How Does Distraction Work in the Management of Pain?

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Engaging in thoughts or activities that distract attention from pain is one of the most commonly used and highly endorsed strategies for controlling pain. The process of distraction appears to involve competition for attention between a highly salient sensation (pain) and consciously directed focus on some other information processing activity. In this article, the evidence for distraction from pain is examined and the qualities of pain, the distractor, and some individual difference variables that have been shown influence the effectiveness of distraction are described. There has been little examination of the use of distraction in chronic pain, but some ancillary evidence suggests that it should be used with caution.

Introduction

Our understanding about attention was defined by some of the earliest theorists in psychology. They observed that from moment to moment, we are recipient of more sensory input than we are able to consciously process; therefore, there must be a filtering process somewhere in the information processing system that allows some information to reach conscious attention and suppresses other input [1,2]. This implies enhancement of some signals somewhere in the nervous system, inhibition of others, or both. In the case of distraction from pain, recent imaging studies have provided considerable insight into this process and are discussed in more detail in this article.

In addition, theorists noted that attention could be endogenous, voluntary, and able to be consciously directed to allow continuity of attentional engagement and facilitate purposeful and coherent goal-directed activity. Attention also could be exogenous and able to be captured by highly salient stimuli to allow interruption of ongoing activity, which allows for management of demands important to the safety of the organism [2,3]. A further contribution from theory to our understanding of the process of distraction comes from Nobel laureate, Daniel Kahneman [4], who developed the resource or capacity theory, which proposes the concept of a limited pool of information processing resources and that using capacity for one activity limits their availability for another activity. Therefore, engaging in an attention-occupying activity limits the attention available and prevents other information from being processed and accessing consciousness. One of the main criticisms of the capacity theory is that there is inconsistent evidence regarding the extent to which the level of demand of one task affects performance on a secondary task [5,6]. This led to the development of the multiple-resource theory, which proposes that there are separate resource pools of information-processing capacity. These resource dimensions are in addition to obvious anatomic limitations that prevent one from looking in two directions at once or simultaneously pressing two spaced buttons with the same finger. The multiple-resource theory suggests that the extent to which two competing activities use the same pool of resources will dictate the extent to which they interfere with or preclude the processing of each other [6,7]. Thus, the more similar two information-processing activities are, the more likely they are to compete for the same resources and interfere with each other's performance.

One may see distraction from pain as a competition between exogenous and endogenous information processing. Perception of a highly salient stimulus (pain) is suppressed by consciously focused attention to a non-pain stimulus or stimuli. Therefore, it seems likely that the efficacy of distraction will be affected by qualities of the distractor, the qualities of the pain experience being suppressed, and factors related to individual differences.

What Makes an Effective Distractor?

As children, we were distracted from pain and as parents, we have used distraction to help our children cope with pain and distress. It is no wonder why we continue to endorse distraction as a coping strategy for pain, although some of the evidence discussed is equivocal regarding its efficacy [8]. However, there is enough clear evidence from a number of studies to conclude that distraction is able to reduce the pain experience. Most of the evidence for the effectiveness of distraction is drawn from studies using experimental pain or from studies of acute pain such as dental pain, childbirth, and procedural pain. There is little evidence from studies investigating distraction in patients with chronic pain.

The evidence regarding the efficacy of different types of distractors is marred by the enormous variation in the methodology of studies. Experimental pain studies have used a large number of different pain stimuli, some of which are more analogous to clinical pain, such as cold pressor and thermal stimulation; however, other stimuli such as electric shock are less similar. These studies also have looked at several different measures of pain as dependent variables. Pain threshold and pain tolerance are popular, but pain-related distress, visual analogue ratings of pain sensation and pain affect, and physiologic measures such as heart rate also have been measured. Studies investigating distraction in clinical pain generally have used pain reports as an outcome. However, many different distractors and of course a variety of painful conditions and circumstances have been investigated.

Experimental investigation of distraction is challenged additionally by the inherent paradox of asking participants not to attend to pain and then presumably focus attention on their pain to provide a pain report. This paradox is particularly pertinent when the measures used require a judgment about when a sensation first becomes painful (pain threshold) or when a pain sensation becomes intolerable (pain tolerance). The many methodologic variations between studies and the problem of measuring pain without focusing attention on it have made the comparisons between distractors used across studies quite difficult.

