Scandinavian Journal of Pain 16 (2017) 29–35

Contents lists available at ScienceDirect

Scandinavian Journal of Pain

journal homepage: www.ScandinavianJournalPain.com

Original experimental

The disruptive effects of pain on multitasking in a virtual errands task

David J. Moore[a,b,*], Anna S. Law[a,b]

[a] Liverpool John Moores University, UK
[b] Research Centre for Brain and Behaviour, Liverpool John Moores University, UK

HIGHLIGHTS

- The Edinburgh Virtual Errands Test was completed with concurrent thermal pain.
- Pain affected multitasking for those reporting greater daily cognitive pain intrusion.
- More errors were made in pain on a virtual errands task e.g. entering incorrect rooms.
- Other aspects, including number of completed errands were unaffected by pain.

ARTICLE INFO

Article history:
Received 26 August 2016
Received in revised form 7 February 2017
Accepted 21 February 2017

Keywords:
Pain
Inteference
Attention
Memory
Cognition
Multitasking

ABSTRACT

Background and aims: Pain is known to have a disruptive effect on cognitive performance, but prior studies have used highly constrained laboratory tasks that lack ecological validity. In everyday life people are required to complete more complex sets of tasks, prioritising task completion and recalling lists of tasks which need to be completed, and these tasks continue to be attempted during episodes or states of pain. The present study therefore examined the impact of thermal induced pain on a simulated errand task.

Methods: Fifty-five healthy adults (36 female) performed the Edinburgh Virtual Errands Task (EVET) either during a painful thermal sensation or with no concurrent pain. Participants also completed the Experience of Cognitive Intrusion of Pain (ECIP) questionnaire to measure their self-reported cognitive impact of pain in general life.

Results: Participants who completed the EVET task in pain and who self-reported high intrusion of pain made significantly more errors than those who reported lower intrusion on the ECIP.

Conclusions: Findings here support the growing literature that suggests that pain has a significant impact on cognitive performance. Furthermore, these findings support the developing literature suggesting that this relationship is complex when considering real world cognition, and that self-report on the ECIP relates well to performance on a task designed to reflect the complexities of everyday living.

Implications: If extrapolated to chronic pain populations, these data suggest that pain during complex multitasking performance may have a significant impact on the number of errors made. For people highly vulnerable to cognitive intrusion by pain, this may result in errors such as selecting the wrong location or item to perform tasks, or forgetting to perform these tasks at the correct time. If these findings are shown to extend to chronic pain populations then occupational support to manage complex task performance, using for example diaries/electronic reminders, may help to improve everyday abilities.

1. Introduction

Pain functions to promote behavioural analgesia by interrupting current concerns and warn of potential danger [1]. This interruption can become disabling and chronic pain patients report cognitive problems, adding to the difficulties they face with the activities of daily living. Research has explored the nature of pain-related cognitive deficits in both chronic pain [2], and using experimentally-induced pain with healthy participants [3–6]. Meta-analyses have shown that the effects of chronic pain are greatest for complex memory, attention, and executive function tasks [7–9] which is supported by findings using experimental

* Corresponding author at: Research Centre for Brain and Behaviour, Liverpool John Moores University, Liverpool L3 3AF, UK.
E-mail address: D.J.Moore@ljmu.ac.uk (D.J. Moore).

http://dx.doi.org/10.1016/j.sjpain.2017.02.006

pain models on tasks ranging from sustained attention to complex dual-task performance [10–12]. However, most of the tasks used so far are artificial and designed to test specific cognitive functions in isolation. In everyday life, patients navigate complex sets of challenges facing multiple competing goals within a limited time (i.e., multitasking) [13]. A range of cognitive functions acting together are required for successful task performance (i.e., cooking or shopping). Therefore, further research is needed with tasks that more closely mimic these demands. A good example is the 'Multiple Errands' methodology [14], where participants are asked to complete a series of errands in either a real or virtual environment. This type of task has been shown to be sensitive to cognitive impairments stemming from acquired brain injury [14–17]. At present a single study has examined the effect of laboratory induced pain on more complex cognitions using the same pain induction technique employed in the present study [18]. Participants performed two tasks; the first involved the preparation of a simulated breakfast where items took different times to 'cook', at the same time as setting the table as many times as possible. In the second, participants tried to generate as many words as they could from two different lists of 7 letters (switching between the lists as often as they liked), participants were then asked to recall how they performed. Findings here were that pain resulted in poorer recall of performance and reduced focus on secondary task demands.

