory and thermal functions, pain should be considered a fifth vital sign, which informs the person about the danger to their physical integrity. That is why it is so important to know how to distinguish physiological from pathological pain. While the first assumes protective and adaptive functions, namely inflammatory and nociceptive pain, the second does not (Luna, 2006; Sneddon, 2017).

Nociception is the process that describes pain processing and responses that pose a threat to the normal state of nervous tissue. In general, pain is classified in two different kinds: acute pain, being transitive, manifests itself in a short period, usually resulting from easily identifiable causes; and chronic pain, a constant or intermittent painful feeling, that extends over time (Riva et al., 2011; Tait et al., 2009).

Even so, pain may differ according to its pathophysiology: nociceptive pain - caused by damage to the body, serving a purpose (protection, for example); neuropathic pain - presupposes a direct consequence of an injury or disease of the somatosensory system but which can be felt in areas far from the injured one; and nociplastic pain - emerges from a nociceptive change, even if there is no evidence or threat of tissue or somatosensory system damage (Jensen et al., 2011; Jensen & Gebhart, 2008; Kosek et al., 2016).

As a typical sign of acute pain, physiological pain responds to stop exposure to the harmful stimulus to preserve tissue homeostasis. For this to happen, it is necessary to intervene with the free nerve endings of first-order neurons, called nociceptors. The harmful external stimulus is transmitted to the Central Nervous System through processes of transduction, transmission, modulation, and perception of the neural signals generated as a response (Pace et al., 2018; Sneddon, 2017).

In a simplified way, this process consists of a chain where the first-order neuron originates from the periphery and protrudes into the spinal cord; the second-order neuron ascends through it, and the third-order neuron protrudes into the cerebral cortex. Projection neurons carry nociceptive information through five main ascending pathways that innervate the thalamus, midbrain, limbic system, and reticular formation, which in turn are responsible for the location of pain, its intensity, and its effective and cognitive aspects (Klaumann et al., 2008; Lamont et al., 2000). The periaqueductal gray of the midbrain is considered the most crucial anatomical region to the endogenous analgesia system, comprising the pathways that originate in the brain stem and spinal cord that end. The inhibition of the nociceptive neurons presents here is made by excitatory connections with serotonergic and noradrenergic neurons which lead to the dorsal horn of the spinal cord which results from the inhibitory neurons of the blades connections I, II, and V (Klaumann et al., 2008; Lamont et al., 2000).