A REVIEW OF LEARNING BEHAVIOR IN HORSES AND ITS APPLICATION IN HORSE TRAINING[1]

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ABSTRACT

A literature review of the equine learning research conducted in the past 20 yr revealed that the purpose of most of the studies was to determine whether horses respond to learning situations in the same way that other animals do. The results indicated that horses can discriminate many different types of stimuli, and they learn through stimulus-response-reinforcement chains. Most equine learning studies have utilized learning tasks depending on primary positive reinforcement to get the horses to work the tests. Yet, the majority of horse trainers use negative reinforcement more often than primary positive reinforcement in their training procedures. Therefore, past research often did not have a direct application to training methods commonly utilized in the horse industry. Research also demonstrated that 1) early experiences of horses can affect learning ability later, 2) equine memory is efficient and 3) concentrating learning trials in long training sessions decreases equine learning efficiency. Many factors that might affect equine learning ability and be applicable to training practices in the horse industry have not been thoroughly investigated; for example, interactions between nutrition and learning and between exercise and learning, the use of negative and secondary reinforcements in horse training, and the horse's ability to make few initial errors compared to its ability to eliminate errors as training progresses all require investigation in future equine learning studies.
(Key Words: Equidae, Learning, Training.)

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Introduction

Today's horse is required to learn a wide variety of different tasks. Many of these tasks are not natural behaviors for the horse. For example, polo ponies are required to discriminate and follow a fast-moving ball while avoiding swinging mallets. Whereas these actions depend on natural physiological responses of the horse, the horse normally would not utilize these responses so intensely for such a long period of time. Many trainers have observed that the natural tendency of horses facing large cross-country or stadium jumps is to go around the obstacle rather than to discriminate the width and height of the obstacle in order to jump it. And, most horses, when given a choice, instinctively avoid entering a dark, narrow area such as the interior of a horse trailer. To perform tasks such as these, the modern horse must learn to suppress many of its natural instincts as well as to learn to discriminate and to respond to a wide variety of stimuli. The ability to learn and respond to different stimuli usually directly influences the horse's usefulness and monetary value to humans. This review examines the current literature on equine learning abilities as it relates to training practices utilized in the horse industry.

Extent of Equine Learning Abilities

Much of the learning research conducted with horses was directed at determining the scope of equine learning abilities. Gardner

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(1937a) determined that horses could discriminate between a regular feedbox and one covered with a black cloth. In a second study, Gardner (1937b) found that if the black cloth was placed above or below the feedbox, rather than directly covering it, the horses' errors increased. Later, Myers and Mesker (1960) showed that a horse could respond to different fixed ratio and fixed interval positive reinforcement schedules. They reported that few reinforcements were required under each new presentation schedule to get stable response rates from the horse. Their results ranked the horse's response to the different reinforcement schedules as similar to the responses of tropical aquarium fish, guinea pigs and octopi. Warren and Warren (1962) reported that horses could discriminate between a black and a white feed box and that they could learn a daily reversal of which box contained feed. Voith (1975) investigated horses' discrimination of visual reversal problems (black vs white stimuli) and spatial reversal problems (left vs right). She reported that horses learned both types of discriminations, but that the spatial reversals were more easily learned than the visual reversals.

Other studies also were directed at determining whether horses could learn particular responses. Giebel (1958) conditioned a horse, donkey and zebra to discriminate the correct choice in 20 pairs of visual patterns; the horse learned all 20 pairs of patterns. In a similar study, Dixon (1970) reported that a pony could learn to discriminate a correct (rewarded) pattern in each of 20 different pairs of patterns (Figure 1). McCall et al. (1981) utilized a Hebb-Williams closed field maze to investigate the extent of equine learning abilities. In this study, horses were presented with a new maze problem each day for 12 d (Figure 2). The horses did learn each new problem, and this maze did allow the researchers to rank the horses in order of maze-learning ability.

