

Short report

Investigating attentional processes in depressive-like domestic horses (*Equus caballus*)

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ABSTRACT

Some captive/domestic animals respond to confinement by becoming inactive and unresponsive to external stimuli. Human inactivity is one of the behavioural markers of clinical depression, a mental disorder diagnosed by the co-occurrence of symptoms including deficit in selective attention. Some riding horses display 'withdrawn' states of inactivity and low responsiveness to stimuli that resemble the reduced engagement with their environment of some depressed patients. We hypothesized that 'withdrawn' horses experience a depressive-like state and evaluated their level of attention by confronting them with auditory stimuli. Five novel auditory stimuli were broadcasted to 27 horses, including 12 'withdrawn' horses, for 5 days. The horses' reactions and durations of attention were recorded. Non-withdrawn horses reacted more and their attention lasted longer than that of withdrawn horses on the first day, but their durations of attention decreased over days, but those of withdrawn horses remained stable. These results suggest that the withdrawn horses' selective attention is altered, adding to already evidenced common features between this horses' state and human depression.

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1. Introduction

One of captive/domestic animals' responses to confinement is to become inactive and unresponsive to external stimuli (Fuchs and Flügge, 2002), as reported for many lab/farm species experiencing inappropriate living conditions (e.g. fur-farmed mink; tethered sows; caged dogs, Cronin, 1985). Humans' inactivity is one of the behavioural markers of clinical depression (APA, 2013), a complex heterogeneous mental disorder diagnosed by the co-occurrence of affective, cognitive and behavioural symptoms (APA, 2013). Symptoms include deficits in selective attention (i.e. ability to focus perception on one stimulus while filtering out other simultaneous stimuli, Posner et al., 1980), as evidenced e.g. by slower reactions in an auditory oddball task (Kemp et al., 2010). Most reports of horses' impaired welfare (Burn et al., 2010; Pritchard et al., 2005) or pain (e.g. Ashley et al., 2005; review in Hausberger et al., in press) indicate that some horses are unresponsive to

environmental stimuli. A 'withdrawn' state was recently described more formally (Fureix et al., 2012): during a withdrawn bout, horses remain totally motionless (immobility with no neck, head, and ear movements); displaying a flat-necked posture; wide open, rarely blinking eyes; and backwards-pointing ears. Compared to non-withdrawn horses from the same stable, withdrawn horses react less to human approach and tactile stimulation, and consume less sucrose (Fureix et al., 2015), a sign of anhedonia i.e. loss of interest or pleasure (Willner et al., 1992), which is a core symptom of human clinical depression. We hypothesized that if withdrawn horses were in a depression-like condition their selective attention would be altered (Greimel et al., 2015). Therefore we submitted 12 withdrawn horses and 15 non-withdrawn control horses from the same stable to unfamiliar auditory stimuli.

2. Material and methods

2.1. Ethical note

This study complied with French laws related to animal experimentation and the European directive 86/609/CEE.

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2.2. Subjects

Twenty-seven horses ($N_{\text{mares}} = 6$; $N_{\text{geldings}} = 21$; aged 5–20 years, $\bar{X} \pm \text{SE} = 12.7 \pm 0.9$, 77% French Saddlebred) from the same riding school were observed in June 2012. The horses were kept in 3 m × 3 m individual straw-bedded stalls in a barn, allowing visual contact with conspecifics. Each stall was cleaned every morning, and was equipped with an automatic drinker. Animals were fed hay once a day (13:00 h), and commercial pellets three times a day (07:00 h, 12:00 h, 19:00 h). Groups of 7–8 horses were released (allowing contact) into barren paddocks for two days at the weekend. Horses worked in riding lessons for 6–10 h a week (two rest days). The time each horse spent being withdrawn in its stall was determined using instantaneous scan sampling (Altmann, 1974) every 2 min for 1 h periods, repeated daily at different times of day (from 6:00 a.m. to 9:00 p.m.) over 15 days (average number of total scans per subject: 907 ± 11.14) (Fureix et al., 2015). Twelve of the 27 horses ($N_{\text{mares}} = 3$; $N_{\text{geldings}} = 9$; called withdrawn horses hereafter) displayed the previously described withdrawn state at least once.

2.3. Test settings

Five stimuli, all initially novel for the subjects, were broadcasted within the stable: three vocalizations of different species (baboon, barnacle goose and whale), one vocalization of an unfamiliar conspecific, and one non-biological sound (piano music). Horses were randomly exposed by groups of 4–6 in neighbouring stalls, following Noble et al. (2013), to one of the five auditory stimuli, which differed for each group on a given day (e.g. the 1st test day, the 1st group heard the baboon, the 2nd the whale etc; the 2nd test day the 1st group heard the piano, the 2nd the baboon etc). The loudspeaker (Nagra Kudelski HP monitor[®]) was at equal distances (2 m) from each horse. Stimuli were broadcast for 3 s at 80 db, always between 13:00 h and 14:00 h and for 5 consecutive days. Data collected on the fifth test day were discarded, due to a different (from the other test days) horses' management (i.e. no riding activities). Proportions of non-withdrawn and withdrawn horses were balanced within each group. Observations focused on small groups because we could not isolate subjects, or observe all the 27 horses simultaneously in the barn.

