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RESEARCH PAPER

The effect of postsurgical pain on attentional processing in horses

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Abstract

Objective To investigate the effect of postsurgical pain on the performance of horses in a novel object and auditory startle task.

Study design Prospective clinical study.

Animals Twenty horses undergoing different types of surgery and 16 control horses that did not undergo surgery.

Methods The interaction of 36 horses with novel objects and a response to an auditory stimulus were measured at two time points; the day before surgery (T1) and the day after surgery (T2) for surgical horses (G1), and at a similar time interval for control horses (G2). Pain and sedation were measured using simple descriptive scales at the time the tests were carried out. Total time or score attributed to each of the behavioural categories was compared between groups (G1 and G2) for each test and between tests (T1 and T2) for each group.

Results The median (range) time spent interacting with novel objects was reduced in G1 from 58 (6–367) seconds in T1 to 12 (0–495) seconds in T2 ($p = 0.0005$). In G2 the change in interaction time between T1 and T2 was not statistically significant. Median (range) total auditory score was 7 (3–12) and 10 (1–12) in G1 and G2, respectively, at T1, decreasing to 6 (0–10) in G1 after surgery and 9.5 (1–12) in G2 ($p = 0.0003$ and $p = 0.94$, respectively). There was a difference in total auditory score between G1 and G2 at T2 ($p = 0.0169$), with the score being lower in G1 than G2.

Conclusions and clinical relevance Postsurgical pain negatively impacts attention towards novel objects and causes a decreased responsiveness to an auditory startle test. In horses, tasks demanding attention may be useful as a biomarker of pain.

Keywords attention, horse, novel object, pain, surgery.

Introduction

The experience of pain is multidimensional and comprises sensory and affective-motivational elements. The sensory element represents pain intensity and quality, while the affective element encompasses unpleasantness, emotions and cognition. These elements are strongly correlated; in human infants, as pain intensity increases, the more unpleasant it becomes with a greater effect on cognition and emotions (Slater et al. 2008). This has also been demonstrated in rats, whereby pain negatively affected awareness in attention-demanding tasks (Boyette-Davis et al. 2008; Pais-Vieira et al. 2009). Similar studies of pain in humans (Eccleston et al. 1997; Lorenz et al. 1997) provide evidence that pain and cognition are strongly related (Eccleston et al. 1997; Millecamps et al. 2004), and it is widely accepted that attention can modulate pain and *vice versa*. Distraction from pain can result in reduced pain perception (Boyette-Davis et al. 2008), while pain can have a negative effect on attention-demanding tasks (Millecamps et al. 2004; Pais-Vieira et al. 2009). Recent studies (Moore et al. 2013; Keogh et al. 2014) report preliminary findings that common conditions such as acute headache and menstrual pain lead to an overall dampening of attention, which results in decreased task performance. This is of particular interest as altered performance in experimental tasks is a valid alternative to verbal assessment of pain (Jensen and Karoly 1992; Rosenfeld et al. 1993) and attention has been indicated as one of the 'pain-affected complex

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behaviours' by which pain may be judged (Mogil 2009). Attention could therefore be used as an indicator of pain, especially in cases where self-reporting is not possible, for example, in animals or nonverbal human infants.

Unlike in humans, there is currently no 'gold standard' for pain assessment in horses. This is mainly attributed to the difficulties of interspecies communication but also due to the limited knowledge of pain-related behaviours in horses. Horses are stoic by nature, having evolved to mask signs of pain from predators, and are reluctant to show signs of pain that humans are able to recognize (Ashley et al. 2005). Although some generic behavioural responses to pain displayed by horses are a useful aid for pain detection (Molony and Kent 1997), those recovering from surgery are least able to display them (Hansen et al. 1997). Despite this, as in human infants (Büttner and Finke 2000), behavioural and physiological indicators of pain are heavily relied upon to assess pain. There is also evidence to suggest that physiological parameters such as respiration rate and heart rate lack sensitivity for pain (Hansen et al. 1997; Molony and Kent 1997; Büttner and Finke 2000; Price et al. 2003).

Two studies (Price et al. 2003; Ashley et al. 2005) have reported changes in attention-type behaviours (decreased exploratory behaviour, distracted demeanour) in postsurgical horses. However, to our knowledge, the direct effect of acute pain on attention in horses has not been previously investigated. However, very recently the effect of chronic lower back pain on attention to the environment was investigated in horses (Rochais et al. 2016). This study found that lower attentional engagement and the level of back disorders were correlated, suggesting that attentional engagement could become a reliable indicator of chronic pain in horses. The aim of this study was to investigate if postsurgical pain altered attentional processing in horses. We hypothesized that horses recovering from surgery would have a decreased response to test stimuli compared with control horses that were free from pain. If correct, attention tasks may provide insight into affective states and have the potential to be a new biomarker of pain in horses.

Materials and methods

Animals

Thirty-six, healthy (American Society of Anesthesiologist grade I–II) mixed-breed horses were included in the study, which was carried out at the University of Bristol, between August 2013 and March 2014. Twenty horses (three mares, 15 geldings, two stallions) undergoing elective surgery, with minimal or no presurgical pain were included in the 'surgery' group (G1). Sixteen horses (10 mares, six geldings) admitted for nonpainful procedures, such as treadmill evaluation of poor athletic performance, were included in the 'control' group (G2). A power calculation was not carried out prior to the start of the study as there were no preliminary data on which to base such an analysis and data collection was bound by the number of eligible horses that presented to the clinic during the time that the study could be carried out.

All horses were stabled individually in standard stables (4 × 3 m), bedded with cardboard or shavings. A minimum of 3 hours' postadmittance to the clinic was allowed for the horse to acclimatize to the new environment before the first experimental test session (T1) was carried out. All food was removed from G1 horses a minimum of 6 hours prior to surgery. Control horses had full rations of food during the study. The study was approved by the University of Bristol AWERB, and owner or agent consent was obtained prior to inclusion of horses in the study.

Anaesthesia and surgery (G1 horses)

The anaesthetic protocol for G1 was similar for each horse but was not standardized between animals. Preanaesthetic medication comprised 0.03 mg kg^{-1} intravenous (IV) acepromazine (ACP Injection; Elanco, UK) administered at least 30 minutes before induction of anaesthesia. Immediately prior to induction of anaesthesia, further sedation was provided with an alpha 2 adrenergic agonist [romifidine (Sedivet; Boehringer Ingelheim, UK) 80 µg kg^{-1} or detomidine (Domidine; Dechra Veterinary Products, UK) 10 µg kg^{-1}] administered IV. Anaesthesia was induced with a combination of midazolam (30 mg Hypnovel; Roche Products Ltd., UK) and ketamine (2.2 mg kg^{-1} Narketan; Vetoquinol UK Ltd., UK) IV. Following orotracheal or nasotracheal intubation with a suitably sized cuffed endotracheal tube, anaesthesia was maintained with isoflurane (IsoFlo; Zoetis UK Ltd., UK) vapourized in oxygen delivered via a large animal circle system (Tafonius; Vetronic Services and Hallowell EMC). The concentration of isoflurane was adjusted to maintain an adequate depth of anaesthesia for surgery. Respiration was supported with mechanical ventilation. Episodes of inadequate anaesthesia, signalled by gross purposeful movement, were treated

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