Stimulus-Response-Reinforcement Training

Generally, all current equine learning research is based on the assumption that horses learn through stimulus-response-reinforcement chains (trial and error). The stimulus-response-reinforcement theory states that the horse perceives a stimulus or cue, such as the rider's legs or seat or a black or white bucket. The

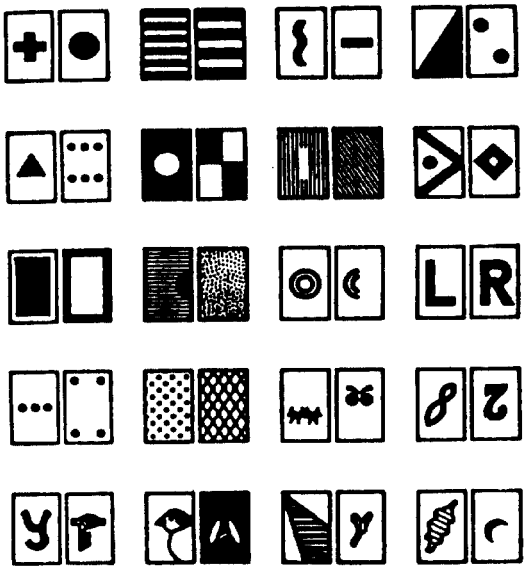

Figure 1. Pattern discrimination pairs used by Giebel (1985), Dixon (1966) and Voith (1975). The left pattern of each pair was the rewarded pattern.

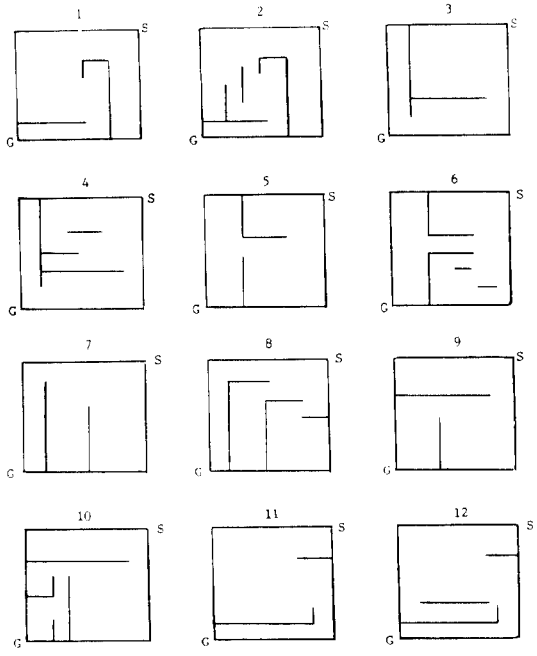

Figure 2. Test problems 1 through 12 in the Hebb-Williams closed field maze used by McCall et al. (1981). S = start; G = goal.

horse then makes a random response to this stimulus. If this response is correct, the horse receives positive reinforcement (reward). If the response is incorrect, the trainer can either ignore the response and repeat the stimulus or apply negative reinforcement until the horse makes the correct response. Equine learning research has investigated each part of the stimulus-response-reinforcement theory in an attempt to better understand how this theory works with horses and how it can be applied to horse training.

Stimulus

In order for a stimulus to elicit a response, the horse must be able to determine what constitutes a stimulus. Generally, horses are very good at discriminating stimuli. This was clearly demonstrated early in this century by the horse Kluge Hans (Pfungst, 1907), which seemed to possess the ability to answer mathematical and spelling questions. However, a scientific investigation revealed that Kluge Hans could correctly answer questions only if the questioner knew the correct answer. The questioner unintentionally was cueing the horse to make the correct answer by very subtle tensing and relaxing of his facial and body muscles. Dixon (1970) also demonstrated the depth of equine discrimination with her study in which a pony learned to discriminate the correct pattern in each of 20 different pairs of patterns. Horses seem to utilize many senses when discriminating stimuli. Yeates (1976) reported no significant differences in the number of correct responses that horses made to auditory, visual and tactile stimuli. This work was supported by Mackenzie et al. (1987), who reported that combined visual and auditory stimuli were as effective as combined visual, auditory and tactile stimuli in habituating horses to electric clippers.

Because the horse is so adept at discriminating stimuli, trainers must be specific and consistent with their presentation of cues. If a specific cue is not similar in presentation method and timing each time that it is used, the horse must generalize to continue responding to that cue. Eventually, stronger, more obvious cues will be needed to get the horse to perform at its initial level of responsiveness. A familiar example is the horse used to teach riding lessons. Lesson horses become so habituated to accidental stimuli from beginning riders that they become dull and unresponsive to subtle cues. Good trainers also know that in order for the horse to respond quickly to a stimulus, the stimulus must be presented at a time when the horse is able to respond. For example, the only time the horse can move its leg laterally is when that leg is in the air, therefore, the best time to present a stimulus asking the horse to move laterally is when the horse's responding legs are off the ground. The correct timing of cue presentation is where the art of good horsemanship joins the science of learning psychology.

