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A systematic review and meta-analysis of pain neuroscience

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ABSTRACT
Pain is a common word used to refer to a wide range of physical and mental states sharing hedonic aversive value. Three types of pain are distinguished in this article: Physical pain, an aversive state related to actual or potential injury and disease; social pain, an aversive emotion associated to social exclusion; and psychological pain, a negative emotion induced by incentive loss. This review centers on psychological pain as studied in nonhuman animals. After covering issues of terminology, the article briefly discusses the daily-life significance of psychological pain and then centers on a discussion of the results originating from two procedures involving incentive loss: successive negative contrast—the unexpected devaluation of a reward—and appetitive extinction—the unexpected omission of a reward. The evidence reviewed points to substantial commonalities, but also some differences and interactions between physical and psychological pains. This evidence is discussed in relation to behavioral, pharmacological, neurobiological, and genetic factors that contribute to the multidimensional experience of psychological pain.Systematic review of randomized control trials (RCTs) for the effectiveness of pain neuroscience education (PNE) on pain, function, disability, psychosocial factors, movement, and healthcare utilization in individuals with chronic musculoskeletal (MSK) pain.

Keywords: Psychological pain, Physical pain, Chronic pain; explain pain; pain neuroscience education; therapeutic neuroscience education

I. INTRODUCTION:

In English and other languages, "pain" has both a physical dimension (e.g., discomfort caused by injury or disease) and a psychological dimension (e.g., suffering caused by grief or disappointment; Eisenberger and Lieberman, 2004). The identification of these two sources of aversive emotion with the same word, "pain," suggests that there might be important underlying commonalities in the brain mechanisms underlying these two dimensions of pain. In this article, we will argue that there is evidence of an extensive common ground, but also that important differences are starting to emerge. This paper centers on psychological pain, but relations to both physical and social pains are pointed out as required by the argument. This review sets out to achieve three goals. First, to identify common themes, concepts, and outcomes among lines of research that have proceeded largely independently. This also requires a relatively homogeneous terminology to avoid unwanted semantic confusion. Second, to show the substantial overlap in the neurobiological basis of these types of pain despite the seemingly different procedures used to induce them. Although not phrased in terms of "pain," functional and neurobiological connections between physical and psychological pains have been recognized since the 1960s in terms of common outcomes in situations involving fear conditioning and frustrative nonreward (Gray, 1975, 1987; Wagner, 1966, 1969). Finally, the last aim of this review is to identify areas in which systematic research could have a significant impact in our understanding of psychological pain. As in any emergent area of research, bringing together domains that have been treated separately in the past creates terminological confusion. To complicate matters further, many of the technical words used in descriptions of this type of research are also of common usage and therefore have less precise semantic limits. It is also important to recognize that many of the relevant concepts can be characterized either as intervening variables (Tolman, 1938) or hypothetical constructs (MacCorquodale and Meehl, 1948), that is, unobservable variables postulated theoretically to account for empirical evidence, but with the

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implication of mapping to a lower level of analysis(1).

The terminology is complicated because social life, especially in humans, distinguishes many types of situations that might induce such an aversive state. This could be illustrated using social rejection. Whereas the actual emotion may be described in terms of feelings of personal rejection,the anticipated form may be described in terms of social threat (MacDonald and Leary, 2005). Thus, it seems plausible that a person who has felt rejected in a certain type of situation (e.g., a party with a specific group of friends) may later avoid confronting a similar situation. Much of the recent research on social pain with human participants is based on traditional methods of experimental social psychology occasionally combined with brain imaging techniques. A close analog in nonhuman animals would be research on mother–infant separation as studied in nonhuman primates and other animals. Such studies have provided important information on the impact of rejection, exclusion, separation, and incentive loss. The researchonmother–infant separationusually focuses onthe immediate consequences and the long-term effects of early experience (Suomi, 2006), rather than the anticipatory effects(2).

Comparative studies of psychological pain:

What procedures can be used to study psychological pain? Although experimental preparations for the study of psychological pain have existed for a long time, they have traditionally been viewed in connection to learning and cognitive processes, rather than in terms of emotion(3) . We suggest here that these training protocols include the necessary conditions to induce psychological pain related to reward downshifts (devaluation or omission), as defined above. Consider the following two procedures extensively: cited in this article: successive negative contrast and appetitive extinction.

