Learning About the Levade

The McPhail Center continues its research into the biomechanics of collection

BY HILARY M. CLAYTON, BVMS, PHD, MRCVS
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IN MY PREVIOUS "VETERINARY Connection" column (July), I described a research study in which dressage trainer Paul Belasik took part in an investigation of the mechanics of collection. During that study, Paul caught the research bug. As a student of classical dressage, he was curious to learn more about how the horse performs highly collected movements. Specifically, he wanted to know how the horse elevates his forehand into the levade: Is the forehand raised by a push from the front limbs or by a pull from the hindquarters?

Because horses that perform a correct levade are few and far between, Paul offered to bring one of his own horses to the McPhail Center at Michigan State University's College of Veterinary Medicine. The horse he brought was St. Graal (known as "Eli" in the stable), a fourteen-year-old Thoroughbred gelding who graces the cover of Paul's most recent book, *Dressage for the 21st Century.*

COURTESY OF PAUL BELASIK

Paul Belasik and St. Graal in levade

COURTESY OF PAUL BELASIK

In pesade

The Movements Defined

The forerunner of the levade is the pesade, in which, from an energetic piaffe, the horse bends and lowers his hocks, lifting his forehand off the ground until his body is at a 45-degree angle. The levade—called the mezair in some works of classical equestrian literature—evolved from the pesade as a more challenging movement, with the horse elevating his forehand only to about a 30-degree angle to the ground. Classical trainers began experimenting with lowering the pesade in the nineteenth century, and some experts re-

gard the levade as the most difficult of the "airs above the ground."

Originally, the horse held the pesade or levade for just a moment, using the position as a momentary base of sorts from which he could spring into one of the airs above the ground, such as the courbette or the capriole. Eventually the levade developed into an "air" of its own, with the horse maintaining the position for a few moments and then gently lowering his front limbs to the ground to return to a normal standing position. Like the piaffe, the levade is considered a natural evolution of collection and the ultimate test of a trainer's ability to collect the horse.

Important indicators of correctness in the pesade and the levade include the angle of elevation and the lowering of the hocks. If the horse lifts himself to an angle higher than 45 degrees and does not bend the joints of his hind limbs, he is simply rearing and is not performing a classical movement.

The Study

Paul and Eli warmed up in the Gaide Arena, which is adjacent to the rubberized data-collection runway. They then trotted along the runway and performed some piaffe sequences on the force platform as a preliminary exercise. After he was satisfied with the piaffe, Paul asked for a levade in front of the video cameras and in the vicinity of the force platform. Each time Eli stepped on the force platform, the device measured the magnitude and direction of the force with which his hoof pushed against the ground.

In order for us to collect useful force data, the horse must have only one hoof at a time on the force platform. This can be difficult to achieve, particularly during such precision exercises as the piaffe and levade. We were able to record a number of good "hits" during Eli's piaffe and levade, however, which enabled us to make comparisons between the two movements (see Figures 1 and 2 below).

As Eli began the levade, one front limb contacted the ground and lifted off, followed by the other front limb. In piaffe, the force of the front limbs pushes the horse upward and forward, with the forward component being balanced by a backward force from the hind limbs. In preparation for the levade, however, the front-limb force changed to an upward and backward direction (Figure 2). The backward orientation allowed Eli to retract his front limbs into the levade position as they left the ground. The forces exerted by his front limbs at the initiation of the levade were no higher than those recorded in the preceding steps of the piaffe (Figure 1). This finding indicates that Eli was using the muscles of his back and hindquarters to raise his forehand, rather than using his front limbs to push his forehand upward.

Throughout the levade, Eli's hind limbs were planted firmly on the ground. His hind hooves were 83 centimeters apart in the levade, compared with 39 cm in the piaffe. The adoption of a broad base of support during the levade is a means of making the horse's balance more stable. It is a consistent feature of this movement.