Successful trainers begin horse training utilizing simple, natural stimuli. After the horse has mastered these, it can be taught more subtle, or learned, stimuli by pairing the new stimulus with the old, already learned stimulus. Although no published data are available on the efficiency of different timing of cue presentation in the horse, empirical evidence and research with other species (Tarpy, 1975) indicate that the horse probably learns best through either a delayed or a trace conditioning procedure. In delayed conditioning, the new stimulus is given to the animal and is continued until the old stimulus is presented. In trace conditioning, the new stimulus is presented to the animal and is terminated before presentation of the old stimulus, leaving an empty interval between the new stimulus offset and the old stimulus onset. Animals exhibit efficient learning in both the delayed and the trace conditioning stimulus presentation. In other schedules of stimulus presentation, such as a simultaneous presentation, in which the new and the old stimulus are presented at the same time, or a backward presentation, in which the old stimulus is presented first and followed by the new stimulus, learning has been shown to be very ineffective or possibly nonexistent. Therefore, successful horse trainers utilize delayed or trace conditioning procedures. For example, to teach a horse to respond to a neck rein, trainers lay the neck rein (new, subtle cue) against the horse's neck, then follow it with the direct rein (previously learned, more natural cue). By presenting the new cue then the old cue, trainers are using the old cue to show the horse the meaning of the new cue and to "reinforce" the new cue.

Response. Major maneuvers that horses perform start out as many small responses. Trainers teach the horse to perform each small

response to a major maneuver, then connect them together for the large, polished maneuver (shaping). For example, to teach a horse to move backward, the trainer first teaches the horse to relax its jaw and shift its weight backward in response to pressure from his legs and the bit. Then the trainer requires the horse to make this response plus take one step backward. The trainer keeps adding more steps to the maneuver and then adds rhythm and speed until the horse has learned the entire movement.

When a horse initially is learning the meaning of a new stimulus, its responses to that stimulus will be random actions. For example, a horse's initial responses to a cue to move backward may be the incorrect responses of throwing its weight forward into the bit, throwing its head into the air, or stepping sideways; or, it might make the correct response, relaxing its jaw against the pressure of the bit and shifting its weight backward. During this initial learning phase, successful trainers ignore the incorrect and encourage the correct, random response of the horse. This encouragement that connects the correct random response to a specific stimulus is reinforcement.

Reinforcement

Reinforcements in horse training can be either giving the horse something it likes (positive reinforcement) or removing something it does not like (negative reinforcement). Both positive and negative reinforcement strengthen the connection between a specific stimulus and the desired response, so that when the specific stimulus is presented again there is a greater chance of the horse's making the correct response (Tarpy, 1975). Like stimuli, reinforcements can be either natural, or "primary" (food, pain, return to herdmates), or learned, or "secondary" (pat on the neck, voice). Trainers teach horses secondary reinforcements by pairing them with primary reinforcers in the same way that a new stimulus is paired with an old stimulus. That is, they present the new, secondary reinforcement (the voice, "good horse") then follow it with the old, primary reinforcement (carrot). After a number of such pairings, the horse will associate the voice praise with the rewarding properties of the carrot.

Trainers mainly utilize secondary reinforcements in horse training, and they use more negative reinforcement than positive. In contrast, most equine learning tests employ primary positive reinforcement. This discrepancy may make it difficult to apply equine learning research results to horse industry training procedures or to utilize learning test results as a predictor of later training success of a horse. However, a study by Haag et al. (1980) indicated that equine learning abilities are similar under primary positive and primary negative reinforcements. They reported that the ponies that learned better in a shock avoidance, a negative reinforcement situation, also were better learners in a positive reinforcement single-choice point maze.

