



Descending on a bicycle requires a combination of skills that are more commonly used in motorcycling. When descending, a bicycle has some of the power and speed that is more common with motorcycles, and it requires some of the same skills. This does not mean that criterium racing doesn't also challenge these skills that require a combination of lean angle and braking while choosing an appropriate line through curves. However, you don't need to be a racer to understand and practice some of the following skills. Finding out that you are in way over your head part-way through a descent on a mountain pass is no way to enjoy a tour.

Unlike motorcycle tires, bicycle tires have little margin for slip, so that even a small slip, on pavement, is usually unrecoverable. Understanding the forces involved and how to control them comes more naturally to some riders than others.

Drifting a Road Bicycle on Pavement

Some riders claim that one can slide on dry pavement to achieve greater speed in a curve as in drifting through a turn. Drift means to slide both wheels, which is even more challenging. I believe this is pure wishful thinking and may come from observing motorcycles that can apply power when banked over at their maximum lean angle to partially break traction.

A bicycle can be pedaled only at lean angles far less than the maximum without grounding a pedal, so that hard cornering is always done coasting, so there is no power to be applied in the curve. Besides, bicycle tires have no margin for recovering a slip at the critical angle - that has been measured by lean-slip tests on roads and testing machines. In these tests, the slip out (at slightly less than 45 degrees from the road surface) for smooth tires on pavement was found to be precipitous and unrecoverable.

How to Corner

Cornering is the skill of anticipating the appropriate lean angle with respect to the ground before reaching the apex of the turn. The angle to the road surface is the critical parameter and it is limited by traction. This requires the rider to have an eye for velocity and traction. For most pavement this is about 45 degrees in the absence of oil, water, or other smooth and slick spots. So, if the curve is positively banked 10 degrees, a lean of up to 55 degrees from the vertical is possible. In contrast, a crowned road with no banking, where the surface falls off about 10 degrees, would allow only 35 degrees (at the limit).

Estimating the required lean angle for a curve is derived from the apparent traction and what the speed will be in the apex of the turn at the current rate of braking. Anticipating the lean angle is something humans, animals and birds do regularly in self propulsion. When running, anticipating how fast and sharply one can turn on a sidewalk, dirt track, or lawn is readily done by most people. This requires an estimate of the lean for the conditions and appropriate speed control to not exceed that angle. Although on a bicycle the consequences of error are more severe, the method is the same.

These are reflexes that are developed by most people in youth, but some have not exercised them in such a long time that they don't trust their skills. A single fall strongly reinforces this doubt. For this reason, it is best to improve and regenerate these abilities gradually through practice.

Countersteer

Countersteer is a popular subject for bicyclists and motorcyclists who belatedly discover, or rediscover how to balance, it is a contrived subject. A two wheeled vehicle can only be balanced or turned using countersteer, there is no other way to do it. It is how a broomstick is balanced on the hand, or a bicycle on the road. The point of support is moved beneath the mass to align with the combined force of gravity and the cornering force.

That this requires steering skills should be evident. To make a hard turn to the right for example, the rider must first make a quick turn to the left. This causes the bike and rider to lean out to the right. Now the handlebars can be turned right, and the lean is correct for the right turn. This can also be reapplied part-way through a turn to achieve an even greater lean angle and an even tighter turn. Nonetheless, exceeding the traction limit of your tires must always be kept in mind.

Braking

Once the basics of getting around a corner are in place, the big difference between being fast and being faster is another problem entirely. How the brakes are used before and in curves makes the difference between the average rider and the fast one. When traction is good, the front brake can be used almost exclusively because, with it, the bicycle can slow down so sharply that the rear wheel carries no weight.

Threshold Braking

When braking to the point of rear wheel lift-off, the rear brake is obviously useless. Once in the curve, more and more traction is used by the lean angle, although braking continues to trim speed. This is done with both brakes, because now neither wheel has much traction to spare. To develop a feel for rear wheel lift-off, practice hard front braking at a low and safe speed. In *Cycling 101* we call this *Threshold Braking*. Essentially the rear braking wheel is used as an indicator of when you are approaching the limit of total braking. In practice, apply the rear brake just enough for a gradual stop. Now apply the front brake and continue to apply more and more pressure until the back wheel begins to lose traction. That becomes your threshold of braking – which, if measured, would be about 0.5 G.

Braking in Corners

Why brake in the turn? If all braking is done before the turn, speed will be slower than necessary early in the turn. Because it is impossible to anticipate the exact maximum speed for the apex of the turn, and because the path is not a circular arc, speed must be trimmed all the way to the apex of the turn. Fear of braking in curves usually comes from an incident caused by injudicious braking. The use of the front and rear brake must be adapted to the conditions.

