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Trailer-loading of horses: Is there a difference between positive and negative reinforcement concerning effectiveness and stress-related signs?

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KEYWORDS:
- negative reinforcement
- positive reinforcement
- horse
- behavior
- heart rate
- trailer-loading

Abstract
The traditional way to train horses is by the application of negative reinforcement (NR). In the past few years, however, the use of positive reinforcement (PR) has become more common. To evaluate the effectiveness and the possible stressor effect of the 2 training methods, 12 horses showing severe trailer-loading problems were selected and exposed to trailer-loading. They were randomly assigned to one of the 2 methods. NR consisted of various degrees of pressure (lead rope pulling, whip tapping). Pressure was removed as soon as the horse complied. PR horses were exposed to clicker training and taught to follow a target into the trailer. Heart rate (HR) was recorded every 5 seconds and behavior denoting discomfort was observed using one-zero sampling with 10 seconds sampling intervals. Training was completed when the horse could enter the trailer upon a signal, or was terminated after a maximum of 15 sessions. Of the 12 horses, 10 reached the criterion within the 15 sessions. One horse was eliminated from the study because of illness and 1 PR horse failed to enter the trailer. A Mann–Whitney U-test indicated that the horses trained with NR displayed significantly more discomfort behavior per training session than horses trained with PR (NR: 13.26 ± 3.25; PR: 3.17 ± 8.93, P < 0.001) and that horses in the PR group spent less time (second) per session to complete the training criterion (NR: 672.9 ± 247.12; PR: 539.8 ± 166.37, P < 0.01). A Mann–Whitney U-test showed that no difference existed in mean HR (bpm) between the 2 groups (NR: 53.06 ± 11.73 bpm; PR: 55.54 ± 6.7 bpm, P > 0.05), but a Wilcoxon test showed a difference in the PR group between the baseline of HR and mean HR obtained during training sessions (baseline PR: 43 ± 8.83 bpm; PR: 55.54 ± 6.7 bpm, P < 0.05). In conclusion, the PR group provided the fastest training solution and expressed less stress response. Thus, the PR procedure could provide a preferable training solution when training horses in potentially stressing situations.

Introduction
Horse training is to a large extent based on tradition (van Weeren, 2008). In contrast to the training of other animals, the application of modern learning theory in equitation is relatively new (McGreevy and McLean, 2007). Undoubtedly, the use of pressure and release is as old as the tradition of handling horses, still, the understanding of how negative reinforcement (NR) works is surprisingly lacking among riders and handlers. By contrast, positive reinforcement (PR) is mostly considered something that only alternative trainers use in their work. It is well established (and fairly
well accepted among riders) that application of punishment is not a good way to teach new responses the horse (Mills, 1998). Consequently, there is an increasing understanding that training should be based on reinforcement of correct behavioral responses, but our knowledge about the kind of reinforcement that works best is scarce (Ladewig, 2007). The status of the horse plays a role when determining which reinforcement to use, for example, whether the horse is naïve or whether it has past (bad) experience with a training situation. Furthermore, timing, for example, the correct application of the reinforcement, is probably more important for NR than for PR. NR is only effective when the application of a pressure is followed by the immediate removal once the horse performs the desired behavior (McLean, 2003). If the horse does not obtain freedom from pressure, it might become unresponsive and dangerous (McGreevy, 2006), which will create an unsafe training environment.