Punishment

When the trainer applies an aversive stimulus after the horse makes an incorrect response, the trainer is utilizing punishment. Both punishment and negative reinforcement use aversive stimuli. In punishment, the trainer presents the aversive stimulus *after* the horse has made an undesirable response. In negative reinforcement, the trainer presents the aversive stimulus *before* the horse makes the correct response and postpones or terminates the aversive stimulus when the horse makes the desired response. Punishment differs from reinforcement (both positive and negative) in that it works to suppress or eliminate a response, whereas reinforcements increase the probability that the response will occur again with the presentation of a specific stimulus (Tarpy, 1975). For example, when the horse bites or kicks at the trainer, the trainer would use an aversive stimulus (punishment) to eliminate that response. Trainers must guard against unintentional use of punishment (falling back in the saddle or jerking the bit over a jump) or desirable behavior (jumping the obstacle) will be suppressed.

Kratzer et al. (1977) examined the effect of an aversive stimulus (CO_2 fire extinguisher during incorrect responses) on the performance of horses that previously had learned to escape from a single-choice point maze for primary positive reinforcement. They reported that the horses made fewer errors after the introduction of the punishment but spent more time deciding which side of the maze to enter.

Factors Affecting Equine Learning Abilities

Accomplished horse trainers follow many practices that have been shown to enhance learning in other species but have not been

formally studied in the horse. Contingency between response of the horse and reinforcement is one of these practices. Trainers attempt to apply reinforcements immediately following the horse's response. This time connection between response and outcome (reinforcement) enables the horse to know when it has performed correctly and incorrectly, and it gives the horse a sense of order and expectancy about its responses. Trainers also must make sure that the correct response is available to the horse when they use aversive stimuli or reinforcements. For example, if the trainer wants the horse to move laterally, he must make sure the horse is physically capable of moving laterally and that no obstacle is blocking the movement before applying negative reinforcement. If contingent reinforcement and correct responses are not provided for the horse, the horse's behavior becomes unpredictable and neurotic (Tarpy, 1975; Potter and Yeates, 1977). The horse may become so intent on watching and understanding the trainer than its performance deteriorates. Good trainers also make sure that negative reinforcement is not so intense that it makes the horse unmanageable. If the horse becomes so panicked by the negative reinforcement that the trainer must stop its application before the desired response is obtained, then the horse may quickly learn that unmanageable behavior stops negative reinforcement.

Trainers also make use of the principles of extinction (i.e., non-reinforced behavior will decrease in frequency) (Tarpy, 1975). When a horse is initially learning a new response, it makes many incorrect, and often annoying, responses. If these incorrect responses are ignored by the trainer and only the correct response is reinforced, the incorrect responses eventually decrease in frequency until they are rarely exhibited. At the same time, the correct response increases in frequency to replace the incorrect responses.

Variable reinforcement schedules, in which the reinforcement occurs after an irregular number of responses from the animal or after an irregular time interval, have been shown to be valuable in maintaining high response rates in other animals (Tarpy, 1975). Animals work harder to obtain reinforcements when the reinforcement is not on a predictable or continuous schedule. Myers and Mesker (1960) showed that horses could respond to several fixed ratio and fixed interval reinforcement schedules, but no research has investigated the value of variable reinforcement schedules in horse training. However, most horsemen shift to variable reinforcement schedules after the horse has initially learned a response. Variable reinforcement seems to keep response rates higher than continuous reinforcements, and it gives the appearance of the horse's responding willingly in the absence of any overt reinforcements.

Most learning researchers agree that concentrating trials in long training sessions leads to inefficient learning; Rubin et al. (1980) reported similar findings in ponies. In their study, ponies were trained for either 7 d, 2 d or 1 d/wk in a shock avoidance response. The ponies trained 1 d/wk achieved a higher level of performance in fewer training sessions than the other treatments; however, their total elapsed time from the beginning to the end of training was longer than that of other treatments. These results indicate that concentrating trials in long learning sessions is an inefficient method of horse training, and they raise the question of whether it is more efficient to have fewer training sessions spread out over more total time or to have more training sessions per week with an overall shorter training time. Professional trainers must consider the results of this study in relation to their own goals and training techniques. However, nonprofessional trainers, who are not concerned with obtaining results within a specific time, should utilize the results of this study in their training practices. They should keep their training sessions short, work on a different maneuver each day of the week, and refrain from drilling a horse on a maneuver after the horse has performed it correctly.