When riding straight ahead with good traction, substantial weight transfer from the rear to the front wheel is permissible, allowing strong use of the front brake. When traction is poor, deceleration and weight transfer is small, so light braking with both wheels is appropriate. If traction is miserable, only the rear brake should be used, because although a rear skid is recoverable, one in the front is generally not.

Estimating the required lean angle for a curve is derived from the apparent traction and what the speed will be in the apex of the turn at the current rate of braking. Take for example a rider cornering on good traction, leaning at 45 degrees that equals 1 G centrifugal acceleration. Adding 1/10 G braking hardly increases the traction load on the tires, which is given by the square root of the sum of the two accelerations squared, $\text{SQRT}(1^2+0.1^2)=1.005$ or an increase of 1/2%. In other words, there is room to brake substantially during maximum cornering. Because the lean angle changes as the square of the speed, braking can rapidly reduce the lean angle and allow even more braking. Therefore, there should be no doubt as to why racers are nearly always applying both brakes at the apex of high-speed turns.

Suspension

Beyond lean and braking, suspension helps substantially in descending. For bicycles without built-in suspension, this is furnished by the legs. Standing up is not necessary on roads with fine ripples, merely taking the weight off the pelvic bones is adequate. For rougher roads, there must be enough clearance, so the saddle carries no weight. The reason for this is twofold. Vision will become blurred if the saddle is not unloaded, and traction will be compromised if the tires are not kept in contact with the road while skimming over bumps. The ideal is to keep the tire on the ground at uniform load.

Lean the Bicycle, the Rider, or Both

Some riders believe that sticking the knee out or leaning the body away from the bike, improves cornering. Sticking out a knee is the same thing that riders without cleats do when they stick out a foot in dirt track motorcycle fashion. It is a useless but reassuring gesture that, on uneven roads, even degrades control. Any body weight that is not centered over the bicycle (leaning the bike or sticking out a knee) puts a side load on the bicycle, and side loads cause steering motions if the road is not smooth. Getting weight off the saddle is also made more difficult by such maneuvers.

To verify this, coast down a straight but rough road standing on one pedal with the bike slanted and note how the bike follows an erratic line. In contrast, if you ride centered on the bike you can ride no-hands perfectly straight over the same road. When you lean off the bike you cannot ride a smooth line over road irregularities, especially in curves. Centered over the bike gives the best control,

Outside Pedal Down

It is often said that putting the outside pedal down in a curve improves cornering. Most experienced riders do this, but not because it has anything to do with traction. The reason is that it enables the rider to unload the saddle while standing with little effort on a locked knee, and this can only be done on the outside pedal because the inside pedal could hit the road. However, standing on one extended leg does not work if the road is rough, because a stiff leg cannot absorb road bumps nor raise the rider high enough from the saddle to avoid getting bounced. Rough surfaces require rising high enough from the saddle to avoid hard contact while the legs supply shock absorbing knee action, pedals horizontal.

Vision

Where to direct vision is critical for fast cornering. Central vision involves mostly the cones in the retina of the eye. The cones are color receptive and interpreting their images takes more time than information received by the rods in the peripheral vision. For this reason, central vision should be focused on the pavement where the tire will track, while looking for obstacles and possible oncoming traffic with peripheral vision that is fast, black and white, and good for motion detection.

If central vision is directed at the place where an oncoming vehicle or obstacle might appear, its appearance will bring image processing to a halt for a substantial time. Because the color or model of car is irrelevant, this job can be left to peripheral vision in high-speed black and white, while concentrating on the surface and curvature of the pavement. Essentially, look where you want to go.

Many riders prefer to keep their head upright in curves, although leaning the head with the bicycle and body is more natural to the motion. Pilots who roll their aircraft do not attempt to keep their head level during the maneuver, or in curves, for that matter.

The Line

Picking the broadest curve through a corner may be obvious by the time the preceding skills are mastered but that isn't always the best line either for reasons of safety or the road surface. Sometimes it is better to hit a bump or a "Bott's dot" than to alter the line, especially at high speed. Tires should be large enough to absorb the entire height of a lane marker without pinching the tube. This means that a minimum of a 25mm cross section tire is advisable. At times, the crown of the road is sufficient to make broadening the curve, by taking the curve wide, counterproductive because the crown restricts the lean angle.

Mental Speed

Mental speed is demanded by all of these. However, being quick does not guarantee success, because judgment is even more important. Above all, it is important to not be daring, but rather to ride with a margin that leaves a feeling of comfort not high risk. Just the same, do not be blinded by the age-old presumption that everyone who rides faster than me is crazy. "He descends like a madman!" is one of the most common descriptions of fast descenders. The comment generally means that the speaker is slower.

Our intent for this article was not to turn any of you into racers, but more to understand the dynamics of descending, braking, and cornering on a bicycle. As stated earlier, finding out part way through a curve on a mountain pass that you should have practiced your descending and braking skills is no way to enjoy a ride.