Successive negative contrast (SNC):

In SNC, following acquisition with a large reward, animals are downshifted to a small reward and their performance is compared to that of unshifted controls always exposed to the small reward. Downshifted animals exhibit a transient reduction in response strength relative to unshifted controls. SNC has been traditionally considered in discussions of animal models of anxiety (4). There are two basic procedures to study SNC. One procedure involves instrumental behavior (iSNC), that is, behavior that reflects the effect in anticipation of the goal event.In his classic demonstration, Elliott (1928) administered one trial per day to two groups of rats in a complex maze. One group rapidly learned to locate a highly palatable cereal mixture, whereas the other learned to locate a less valuable sunflower seed reward.When the groups had demonstrated a substantial reduction in errors, the reward was unexpectedly devalued from cereal to sunflower seeds in one group, while remaining unchanged in the group that had started with sunflower seeds. Elliott found that such a qualitative reward downshift led to a rapid deterioration of behavior. Similar effects were subsequently shown with downshifts in reward magnitude (5). Second, a procedure that involves consummatory behavior (cSNC), that is, changes in the consumption of the reward. In another classic demonstration, trained monkeys to expect either a highly prized piece of banana or a less preferable, but usually acceptable leaf of lettuce; monkeys could observe the experimenter hiding the reward underneath one of two cups. Choice was allowed after a short retention interval. In occasional probe trials, the banana was switched for lettuce during the interval and outside the monkey's view.

Why Physiological Pain?

Pain plays an important in the survival of all animals. It acts as a signal, alerting us to potential tissue damage, and leads to a wide range of actions to prevent or limit further damage.

Physiologically, pain occurs when sensory nerve endings called nociceptors **(**also referred to as pain receptors) come into contact with a painful or noxious stimulus. The resulting nerve impulse travels from the sensory nerve ending to the spinal cord, where the impulse is rapidly shunted to the brain via nerve tracts in the spinal cord and brainstem. The brain processes the pain sensation and quickly responds with a motor response in an attempt to cease the action causing the pain.

There are two major classes of nerve fibers associated with the transmission of pain:

1. Unmyelinated C fibers
2. Myelinated A-delta fibers

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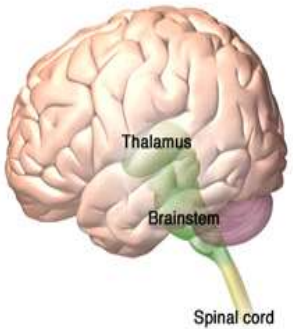
Destinations of the Spinothalamic and Spinoreticular Tracts in the Brain



The thalamus is the destination of spinothalamic tract—the sensory pathway responsible for processing pain, temperature, and crude touch. The brainstem reticular formation, which forms a diffuse, central core within the brainstem is the destination of the spinoreticular tract. Source: 3DScience.com. Used by permission.

The C fibers are small and conduct impulses slowly. They respond to thermal, mechanical, and chemical stimuli and produce the sensation of dull, diffuse, aching, burning, and delayed pain. A-delta fibers, which are myelinated and thus conduct impulses rapidly, respond to mechanical (pressure) stimulus and produce the sensation of sharp, localized, fast pain.

One of the most important central pain pathways is the spinothalamic tract, which originates in the spinal cord and extends to the thalamus. This spinal tract transmits sensory information related to pain, temperature, and crude touch.

Another prominent pathway is the spino-reticular tract, which is involved in nociceptive processing. The spinoreticular tract is similar to the spinothalamic tract in that it is excited by similar sensory fibers. Rather than ascending to the thalamus however, spinoreticular neurons terminate within the brainstem(6).

