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Coordination dynamics in horse-rider dyads

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ABSTRACT

The sport of equestrianism is defined through close horse-rider interaction. However, no consistent baseline parameters currently exist describing the coordination dynamics of horse-rider movement across different equine gaits. The study aims to employ accelerometers to investigate and describe patterns of motor coordination between horse and rider across the equine gaits of walk, rising trot, sitting trot and canter. Eighteen female ($N = 18$; mean age ± *SD*: 37.57 ± 13.04) Dutch horse-rider combinations were recruited to participate in the study. Horse-rider coordination was recorded using two tri-axial wireless accelerometers during a standard ridden protocol. Multiple measures of horse-rider coordination were calculated to investigate the relationship between the horse and rider, while the unpredictability of the acceleration-time series of the horse and rider during task performance were determined separately by means of approximate entropy analysis. The kinematic variables of horse-rider correlation, mean relative phase, mean standard deviation of the relative phase, approximate entropy rider, approximate entropy horse and spectral edge frequency at 95% of the power in the 0–10 Hz frequency band were examined using multiple correlational analyses and multivariate analysis of variance (MANOVA). Findings showed significantly different coordination dynamics between equine gaits, with the gait of canter allowing for the highest levels of horse-rider synchronicity. It may be concluded that accelerometers are a valuable tool to map distinct coordination patterns of horse-rider combinations.

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1. Introduction

A multitude of daily activities are governed by, if not dependent on, the close interaction with others. Shaking hands in greeting, attempting to move a large, cumbersome object together or filing in through an open door are all routine examples of how people regularly engage in considerable levels of interpersonal coordination (e.g., Bernieri & Rosenthal, 1991; Chartrand & Bargh, 1999). As a result, the way two people coordinate their bodies and limbs when engaging in increasingly complex social interactions has been the subject of extensive study (e.g., Bekkering et al., 2009; Sebanz, Bekkering, & Knoblich, 2006). While earlier research focused in particular on elements of imitation as a function of social attraction and affiliation (Chartrand & Bargh, 1999; Lakin & Chartrand, 2003; Lakin, Jefferis, Cheng, & Chatrand, 2003), more recent studies have also included the dimension of temporal alignment (Goodman, Isenhower, Marsh, Schmidt, & Richardson, 2005; Konvalinka, Vuust, Roepstorff, & Frith, 2010). Interpersonal entrainment can generate feelings of rapport and connectivity and as such is thought to help build social units (Marsh, Richardson, & Schmidt, 2009). It has even been argued that it augments the memorability of an interaction (Macrae, Duffy, Miles, & Lawrence, 2008; Miles, Nind, & Macrae, 2009) and is likely to foster better team performances (Riley, Richardson, Shockley, & Ramenzoni, 2011).

While undoubtedly playing an important role in human-human relationships, the coordination of motor behavior might also be considered valuable in the interaction of human and non-human animals. The sport of equestrianism, for example, is defined through the close interaction between horse and rider, while effective training relies heavily on timing and consistency (Goodwin, McGreevy, Waran, & McLean, 2009). The governing body of the sport and participating riders stress that principles of harmony and cooperation should be paramount in all equestrian disciplines (FEI, 2009; Hawson, McLean, & McGreevy, 2010). Previous studies refer to this ideal state, which most horse-rider dyads are striving to achieve, as operating "as one" (Brandt, 2004; Meyers, Bourgeois, LeUnes, & Murray, 1997). While the notion that optimal behavioral coupling or movement synchronicity may be considered a function of harmony in human-human interactions (e.g., Miles, Griffiths, Richardson, & Macreae, 2010; Miles et al., 2009), similar assumptions about horse-human dyads pose a number of difficulties, ranging from emotional, cognitive and intellectual differences to intrinsic variations in bi- versus quadruped movement patterns. Natural, intrinsic movement patterns in animal (Bergerud, 1975) and human (Hurmuzlu & Basdogan, 1994) populations have been found to exhibit steady-state-frequencies, which may be argued to represent a function of movement efficiency and even harmony. To date, a handful of studies have investigated aspects of movement coordination between horse and rider focusing on the equine gait of trot (e.g., Lagarde, Peham, Licka, & Kelso, 2005; Peham, Kapaun, Licka, & Scheidl, 1998; Peham, Licka, Kapaun, & Scheidl, 2001; Peham, Licka, Schobesberger, & Meschan, 2004; Schöllhorn, Peham, Licka, & Scheidl, 2006). Peham et al. (1998, 2001) were able to demonstrate that an experienced, professional rider was able to ride a horse close to its limit cycle, with minimal changes in velocity and a close approximation of the ideal state-state. An additional study by Peham et al. (2004) showed that even compared to non-ridden conditions, movement stability in the horse trotting on a treadmill improved under a professional rider using a well-fitting saddle. These results were further supported by studies of Lagarde et al. (2005) and Schöllhorn et al. (2006). Their work showed that expert riders were better able to coordinate their own motor behavior with that of the horse and elicit more consistent, stable movement patterns in the horse.

Lagarde et al. (2005) argued that horse riding is dependent on riders being able to adjust their movement patterns to resonate as closely as possible with those of the horse. Furthermore, existing evidence seems to suggest that riders' adaptation to and control of the movement patterns of horses is a function of rider expertise. However, there still remains a lack of consistent baseline parameters describing the coordination dynamics of horse-rider movement for different levels of rider expertise and across different equine gaits. The equestrian discipline of dressage requires the horse to execute a variety of exercises in the three distinct gaits of walk, trot, and canter (FEI, 2009). The movement patterns of each of these gaits are inherently stable, with a loss in stability likely leading to a switching of patterns, i.e., gaits (Schöner, Jiang, & Kelso, 1990). The walk consists of a four-beat sequence with no suspension phase and an average tempo of 55 strides per minute (Clayton, 2004). Each hind limb is always being followed by the forelimb on the same side, and each forelimb being followed by the