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Scholarly Dialog

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The relevance of auditory perception and the effects of music on horses

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Abstract

Recent acquisitions on perceptive, behavioural and cognitive features of horses are reported. The effects of perceptive and cognitive abilities on horse-human interactions are reviewed. The role and relevance of auditory perception in horses is underlined. The effects of music on different animal species are revised, and a special emphasis on the effects of music on horse welfare and sport performance is devoted.

Keywords: auditory perception, horse, horse-human interaction, music, sport.

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Introduction

Horses are social animals, and have interactions with co-specifics and other species, including humans in leisure, sport activities and equine-assisted services (1-5). Nevertheless, horses perceive humans as predators, and experiment stressful environment and conditions, reacting to handlers, trainers, riders or patients with emotional responses and stereotypies (1, 6-18).

Sensory stimuli are essential to identify predators and respond to potentially alarming stimuli by preparing for flight or fight. However, in riding and therapeutic conditions, horses can become synchronous with humans (19-23), showing. e.g., increased heart rate (HR) in response to riders' increased HR (24), and dependence on the level of human attachment (25) or emotional state (26).

Horse cognition and learning abilities, besides selection, temperament and personality (1, 27, 28), have a great impact on welfare and horse-human relationships (29-31), improving adaptive functions (24, 32, 33).

Therefore, horses' welfare can be implemented by knowledge of their perceptive and cognitive abilities, useful during management, training and utilization for sport and therapeutic activities. Equitation science is continuously evolving to pursue the best methodologies to improve horse-human relationships and equine performances. Scientific research is carried out on equine perceptive and cognitive abilities from a basic and applied perspective (34).

Horse perceptive and behavioural features and interactions with humans

The perceptive and behavioural features of horses have been extensively reviewed (6, 35-37). Horse welfare depends on sensory perception and primary needs (nutrition, fight and flight). Body care, preservation of individual space, locomotion, exploratory and social behaviour, rest are of outmost importance.

Horses show peculiar sensory cues, improving with increasing age and training (37, 38). Taste and smell play a key role in the inner world and experiences of horses with external world. They sustain food selection, olfactory activity and manifestations of feeding, social, defence and sexual behaviour. The information, received from receptors in the mouth (taste), nasal, sinus cavities and vomero-nasal organ, reaches rhinencephalon (smell) or thalamus, amygdala and hippocampus, where emotions, learning and memories take place. Scent work is a new discipline in horse-human relationships (39).

Horses have monocular and panoramic vision (228°). Head positioning and neck flexibility allow them to focus objects at short distances. They need a frontal vision and have a good peripheral vision, but cannot see above eyelevel, so inducing unexpected expressions of fear. Horses possess a dichromatic colour vision (blue, green) and are reluctant to enter into a dark area. They can distinguish human faces and voices, and can match familiar voices to familiar faces (40). The abilities of horses to discriminate between two-dimensional images of faces of conspecifics and domestic species (41) and to associate human vocal and facial expressions of sadness and joy (42) have been demonstrated. Horses are attracted to facial expressions of joy and are more aroused by human voices expressing joy than sadness (43), regarded as a premise of empathy (44).

Horses manifest acute sensitivity to auditory stimuli (55 Hz–33.3 kHz), due to ears' position and body positioning that improve the ability to localize environmental sounds. Horses can localize and discriminate sound up to a threshold of 22° to identify the sound source (44-46). They learn to differentiate sounds (33). In sport horses that cope with stress caused by unfamiliar environments and training routines or transport (6,46), the auditory perception is central to the processing of sensory signals, that inform physiological and behavioural responses.

The sense of position and equilibrium depends from stimulation of hair cells receptors of ears' semicircular canals, in relation to head movements; it determines balance and evokes the reflexes concerning the maintenance of body position in motion.