Using Neuroimaging to Understand Pain:

Our understanding of how the brain changes in response to chronic pain or to pharmacologic or other therapeutic interventions has been significantly improved as a result of neuroimaging techniques. Until the advent of these techniques, the living brain was largely invisible to clinicians and researchers. The development of computed tomography (CT) and, soon thereafter, magnetic resonance imaging (MRI), allowed researchers to look into the living brain and gain some understanding of the parts of the brain affected by certain types of pain. The development of positron emission tomography (PET) has allowed researchers, for the first time, to investigate neuronal activity throughout the entire brain (7).
Functional magnetic resonance imaging (fMRI), positron emission tomography (PET), magnetoencephalography (MEG), and scalp electroencephalography (EEG) have been used to study the neural bases of pain. Other magnetic resonance-based measures such as diffusion tensor imaging, spectroscopy, and volumetric imaging are being used to assess pain-related changes in the brain's wiring, chemistry, and structure; this will help gain further insights into the neurobiology of pain, particularly chronic pain (8).

As a result, we now know that pain sensation is more complex than previously thought and involves diverse regions of the brain. Imaging techniques have allowed us to understand that pain results from activation of a number of brain regions such as the amygdala, insula, or the anterior cingulate cortex. We are learning that pain is a result of complex interactions between the immune, nervous (both CNS and autonomic nervous system), and endocrine systems (9).

In a study of patients with chronic low back pain, neuroimaging showed significant differences in brain function. Compared to healthy controls, chronic low back pain patients showed activation in pain-related brain regions during administration of experimental pain, differences in activation during emotional decision-making tasks, and changes in specific brain regions during a simple visual attention task (9).

Memory modulators:

The researchers argued that situations involving reward loss, whether in terms of devaluation (SNC) or omission (appetitive extinction), may induce the consolidation of two different types of memories. First, the downshift in

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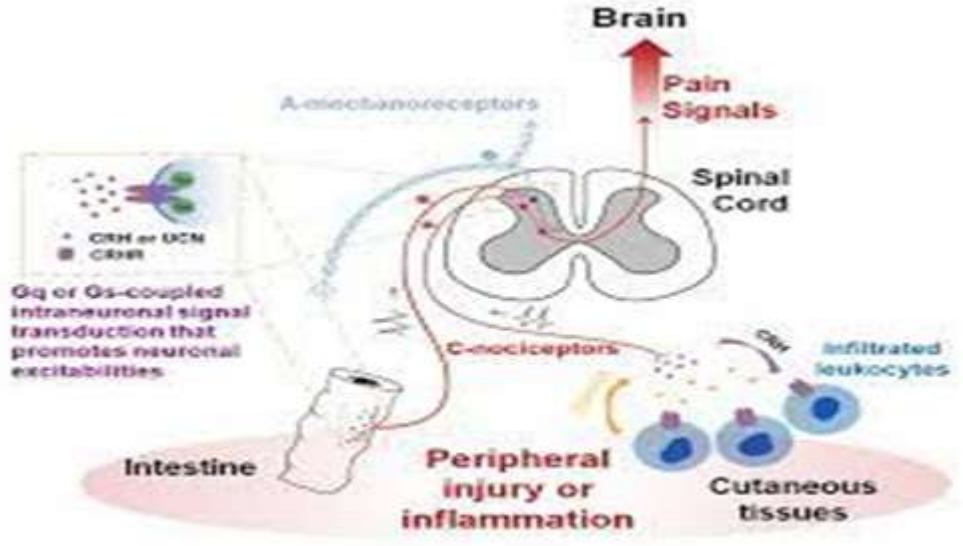
incentive conditions may promote, if significant enough,the acquisition of an emotional memory encoding the organism's reaction to the loss. This was called egocentric memory since it contains information about the organism's emotional state—an internal event. Second, interaction with the new incentive conditions may promote the acquisition of a cognitive memory about the properties of the new reward. This was called allocentric memory because it contains information aboutthe new reward—an external event.Whenreactivated,these memories tend to have opposing effects on behavior. For example, in the cSNC situation, consolidating or retrieving the egocentric memory would promote suppression of consummatory behavior and, of course, failing to consolidate/retrieve such a memory would promote enhancement of consummatory behavior. Notice, however, that the two memories are theoretically established in rapid succession and without a clear boundary. After the organism detects a significant downshift (10), the emotional response is recruited and egocentric memory is hypothesized to become encoded; but soon after, as it interacts with the new incentive conditions, the organism will automatically learn about them, thus encoding the allocentric memory. Whereas egocentric memory is hypothesized to promote withdrawal, rejection, and avoidance of the goal, thus extending the effects of reward loss, allocentric memory is hypothesized to promote approach to the goal, thus facilitating recovery from reward loss.

