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Evaluation of operant learning in young foals using target training

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ABSTRACT

The primary purpose of this study was to characterize operant learning performance of young foals. For each of 26 foals, aged 6–20 weeks, learning performance was quantitatively evaluated in a single brief training trial using a standard operant conditioning task and paradigm analogous to those common to training and management of domestic horses, popularly referred to as "target training." With no human interaction in the interim, retention of the learning was evaluated seven to 26 days after the initial training trial. All 26 foals demonstrated learning in this operant paradigm. In this operant paradigm, learning was as efficient in the foals of 6 weeks to 3 months of age (n = 14) as foals of 3–5 months of age (n = 12). Some evidence was found for more efficient learning in female (n = 13) than in male foals (n = 13), as well as in certain sire lines. Seventeen of the 26 foals (65%) met the criterion for retention. Differences in the proportions of males and females and of younger and older foals that met this criterion were not significant (Fisher's Exact Test). This work demonstrates the ability of young foals to efficiently learn and to retain an operant task.

1. Introduction

How and when horses learn are important to training efficiency and efficacy, as well as horse and handler compatibility and safety. Much of the large body of published work on principles of learning that generalize to all species certainly apply to the horse and other domestic animals. In addition, in recent decades there has been a growing interest and resulting body of literature concerning learning specifically in horses (McCall, 1990; Hanggi, 2005; Nicol, 2005; Murphy and Arkins, 2007; Leblanc, 2013). Example topics addressed have included spatial task learning (Haag et al., 1980; McCall et al., 1993; et al., 1996Wolff and Hausberger, 1996; Murphy et al., 2004; Hothersall et al., 2010), simple stimulus and concept discrimination (McCall, 1989; Sappington and Goldman, 1994; Hanggi, 2003; Visser et al., 2003; Hanggi and Ingersoll, 2009; Hothersall et al., 2010), and interocular transfer of learning (Hanggi, 1999). Factors studied affecting learning have included breed (Mader and Price, 1980; Hausberger et al., 2004; Lindberg et al., 1999), age (Haag et al., 1980; Mader and Price, 1980; Houpt et al., 1982; Lindberg et al., 1999; Visser et al., 2003; Lansade et al., 2004; Murphy et al., 2004; Krueger et al., 2014), sex (McCall et al., 1993 Wolff and Hausberger, 1996; Murphy et al., 2004), social dominance (Haag et al., 1980; Mader and Price, 1980), emotional reactivity (Heird et al., 1981; Heird et al., 1986; Visser et al., 2003; Lansade et al., 2004; Mengoli et al., 2014), rearing conditions (Houpt et al., 1982), nutritional condition (Haag et al., 1980; Hanggi, 2003), social observational learning opportunity (Clarke et al., 1996; Lindberg et al., 1999), and early intensive handling (Heird et al., 1981; Heird et al., 1986; Williams et al., 2002; Lansade et al., 2004; Spier et al., 2004; Santamaria et al., 2005; Ligout et al., 2008).

Understanding learning in juveniles is important, particularly to the extent that it may be related to or may affect later trainability. Recently, researchers at Bristol reported that 5 of 5 domestically managed foals ranging in age from 17 to 21 weeks successfully demonstrated visual discrimination learning in an operant paradigm (Hothersall et al., 2010). To our knowledge, no systematic studies of learning have included foals younger than 17 weeks. The primary purpose of this study was to characterize learning performance of foals 6–20 weeks of age. A standard operant conditioning task analogous to tasks common to training and management of domestic horses was used to evaluate initial learning as well as retention. Secondary objectives included comparing performance of (a) younger and older foals, (b) male and female foals, and (c) foals of different sire lines. Additionally, we explored behavioral correlates of learning performance. We hypothesized that foals would demonstrate learning, and that learning efficiency would vary among sire lines. We had no hypothesis concerning effects of age or sex.

2. Materials and methods

This study was conducted during July to August 2013 with all animal care and procedures approved by the Institutional Animal Care and Use Committee of the University of Pennsylvania.

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2.1. Subjects

Subjects included 26 Shetland-type pony foals (13 males and 13 females), ranging in age from 47 to 139 days at the time of their initial learning assessment trial. These foals were born during 2013 foaling season within the semi-feral herd of Shetland-type ponies maintained at the University of Pennsylvania's New Bolton Center primarily for the purpose of observational study of equine behavior under natural social conditions. The herd was maintained on all natural forage, water sources, and shelter through the period of study. Previous handling of these foals had been limited to a single 30-min session of gentle handling alongside their dam and harem group at between two and four weeks of age. This procedure is meant to acclimate the foal to touch to all parts of the body during quiet, gentle interaction with humans.

These 26 foals represented offspring from a total of 7 sire lines (common sire or grandsire). Three of these sire lines had 4 or more foals (4,6 and 8), such that learning performance by sire line could be compared.

