Recently, Jirsa & Kelso (2005) proposed a model construct (they referred to as 'excitator' as it belongs to the class of excitable systems) that, dependent on the parameters, may generate discrete and rhythmic movements. When prepared in the 'discrete' régime, a movement will be executed only due to an external input, while in the limit cycle régime the system is autonomous (i.e., requires no external input). That is, movement generation comes about through distinct mechanism in both régimes.

Departing from this perspective, we examined human timing through computational analyses and an experiment involving human participants. For the computational analyses, we examined the behavior of an 'excitator' when prepared in the 'discrete' régime as well as in the limit cycle régime under a wide range of parameters, including movement frequency. Using a variety of measures, we showed that when prepared in the limit cycle régime, the system could comply with all imposed timing requirements (i.e., frequencies). In contrast, when prepared in the discrete régime the system was able to comply with the temporal constraints only at low frequencies (due to interference effects). In other words, movement generation that depends on an external stimulus can only be operative in a limited range of task constraints.

In the experiment, participants 'tapped' their index finger at auditory-paced increasing and decreasing frequencies under various instructions. Comparison of the human and computational data indicated that movements at low frequencies were generated in a discrete fashion (except when instructed to move 'as smooth as possible)', while at higher frequencies the participants switch to rhythmic behavior. Furthermore, we found a hysteresis effect: the switch from discrete to rhythmic behavior occurred at a lower frequency when movement rate was increased than when it was decreased. The implications of these findings are two-fold: First, discrete and rhythmic movements constitute two distinct classes (an externally driven and autonomous system, respectively). Second, the discrete system is operational only in a limited range of temporal constraints.

10. Horse-rider interaction

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Like many complex biological systems, the coupled horse-rider system can be more or less coordinated, a phenomenon commonly described by equestrians, who will feel that the harmony achieved with a horse varies depending on both participating individuals.

Less is known about the influence of teaching to the motion pattern of horse and rider. This question will be discussed by the presentation of Ulm et al. (Comparison of learning approaches in horse dressage riding) and Dvorakova et al. (The measurement of pressure forces created by the contact of a rider's body on the horse's back during hippotherapy).

Crucial in the communication between horse and rider is the saddle, in particular the type and the fit of the saddle. This question will be tackled by Witte et al. (Motion pattern analysis of gait in equitation by means of Karhunen-Loève transform) and Hofmann et al. (Evaluation of pressure distribution under a fitting and a too wide saddle with different saddle pads). The influence of the rider via reins to the horse is a very important question not only in dressage competions. An answer to this question will be given by Weishaupt et al. (Effect of head and neck position on temporal and force parameters in the unridden and ridden horse at the trot).

This Minisymposium will provide very important insights into the behavior of a complex coupled system, the horse rider interaction.

Comparison of learning approaches in horse dressage riding

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Traditionally, in horse dressage riding riders are taught to copy a person's independent ideal position on the horse by means of many repetitions and error corrections. The recognition of individual riding patterns of horses as well as individual interactions between riders and horses (Schöllhorn et al., 2006a) suggest a more individual and less person independent teaching approach. An alternative approach in human sports is suggested with the differential learning approach that is mainly characterized by adding random components to the to-be-learned posture or movement without repetitions and without error correction (Schöllhorn et al., 2006b). The underlying idea is to scan a possible potential landscape with noisy exercises in order to improve the ability to adapt to new situations. Results from previous experiments show superiority of this approach in comparison to classical approaches. Consequences of this approach on two noisy systems (athlete and horse) are unknown. In this study we compare the traditional with the differential approach with respect to the quality of riders' performances in horse dressage riding.

Twenty-four participants engaged in four weeks of training with nine 45-minute lessons and were evaluated in a performance intervention program that consisted of pre-/post-test experimental interventions. All participants were recreational riders (age = 20–34; 2 male; 22 female) on an advanced level. The 'traditional' group was trained by a member of the Spanish Riding School, Vienna. He instructed the riders classically, which includes feedback and numerous repetitions of the to-be-learned target movements. The 'differential training' group practiced the skills with high variability added to the target skills according to the differencial learning approach. In the tests, participants were required to ride a dressage test. Internationally experienced German dressage judges evaluated the dressage performances from randomised video recordings. Their rating focused on the rider's seat. Normal distribution of the data was tested with a Kolmogorov-Smirnov test. We compared the dressage scores of the pre-test and post-test of each group with Student T-Test in order to evaluate the relative merits of both types of training programs.

The results showed that neither of the two groups was able to improve their performance within the training period significantly. Whether this result is dependent on the level of the riders or on the duration of the intervention needs further research. On the other side adding variability to performance task constraints causes the same effect as traditional training in the case of issue. The increased variations did not obstruct the learning process.

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The measurement of pressure forces created by the contact of a rider's body on the horse's back during hippotherapy

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One of the most important tasks of a therapist practicing hippotherapy is to induce 'a movement dialogue' between the horse and the client. It takes some time until the client adapts to the movement of the horse. The appropriate movement pattern of the client is built over time. As soon as this happens, we can say that the therapy has a neurophysiological effect.

The aim of our study was to describe how the increasing experience of the rider changes the cyclic pressure distribution between the rider and the horse. For measurements the pressure measuring pad (Pliance System, Novel) was used directly on the horse's back. We measured a group of five healthy subjects (age, body mass) without earlier riding experience (in a healthy subject we assume normal motor abilities, without the bias of any health deficiency) at the first and the sixth sessions of hippotherapy at the walk. In each session the physiotherapist assisted from behind and corrected the posture of each subject.

The cycle of pressure distribution in hippotherapy has similar characteristics as the pressures occuring during athletic horse riding. In the first measurement the range of total power is between 568 and 406N, the maximal pressure varies from 1.31 to 1.84 Nm^{-2} and minimum from 0.38 to 0.44 Nm^{-2}. Six hippotherapy sessions later, the results of the second measurement were the range of total power between 639 and 453N, the maximal pressure from 1.59 to 2.1 Nm^{-2} and minimum from 0.41 to 0.49 Nm^{-2}.

The effect of six sessions of training was an increase in forces on the horse's back, which we assume is due to increased contact between horse and rider as the excitement and stress of the new situation and movement activity recedes.

Motion pattern analysis of gait in equitation by means of Karhunen-Loève transform

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The aim of this paper was to study the movement coordination between horse and rider at the three natural gaits: walk, trot and canter. Of particular interest was the influence of saddle type on movement behaviour. Low-dimensional principal component analysis, a valuable tool to describe the complex dynamics of two interacting organisms, was used to identify the major dynamic constituents of the three natural gaits. With this method it could be shown that trot is characterized by only one major component. Additional phase plane analyses made transparent a potential influence of the saddle type on movement coordination for the majority of horses.

Keywords

Kinematic analysis, horse, treadmill, Karhunen-Loève transform, principal component analysis

Evaluation of pressure distribution under a fitting and a too wide saddle with different saddle pads

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Reasons for performing study

Saddle pads are used for many different reasons in riding. Information about the effect of saddle pads on the fitting of a too wide saddle is currently lacking.

Hypothesis

Saddle pads can adapt the fitting of a saddle with too wide saddletree.

Methods

18 sound horses were ridden by the same rider on the treadmill at walk and trot. The horses were wearing a dressage saddle with a too wide saddletree and four different saddle pads (leather, reindeer-fur, gel, sponge rubber). The movements of horse and rider were documented by a high-speed video system using reflective markers. For collecting the kinetic data a pressure measuring saddle pad was used. The maximum