The horse is very sensitive to touch and pain. Distinct receptors respond to heat, cold, touch, pressure, joint positions and pain. In response to pain, reflex escape or withdrawal efforts are made; and the activation of sympathetic nervous system induces fear or rage, fight or flight, giving rise to a painful experience, durable in a horse's memory, plus a behavioural and emotional response. Communication and social interactions are entrained by horses using vocalizations and body language (ears, mouth, nose, neck, tail, body postures, etc.). Horse whinnies are composed of two fundamental frequencies (F0 and G0), suggesting biphonation. F0 and the energy spectrum indicate emotional arousal, while G0 and whinny duration indicate emotional valence (47,48).

Horses perform cognitive tasks, such as memorization, discriminative learning and concept formation (34, 49-51). Social and observational learning are adopted during horse training (51). Research is still

necessary concerning the independent learning, discriminative and generalized learning and reversal learning (34)

The interactions of horses with humans are challenging; they depend on different factors (25,26, 53), and are important for the welfare and safety of both humans and horses (21,54). Horses can display sensibility towards humans and human actions. They recognize and remember individual trainers and handlers, evaluating whether past interactions had been negative or positive (55-57). Horses use multisensory information to distinguish between humans, and to assess human attentional state. They monitor an unfamiliar person more often and for longer periods of time compared to a familiar person (40, 57). When human faces and voices are mixed, the horses look in the direction of the signals quicker, more often, and for longer time (55). Studies were also carried out on the human-gesture responsiveness by horses (58). Moreover, horses are more obedient if a familiar person is looking at them when he gives a verbal command (55).

During human-horse interactions for basic education and training for sport activities, these acute sensory and cognitive abilities are significant to allow individual recognition and social interactions, and to consolidate and improve horse behaviour and cognition in a large range of tasks and learning abilities; in sport horses to improve horse-human interactions and obtain obedience to vocal and riding aids control and performance. Therefore, the perceptive and cognitive abilities are empowered in the context of all the sport activities, and especially of show jumping or dressage (37).

The effects of music on horse emotional state and performance.

It is known that a novel auditory stimulus elicits both a behavioural and physiological response (59). Sport horses are exposed to a variety of sensory stimuli. Nevertheless, during competition horses perform without responding to auditory and sensory stimuli. However, in some contexts, such as in dressage, horses must perform following musical themes.

The audience during horse activities may increase emotional excitability and provoke stress reactions, negative emotions, frustration or aggression, as well as physiological changes. It may be detrimental in competitions and could result in elevated levels of HR (60).

Improving the knowledge of responses to sounds encountered in competition environments could enhance the ability to manage horses and maintain safety and performance.

The relationship with music of animals has been hypothesized since Darwin (61,62). He first considered that perception of musical rhythms can have an adaptive role for different functions, including social communication, social cohesion and group selection; and it would be dependent on common nervous structures. It remains still famous the report on “Clever Hans”, the horse that demonstrated mathematical and musical ability to obtain a reward (63).

Music has been categorized as similar to language, and its complexity depends on many variables,

tempo, harmony, amplitude, pitch, rate, attack speed, that are “auditory inducers” of emotions. However, research showed not uniform emotional responses among the species according to the different variables of music (64).

In many species it is recalled the “Mozart effect” (Sonata for two pianos K448) to explain their preference and positive effects of music on emotional responses and behaviour (65); a differentiated relationship music-species is becoming evident, showing their ability to discriminate between Bach and Stravinsky, or between Bach and Stravinsky or Schonberg, even demonstrating music or silence preference (64).

Different species show a synchronous behavior with music, that can be spontaneous or learned (64). Beat synchronization has been characterized as reactive movements to an audible beat (66,67). In humans, beat perception, synchronization and neural tuning in the auditory cortex is common within 120 to 140 beats/min, frequently used in musical compositions (68-70). The hypothesis that the optimal tempo for beat synchronization is determined by the time constant of neural dynamics conserved across species has been recently supported (71). Both subcortical and thalamo-cortical pathways are likely responsible for a short-time adaptation (66, 72-76). Studies on beat synchronization in animals shaped this adaptive behavior through training or exposure to a musical environment (66, 67,77-80*)*.