In modern equitation most trainers want a short learning period to obtain rapid results, despite the implications this might have for the horse; however, to obtain a safe and ethically correct training environment, the mental state of the horse should be taken into consideration. In the present study, effectiveness of NR and PR was ascertained through the duration of the training period and occurrences of stress-related signs. Several parameters can be used as measures of stress. A minimal invasive approach is the measurement of cardiac activity to register the parasympathetic—sympathetic balance. At rest, parasympathetic regulation dominates, whereas increased stress (e.g., physical activity) is characterized by increased sympathetic regulation (Borell et al., 2007). Methods measuring this balance will provide knowledge of individual stress vulnerability and the magnitude of an actual stress response (Porges, 1995). Heart rate (HR) represents the net interactions between parasympathetic (which reduces HR) and sympathetic (which increases HR) regulation. Thus, HR along with the behavioral parameters reflecting discomfort, were used as indicators of stress in the current study. Numerous situations can cause stress in an organism, and fear is one of the major psychological stressors (Grandin, 1997). Being loaded into a trailer is a very unnatural situation for a horse and could be the cause of fear. The aim of this study was to train horses with a high fear response to load into a trailer using either the PR or NR procedure. All horses had previous bad experiences with trailer loading and could not be loaded by their owners. It was hypothesized that a difference between the 2 groups would be seen in the expression of stress-related signs and in the speed at which the horses would reach the training criterion, because of the application of different reinforcement procedures. The results of this study will contribute to knowledge regarding the application of reinforcement, adding to the knowledge, development, and improvement of the training of horses.

### Materials and methods

#### Horses and location

A total of 12 mature horses of different gender and breed, between the ages of 7 and 20 years, were selected for the study. Consequently, the horses were not balanced regarding several potential confounding factors such as breed, gender, age, and background. It was impossible to avoid this, as the selection of horses was based on the criterion that they could not be loaded into a trailer. All the horses were able to follow their owner to the beginning of the ramp leading into the trailer, but no further. The horses were randomly divided into 2 groups: 6 of the horses were trained with the PR procedure and 6 with the NR procedure. Training sessions were conducted at 4 different locations using the same trailer, setup, and training procedure. The same trainer trained all horses.

#### Materials

A 2-horse, side by side, straight load trailer with a slightly sloping ramp was used. The center partition was moved to one side, making as much space as possible for the horse during training. A green piece of plastic (size: $2 \times 2$ m$^2$) was used before the trailer-loading training sessions, while teaching the horses the training methods. In the PR procedure, a yellow ball (the size of a tennis ball) on a stick (150-cm long) was used as a target. Food items (carrot and apple cubes) were used as primary reinforcement and a hand-held clicker was used as secondary reinforcement. During training with PR, the horses would wear a standard halter and have a lead rope (150 cm) attached, but pressure through the lead rope would only be applied if the horses moved more than 10-m away from the trailer without responding to the trainer’s signals. In the NR procedure, the equipment consisted of a standard halter, a lead rope (150 cm), and a 120-cm dressage whip. During all training sessions, mean HR (bpm) of the horses was measured using a Polar heart rate monitor watch (Polar RS800; Kempele, Finland).

#### Prior to trailer training

To achieve information on the usual reaction patterns of the horses when being loaded, the owners would attempt to load the horse while HR was recorded. Most owners would subject the horse to extensive lead rope pulling while attempting to lure the horse with food. After 7-11 days, the horses were randomly assigned to one of the 2 experimental groups. Horses in the PR group were trained to touch a target. When the target was touched, the horse would receive a click (secondary reinforcer) followed by a food reward (primary reinforcer). Horses in the NR group were trained to react to a pressure applied with the lead rope. If
the horse did not respond to the signal, it would be intensified by tapping with a whip on its shoulder, as described by McLean (2003). The pressure would be released the moment the horse performed the desired behavior. The horses in each group would learn to move forward, backward, and to stand still.

To test whether the horses in both groups reacted correctly to the training method, each horse was signaled to walk across a piece of plastic. None of the horses had tried to walk across plastic before this study. When the horse was able to cross the plastic 5 times forward, 5 times backward, and to stand still on it when the trainer signaled, the horse was considered to be ready to start trailer training.

Furthermore, a baseline HR for the PR and the NR group was calculated. One baseline value was measured per horse and the values from horses within each group were averaged, thereby providing mean baselines. The baseline was not equivalent to a resting value, but was measured while the horse was stationary. Baseline was measured in a stable compartment, with a familiar horse in the compartment next to it.

