PAIN® 154 (2013) 1840–1845

PAIN®

www.elsevier.com/locate/pain

Headache impairs attentional performance

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

ARTICLE INFO

Article history:
Received 23 February 2013
Received in revised form 24 May 2013
Accepted 3 June 2013

Keywords:
Attention
Headache
Pain
Executive function
Cognition

ABSTRACT

Attentional disruption has been demonstrated using laboratory-induced pain, but has not been reliably established in everyday pain conditions. This study is the first to examine the effect of everyday acute headache on attention. Seventy-five frequent headache sufferers completed a flanker task, n-back task, attentional switching task, and dual task. Participants completed this battery of tasks twice: once when experiencing an episode of tension-type headache, and once when pain free. Headache impaired performance on the n-back task, retarded general responding on the flanker task, and produced more errors on the attentional switching task. Headache did not, however, alter performance on the dual task, or the size of the attentional switching effect or result in a flanker effect. It must therefore be emphasised that headache pain appears to impair general task performance, irrespective of task complexity, rather than specific attentional mechanisms. Headache pain has an effect on the core cognitive components necessary for the successful completion of tasks, and in particular those involving the updating of the cognitive system.

1. Introduction

Pain functions to interrupt current concerns and to prioritize the avoidance of threat and potential harm [9]. Repeated interruption, however, is a maladaptive and frustrating feature of many chronic pain states, including headache. Attentional mechanisms have been implicated in current theories of the development and maintenance of chronic pain [6,12]. This field has been dominated by the primary task paradigm in which a sudden-onset pain interrupts participants' ability to make a simple stimulus discrimination task [5,7,24]. However, these studies have not considered the effect of pain on a broader range of attentional tasks.

Characteristics of the person, pain, and context are thought to influence the extent of attentional disruption. In particular, top-down motivational characteristics (eg, threat) and bottom-up stimulus characteristics (eg, intensity) have shown effects [12]. For example, when performing a Stroop-like task, chronic pain patients who describe their pain as low intensity cannot be distinguished from controls. However, pain described as high intensity resulted in significant performance impairment [8].

Research examining these processes in acute pain is at an early stage. Using laboratory-induced thermal pain, we investigated 7 different forms of attentional function. Pain was found to affect complex attentional functions, but not simpler ones [14]. These effects have been shown to be relatively stable and reproducible [15], and for some tasks have been shown by other groups [2,12]. Studies using laboratory-induced pain models have been helpful to our understanding of the interruptive effect of pain on attention. However, the implications of these findings are limited by the artificial nature of experimental pain stimuli: pain outside of the laboratory is described as having different sensory qualities and greater emotional and motivational significance [10]. The next phase of this research is to examine the effects of noninduced pain models on cognitive performance.

Experimental studies of acute noninduced pain are rare, but valuable [8]. Headache is a highly prevalent pain complaint [20,21,23] with clear diagnostic criteria. These factors make headache an excellent model to examine pain's effect on cognition. Surprisingly, there is only a small amount of literature examining cognitive performance during painful headache episodes [11,22]. For example, Kuhajda et al. [11] recruited participants with chronic migraine and tension-type headache, and examined memory encoding and retrieval during headache pain or when pain free. They found that headache selectively affected the recall but not encoding of information.

We are unaware of any study that has systematically examined the effects of headache on attentional performance. Therefore, the current study was designed to extend previous research [14,15], and use the same cognitive tasks to investigate attentional disruption by headache. Measures of attention span, attentional switching, and divided attention were used, which were supplemented with a selective attention task. We also examined the moderating role of headache pain intensity on task performance. It was

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0304-3959/$36.00
http://dx.doi.org/10.1016/j.pain.2013.06.006

predicted that when experiencing headache, participants would show greater decrements in speed and/or accuracy on the core tasks, and that these effects would be larger in individuals experiencing higher-intensity pain.

2. Methods

2.1. Participants

Participants who identified as frequent tension-type headache sufferers were recruited from the University of Bath staff and student population. Participants were tested on 2 counter-balanced occasions: once when they reported having a tension-type headache, and once when pain free. Typical and current headache was assessed using the criteria for tension-type headache of the Headache Classification Committee of the International Headache Society (1988) [17].