An early narrative review focused mainly on whether distraction worked at all and, on the basis of the capacity theory, argued that distractors that required more attentional capacity would be more effective. The review suggested that distraction reduced pain; however, because of the uncertain capacity requirements of the various distractors compared, McCaul and Mallott [9] could only conclude that the findings were consistent with the capacity argument. A more sophisticated attempt to integrate numerous studies of distraction was carried out by Fernandez and Turk [10], who conducted a meta-analytic review of the efficacy of cognitive strategies. The conclusion was that cognitive strategies significantly reduced measures of pain in 85% of the 47 studies included. Distraction strategies were classified into pleasant imaginings, rhythmic cognitive activities, external focus of attention, and neutral imaginings. Breathing activity and behavioral activity were not included because the focus was on cognitive activities. Of the strategies investigated, neutral and pleasant imaginings and external focus of attention techniques were the most effective, but there were no significant differences between strategy classes [10].

As mentioned previously, the capacity theory argues that a distractor that maximizes attentional demand will be the most effective, suggesting that distraction tasks that are more difficult and require more attentional capacity should work best. However, several studies that have specifically investigated different levels of capacity requirements have not found greater pain relief with more demanding distractors [11,12]; in one case, despite clearly demanding distraction tasks, no beneficial effects of distraction could be found at all [12]. Support for capacity theory predictions in other information-processing domains also has been inconsistent, giving rise to multiple resource theory [6]. An investigation based on the multiple resource theory, which compared the analgesic effects of two equally difficult sensory detection distraction tasks, found no difference between a somatic detection and a visual detection task, although somatic detection was argued to use more resources that were similar to pain. However, both detection tasks reduced pain threshold more than an imagery distractor, perhaps because of the response requirement of the detection distractors [13].

Studies that have examined the effect of attentional demand of distraction in order to quantify demand often have used mental processing tasks that, at their most demanding, are likely quite stressful. That stressfulness may impact the pain experience. Furthermore, engaging in distraction when in pain generally includes more than attentional competition. Popular distractors such as watching videos, listening to music, and pleasant imagery also may alter anxiety, arousal, and mood, all of which have been demonstrated to influence the pain experience.

On the other hand, there is clear evidence that the analgesic effects of attention and anxiety and mood reduction are separable and can be manipulated independently [14,15,16•], suggesting an independent attention effect. For example, Villemure *et al.* [15] used pleasant and unpleasant odors to manipulate emotion while shifting attention between odor and pain. In this study, emotional changes altered the pain affect while attentional manipulations appeared to vary pain sensation.

Emotional change resulting from the distraction activity chosen may have additional impact in clinical settings. The usefulness of distraction clearly is influenced by the willingness of the pain sufferer to use it and maintain engagement with it. In contrast to experimental studies in which the cooperative volunteer will attempt to comply with the experimenter's request and the time scale generally is relatively brief, in clinical settings, the patient is attempting to commence and maintain attention on the distractor independently. As mentioned previously, distraction has the advantage of high acceptability among pain sufferers. If the distractor additionally improves mood or reduces anxiety, it will be more rewarding to use, potentially more engaging, and absorbing and adherence should be improved.

Individual differences in interests and abilities may determine the best distractor for an individual. For example, asking a pain sufferer with a history of failure at mathematics to engage in mental arithmetic as a distractor is unlikely to be a successful ploy, in contrast to the individual who does math puzzles as a hobby. Thus, from a clinical perspective, the specific manner of operation of a distractor may be less important than the fact that it works to assist the pain sufferer. A distractor that is able to alter mood, anxiety, and arousal and effectively engage attention is likely to be most useful and individual differences such as those mentioned previously suggest that canvassing and trying various options with a patient will be most successful. Morley *et al.* [17•,18] have developed and reported on a comprehensive manual for training attention management for chronic pain that describes procedures for accomplishing this. Although this manual was designed for chronic pain, the techniques discussed also will be valuable for patients who experience acute, episodic, and procedural pain.

Nervous System Mechanisms of Distraction Analgesia

In one of the earliest studies to indicate that distraction may suppress nervous system activity associated with pain, reduced activity occurred in neurons in the medullary dorsal horn that respond to noxious heat when water-deprived monkeys were engaged in a discrimination task in which a light signaled response-contingent water availability [19]. The involvement of the endogenous opioids in distraction was first suggested by a study that showed analgesia occurring to a lesser extent in a group of participants who were pre-administered the opioid antagonist naloxone, compared with a group administered saline when they used cognitive coping strategies that included distraction [20].

