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The experimental analysis of the interruptive, interfering, and identity-distorting effects of chronic pain

Johan W.S. Vlaeyen [a, b, *], Stephen Morley [c], Geert Crombez [d, e]

[a] Research Group Health Psychology, Faculty of Psychology and Educational Sciences, University of Leuven, KU Leuven, Belgium
[b] Department of Clinical Psychological Science, Maastricht University, The Netherlands
[c] Leeds Institute of Health Sciences, University of Leeds, Leeds, United Kingdom
[d] Department of Experimental-Clinical and Health Psychology, Faculty of Psychology and Educational Sciences, Ghent University, Belgium
[e] Centre for Pain Research, University of Bath, United Kingdom

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ABSTRACT

Pain is an unpleasant sensory and emotional experience urging the individual to take action to restore the integrity of the body. The transition from a common episode of acute pain to a state of intermittent or chronic pain has been a constant preoccupation of researchers and clinicians alike. In this review, we approach chronic pain from a modern learning perspective that incorporates cognitive, affective, behavioral and motivational aspects. We view pain as a biologically hard-wired signal of bodily harm that competes with other demands in the person's environment. The basic tenet is that pain urges people to interrupt ongoing activity, elicits protective responses that paradoxically increase interference with daily activities, and compromises the sense of self. Here we briefly summarize existing evidence showing how pain captures attention, and how attention for pain can be controlled. We also consider pain as a strong motivator for learning, and review the recent evidence on the acquisition and generalization of pain-related fear and avoidance behavior, which are likely to interfere with daily life activities. We highlight the paradoxical effects of pain avoidance behavior, and review treatment effects of exposure in vivo. A generally neglected area of research is the detrimental consequences of repeated interference by pain with daily activities on one's sense of "self". We end this review with a plea for the implementation of single-case experimental designs as a means to help customize and develop novel cognitive-behavioral treatments for individuals for chronic pain aimed at reducing the suffering of this large group of individuals.

1. Introduction

Pain is a biologically relevant and vital signal of bodily threat, urging the individual to protect him/herself. Immediate protective responses to acute pain include increased arousal, orientation to the sources of threat, and various safety-seeking behaviors including escape and avoidance. Acute pain usually disappears within days or weeks, but in some individuals, pain persists despite the alleged healing of the initial injury. The transition from a common episode of acute pain to a state of intermittent or chronic pain has been a constant preoccupation of researchers and clinicians alike. Despite the difficulty to provide precise estimates of prevalence and incidence, the burden of chronic pain is unquestionably large, both in youth as in adults. For example, a survey in 400,000 children and adolescents aged 11–15 years reported the 1-month prevalence of low back pain to be no less than 37.0% (Swain et al., 2014). In adults, the median prevalence of chronic low back pain, which is back pain that lasts for at least 12 weeks lies between 5.6 and 18.1% (Henschke, Kamper, & Maher, 2015). Pain problems have been viewed as complex, multidimensional developmental processes where various biological, psychological and social factors are considered of utmost importance (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). However, it has been difficult to specifically spell-out the mechanisms by which pain acute problems become chronic. In this invited review, we will approach this question from a modern learning perspective in which attention, memory, behavior, and individual goals take a prominent place. We start from the idea that pain has an inherent interruptive function, and that the extent to

* Corresponding author. Research Group Health Psychology, University of Leuven, Tiensestraat 102, Box 3726, 3000 Leuven, Belgium.
E-mail address: johannes.vlaeyen@kuleuven.be (J.W.S. Vlaeyen).

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which pain interrupts depends on the threat value as well as the environmental demands. Pain interrupts individuals to prepare for escape and avoidance of potentially harmful stimuli, which is adaptive. However, the general tenet of our approach is that prolonged protective and recuperative behavior that usually is adaptive in the short term, may in the long term paradoxically maintain the problem through the adverse effects of avoidance and the spreading of these behaviors to an increasing set of situation that share perceptual features with the initial event during the original pain episode. The longer the problem persists, the greater the discrepancy between the actual situation and the valued goals of the individual thereby compromising the sense of "self". In this paper we will review the recent research on the interruptive function of pain, the role of learning and memory in the maintenance of avoidance behavior, and the effects of chronic pain on individual goals and identity.