2.2. Learning assessment

2.2.1. Environment

Learning assessments were done using a sub-enclosure within the herd enclosure. This sub-enclosure is formed by closing gates at either end of a laneway through which the herd passes daily on treks from grazing to water, and where the herd occasionally rests and loafs. On the day of assessment, each harem group was held as it passed through the laneway, such that the group could comfortably loaf together as a harem for the duration of their foals' trials. For each individual foal trial, the dam and foal were separated into a sub-enclosure adjacent to the harem group enclosure by quietly luring the dam with a small amount of palatable feed. Once in the assessment enclosure, the foal was separated into an adjacent pen (2.35 m × 2.10 m). The dam was kept comfortably occupied with a palatable feed along the gate separating the mare and foal pens, where the foal and dam could see and interact vocally but not touch one another. The three remaining sides of the foal enclosure were lined with standard equestrian vinyl covered padding.

Three standard target locations included midway along the gate separating the foal and dam and along each of two other sides of the pen. These were measured and marked on the natural substrate.

Each learning assessment trial was video/audio recorded (Sony HDR-XR520 with digital high definition 0.45X wide angle lens with macro; Minato, Tokyo, Japan). The video camera on a tripod was positioned outside the foal pen to span the entire pen.

2.2.2. Procedure

The experimenter entered the foal pen and quietly approached the foal, gauging and adjusting manner and pace of approach so as to establish tactile contact while eliciting minimal avoidance behavior. Once contact was established, the experimenter proceeded with gentle scratching of the foal to identify an area to which it responded especially favorably (typically at the withers, chest neck, or rump which are the common mutual grooming sites for horses; McDonnell, 2003). This scratching is used routinely in our laboratory and clinic as primary positive reinforcement for young foals in lieu of food rewards to which they are not yet acclimated since they are nursing. Example indications of a foal's positive perception of the scratching include wiggling the body part back and forth as if to facilitate scratching, presenting, moving toward or pushing the body part into the scratching hand, or raising the hindquarters toward the hand scratching. The duration of this acclimation phase of the trial varied with individual foal, ranging approximately from 30 s to 135 s.

In the following 2.5 min, the unconditioned (primary) reinforcement (UCR) of scratching was paired with the spoken word "good" as a conditioned (secondary) reinforcer (CR). UCR-CR pairing was repeated at approximately 10-s intervals for 10 pairings. After the 10 pairings, the CR was presented alone to evaluate for behavioral indications of anticipation of UCR (e.g. presenting body part to experimenters, gazing toward experimenter's hand, nibbling experimenter as in mutual grooming initiation gesture). If none, UCR-CR pairings continued for an additional 30 s. The duration of this classical conditioning or "loading" phase was based on preliminary trials with adult animals using the same UCR-CR pairings.

The remainder of the 6-min trial was devoted to operant shaping of touching and holding the muzzle to a target object in response to a verbal prompt. The designated target was a rock (approximately 23 cm × 15 cm × 9 cm) obtained from the herd enclosure that had been painted with white stripes (5 cm wide at 5 cm intervals running lengthwise) (Alu-Spray Non-Toxic Aerosol, Vetoquinol NA for Neogen Corporation, Lexington, Kentucky, USA)

The target was initially placed midway along the gate nearest the dam and then moved to the locations progressively further from the dam, for approximately 2 min at each location.

After initial placement of the target, if the foal did not voluntarily attend to it within an approximately 5 s, the experimenter gently guided the foal toward the target. As the foal first appeared to focus on the target (gaze or investigate with pawing) the experimenter spoke the work "target" as a prompt. When the foal touched the muzzle to the target, the experimenter simultaneously spoke the word "good" and delivered a scratch of 2–3 s duration. For as long as the foal held the muzzle to the target, the UCR-CR pairings were continued at 2–3 s intervals. If the foal appeared to lose focus on the target for 15 s, it was again gently guided back toward the target. This guiding of the foal to attend to the target typically occurred, if at all, once or twice at the beginning of the shaping session, and only occasionally later during the session.

2.2.3. Yoked controls

To evaluate that learning in fact occurred, seven of the 26 subjects served as yoked controls. Procedures for yoked controls were similar to those for operantly trained foals, with the exception that prompts and reinforcements were delivered on the schedule received by a trained foal matched for age and sex rather than based on the yoked foal's own response. This was achieved using audio playback of the matched training trial via wireless earpiece to the experimenter. After a three-week washout period, these seven foals were subjected to operant training trials for inclusion of their data with other trained foals. On this second exposure, a total of one minute was devoted to acclimation and refresher-loading before proceeding to the operant conditioning phase as described above for all other 19 subjects. The rationale for subsequent use of these 7 foals in operant training was that no evidence of learning was observed in their yoked trial and that the brief control trial experience did not appear to be particularly positive or negative such that it would affect a subsequent operant conditioning trial.

2.2.4. Measures from video analysis

From the video record of each trial, the learning measures defined in Table 1 were derived.

2.2.5. Retention assessment

To evaluate retention of the learned operant task, between 7 and 26 days after the initial target training trial, each foal received an abbreviated second training trial. Procedures and measures were the same as for the initial training trial except that the duration of the classical conditioning phase was limited to 1 min, the operant conditioning phase was limited to 2 min, and the target was located at a new position in the center of the enclosure.