Imaging studies recently have cast considerable light on central processing of pain information. We know there are particular cortical and subcortical areas associated with pain processing, including parts of the thalamus, the primary sensory cortex (S1), the insular cortex, and the anterior cingulate cortex (ACC) [21]. Furthermore, there is evidence that aspects of painful experiences are processed in slightly different brain areas. The sensory aspect of pain is reflected particularly in activity in S1, while some pain responsive areas of the ACC appear to respond to a greater extent to the affective dimension of pain [22–24]. Activation occurs in the ACC during an attentionally demanding task in the absence of pain, suggesting that parts of the ACC have a more general role in allocation of attention [25].

Studies of distraction using functional imaging techniques have shown that distraction-induced reductions in pain perception are accompanied by reduced activity in a number of the areas that typically show increased responding during painful stimulation, including the thalamus, S1, insula, and the midcingulate region of the ACC, which appears to be responsive to pain affect and attention. Distraction also produces increased activation in the orbitofrontal cortex and in the perigenual cingulate cortex. The former is an area that has reduced activity when pain is higher and the latter is a region that is inhibited by activity in the midcingulate [26]. However, changes in activation in pain-responsive brain areas may depend on the response strategy used for the distractor task. A recent imaging study found that performance on a distraction task was improved for some participants, while others' performance deteriorated during painful stimulation. The group whose performance improved showed reduced activation in pain-responsive areas similar to those already mentioned, although those whose performance deteriorated showed no alterations [27]. Further examination has shown that distraction produces activation in the periaqueductal grey, which is shown in Figure 1A. This activation is increased significantly when participants are instructed not to attend to the painful stimulus compared with attending to it (Fig.1B) [28]. This is an area associated with fiber tracts that when stimulated, produce analgesia and are thought to be associated with descending inhibitory control, which was described by Melzack and Wall [29] in their Gate Control Theory.

A preliminary summary of these data may suggest the possibility that distraction produces activation in the orbitofrontal cortex and areas of the ACC that trigger an endogenous opioid-mediated pain inhibition that involves descending inhibitory control through the periaqueductal gray. This reduction of activity then is reflected in diminished activity in pain-activated cortical and subcortical areas.

Pain as a Distractor

Based on a cogent argument that the function of pain is to interrupt and attract attention over other demands to deal with the threats to the organism that pain often signals, Eccleston and Crombez [30••] have investigated the qualities of pain and pain sufferers that make pain most likely to interrupt ongoing activity. The typical research design used in these studies measures the extent to which different aspects of painful stimulation, experimental in some studies or levels of chronic pain in others, impact the performance of an ongoing experimental task. The effects of different participant qualities and beliefs on performance also have been examined.

As may be expected, the severity of pain increases the impact on other activity [31]. Disruption of performance occurs more at the onset of pain [32]; temporal unpredictability [33] and novelty of pain [34] also reduce performance. Pain, the expectation of pain, and the threat of intense pain also disturb the performance of other behaviors [35].

In addition to these pain qualities, certain qualities of the individual also are associated with pain's capacity to disrupt other activity. Pain patients, pain-free participants who are highly fearful of pain and those who participate in more catastrophic thinking about pain [36–39], and chronic pain patients who are more somatically aware [40] are more vigilant to pain and are readily disrupted in their ongoing activity by pain.

Summarizing these various qualities, it appears that pain has its greatest impact on other activity and its greatest capacity to interrupt is when it is surprising or threatening. Furthermore, individuals who think catastrophically about pain struggle to disengage from pain and shift to other tasks [41]. These findings are of particular interest