Neuroscience studies:

the complex processes occurring within a single neuron. Neurons are cells specialized for communication. They are able to communicate with neurons and other cell types through specialized junctions called synapses, at which electrical or electrochemical signals can be transmitted from one cell to another. Many neurons extrude a long thin filament of axoplasm called an axon, which may extend to distant parts of the body and are capable of rapidly carrying electrical signals, influencing the activity of other neurons, muscles, or glands at their termination points. A nervous system emerges from the assemblage of neurons that are connected to each other.

The vertebrate nervous system can be split into two parts: the central nervous system (defined as the brain and spinal cord), and the peripheral nervous system. In many species — including all vertebrates — the nervous system is the most complex organ system in the body, with most of the complexity residing in the brain. The human brain alone contains around one hundred billion neurons and one hundred trillion synapses; it consists of thousands of distinguishable substructures, connected to each other in synaptic networks whose intricacies have only begun to be unraveled. At least one out of three of the approximately 20,000 genes belonging to the human genome is expressed mainly in the brain(11).

Divergent aspects of Physiological Pain:



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II. CONCLUSION:

It is clear that psychological and physical pains are controlled by similar neural mechanisms that need to be studied in greater detail. Although the components of the neural circuit underlying the processing of psychological and physical pains remains to be fully identified, it is likely that the system encompasses the body-self neuromatrix that has been proposed to engage perceptual, behavioral, and homeostatic systems in response to injury and chronic stress. Examining the complex interaction of different forms of "pain" will most certainly increase our understanding of how biological and psychological mechanisms contribute to the onset and maintenance of several psychological phenomena not obviously related. In addition to theoretical issues in learning theory, brain function, and evolution

REFERENCE:

[1]. Abler, B., Walter, H., Erk, S., 2005. Neural correlates of frustration. Neuroreport 16, 669–672.

[2]. McEwen, B.S., 2003. Early life influences on life-long patterns of behavior and health. Mental Retard. Dev. Disabil. Res. Rev. 9, 149–154.

[3]. Delamater, A.R., 2004. Experimental extinction in Pavlovian conditioning: behavioural and neuroscience perspectives. Q. J. Exp. Psychol. 57B, 97–132.

[4]. Flaherty, C.F., Grigson, P.S., Rowan, G.A., 1986. Chlordiazepoxide and the determinants of contrast. Anim. Learn. Behav. 14, 315–321

[5]. Crespi, L.P., 1942. Quantitative variation in incentive and performance in the White rat. Am. J. Psychol. 40, 467–517

[6]. Abrams DI, Dolor R, Roberts R, et al. (2013). The BraveNet prospective observational study on integrative medicine treatment approaches for pain. Doi:10.1186/1472-6882-13-146. Retrieved May 27, 2016 from http://bmccomplementalternmed.biomedcentral.com/articles/10.1186/1472-6882-13-146.

[7]. Casey KL. (2015). Brain imaging and pain: A historical perspective. In: The Brain Adapting with Pain: Contribution of Pain Imaging Technologies to Pain Mechanisms. A.V. Apkarian, editor. IASP Press. Retrieved June 15, 2016 from https://books.google.com/books?isbn=1496317505.

[8]. Lee MC, Tracey I. (2013). Imaging pain: A potent means for investigating pain mechanisms in patients. Br. J. Anaesth 111(1):64-72. Doi:10.1093/bja/aet174. Retrieved July 29, 2016 from http://bja.oxfordjournals.org/content/111/1/64.full.

[9]. Zouikr I, Bartholomeusz MD, and Hodgson DM. (2016). Early life programming of pain: Focus on neuroimmune to endocrine communication. Journal of Translational Medicine. 14:123. Doi:10.1186/s12967-016-0879-8. Retrieved August 11, 2016 from https://translational-medicine.biomedcentral.com/articles/10.1186/s12967-016-0879-8.

[10]. Papini, M.R., Pellegrini, S., 2006. Scaling relative incentive value in consummatory behavior. Learn. Motiv. 37, 357–378.

[11]. U.S. National Institute of Neurological Disorders and Stroke. Brain basics: genes at work in the brain. Date last modified: 2018-12-27. [1] Retrieved Feb. 4, 2019.