The Canter Considered

Last in a series of in-depth looks at the three gaits

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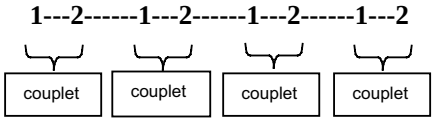
MY LAST TWO COLUMNS described the mechanics of the walk and the trot ("Veterinary Connection," April and July 2002). This month, I'll explore the canter. As in my previous articles, I'll take a close look at how the characteristics of the gait change in the different types of canter.

Before we begin, let's review: In any gait, a *stride* is a complete cycle of limb movements. When we discuss the canter, we usually begin the stride when the first hind limb (the trailing hind limb) meets the ground. The next time that limb touches down marks the end of one stride and the beginning of the next.

The Canter Defined

Both the walk and the trot are *symmetrical gaits*, meaning that both sides of the horse's body show identical movement patterns and that the movements of the left and right limbs are equally spaced in time, so that the footfalls have a regular rhythm. The canter, in contrast, is an *asymmetrical gait* because the footfalls of the front limbs and the hind limbs occur as couplets. This means that, if you listen to the rhythm of either the two front limbs or the two hind limbs, you'll hear a short interval followed by a long interval, like this:



The first footfall of the couplet is the trailing limb, and the second one is the leading limb. In the above example, the "1" beat is the trailing limb and the "2" beat is the leading limb.

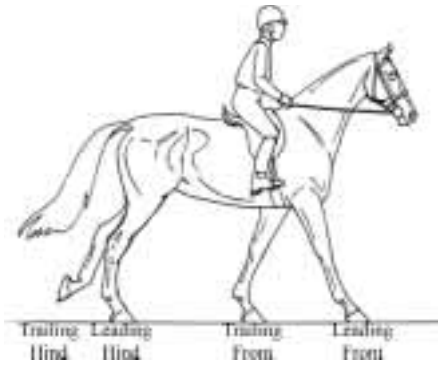


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Figure 1. The trailing limbs appear to trail behind the leading limbs, which are reaching forward.

This naming convention is confusing at times, especially to people who are not familiar with equine gaits, because it would seem more logical that the first limb to contact the ground would be called the leading limb. However, the naming makes more sense in relation to the movements' visual appearance: When you watch a cantering horse, the leading limb is the one that appears to reach further forward, while the trailing limb appears to be trailing behind (Figure 1).

The canter has a three-beat rhythm: two limbs that move independently and a diagonal pair of limbs that moves together. The first footfall is the trailing hind limb (TrH). The second beat is the synchronous footfalls of the leading hind (LdH) and the trailing front (TrF) diagonal pair. The third beat is the footfall of the leading front (LdF) limb. This pattern of footfalls (which occurs in the gallop as well as in the canter) is called a *transverse sequence* because the order of limb placements alternates between the left and right sides (Figures 2a–b and 3).

Footfall formula for the canter:

General	TrH : LdH-TrF : LdF

Transverse (true) canter:

Left lead	RH : LH-RF : LF
Right lead	LH : RH-LF : RF

Some animals use a *rotary sequence* of limb placements at the canter and gallop, in which the order of footfalls goes in a circle (Figure 2a–b). A characteristic of the rotary sequence is that the footfalls of a lateral pair of limbs occur synchronously, rather than as a diagonal pair. A horse whose canter is said to be "disunited" is moving in a rotary sequence.