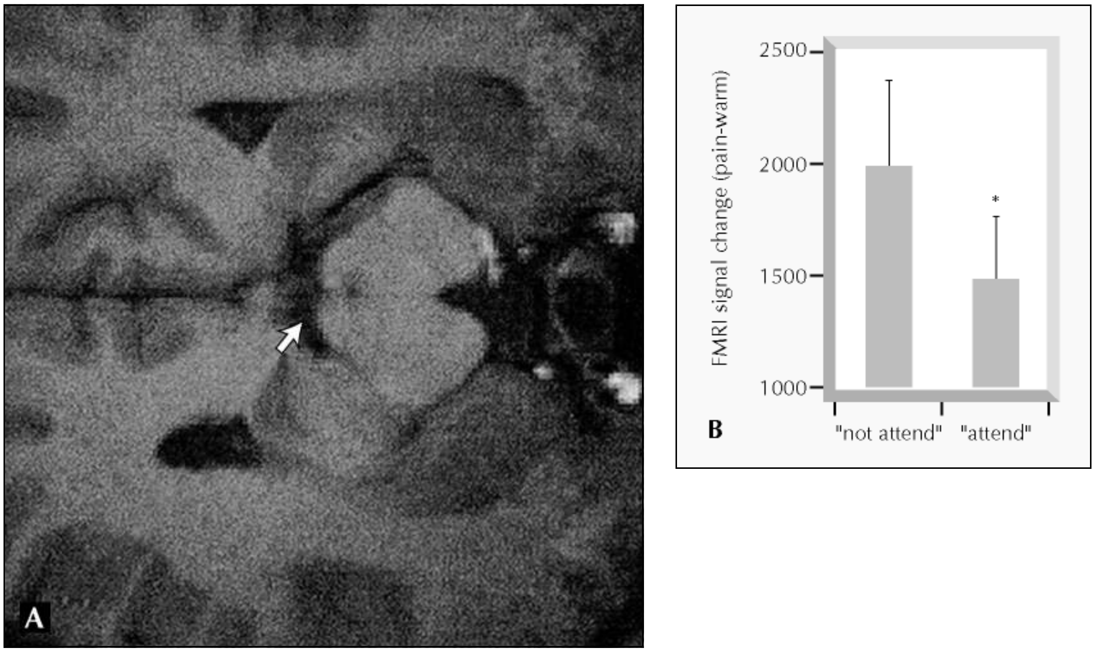

Figure 1. A, The area (arrow) within the periaqueductal gray where activation is altered by instructions to attend to or away from a painful hot stimulus for one participant. **B,** Total signal intensity (arbitrary units) within the periaqueductal gray for the two attentional conditions (mean, -SE; *$P < 0.05$). (*Data adapted from* Tracey *et al.* [28] *with permission*.)

because they may explain why distraction has not been shown to have an impact on pain in some studies.

The Challenge of Chronic Pain

There is a large body of literature that argues that catastrophic thinking and pain-related fear are related to pain severity and pain-related disability. Pain sufferers who tend to ruminate about pain or perceive pain to be a serious risk to their well-being tend to report pain as more severe, experience more distress, and be more disabled [42,43]. The models that have been developed that incorporate catastrophizing and fear of pain suggest that individuals who tend to catastrophize about and fear pain also tend to be hypervigilant for pain sensations; consequently, their attention is interrupted more easily by pain [44]. For this reason, distraction strategies are less likely to be used effectively by such individuals unless their fear of pain and their catastrophic thinking is addressed. Therefore, it can be argued that for such individuals, distraction is best managed within the context of a program that deals with such apprehension and beliefs, such as a cognitive behavioral treatment program [17•].

There is little information about the effectiveness of using distraction in chronic pain. One early study showed beneficial effects of distraction, but the distraction intervention was confounded with other interventions [45]. Distraction has been shown to allow patients with chronic low back pain to engage in a pain-producing activity for longer, although the same distractor did not increase their tolerance for cold-pressor pain [46]. Evidence of a different kind that has bearing on the value of distraction in chronic pain comes from studies investigating strategies for coping with chronic pain by assessing the pain-coping responses of chronic pain sufferers and correlating them with measures of adjustment [47]. Distraction is a coping skill used commonly by patients with chronic pain. However, the use of the technique for managing chronic pain is questionable. There are suggestions that chronic pain patients who use distraction as a coping strategy experience more intense pain. For example, chronic pain patients who score higher on a factor of Rosenstiel and Keefe's Coping Strategy Questionnaire, which assesses the use of diverting attention and hoping and praying as coping skills, tend to have higher pain on average [48,49]. This does not seem to be attributable to the praying and hoping component of the factor, as higher-rated pain has been associated specifically with the diverting attention score [50]. This relationship may result from the cross-sectional nature of the studies, with more severe pain sufferers more likely to use distraction. Alternatively, there are a number of reasons that distraction may be unhelpful. Distraction tasks that demand sufficient attention to impact on pain are effortful and fatiguing. This fatigue may impair ability to engage in other behaviors that are helpful for pain sufferers. In addition, attempting to suppress experimental pain appears to be counterproductive, slowing recovery from cold-pressor pain [51]. Because distraction is effective in the short term, it may be unhelpful subsequently. For example, the individual who uses distraction may turn off warning signals and, without this feedback, exacerbate their injury, causing maintained or increased pain [46]. Clinical observations