A total of 114 participants (25 male) were initially recruited into the study with a mean age of 25.09 (SD 8.77) years. Of these, 1 participant reported to the laboratory with a headache during the research but was unreachable for their nonpain trial; 22 participants completed nonpain trials but did not report any headache during the duration of the study; and 16 enrolled in the study, were assigned to the headache first condition, but reported no headache and therefore completed no cognitive testing. This left 75 participants (52 female) who completed both phases of testing; this sub-sample had a mean age of 24.87 (SD 8.74) years. Of the 75 participants who completed the study, 35 completed the nonheadache condition first, and 40 completed the headache condition first. All participants reported that they had no existing chronic pain condition, and were not taking analgesic medication. Thirteen participants reported having had their headache for less than an hour, 53 more <12 hours but more than an hour, and 8 for longer than 12 hours, with 70 of the participants reporting headache once a week or once a month. When participants reported for testing in their headache testing session, some participants reported additional symptoms from those typically associated with tension-type headache. Only 8 participants reported a headache with any qualities other than the pressing/tightening sensations associated with tension-type headache. Seventeen participants said their headache worsened with exercise, 6 said they had some nausea, 22 had some sensitivity to light, and 24 had sensitivity to sound. No participant reported having more than 2 of these additional symptoms, and only 14 participants reported having 2 (10 of which were reported as concurrent sensitivity to light and sound). Participants were paid a modest sum of money for participation.

2.2. Attentional task battery

The attentional tasks used in the current study closely resembled those used in previous pain studies, which are described in detail elsewhere [14,15]. The tasks were designed and controlled using E-Prime II professional software (Psychology Software Tools Inc., Sharpsburg, PA, USA) [18]. Stimuli were presented on an Iiyama ProLite B1902S TFT monitor (Iiyama International B.V., Hoofddorp, The Netherlands), which was powered by a Viglen genie desktop computer (Viglen Ltd, St. Albans, Hertfordshire, UK) with a 3-GHz Pentium Intel Core 2 duo processor (Intel, Santa Clara, CA, USA) and 2Gb of RAM. Responses were made using a PST model 200a serial response box (Psychology Software Tools). A brief description of the tasks used follows.

2.2.1. Flanker task

This task is used as a test of selective attention. Participants were presented with a central fixation cross for 500 ms on a computer monitor. This cross was replaced by a target: either the number "2" or number "4." Participants indicated, by forced choice response, whether a "2" or "4" had been presented. Two flanker conditions were also included, which comprised congruent (flanked with the same stimuli) or incongruent (flanked with the opposing stimuli) distractors. The whole display occupied 3.3° of visual angle. A random interstimulus interval of 500, 1000, or 1500 ms was introduced between trials. A total of 80 trials were presented, 40 of each trial type, with a total duration of approximately 2 minutes.

2.2.2. n-Back task

This is a task of attention span. During this task, participants were presented with a stream of 90 letters, each appearing one at a time on the computer monitor. Each letter was presented for 500 ms, followed by a 1500-ms blank screen. Participants were instructed to report whether the letter currently on screen matched the letter presented 2 letters back. Participants pressed one key if the letter was the same as that presented 2 letters previously, and another if the letter was different from 2 letters previously. There were 30 target stimuli presented and 60 nontarget stimuli randomly distributed through the task, and the task lasted approximately 3 minutes.

2.2.3. Attentional switching task

This task measures attentional switching. Participants were presented with single-digit numbers (1, 2, 3, 4, 6, 7, 8, 9), which occupied .7° of visual angle on the screen. Before seeing each number, participants were presented with a priming screen for 500 ms, which instructed them as to which of 2 tasks to perform. On some trials, participants indicated whether the number was odd or even, whereas on other trials they indicated whether the number was > or <5. For each trial, the task could either remain the same as the one just completed, or randomly switch to the alternative task. Target stimuli were presented to participants until a response was made. A total of 200 trials were presented, with a total duration of approximately 6 minutes.

2.2.4. Divided attention

For the current study, a dual task paradigm was used. Participants were presented with a display for 1 second, which consisted of a number at the centre of the screen and 2 lines that could be either horizontal or vertical in orientation. The central number occupied .7° of visual angle and the lines were presented 14.2° from the centre. Participants were given 2 tasks to perform with equal priority. One task was to respond with a single key press when 3 consecutive odd or even digits were presented. The second task involved responding with the same key when the 2 lines were presented in different orientations (ie, one presented vertically and one horizontally). There were 8 number and 8 line targets per 80 displays, and number and line target were never both presented on the same trial. Participants were presented with a total of 400 displays, and the task lasted approximately 7 minutes.

2.3. Headache screening

A screening tool was administered to assess the manifestation and quality of participants' headaches. Following previous studies [3,16], this measure was based on the criteria of the Headache Classification Committee of the International Headache Society, and included questions about what provoked their headache, as well as its duration, frequency, intensity, and location. Participants were also asked to describe the headache and indicate if it was associated with nausea, sensitivity to light or sound, and if it was exacerbated by exercise. This measure also included a 100-mm visual analogue scale to measure the pain intensity of the headache, similar to that used in tests of over-the-counter