The footfall patterns for a disunited canter are:

Rotary (disunited) canter:

Left lead	LH : RH-RF : LF
Right lead	RH : LH-LF : RF

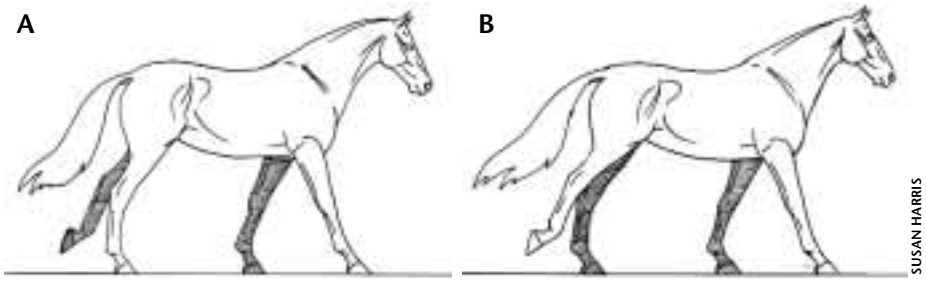

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Figure 2a–b. Transverse (a) and rotary (b) sequences of limb placements in right-lead canter. In the transverse sequence, the diagonal limb pair moves together, and the order of limb placements alternates between the left and right sides of the body. In the rotary sequence, the lateral limb pair moves together, and the order of limb placements moves in a circle. Left limbs are shaded.

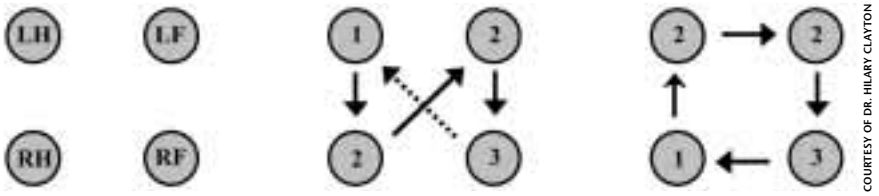

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Figure 3. Order of limb placements in the canter. The diagram at left shows the locations of the left hind (LH), right hind (RH), left front (LF), and right front (RF) limbs. The center diagram indicates the order of footfalls in the transverse (true) canter, and the diagram at right indicates the order of footfalls in the rotary (disunited) canter.

The canter is a leaping gait, meaning that each stride has an airborne phase (or suspension), when all of the limbs are off the ground. The airborne phase occurs between lift-off of the leading front limb and contact of the trailing hind limb.

Four types of canters are required in dressage competition: collected, working, medium, and extended. Using slow-motion photography, we have been able to measure the gait variables of the different types of canter with great accuracy. The findings that I'll share with you in this article are based on analysis of successful national-level Grand Prix horses.

Canter Speeds

As I've explained in previous articles, the speed of a gait is calculated as follows:

Speed (meters per minute) =
Stride length (meters) x
Tempo (strides per minute)

Horses show distinct changes in speed among the various types of canter:

- *Collected canter:* 196 meters per minute (7.2 miles per hour)
- *Working canter:* 235 mpm (8.7 mph)
- *Medium canter:* 294 mpm (10.9 mph)
- *Extended canter:* 358 mpm (13.2 mph).

As you can see, there are large increases in speed from working to medium and from medium to extended canter. It's interesting to note that the speeds of the collected and working canter are fairly similar to those of the collected and working trot, but the medium and extended canter are performed at progressively faster speeds than the medium and extended trots (see the graph in Figure 4).

Horses alter the speed of a gait by adjusting stride length, tempo, or both. When a horse canters on a treadmill at progressively increasing speeds, he adjusts both stride length and tempo. As speed continues to increase, he moves from a canter to a gallop by dissociating the movements of the diagonal limb pair so that the leading hind limb contacts the ground before the trailing front limb, thereby changing the gait from a three-beat rhythm to a four-beat rhythm.

Dressage horses are taught to change speed by adjusting stride length while maintaining an almost constant tempo. The tempo is maintained better in the canter as the horse makes transitions within the gait than it is in the trot or the walk.