2. The interruptive function of pain

Pain is a hardwired signal of bodily harm, and is designed to capture attention, and to interrupt ongoing activities (Eccleston & Crombez, 1999; Gatzounis, Schrooten, Crombez, & Vlaeyen, 2014). There is a wealth of experimental studies that demonstrate this automatic function of pain (Berryman et al., 2013; Moore, Keogh, & Eccleston, 2012). In an example of the primary task paradigm, participants perform as quickly as possible an auditory discrimination task in the presence or absence of painful stimuli (Crombez, Eccleston, Baeyens, & Eelen, 1996). Despite the fact that the processing of pain is task irrelevant and not instrumental for immediate escape and avoidance, clear interruptive effects of pain on task performance were found. When a painful stimulus was present, participants were slower in the auditory discrimination task than when pain was absent. Several pain-related variables have been identified that contribute to the interruptive capacity of pain. Evidently, the intensity of pain is a key variable. When pain is intense, it interferes more with the performance on a cognitive task in healthy participants (Van Ryckeghem, Crombez, Eccleston, Legrain, & Van Damme, 2013) and chronic pain patients (Eccleston, 1994). Individuals with chronic pain who report pain of high intensity at the moment of testing, show substantial decrements of performance on a cognitively demanding task in comparison with patients who report pain of low intensity. Research has further indicated that attention is more easily captured when pain is novel (Crombez, Eccleston, Baeyens, & Eelen, 1997; Legrain, Bruyer, Guerit, & Plaghki, 2005), when pain is unpredictable (Crombez, Baeyens, & Eelen, 1994a, 1994b), and when pain is experienced as highly threatening (Crombez, Eccleston, Baeyens, & Eelen, 1998a). All in all, this line of research reveals that pain has a profound capacity to capture attention and to interrupt ongoing activities in order to facilitate escape and avoidance. This interruptive function is not easily relinquished, even when pain proves to be a false alarm, or when pain has become chronic. It may then be no surprise that one of the prominent complaints of patients with chronic pain concerns difficulties concentrating and remembering things (Turk et al., 2008).

2.1. Individual differences

Although the capture of attention by pain is unintentional, the effect is variable and not unconditional. Indeed, experimental studies reveal averaged causal effects, which do not imply that each individual will display the same effect. Furthermore, the careful manipulation of one variable while others are kept constant, does not imply that these other variables are unimportant, and should be ignored. This also is the case with the capture of attention by pain. First, not all participants show the interruptive effect of pain. As yet, we do not fully understand which individual characteristics contribute to the variability of the effect within a particular study. A usual suspect is trait anxiety or neuroticism, which is defined as the predisposition to experience anxiety and distress across situations. Although evidence in the anxiety literature indicates that participants scoring high on trait anxiety are more easily distracted by irrelevant events (Moser, Becker, & Moran, 2012), its role in the capture of attention by pain is largely unsubstantiated. The role of individual differences in catastrophic thinking about pain is better documented (Crombez, Eccleston, Baeyens, & Eelen, 1998b). When threatening information about an impending pain stimulus is provided, those who report catastrophic thoughts about pain, show a pronounced attentional capture by pain. This effect remains even after controlling for the effect of trait anxiety (Crombez, Eccleston, Van den Broeck, Van Houdenhove, & Goubert, 2002). Second, the attentional capture by pain is conditional upon the presence of other, contextual variables. These non-pain related variables may profoundly affect the interruptive function of pain. Well-known is the example provided by Henry Beecher, a surgeon active during the World War II, who observed that soldiers leaving the battlefield, did not report pain despite the presence of severe wounds. Later studies, most often using non-human animals, revealed that stress may activate brain mechanisms that dampen or even inhibit pain (Bodnar, Kelly, Brutus, & Glusman, 1980), hence overruling the capacity of pain to capture attention. More mundane -at least for an experimental psychologist-, is the following unpublished observation. Whilst piloting and developing the primary task paradigm, we quickly found out that instructions did matter. When participants were informed that we were interested in the study of the interruptive effect of pain, the effect was masked. It turned out that participants were compensating an expected task decrement by increasing their effort to overcome the decrement. It may well be that such compensatory strategy has also downsized the interruptive effects of pain on task performance in our published studies. In line with this argument, participants reported to have put substantial effort to perform the task in the presence of pain, and to be eager not to be distracted by pain (Crombez et al., 1996, 1997).

2.2. Controlling attention for pain

An interesting question is then how and when the capacity of pain to capture attention can be controlled. Answers to this question may inform us about which tasks or techniques are to be learned by patients to better live with chronic pain. These questions have mainly been addressed in distraction research, which investigates how and when directing attention away from pain affects pain. This research has a long pedigree, but results are not consistent in healthy volunteers as well as in patients with chronic pain (Snijders, Ramsey, Koerselman, & van Gijn, 2010). Based upon the disappointing results of an earlier study (McCaul, Monson, & Maki, 1992), Leventhal provocatively stated in an accompanying editorial "*I know distraction works even though it doesn't!*" (p. 209) (Leventhal, 1992). We do not want to go as far in our conclusion as Leventhal does. There is abundant evidence that directing attention away from pain is effective (Legrain, Crombez, Plaghki, & Mouraux, 2013). What is puzzling is the difficulty to find out why, when and for whom distraction from pain works. Research has often manipulated "cold", cognitive characteristics of the task, such as task difficulty and complexity (McCaul et al., 1992). The basic idea is that when individuals use their processing capacity for the performance of an ongoing task, there is no processing capacity left for processing pain. This idea may be overly simplistic, and relying too much on the metaphor that humans process information just as a