Visceral and Somatic Pain:

The Gift That Nobody Wants and Everybody Needs

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Warning: Life without pain could hurt you
—Paul Brand and Philip Yancey, 1993

In their Focus article, Al-Chaer, Feng, and Willis summarize the results of animal and clinical studies regarding the classical view of the role of the spinothalamic tract (STT) and the dorsal column (DC) pathway in somatic and visceral sensation, especially in pain perception. In addition, they summarize their own recent findings to conclude that DC conveys not only somatic low threshold information, but in addition transmits nociceptive visceral information. These new studies show that (1) visceral information from the colon is conveyed via the postsynaptic DC (PSDC) to the nucleus gracilis, and that (2) the DC pathway is important for nociceptive visceral and non-nociceptive somatic information transfer to the somatosensory thalamus, while the STT is more important for the transmission of nociceptive somatic information. Furthermore, they discuss whether the DC contains a visceral pain pathway, or whether visceral pain is due to an "equilibrium shift in a sensory-autonomic loop" or "a disturbance in the sensorimotor continuum," respectively. They come to the following conclusions: (1) Because there is no "global surveyor," we are unable to decide whether visceral pain is conveyed via a spinal pathway, or is due to disturbances in sensori-autonomic loops. (2) One should not resign, but go on helping patients to get rid of their pain.

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The subtitle of this article is taken from the title of the book by Drs. Paul Brand and Philip Yancey (Ref. [5]).

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The presented review adequately covers the subject matter and we will not attempt to extend it here. We, however, disagree with our colleagues regarding the dichotomy that they develop as supposed alternative theories for understanding visceral pain. We emphasize that understanding visceral pain is not in any way any more daunting a process than that of somatic pain, and that proper management of both types of pain can only be achieved by further focusing on scientific understanding and not utilitarian expediency.

In contrast to the prologue presented in the Focus article, we want to emphasize the necessity of normal everyday pain perception for survival. In this respect, Paul Brand's experience with leprosy patients is highly revealing [5]. He describes the severe bodily damage that patients lacking nociceptors can exhibit, which results in infections, crippling skin and bone degenerations and, if not properly treated, to eventual death from massive tissue damage. Therefore, acute pain is the sensory system designed to protect the organism from physical assaults. In contrast, chronic pain is a pathologic state of the nervous system that does not seem to have any survival benefits. From this point of view, there are no significant differences between acute somatic and visceral pain, because they both serve the same protective function to different portions of the body. Because the site of insult is different between the two pain types, the bodily reaction to somatic versus visceral pain is different. For example, when skin of a hand is burned, it is of interest to remove that hand as quickly as possible from the heat source. So, in the case of somatic tissue damage, sophisticated motor control is an essential part of this protective mechanism. In the case of the viscera, because under normal circumstances an internal organ will not encounter a stimulus that can cause, for example, burning of the mucosa, it is evolutionarily reasonable for such a stimulus not to cause pain. In contrast, distending the wall of an internal organ or cramps leading to ischemia are perceived as painful and can

cause reactions such as vomiting to get rid of the source of the problem. In addition, visceral pain often immobilizes a sick individual, forcing rest and healing. Thus, the adequate stimuli and bodily responses to pain of somatic and visceral origin appropriately correspond to the respective environments and proper responses. We argue that the physiologic organization of the somatic and visceral pain systems exhibits properties consistent with their environmental peculiarities.

Our single-unit electrophysiologic studies in the monkey lateral somatosensory thalamus (mainly ventral posterolateral [VPL]) indicate that all visceral organs tested are represented in this region [6]. This representation overlaps with the skin touch representation in a nontopographic or very weakly topographic manner. By the way, this observation, and not any mathematical calculation, led us to hypothesize that the DC pathway mediated visceral inputs to the lateral thalamus. Within VPL, the majority of neurons have somatic innocuous inputs (only 10% of these cells respond to somatic noxious stimuli [3]). In contrast, almost all neurons with visceral inputs show responses to distending the tested organs to noxious intensities. Thus, this region of the thalamus can be regarded as a visceral nociceptive area. Consequently, the lack of visceral topography in VPL is completely consistent with this role, because visceral pain is usually very poorly localized. Moreover, the dual visceral and somatic representation in VPL is also consistent with the referred pains that ensue from visceral pain. The mathematical model we have presented attempts to indicate mechanisms with which the interactions between the overlapping representation may explain referred pain [2]. We have observed a similar visceral nociceptive representation overlapping on innocuous somatic representation in the primary somatosensory cortex of the monkey [9].

As Berkley and Hubscher [4] have emphasized, visceral responsive neurons are now described in many regions of the nervous system. However, simply documenting these response properties has clearly not been a proper approach for identifying the functional roles, or the specific features extracted in each of these areas. The visceral responses in relation to other inputs, and in combination with each other, at the populational level needs to be studied to identify the functional specializations, which undoubtedly exist.

In a recent study, we examined the modulatory interaction between visceral and somatic inputs to VPL [7]. At a populational level, the study indicated that visceral innocuous and noxious inputs depress responses to somatic inputs, thus enhancing the coding of visceral inputs, even though at this populational level the visceral stimuli resulted in no overall increase in the number of spikes. The study was a simple approach in identifying the interactive role of overlapping representations. More thorough studies along these lines are underway in our lab [10].

The authors of the Focus article pose the question "pathways or no pathways?". To clarify this, the authors present two figures, one outlining the visceral input to DC, then to the gracile nucleus, and then to the thalamus. The other figure, taken from Berkley and Hubscher [4], emphasizes the extensive overlap and multiple representations of somatic and visceral inputs in the nervous system. We think neither version provides significant insights into the mechanisms underlying pain perception. First, as Berkley's figure intends to point out, there are a myriad of other pathways, ascending and descending, that transmit visceral information. For the most part, we remain ignorant about their functional specializations. Second, is there any doubt that lesioning a spinal pathway alters central representation and perception and, moreover, results in a cascade of plastic changes that compensates for the lesion in ways yet to be understood? After all, multiple representation of the same sensory input is a universal rule in the nervous system. The discovery of 32 visual cortical areas have greatly increased our understanding of visual information processing, although simply presenting their interconnectivity reveals very little about their functions.

We do not understand where the authors were searching for the "global body surveyor," or how they would identify him/her. As Ashby [1] pointed out years ago, the primary role of the scientist is to identify the few essential parameters to control and study in the infinite variables that make up any system under study. Thus, the "surveyor" is the scientist who designs the experiments and refuses to succumb to utilitarianism.

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