2.4. Behavioural measurements

Tests were videotaped (Sony HDR-XR105[®]) and standard measures of attentional states were extracted from videos using continuous focal sampling (Altmann, 1974). We recorded the presence or absence of reaction (i.e. change in behaviour interrupting the ongoing activity after a broadcast, characterized by any ear, head, neck or whole body movement) to estimate attentional capture. We recorded the total duration of attention (i.e. standing motionless with eyes, ears, head or neck oriented towards the loudspeaker (Waring, 2003)) during the 5 min following a broadcast. Three horses (1 non-withdrawn, 2 withdrawn) were scared by the stimuli on the 1st and 2nd test days (i.e. alarm posture associated with dilated nostrils and snorting and active walking in the box; Kiley-Worthington, 1976; Wolff et al., 1997). As these horses did not show any attention patterns, they were excluded from the analyses, so our analyses included only 24 horses.

2.5. Statistical analyses

Normality and homogeneity of variances were assessed by inspection of residuals and Shapiro–Wilk W tests (Ha and Ha, 2011). Because our data were not normally distributed, we applied

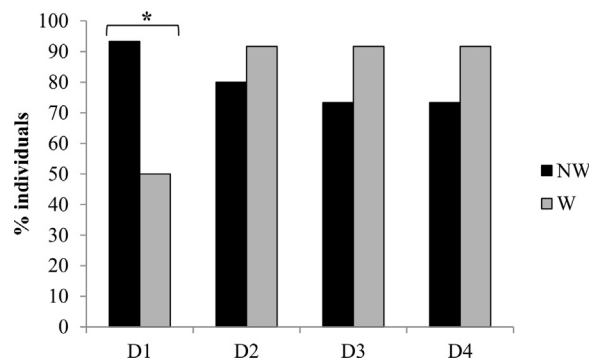


Fig. 1. Proportion of reactive horses towards auditory stimuli in withdrawn (W) and non-withdrawn (NW) horses over 4 test days. (Fisher exact test $*P < 0.05$).

non-parametric statistical tests (Siegel and Castellan, 1988). Fisher's exact and Chi-square tests were used to evaluate the influence of test day on the proportion of reactive versus non-reactive horses. Friedman tests, followed by multiple pairwise comparisons using Wilcoxon signed rank t -tests applying a false discovery rate correction (Benjamini and Hochberg, 2000) were used to evaluate relationships between duration of attention, stimulus type and test day. Kruskal–Wallis tests were used to assess relationships between duration of attention and group observation. Mann–Whitney U -tests (for each test day) compared durations of attention between non-withdrawn (NW) and withdrawn (W) horses, and gelding/mares. Analyses were conducted using R software (accepted two-tailed P level at 0.05). Descriptive statistics are means (\bar{X}) followed by standard errors (SE).

3. Results

Neither sex nor type of stimulus nor observation group influenced reactions and durations of attention significantly (sex: Mann–Whitney U tests, $P > 0.05$; stimuli: Friedman tests, $1.2 < F < 7.2$, $P > 0.05$; group: Kruskal–Wallis tests, $6.8 < H < 10.2$, $P > 0.05$), therefore data were pooled for subsequent analyses.

3.1. First test day

More NW horses (93%) than W horses (50%) reacted (Fisher exact test, $P = 0.02$) (Fig. 1). Reaction times ranged from 0.41 to 4.48 s ($\bar{X} = 1.8 \pm 0.2$ s), but did not differ between NW and W horses (Mann–Whitney U test: $N_{\text{NW}} = 14$, $N_{\text{W}} = 10$, $\bar{X}_{\text{NW}} = 2.0 \pm 0.2$ s, $\bar{X}_{\text{W}} = 1.2 \pm 0.2$ s; $U = 28$, $P = 0.27$).

Durations of attention in reactive horses varied between subjects (from 1.0 to 10.8 s, $\bar{X} = 4.2 \pm 0.7$) and were longer for NW horses than for W horses (Mann–Whitney U test: $N_{\text{NW}} = 14$, $N_{\text{W}} = 10$, $\bar{X}_{\text{NW}} = 5.6 \pm 0.8$ s, $\bar{X}_{\text{W}} = 2.4 \pm 1.1$ s; $U = 38$, $P = 0.01$) (Fig. 2).

3.2. Changes of response to auditory stimuli in relation to time

Although all horses paid attention to the auditory stimuli at least once, patterns of response of W and NW horses differed in relation to time. The proportion of reactive W horses increased significantly on day 2 ($\chi^2 = 10.5$ $P = 0.0002$) and remained high on the following days, contrary to NW horses (Fig. 1). Durations of attention of NW horses decreased on day 2 compared to day 1 (Friedman test ($N=14, df=4$) = 12.4 $P = 0.01$; Wilcoxon signed-rank test $\bar{X}_{\text{D1}} = 5.6 \pm 10.8$ s, $\bar{X}_{\text{D2}} = 2.9 \pm 0.6$ s, $\bar{X}_{\text{D3}} = 3.1 \pm 10.7$, $\bar{X}_{\text{D4}} = 3.7 \pm 0.5$, $P < 0.05$ for all), whereas they did not vary significantly for W horses (Friedman test ($N=10, df=4$) = 1.3 $P = 0.85$) (Fig. 2).

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