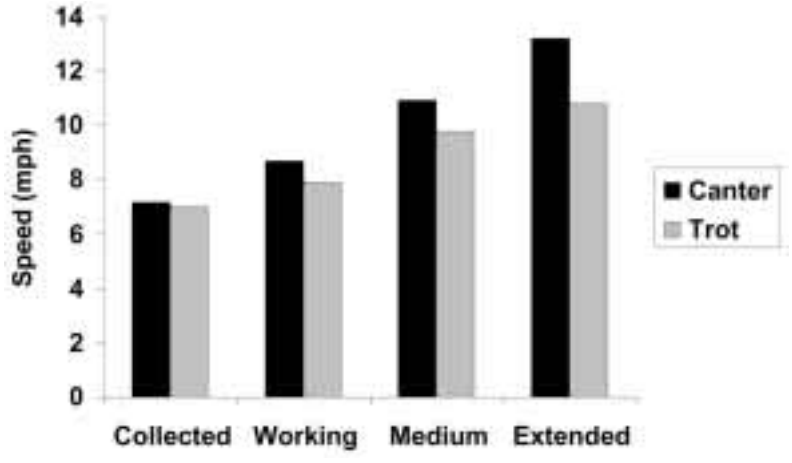

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Figure 4. Average canter and trot speeds at the paces required in dressage competition.

Stride Length

Almost all changes in speed associated with transitions among different types of canter are a result of alterations in stride length. In one study of a group of Grand Prix horses, I found that stride length increased from 2.0 meters in the collected canter to 2.4 meters in the working canter, 2.9 meters in the medium canter, and 3.5 meters in the extended canter.

The overall increase in stride length from collected to extended canter was almost entirely the result of an increase in the distance covered during the airborne phase. The longer a horse is airborne, the greater the forward distance he travels during the airborne phase. The best way to prolong the airborne phase is for him to project his body higher into the air so that it takes longer for the force of gravity to slow his upward movement and accelerate him in a downward direction. Therefore, the secret to achieving a ground-covering extended canter is for him to project his body high into the air, rather than simply increasing his forward propulsion. The higher he projects his body, the longer he remains airborne and the further forward he travels while in the

air. The duration of the airborne phase is about 90 milliseconds in the extended canter (one millisecond = 1/1000 second), compared with about 5 ms in the working canter. The collected canter often does not show a distinct airborne phase.

Tempo

Ideally, a dressage horse should maintain the same tempo (stride rate) in the transitions between the different types of canter. Our group of Grand Prix competitors had, on average, a slightly slower tempo in the collected canter (99 strides per minute) than in the extended canter (105 strides per minute). This difference was measured using sophisticated gait-analysis techniques; the discrepancy is small enough that even an experienced judge would be unlikely to detect it.

Rhythm

All types of canter have a three-beat rhythm. Slow-motion analysis has shown that the timing of the footfalls within that rhythm changes slightly in the various types of canter. Why? Because, as speed increases, so does the length of the airborne phase. In order to maintain the overall tempo of the gait, the individual footfalls must occur in more rapid succession in the medium and extended canters. As a result, the intervals between contacts of the trailing hind limb and the diagonal pair, and between contacts of the diagonal pair and the leading front limb, are reduced. Again, this difference is so small that it cannot be detected without slow-motion analysis.

Limb Movements

During every stride of every gait, each limb has a *stance phase* and a *swing phase*. The stance phase is the period when the limb is in contact with the ground and is supporting weight; the swing phase is the period when the limb is off the ground and moving through the air. Don't confuse the swing phase of the limb with the airborne phase of the stride. When a horse is airborne, all four limbs are in the swing phase at the same time.