The interactions between early experiences in a horse's life, emotionality, training ability and learning ability have been investigated in several studies. Fiske and Potter (1979) reported a positive correlation between the test performance of young horses on a serial reversal learning task and subsequent training for riding. They reported that horses that were less emotional during the learning test exhibited higher learning scores and subsequently were more easily trained for riding than the more emotional horses were. Heird et al. (1986) reported similar results in young horses used in a maze learning study. Horses that were continuously handled as weanlings and yearlings were less emotional, showed a higher

maze learning performance and were more trainable for riding than were horses receiving less early handling. In contrast, an earlier study by Heird et al. (1981) found that horses with intermediate handling experiences scored higher on maze performance than those with either limited or extensive handling. However, the intermediately handled horses in this study were the least emotional group, so inherent emotionality of horses may have more influence on learning ability than the amount of early handling they receive. However, the work by Heird et al. (1981, 1986) clearly indicates that early handling experiences of horses has a positive influence on their subsequent learning and training ability.

Houpt et al. (1982) investigated how a foal's early experience with its dam could influence the foal's learning ability. They compared the learning abilities in a single-choice point maze of foals raised with their dams to that of orphan foals. Although the orphan foals spent more time in the maze during their first exposure to it than normally raised foals, the learning abilities of the two groups did not differ. Their study concluded that the early experience of being mothered did not affect subsequent learning abilities of horses. In the same study, Houpt et al. (1982) compared the learning abilities of the foals to that of their dams and reported that the foals scored better on the learning test. Mader and Price (1980) also reported that older horses show a slower rate of learning than younger horses do. This decrease in performance as the horse ages may be caused by a decrease in reactiveness in older horses. Older horses may have slowed reaction times because their perceptual or physical abilities may decrease as they age. However, it seems more likely that learning performance decreases in older horses because they have learned to ignore the type of stimuli often utilized in learning studies.

Many trainers readily say that horses can learn bad habits from each other. However, two published studies (Baer et al., 1983; Baker and Crawford, 1986) have indicated that horses do not readily learn by observing another horse perform a task. In both of these studies, horses allowed to observe a demonstrator horse perform a task did not learn the task any more quickly than horses that did not watch the demonstrator. Therefore, bad habits, or vices, that horses seem to quickly "learn" from other horses may be the result of the horses' being in a similar environmental situation rather than the outcome of a true learning experience.

Equine learning research and trainers usually agree that equine memory is very good. Giebel (1958) reported very little discrimination memory loss on 20 pairs of visual patterns when his horse was retested at 3, 6 and 12 mo. Dixon (1970) reported that her pony had an 81% retention rate on 20 pairs of learned discriminations 1 mo after learning them. Three months after learning the initial discriminations the pony still performed at a 78% correct level, and 6 mo after the initial learning tests the pony still knew 77.5% of the correct discriminations. Dixon (1970) also reported that the pony seemed to learn a general solution to the discrimination. The pony "seemed to realize" that one pattern in each set would be rewarded. After the sixth pattern set, the pony needed only a few trials to learn which pattern in the remaining pairs was rewarded. The pony had "learned to learn." It had learned a general solution to a problem that made subsequent problems easier to solve. Other researchers (Fiske and Potter, 1979; McCall et al., 1981; Baer et al., 1983) also have reported that horses "learn to learn." This finding has many important implications in practical horse training. Many nonprofessional trainers avoid teaching the horse a new task with the rationalization that the horse will never have to utilize that task. However, because each new task learned may form a basis to help the horse learn subsequent, "useful" tasks more easily, trainers should not be afraid to teach the horse tasks that it may never use in competitions. The more tasks a horse learns to perform, the easier it will be for that horse to learn new tasks. This "learning to learn" phenomenon also indicates that training should follow logical and progressive steps. A trainer must teach the horse to move away from pressure before he can expect the horse to be able to perform a leg-yield or side-pass.

Implications

The recent research literature on horse behavior indicates that horses learn through stimulus-response-reinforcement chains in much the same way as other animals do. Horses have good discriminative ability and respond to both positive and negative reinforcement. Early handling experiences decrease emotionality and increase learning abili-

ties of horses. The horse has a good memory and can form general solutions to learning problems. Many factors that may influence the horses's learning ability have not yet been investigated, such as interactions between exercise and learning abilities. Equine learning tests utilizing negative reinforcements that meet both humane and research requirements need to be developed, so that the use of negative reinforcements in horse training can be examined. Finally, the use of secondary reinforcements in equine training procedures need to be studied in more depth.

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