

## Heart rate responses to training and handling activities in horses

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A range of handling, riding and husbandry procedures result in signs of behavioural and/or physiological stress in horses. Exposure to stress may be positive or negative depending on the stressor and the cost and outcome of coping. We analysed 23 studies which reported stress responses of horses to three common types of training conditions: foundation training of naïve horses (F,  $n = 9$ ), exposure to novel objects/stimuli or contexts (E,  $n = 7$ ) and retraining/training of experienced horses (T,  $n = 7$ ). Signs of stress system activation in horses undergoing handling or training such as increases in heart rate (HR) and glucocorticoid levels (GC), are commonly viewed as indicative of welfare compromise. However, research in other species suggests that moderate elevations in stress responsive neurotransmitters such as noradrenaline which also increases HR and GC improve learning. This review focussed on reported HR responses. Mean HR for F horses was the highest at  $83.81 \pm 23.73$  bpm with a mean peak of  $113.87 \pm 36.85$  bpm. T horses exhibited mean HRs of  $77.91 \pm 31.76$  bpm and mean peak  $110.18 \pm 27.62$  bpm. E horses exhibited a mean HR of  $71.95 \pm 23.53$  bpm and mean peak of  $83.58 \pm 24.28$  bpm. Further analysis was undertaken on studies that included at least one treatment and a control. All groups resulted in a significant increase in mean heart rate compared to controls ( $87 \pm 5.5$  and  $51 \pm 1.5$  respectively, one-sample  $t = 7.1$ ,  $df = 31$ ,  $P < 0.0001$ ). Pairwise comparisons indicated that the mean heart rate of group E increased significantly more than the mean heart rate of group T (T-test  $t = 3.3$ ,  $df = 24$ ,  $P < 0.01$ ). These results suggest that prior exposure to controllable stress during earlier training in the T group horses may have attenuated their stress responses to the treatment stressor, mirroring the findings of the rodent literature. Uncontrollable stressors from which animals cannot escape are the most detrimental to welfare, whereas controllable stressors which the animal can learn to escape or avoid can be adaptive, leading to enhanced learning and improved stress resilience. Training methods that gain control of horse behaviour may be perceived as controllable or uncontrollable by the horse, depending on how successfully the horse learns to escape or avoid aversive stimuli. The dose effects of stress-related neurotransmitters on equine learning are unknown and further research could identify the levels at which training related increases in stress biochemistry shift from enhancing to impairing learning.

**Lay person message:** Many handling and training activities are stressful for horses. If the stress is uncontrollable, the horse's capacity for learning may be impaired. Research has showed that heart rates of horses undergoing foundation training were higher than those encountering novel stimuli or learning a new behaviour. Experienced horses undergoing further training or exposed to novel stimuli had lower heart rates. This suggests that the experience of controllable stress in previous training helped the experienced horses cope with stress better and confirms the importance of ensuring that training methods allow horses to learn how control their exposure to stress during training.

**Keywords:** learning; stress; heart rate; foundation training; equine; welfare.