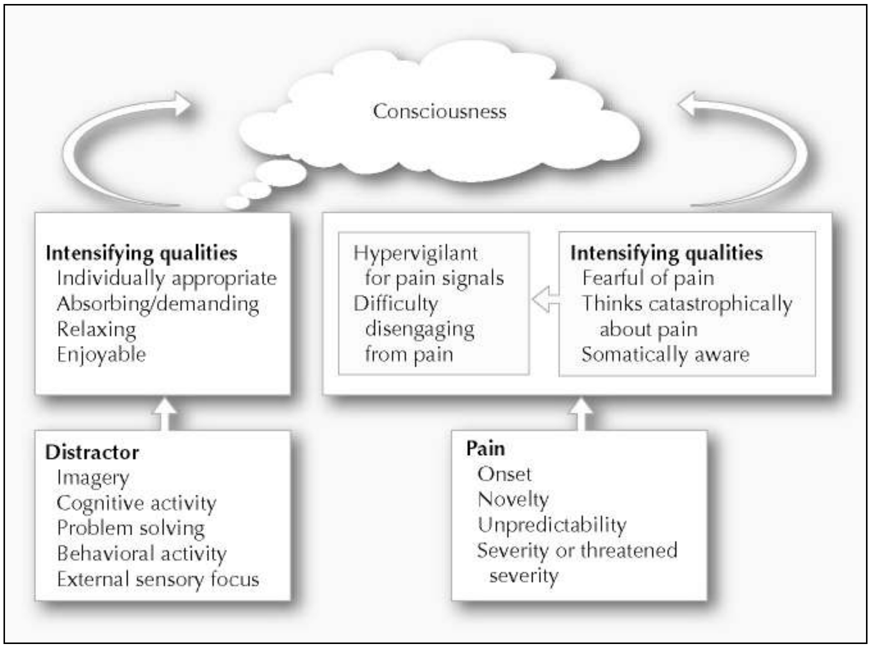

Figure 2. Representation of types of distractor, the variables that appear likely to maximize their effectiveness, and the variables that make pain more salient and more difficult to distract from.

certainly suggest that some patients with chronic pain report continuance of enjoyable activities, unaware of their pain, and then suffer increased pain subsequently.

In a recent examination of distraction on chronic pain, patients carried out a standard pain-producing activity with and without distraction. Distraction did not reduce pain during the activity, but participants reported increased pain immediately after the distraction trial [52]. Because the activity was constant across distracting and nondistracting conditions, the increase in pain cannot be explained by increases in activity; there must be some other explanation such as fatigue or rebound following suppression. Because the design of the study precluded extended follow-up, it is uncertain whether the pain increase persisted.

Conclusions

It is apparent that attention voluntarily directed away from pain has the capacity to reduce the pain experience and increase pain tolerance, which is reflected in altered responding in some pain-responsive brain regions. On the other hand, one of the functions of pain is to interrupt other activities to allow the organism to ensure its safety, which is reflected in interference by pain with ongoing cognitive activity. Figure 2 shows the variables that appear to influence the competition for access to consciousness between distraction activity and pain. The qualities of pain that increase its interruptive quality appear to be related to how threatening and surprising it is. Inconsistency in the methods for examining distraction means there is little comparative evidence to suggest qualities that may determine the effectiveness of a distractor. However, theory, some data, and common sense indicate that distractors that maximize information processing capacity are enjoyable and not stressful, and will occupy attention and be more likely to be employed.

Fear of pain and catastrophic beliefs about pain increase the threat value of pain, causing sufferers to be vigilant to pain sensations and struggle to disengage their attention from pain. For individuals high in these qualities, distraction is unlikely to be an effective strategy, at least without preliminary therapy to modify these characteristics.

Using distraction with chronic pain sufferers presents special issues. Although there is a small amount of evidence that indicates distraction can be effective, there also are ancillary indications that distraction may be unhelpful and even counterproductive, arguing for caution in its use.

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