The disruptive effects of pain on performance may be mediated by individual differences in cognitive response to pain. For some, the experience of pain may result in pain-related ruminations, consuming attentional resources, while for others, pain may occupy less cognitive focus [19,20]. A self-report measure, the Experience of Cognitive Intrusion of Pain (ECIP), has been developed to index the extent to which individuals are susceptible to cognitive interruptions by pain [20]. In the present study a virtual version of the multiple errands methodology (the Edinburgh Virtual Errands Test, EVET [21]) was utilised to determine whether experimentally-induced thermal pain would have disruptive effects on performance. It was hypothesised that participants who experienced pain during the task would perform more poorly than those experiencing no pain. Further the sample was segmented into 'low' or 'high' groups on the ECIP measure, leading to the prediction that those in the 'high' group would be particularly strongly affected by pain.

2. Methods

2.1. Participants

Sixty-four adult participants were recruited from the staff and student population of Liverpool John Moores University. Of the 64 participants recruited, data is unavailable for 9 participants. Four participants were unable to successfully remember the errand list before completing the EVET and for a further five participants data is available due to a technical failure of either the cognitive task or the software running the pain paradigm. Of these participants 4 were in the non-pain group and 5 in the pain group. This left a total of 55 participants with data available for the EVET task (36 female), with a mean age of 20.27 years (SD = 4.54). Of these, 28 participants were randomly assigned to a pain condition (18 female) and 27 to a no pain control group (18 female). All participants reported that they were not in pain upon arrival on the day of testing, had no existing chronic pain condition, were not taking analgesic medication, had no skin complaints, heart conditions or skin sensitivity were not currently depressed and had no history of psychiatric conditions. First year undergraduate psychology students participated in exchange for course credit with all other participants receiving a small financial remuneration.

2.2. Pain manipulation

Pain induction was achieved through the use of a Medoc PATHWAY – Advanced Thermal Stimulator (ATS). This equipment is designed for use in clinical and research settings, and induces pain through a metal plate placed on the skin. The temperature is delivered and controlled through specialist hardware and software, designed for experimental purposes. First individual pain thresholds were identified for all participants using a search protocol. The 30 mm × 30 mm thermode was attached to the participant's right ankle. The baseline temperature of the thermode was set at 32 °C and participants altered the temperature using two buttons, one to increase the temperature and one to decrease the temperature. Participants were asked to increase the temperature to a level which was 'just painful'. This was then monitored for 15 s and participants were asked again if this was 'just painful', if the participant reported that this level was still 'just painful' then this was taken to be the participant's threshold, if not then participants were asked to adjust the temperature to be 'just painful' and this check was performed again. Participants in the non-pain condition completed the EVET without any painful stimulation.

During cognitive task performance participants in the pain condition completed the EVET task under pain stimulation. This pain stimulation was present only during the 8 min of the main task and all participants completed the learning and training phases pain free. Once an individual thermal pain threshold was identified this was used to personalise a protocol for use during the experimental tasks. Starting from a baseline of 32 °C the temperature increased at a rate of 8 °C/s to 1 °C above each participant's set pain threshold, the temperature then oscillated between 1 °C above and 1 °C below the participant's pain threshold at 8 °C/s for 10 oscillations before returning to the baseline temperature (32 °C) at a rate of 8 °C/s. The duration of each period of pain stimulation varied depending on participants pain threshold however each period of maximal stimulation was approximately 15 s and the break between periods of pain (for the return to baseline and start of another period of 10 oscillations) at the mean pain threshold was approximately 3 s. These various durations to reach threshold also meant participants received different number of total pain episodes (typically approximately 24 episodes during the task). All participants did however spend the majority of the task experiencing a sensation which was subjectively painful to them. This procedure was repeated on a continuous cycle throughout each task. This procedure was used to ensure that participants did not habituate to the painful stimulus.

2.2.1. Edinburgh Virtual Errands Task (EVET)

The EVET was built using Hammer environment editor, part of the software development kit associated with the computer game Half-Life 2, available on the Source games platform (for full description see Logie, Trawley, & Law, 2011).[1] The test takes place within a simulated shopping and office building presented using a standard PC and monitor. Participants navigate through a 4-floor building, taking a first-person perspective, in order to complete a series of errands that they have memorised before beginning the test. Participants control their direction of travel using the mouse and keyboard. There are 8 errands to be executed in 8 min, 3 of which have two steps to them (e.g., pick up a newspaper in G3 and take to desk in S4), two of which have a timed element (e.g., turn on cinema S7 at 5.30 min), and one of which is open-ended rather than discrete (sorting red and blue binders into different piles). A number of dependent measures were yielded:

[1] The EVET and accompanying data extraction utilities are available as a free download from http://www.psy.ed.ac.uk/resgroup/MT/index4.html.