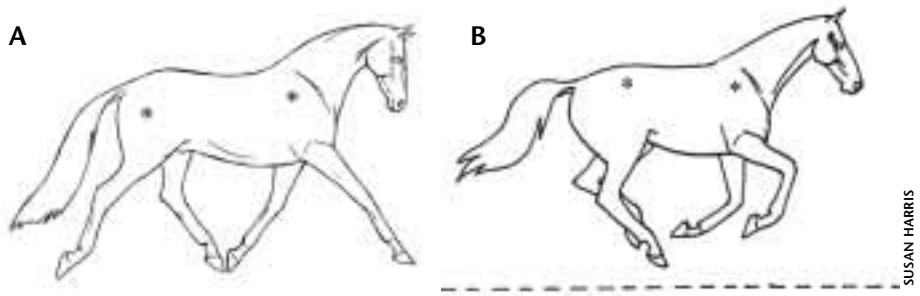

Figure 5a–b. Limb pivot points (asterisks) in a symmetrical gait (a) and an asymmetrical gait (b).

During the swing phase, the limb swings forward (*protracts*) and is then pulled backward (*retracts*) before the hoof meets the ground. The final retraction is necessary to reduce the velocity of the hoof relative to the ground as it makes contact. As speed increases, the duration of the stance phase decreases—about 30 percent shorter in the extended canter than in the collected canter.

One of the distinguishing features of collection is that the horse does not "roll" forward over his forehand as he travels. You can see this easily by observing the angle of the trailing front limb as it leaves the ground. In the collected canter, the trailing front limb leaves the ground just after it passes the vertical position. The longer this limb stays in contact with the ground beyond its vertical position, the less collection is shown. A horse that canters on his forehand rolls far forward over the grounded trailing front limb, as shown in Figure 2a–b.

In the symmetrical gaits, such as the walk and trot, the left and right limbs move out of phase with one another. As the front limbs swing back and forth, they pivot around the upper part of the scapula, while the hind limbs pivot around the hip joint (Figure 5a). In the canter, the movements of the front-limb pair and the hind-limb pair are more synchronous. The fact that both hind limbs are protracting and retracting at the same time allows the pivot point to be moved up to the lumbosacral joint (Figure 5b). This is the junction between the last lumbar vertebra and the sacrum, located just behind the saddle. The advantage of moving the pivot point from the hip joint to the lumbosacral joint is that it helps the pelvis to swing (undulate), which effectively increases the engagement of the hind limb and contributes to lengthening the stride.

Support Sequence

The limb-support sequence describes the number of limbs that support the body at each point during the stride. In the canter, the support sequences in the collected and extended gaits change slightly because of the differences in stance durations of the individual limbs. At slower speeds, each limb has a longer stance phase, resulting in more overlaps between the stance phases of different limbs.

Support sequence in collected canter:
TrH : TrH-LdH-TrF : TrH-LdH-TrF-LdF : LdH-TrF-LdF : LdF : Airborne

Support sequence in extended canter:
TrH : TrH-LdH-TrF : LdH-TrF : LdH-TrF-LdF : LdF : Airborne