Music can produce behavioural indicators of positive or negative emotional states, with measured modifications of neurotransmitters and neuromodulators (norepinephrine, dopamine, brain-derived neurotropic factor, ghrelin, etc.), hormones (cortisol, oxitocin, etc.) and physiological functionalities (blood pressure, HR, HR variability, growth, milking, etc.) (64). Studies of brain activity suggest that the emotional structures of music have specific effects on the brain areas associated with processing different emotions (81). In humans and animals, a series of short rapid calls generally has an arousal effect, and long tonal calls a calming effect. Dissonant or noisy calls can induce fear or anger and aggression, whereas harmonic calls induce relaxed, calm or affiliative behaviour (82). Music-induced physical movements and physical social interactions might have intrinsic rewarding effects (83-87).

Research studying the effects of music on pets and large animals results contradictory, reporting either the positive effects of classical, country and fast tempo music, or that of specific melodies (64, 88-97). The reason for these differences depends on the auditory perception of species and on music genre adopted to obtain specific effects. Consonant music is hypothesized to be therapeutic for most uses with animals, but it is important how animals perceive consonance (64,98).

Horses are sensitive to music, and they show the ability to synchronize movements to musical rhythm (79). Classical music appeared to have no effects; however, although ponies showed no significant behavioral changes to a variety of musical genres, there was a tendency toward increased feeding

with country music (94,98,99).

It is important to consider the acoustic communication system of species in order to determine what frequency range of sounds, what tempos, and what other features of music will be most effective (64). Many species are sensitive to different frequency ranges and different tempos than humans, and music can be effective if it is appropriate for the sensory and communication systems of the species under study, so that subjects respond appropriately to music composed in the frequency range and with the tempos that were common to their vocal communication (90).

The introduction of music (Beethoven's 9th Symphony) in horses had a significant effect on the nocturnal time budget, resulting in significantly more ingestion and recumbent behavior (100).

When exposed to noisy events, horses show intense escape attempts, that may cause severe accidents for the horse and the rider/handler (101).

Classical music appeared to decrease the response of horses exposed to a stressful environment (102). Introducing stress coping methods (relaxing music and massage) brought positive effects and significantly decreased the release of cortisol. The benefits were also found in the race records. The prize per race was significantly higher in the experimental groups than in control group (103).

The study of the HR in horses to different genres of music (rock, country and relaxing music) played in the stable showed that the level of emotional excitability was different. The relaxing music had the mildest effect, the country music acted more strongly, and the influence of the rock music was the strongest. Differences in reactions of the horses to music were related to their sex and age (104). Moreover, playing relaxing music 3 hours a day had more positive effects than playing music for 1 hour (105).

Auditory stimuli can be used to cue the attention of horses or act as a distractor. During competition, the noise could have an impact on the focus and attention of horses, potentially producing a sub-optimal performance (106).

A study (107) recently investigated behavioural and physiological (HR) responses of horses to sounds present in a competition environment. Increased HR for all sounds and an overall difference in behavioural responses were recorded and were attributed to the attempt to localize and attend to the sound. 'Ears scanning' was high for all sounds. Increased 'exploration' in response to applause was evident. A decreased 'exploration' response and an increased 'tail raised' and 'evasive movements' were recorded when exposed to trotting. An increased 'neck lowered' behaviour in response to music confirmed the calming effect of music.

Inter-individual responses to sounds experienced in a domestic or sporting environment, including music and applause, are likely to depend on the prior experience of the individual horse, because auditory perception and resulting behaviours are driven by both bottom-up (sensory input) and top-

down (cognition and experience) processing (37).

The effect of music may therefore depend on the intensity of the stimulus, the horse's individual experience and the environment in which it is played rather than the stimulus itself.

A difference in both physiological and behavioural responses with and without ear covers with a reduction in responsiveness in horses wearing ear covers has been demonstrated (107).

Specific horse rhythms and melodies, including specific pitch, tone and frequencies, by mimicking the rhythm of a horse's gaits and using string instruments, were created by Janet Marlow; and playing music masks outside sounds and vibrations, as well as provides positive and relaxing effects.

Conclusions

Further investigations on the effects of music may contribute to the improvement of horse welfare and performances in equestrian disciplines and activities and during competition.

The Authors declare no conflict of interest

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