**Trailer-loading sessions**

The HR monitor was fitted to the horse before each training session. The HR monitor and stopwatch were started when training commenced. According to McCall (1990) and Meyer and Ladewig (2008), learning efficiency is optimized by short and spaced training sessions. Thus, the horses were trained 3 times a week, with a minimum of 1 day between sessions, and individual sessions would last for a maximum of 18 minutes. The training would always take place before feeding times. In both the PR and NR procedure, a session would end when the trainer observed that the horse started to lose focus. A training session would always stop after the horse had responded correctly to a signal. If the horse could not be loaded within 15 sessions, the training would be terminated. The set of 15 training sessions included the sessions used to teach the horse a method, which would consist of 2-4 sessions.

During each session, progress in training was measured by dividing the trailer training into 7 phases in terms of the actions undertaken by the horse: 1 front hoof on the ramp, 2 front hooves on the ramp, a step with a front hoof, 1 hind hoof on the ramp, 2 hind hooves on the ramp, a step with a hind hoof on the ramp, the entire horse inside the trailer. When the horse was able to conduct 1 phase 5 times successfully on a signal from the trainer, it was considered ready to move on to the next phase. Training was completed when the horse could enter the trailer 5 times on a signal from the trainer and stay inside the trailer for 10 seconds after each entry.

**Measurements**

HR (bpm) was measured every 5 seconds during a training session and discomfort behavior was registered on the basis of direct observations. The same observer was responsible for all observations. Behavior was recorded using one-zero sampling (Martin and Bateson, 1993) with 10 seconds sample intervals. Four behaviors were chosen to indicate the mental state of the horse: widening of the eyes (the eyes widen, thereby exposing the white around the pupil), widening of the nostrils (the nostrils widen and exhalation becomes obvious and louder), tail whipping (the tail makes a few hard whips), and avoidance toward the training was noted every time the horse did not respond correctly to a signal from the trainer. All chosen behaviors when expressed suggest that the horse was feeling discomfort (McLean, 2003; Waring, 2003). Although many behaviors can be indicative of a horse feeling discomfort, to eliminate or reduce possible registration errors, only those behaviors were chosen which were easy to detect for a human observer. The chosen behaviors have multiple functions depending on the circumstances (Waring, 2003), but during training sessions the behaviors were all seen as indicators of discomfort. Avoidance of the training was noted when the horse did not respond correctly to a signal from the trainer.

**Statistical analysis**

All statistical analyses were performed using SAS 9.1 (SAS Institute Inc., Cary, NC). Nonparametric 2-tailed statistical analysis was used, as none of the data followed a Gaussian distribution. All results in the present study were analyzed on the basis of mean values to avoid pseudoreplications. The discomfort behaviors were divided into 2 behavioral elements: discomfort behavior (comprising of widening of the eyes, widening of the nostrils, and tail whipping) and avoidance. A Mann–Whitney U-test was used to compare the level of the behavior elements, time spent to reach the criterion, and level of HR between the NR group and the PR group. A Wilcoxon’s test was used to compare parameter levels (discomfort behavior and mean HR) between the first and the last training session. Furthermore, a Wilcoxon’s test was used to compare baseline HR with mean HR during training.

**Results**

One horse was eliminated from the study because of illness. Thus, the training was completed by all NR horses and 5 of the 6 PR horses. One horse did not get further than the fifth step, placing its hind hooves on the ramp. Even though the horse did not complete training within the 15 training sessions, the data from this horse were included in the statistical analysis. The significant results of the study are shown in Table 1.

The level of discomfort behavior and avoidance expressed during the entire training period differed between the 2 experimental groups (Figure 1). The NR group expressed significantly more discomfort behavior than the PR group (NR: 13.26 ± 3.25; PR: 3.17 ± 8.93, P < 0.0001). The same pattern was seen in avoidance (NR: 5.74 ± 4.18; PR: 1.78 ± 3.14, P < 0.0001). No significant difference was found in
the level of discomfort behavior expressed in the first and the last training sessions for either the NR (first: 15 ± 11.4; last: 3.2 ± 3.96, P > 0.05) or the PR groups (first: 5.17 ± 6.05; last: 2.67 ± 1.86, P > 0.05). The same pattern was evident for avoidance in both NR (first: 2.0 ± 1.87; last: 3.20 ± 3.96, P > 0.05) and PR groups (first: 1.33 ± 2.07; last: 1.83 ± 4.02, P > 0.05).