Ground-Reaction Force

During the stance phase, the hoof exerts a force against the ground and the

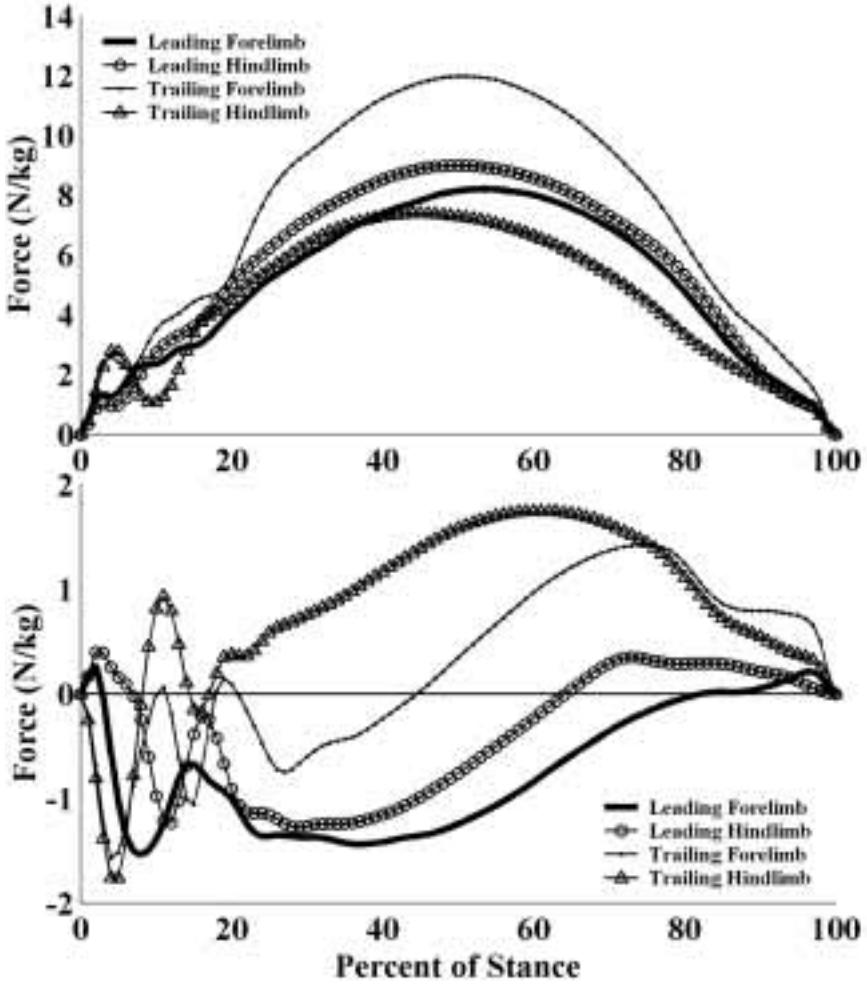

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Figure 6. Vertical (top) and longitudinal (above) ground-reaction forces in the working canter.

ground exerts a force against the hoof. These forces are equal in magnitude and opposite in direction. The reaction force of the ground against the hoof is called the *ground-reaction force*, and it causes movements in the horse's body. The ground-reaction force can be resolved into component forces that act vertically, longitudinally (from back to front, along the horse's body), and transversely (from side to side, across the horse's body).

The *vertical force* opposes the effect of gravity. It rises smoothly to a peak in the middle of the stance phase. In the canter, the vertical force is lowest in the trailing hind limb and highest in the trailing front limb (Figure 6). The force in the trailing front limb is considerably higher than in any other limb, and this reflects the importance of the trailing front limb in elevation of the forehand. Horses with mild front-limb lameness often are more uncomfortable when the lame limb is the trailing limb because it has the highest vertical force and therefore carries the most weight.

The *longitudinal ground-reaction force* has a negative phase (a braking effect on the forward motion) and a positive phase (a propulsive effect). The magnitudes of the braking and propulsive components differ between limbs at the canter (Figure 6). The trailing hind limb provides a large propulsive force without any braking effect. The diagonal limb pair provides both braking and propulsion; propulsion dominates in the leading hind limb, whereas the trailing front limb shows more braking. In the leading front limb, the longitudinal force is almost entirely braking in nature. Thus, the trailing limbs are used to drive the horse forward, whereas the leading limbs provide more braking.

When you evaluate a horse's canter, watch the angle of the trailing front limb as it leaves the ground. If the limb is almost vertical, the horse is moving lightly with his forehand elevated; but if the trailing front limb retains contact with the ground, then he rolls forward over his forehand. This is not a fault in the young horse; but, as training progresses, he should develop the ability to elevate his shoulders.

Undulation of the pelvis, elevation of the forehand, and upward propulsion during the suspension are important qualities both for achieving collection and for lengthening the canter stride. In addition to using dressage exercises to train these skills, it may be useful to include some jumping in the early stages of training (see "Get a Jump on Your Training," page 34). As the front limbs elevate during takeoff, the muscles that elevate the forehand are strengthened; and as the pelvis swings forward to place the hind limbs beneath the body mass, the topline is stretched and the lumbosacral joint is flexed. ▲

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