CORNERING ON A BICYCLE

Master centrifugal force on curves

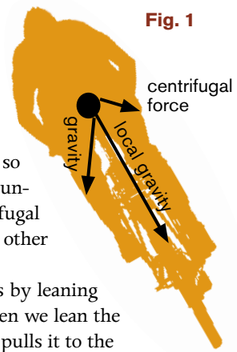
by Jan Heine

Cornering on a bicycle is a remarkably simple process. It has two main components: leaning and countersteering. The rider leans the bike by moving the wheels to the outside of the curve. This is called countersteering. At first sight, countersteering may appear counterintuitive, yet all riders do it because it is the only way to make a bike lean. Countersteering explains why training wheels are counterproductive to learning to balance a two-wheeler. Understanding the processes of cornering can help you corner with more confidence and increase your cycling enjoyment.

Cornering:

When we round a corner, the centrifugal force tries to pull us to the outside of the curve. We can see this when a car goes around a curve. It leans on its suspension to the outside of the curve. The springs compress until they counter the centrifugal force. A bicycle leaning to the outside of the curve would crash, so it needs to counter the centrifugal force in some other way.

Fig. 1

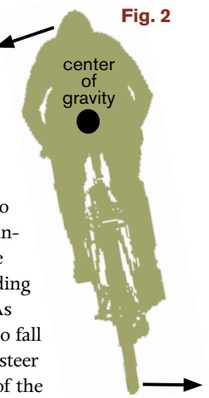


We do this by leaning the bike. When we lean the bike, gravity pulls it to the inside of the curve while the centrifugal force pulls to the outside (Fig. 1). The resulting force of the two, "local gravity," is in line with the bike's wheels. The bike is balanced.

Countersteering:

How do we get our bike to lean? We spin our bodies and bike around the center of gravity (Fig. 2). For example, to turn left, we move our wheels to the right so our bike spins counterclockwise and leans to the left. Gravity pulls us down and keeps our tires on the road.

Fig. 2



To lean left, we must turn our handlebars to the right. Yes, we turn our handlebars in the opposite direction of where we want to go! It is called countersteering, and all cyclists do this. We also countersteer when we balance while riding straight ahead. As the bike begins to fall over, we countersteer in the direction of the lean to rotate the bike in the other direction until it is upright again.

Leaning Your Body:

Can't we just shift our body weight to lean the bike into the curve? Not really. When we move our bodies to one side, inertia tends to keep our center of gravity in the same place. So we lean our upper body to one side, but our bike is leaning to the other side. We remain balanced and cannot resist the centrifugal force of cornering (Fig. 3).

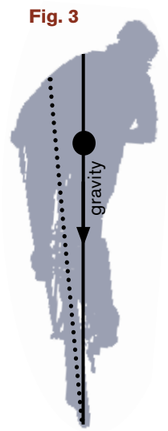
If we could just shift our body weight to change the lean of the bike, it would be easy to balance a bike that is standing still. For most of us, it is impossible to balance a stopped bike because we cannot move the wheels sideways to rotate the bike upright as it falls. (Experienced riders who "trackstand" actually roll back and forth slightly with their front wheel turned sideways. They are countersteering, but instead of going forward and steering right and left, they just steer one way and go back and forth to balance the bike.)

Stability:

Bikes are self-stable because gyroscopic forces and other factors turn the front wheel so that it automatically countersteers to correct changes in lean angle. This means that if you don't provide any input, your bike tends to continue to corner on the same radius. (On the straight, it will continue to go straight.)

When we have fully leaned the bike into the left turn, we simply stop the rightward pressure on the handlebars. The bike stabilizes at its current lean angle and rounds the corner.

Fig. 3



Straightening:

To upright the bike at the exit of the left turn, we simply push the handlebars to the left into the corner. Now the wheels move left, and the bike rotates until it is again upright (Fig. 4).

ILLUSTRATIONS BY GREG SIPLE

Then we are riding on the straight again. We continue to keep the bike upright by countersteering until we need to lean into the next corner.

Fig. 4

Training Wheels:

Many children's bikes are sold with training wheels, which prevent the bicycle from falling over. Unfortunately, they also prevent the bicycle from leaning. They effectively convert the bicycle to a tricycle, which requires the opposite steering input from a bicycle. On a bicycle, we countersteer and push the handlebars to the left when we want to turn right. On a tricycle, we steer and push the handlebars right when we want to turn right — the exact opposite of what we do on a bicycle.

If you ever have the opportunity to ride an adult tricycle, you will be surprised how hard it is to unlearn the instincts of riding a bicycle. Make sure you have enough room and no obstacles!

The reverse is also true. Children have a hard time unlearning the instincts of steering a tricycle when the training wheels are removed. From experiences among my neighbors, children who had training wheels took longer and fell more often as they tried to ride a two-wheeler than those who did not use training wheels.

To teach children balancing on two wheels, you can use a balance bike, which children power by pushing off the ground with their feet. You can create a makeshift balance bike by removing the pedals from the child's bike and lowering the saddle. Or have them ride a scooter. These vehicles allow children to learn countersteering without risking falls because kids push off the ground with their legs as they move along. As they become more confident, they can coast longer and longer, until they are ready to balance all the time and ride a bicycle. (For safety make sure the balance bike has brakes.)

Tips for Confident Cornering:

Cornering can be daunting to some riders who may feel like they are falling over as they lean the bike. It may help to visualize that cornering uses the same mechanisms as riding straight. In both cases, we balance the wheels to stay above the center of gravity except that the "local gravity" now is inclined (Fig. 5). Our bike is as stable in mid-corner as it is on a straight path. And the faster you go, the more stable your bike becomes because the self-stabilizing gyroscopic forces of the wheels increase with speed (Fig. 5).

To corner confidently, relax your grip on the handlebars. Your bike is self-stabilizing even as it leans, as long as the front wheel can move in response to changes in lean. A "death grip" on the handlebars prevents the self-stabilizing forces of the bike from working and makes your bike less stable. A light touch is best to guide your bike.

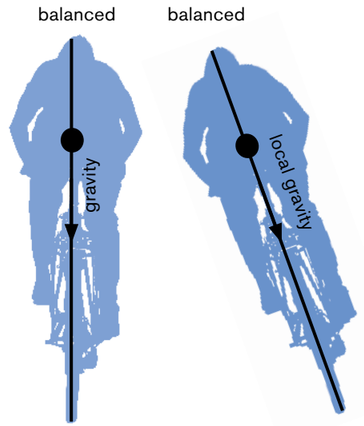
Look where you want to go. If you focus on the obstacle you are trying to avoid, you have to steer the bike in your peripheral field of vision. It is much easier to focus your attention on the path you want to take. The bike is likely to follow. (Use this technique on the straights as well.)

Ride with an experienced cyclist and follow their line. Ask them to keep the speed down at first. You will be surprised how far you safely can lean the bike on most surfaces.

Conclusion:

Cornering is so intuitive that we are not even aware of the process. We countersteer by pushing the handlebars toward the outside of the turn, which leans the bike into the turn. We reverse the process to upright the bike and go straight again. This same countersteering enables us to balance on the straights. AC

Fig. 5



Jan Heine is editor of Bicycle Quarterly, *a magazine about the culture, technology, and history of cycling. This article is adapted from a more detailed article published in the Winter 2010 issue (www.bikequarterly.com).*