After Eli raised his forehand, he maintained the levade position for a short period of time. In the series of levades we analyzed, the duration var-

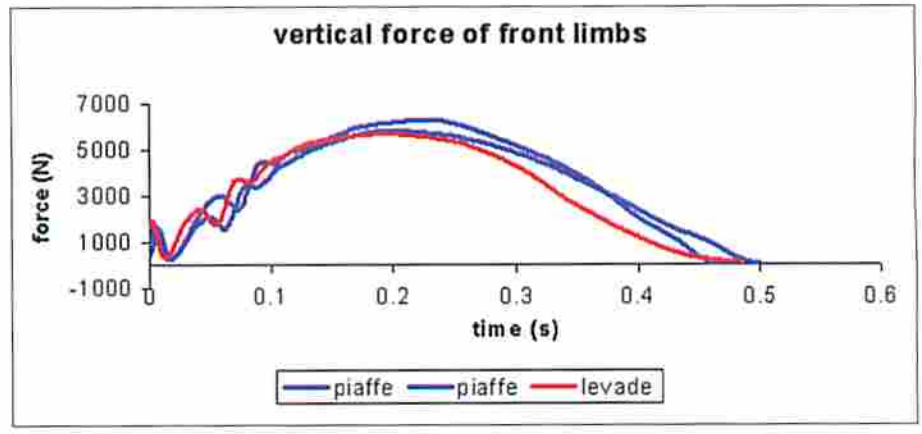

Figure 1. Comparison of vertical force of the left and right front limbs during piaffe (blue lines) with the force of the right front limb as the horse lifts into a levade (red line). In each case, the hoof is in contact with the ground for about 0.5 second. The traces are very similar in shape.

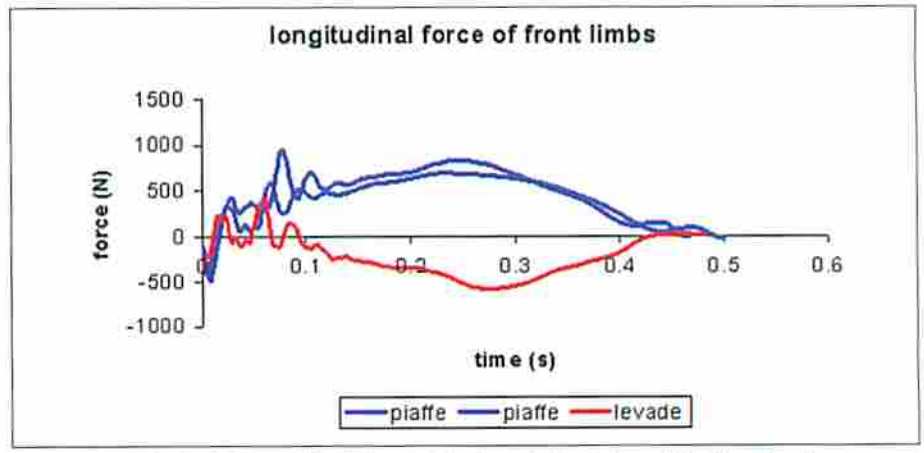

Figure 2. Longitudinal forces of the left and right front limbs during piaffe (blue lines) are positive (above the zero line), indicating that they act in a forward direction. The force of the right front limb at the initiation of the levade (red line) is negative, indicating that it is pushing in a backward direction.

ied from 0.8 second to 2.3 seconds. To put this into perspective, a horse jumping a five-foot fence is airborne for just over half a second.

As I've discussed, the levade and the pesade are differentiated from a rear by the angle of elevation of the horse's trunk and by the lowering of the hocks. In our study, we used a line connecting markers on the horse's pelvis and scapula to represent the trunk (Figure 3), and we considered the trunk angle to be the angle between the trunk and the horizontal.

Eli's trunk angle was around 16 degrees when his front limbs left the ground at the start of the levade, and it increased to 25 degrees in the levade shown in Figure 3. In this photograph, it is evident that his hocks are well flexed. The angles of his hock and stifle joints are about 100 degrees, which is considerably more flexion than occurs in the stance phase of the trot.

COURTESY OF THE McPHAIL CENTER

Figure 3. Paul Belasik on St. Graal performs a levade on the runway in the McPhail Center. The horse's body angle is 25 degrees, and Paul's torso is nearly vertical.