The average length of the individual training sessions varied between the experimental groups. On average, less time was spent on training sessions in the PR group compared with the NR group (NR: 672.9 ± 247.12 seconds; PR: 539.81 ± 9.84 seconds, P < 0.01). Each horse had a maximum of 15 training sessions to reach the criterion of walking into the trailer. No difference was found between groups in the total number of training sessions required to reach the criterion (NR: 9.33 ± 2.88; PR: 6.4 ± 2.51, P > 0.05).

No difference was found in mean HR during training between the NR and PR groups (NR: 53.06 ± 11.73 bpm; PR: 55.54 ± 6.7 bpm, P > 0.05). A comparison of the baseline HR value from each reinforcement group and the HR values during training within each group revealed a significant difference in the PR group (baseline PR: 43 ± 8.83 bpm; PR: 55.54 ± 6.7 bpm, P < 0.05). No significant difference was found in the NR group (baseline NR: 53.06 ± 11.73 bpm; NR: 53.06 ± 11.73 bpm, P > 0.05).

### Table 1 Parameter levels in the comparison of groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test</th>
<th>Group</th>
<th>Mean ± SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavior</td>
<td>Difference in level of discomfort behavior</td>
<td>NR</td>
<td>13.26 ± 3.25</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR</td>
<td>3.17 ± 8.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference in level of avoidance</td>
<td>NR</td>
<td>5.74 ± 4.18</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR</td>
<td>1.78 ± 3.14</td>
<td></td>
</tr>
<tr>
<td>Training time (sec)</td>
<td>Difference in training time per session</td>
<td>NR</td>
<td>672.9 ± 247.12</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR</td>
<td>539.81 ± 9.84</td>
<td></td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>Difference in heart rate between owners’ loading and 1 training session</td>
<td>Owners’ loading</td>
<td>76.91 ± 14.03</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 training session</td>
<td>53.18 ± 9.84</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference in heart rate between PR training and PR baseline</td>
<td>Baseline</td>
<td>43.0 ± 8.83</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR</td>
<td>55.54 ± 6.7</td>
<td></td>
</tr>
</tbody>
</table>

NR, negative reinforcement; PR, positive reinforcement. Note: Only significant results shown.

Figure 1 Mean discomfort behavior expressed per horse. Mean values including standard deviation gathered from the entire training period. Discomfort behavior is divided into avoidance (horse does not respond to trainer’s signals), nostrils (widening of the nostrils), eyes (widening of the eyes), and tail (tail makes a few hard whips). Negatively reinforced horses expressed significantly more stress-related behavior, within all 4 categories, than positive reinforced horses.
42.2 ± 4.1 bpm; NR: 53.06 ± 11.73 bpm, P > 0.05). A significant difference was found between the owners’ loading and the first training session. On average, the horses had a higher mean HR during the loading conducted by the owner as compared with the first training session (owners loading: 76.91 ± 14.03 bpm; first: 53.18 ± 9.84 bpm, P < 0.01). No significant difference was found between the first and the last training session concerning level of HR in either the NR (first: 50.8 ± 10.01 bpm; last: 54.2 ± 13.54 bpm, P > 0.05) or the PR groups (first: 55.17 ± 10.15 bpm; last: 49 ± 7.62 bpm, P > 0.05).

Discussion

Stress-related signs

The discomfort behaviors observed in this study were all indicative of stress of a low intensity, which with continued exposure to the stressor can lead to unwanted behavior such as flight or aggressiveness (McLean, 2003). Significantly more discomfort behavior and avoidance were found in the NR group than in the PR group, suggesting a higher stress response in horses trained with NR, which is in agreement with the findings of Innes and McBride (2008). Furthermore, Innes and McBride (2008) have shown that horses trained with PR in general make more active contact with the human trainer than horses trained with NR, suggesting that the motivation of PR horses to be trained is higher, thus resulting in a low stress response.