During the time that Eli was stable in the levade, the vertical force on one hind limb (Figure 4) was approximately half the combined weights of Eli and Paul, which is what we would expect. The longitudinal force (Figure 5) showed small oscillations in the force from the hind limbs that were produced

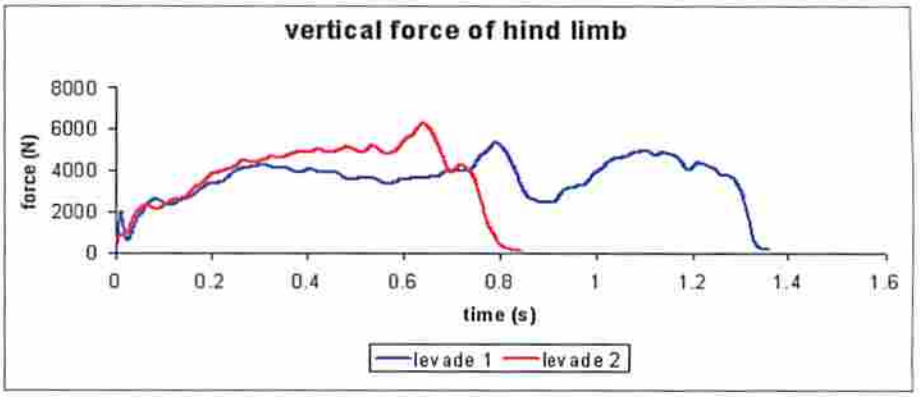

Figure 4. Vertical force of the right hind limb during two levades. Levade 1 had a duration of 0.8 second. Levade 2 had a duration of 1.3 seconds. The force on one hind limb is around 4,000 Newtons, which represents approximately half the combined weight of horse and rider.

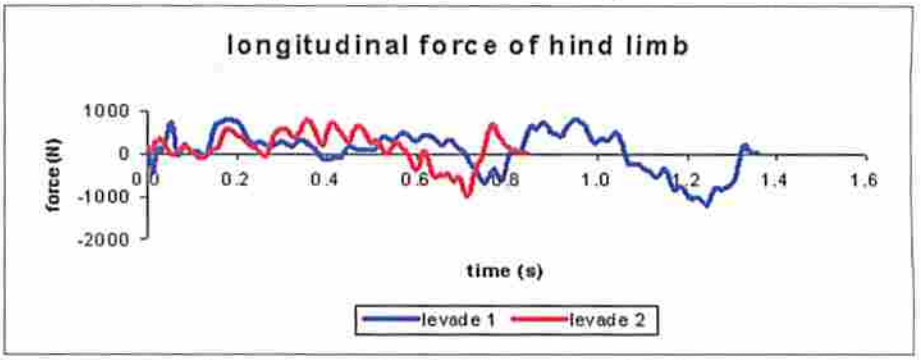

Figure 5. Longitudinal force of the right hind limb during two levades. The oscillations are caused by muscle activity as the horse balances himself in the position.

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During their visit to the McPhail Center, the well-known dressage trainer and author Paul Belasik and his horse, St. Graal, gave a demonstration of classical dressage training at the Grand Prix level.

A recording of this demonstration, together with original footage and computer-generated graphics of the research study of the levade, is available from the McPhail Center. Proceeds will support the research program in the McPhail Center. For more information, call (517) 432-5927 or fax (517) 432-3442.

by muscular contractions used to maintain balance. These appear as wobbles in the longitudinal-force trace. They are an indication that Eli was adjusting the tension in his muscles to compensate for small changes in the position of his center of gravity. A larger dip in the longitudinal-force trace precedes the lowering of the front limbs at the end of the levade.

Implications

The results of this study answered the original question about how the horse elevates his forehand in the levade. Quite clearly, the forehand is not pushed up by the front limbs but rather is pulled up from the hindquarters. This effort requires tremendous strength in the muscles of the hind limbs and the back.

During the levade, the horse is in a rather precarious state of balance and must constantly adjust his muscle tension to maintain the position. The recommendation of the late Alois Podhajsky, former director of the Spanish Riding School, that the rider should sit as still as possible is certainly good advice, for the horse must also compensate for any movements by the rider. During his levades with Eli, Paul's body position remained almost vertical (88 degrees in Figure 3), with his center of gravity vertically above the horse's center of gravity.

Although the levade is not performed in competitive dressage, it is an interesting movement to study biomechanically. As we analyze these data in greater depth, we hope to learn more about the horse's muscular strength and balance in this highly collected movement. ▲

Hilary Clayton, BVMS, PhD, MRCVS, is a world-renowned expert on equine biomechanics and conditioning. Since 1997, she has held the Mary Anne McPhail Dressage Chair in Equine Sports Medicine at Michigan State University's College of Veterinary Medicine, East Lansing. The position focuses on dressage- and sport-horse-focused research. Dr. Clayton contributes a quarterly report to USDF Connection on her team's research efforts and findings, which she hopes will help dressage and sport-horse breeders, owners, riders, trainers, and caretakers to enjoy longer and more productive careers with their animals.