An increase in HR can be a sign of stress, and has been used in several studies concerning stress in horses (Bachmann et al., 2003; Innes and McBride, 2008; Kay and Hall, 2009; Jezierski et al., 1999). But an increased HR does not necessarily indicate that the animal is reaching a stress level which is likely to impair welfare. Physical movement is bound to cause a raise in HR compared with a baseline value with no movement (Borell et al., 2007). As the overall level of movement was the same between sessions and between groups, the potential difference in HR between the 2 experimental groups would be because of a difference in stress level and not because of movement. In the present study, no difference was found in HR between the 2 experimental groups, thereby suggesting that horses in both groups were equally stressed. However, a significant increase was found in the PR group between the baseline HR and the HR measured during the training sessions. This might reflect increased frustration in the horses of the PR group. The withholding of a reward, while the horse is expressing trial-and-error to find the behavior which will result in the acquisition of the reward, can be the cause of this frustration (Frederiksen and Peterson, 1977; Looney and Cohen, 1982).

HR was significantly higher during the owners’ loading than in the first trailer-loading training session. As shown by Keeling et al. (2009), there is a close connection between the HR of the handler and that of the horse. Thus, the anxious state of the owners while attempting to load the horses is likely to result in a higher HR in the horses. Furthermore, the signals the owners used while attempting to load the horse were often insufficient and poorly timed. During the trailer-loading sessions, the horses received accurately timed cues by a calm trainer, which would be easier for the horse to perceive and therefore would result in a calmer horse (Keeling et al., 2009). No difference was found in discomfort behavior and avoidance or in HR between the first and the last training session in either experimental group, suggesting that the potential stress response remained constant during the training period.

NR versus PR

The horses in the PR group voluntarily engaged in the training and thus could terminate a training session at any time. The overall time the PR group spent on a single session proved shorter than the time spent on a session in the NR group. As the NR and PR group required an equal number of sessions to complete the training criterion, the overall time spent to reach the training criterion was shorter in horses trained with PR. This resulted in overall fewer minutes spent on training PR horses. Although the PR procedure was the fastest training solution, all the horses were not easily trained with PR. When using the PR procedure, it is important to find a treatment which will motivate the horse to cooperate (Kurland, 1999), and if this is not possible, PR becomes highly ineffective. In this study, 1 horse trained with the PR procedure was not interested in the treats supplied and thus did not complete the training within the 15 training sessions.

The NR group expressed more discomfort behavior, suggesting a higher stress response, than the PR group, which, if sustained over a prolonged period, could have negative welfare implications (Beerda et al., 1997). The incorrect application of signals can cause complications in training, in particular when training horses to perform behaviors which are fear inducing. This could lead one to conclude that only trainers with extensive knowledge and experience should use the NR procedure. This might be true, but reality is that ridden and handled horses today are all trained to respond to pressure-based signals. Furthermore, Innes and McBride (2008) conclude that the NR procedure may impair welfare implications in horses which are already stressed and Heleski et al. (2008) argue that the PR procedure creates a safer training environment for the trainer and is easier to apply effectively than the NR procedure. Although these 2 studies bring forward potential negative effects of NR, it might not be harmful for a horse to be exposed to pressure over short periods.

In conclusion, the PR procedure provided the fastest training solution and resulted in less stress response. When training horses in potentially fear-inducing situations, a low level of stress response is advantageous, as a motivated and calm horse is less likely to create a dangerous situation.
(Kurland, 1999). Thus, the PR procedure could provide a preferable training solution when training horses in potentially stressing situations, although care should be taken not to induce frustration in the horse, because of the anticipation of a food reward.

Acknowledgments

The authors thank Soeren Feodor Nielsen, Institute of Mathematics, University of Copenhagen, Denmark, and Nils Toft, Department of Large animal Sciences, University of Copenhagen, Denmark, for qualified statistical assistance. Bettina Hvidemose, Ethology Institute, Ballerup, Denmark, is thanked for her advising on the training setup, and the horse owners are thanked for loaning out their horses for this study.

References


