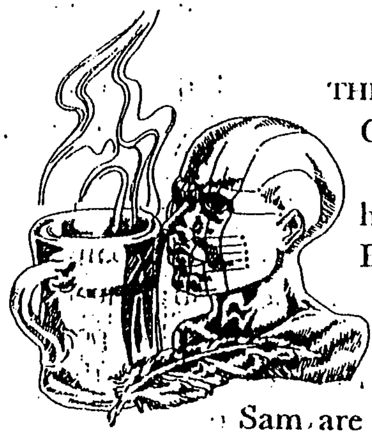
The Roadrunner Triumphs Again



THE ROADRUNNER AND Wile E. Coyote are two of the many popular cartoon characters to have come out of the Warner Brothers studios in the period from the 1930s to the 1950s. Daffy Duck, Bugs Bunny, Elmer Fudd and Yosemite Sam are some of the others, but the Roadrunner and Coyote are unique in that physics plays a key role in their stories.

The Roadrunner/Coyote cartoons are, of course, just endless variations on the theme that the Coyote can never catch the Roadrunner, and in devising more and more complex schemes to trap the elusive bird, he succeeds only in injuring himself in more and more

bizarre ways. Most of the time it's because physics is violated: things happen in the cartoons that cannot happen in the real world, and we laugh. The Coyote releases the catch to launch a boulder from a huge catapult, and the rock, rather than rocketing off into the air, barely clears the catapult and lands right on top of the Coyote. So the next time, he carefully positions himself on the other side of the catapult, out of the path of the stone. But when he releases the catch, the *catapult* flips over the stone and lands on the Coyote's head.

My favourite scenes are those in which the Coyote runs off the edge of a cliff (a gag that's used in many other cartoons as well). In one particular Roadrunner cartoon, the Coyote rents an Acme Super Outfit (his equipment always comes from the Acme company), speeds up to the edge of a cliff and leaps straight out over the chasm below, striking a Superman-like pose. He then slows, stops dead in mid-air, pauses, then plummets straight down like a stone. Sometimes the critical factor in these scenes is the Coyote's realization that he's hanging in mid-air—he's safe until he looks down and sees that he's three hundred storeys up. Only then does he fall.

We laugh because the idea that you could run straight off the edge of a cliff, then fall straight down is, well, laughable. Or is that really why we're laughing?

Five percent of high-school and university students surveyed think that's exactly what happens if you run off a cliff. Five percent isn't much — that still means the vast majority realizes that the Coyote's straight-out then straight-down path *is* a cartoon view of the world. However, more than a third of that sensible majority of students (and so maybe half of the general population) opt for something more realistic: the Coyote would actually go straight out for a while, gradually start to curve down as his outward force diminished, then fall straight down as gravity asserts itself. Much more reasonable, but unfortunately just as wrong.

What path does the Coyote take over the cliff? A constant curve downwards, a path that combines two motions in one. He is always moving away from the cliff, although ever slower because of air resistance, and he's accelerating downward because of gravity. But gravity doesn't have to wait for him to start to lose his horizontal speed — it starts acting the moment he's over the edge of the cliff. The Coyote moves out and down at the same time.

Not only do large numbers of people have no idea what would really happen if the Coyote ran off the edge of a cliff, but amazingly enough, many of them explain their wrong answers in exactly the same terms medieval philosophers would have used.

Straight off the cliff then straight down is just what

the Arab philosopher Avicenna would have predicted in the eleventh century. The idea that the Coyote might go straight for just a little while, then curve gently and finally fall straight down is more modern — it didn't become really popular until the fourteenth century. The philosopher Albert of Saxony would have agreed with this description — it fit very nicely a theory that he and others in the thirteen hundreds espoused, called the "impetus theory."

According to this theory, something that is flying through the air contains impetus put into it by whatever caused it to start flying in the first place. A spear contains impetus imparted to it by the movement of the spearthrower's arm. As the impetus gradually wears away, or leaks out, the spear slows down and gravity takes over. Wile E. Coyote runs off the cliff carrying with him an abundance of horizontal impetus, acquired by pushing his feet against the ground with every step. The impetus theory then predicts he'll continue horizontally for a while, followed by a gradually curving period, as the impetus wears off and the effects of gravity begin to be felt. Then, finally, there's only gravity — the impetus has run out — so the Coyote falls straight down. It sounds pretty reasonable.

It took until the seventeenth century for first Galileo, then Newton, to show that the theory was completely wrong. There is nothing called "impetus" that enters the spear before it's thrown or the Coyote before he runs over the cliff. Newton turned the whole thing around in his first law of motion by saying that there doesn't have to be a force continually acting on moving objects. In fact it's the reverse. An object in motion will continue to move — forever — until an outside force (usually friction) slows it down. By putting the onus on stopping an object rather than keeping it going, Newton changed the whole approach to the problem. But somehow three hundred years later, we still haven't got the message, and there are many other examples besides the Roadrunner and the Coyote to prove it.

Imagine there's a piece of plastic tubing lying on a pool table, the sort of tube that is attached to the back of your clothes dryer to carry the hot air outside the house. This particular tube is bent into a gradual curve, so that if you take a billiard ball and throw it in one end, it'll follow the curve of the tube and exit heading in a new direction. The question is, what sort of path across the table will the ball follow once it's left the tube?

There are several reasonable alternatives: the ball might continue to curve as it was inside the tube, or it'll curve for a while, then straighten out, or it might start to travel in a straight line the moment it leaves the

tube. If you predicted any sort of curve, you were reverting to the fourteenth century. And again, this is a widely held belief — about 50 percent of students polled believe the ball will continue to curve. They apparently think the ball contains a supply of curved impetus. Newton would have known the right answer — once it's clear of the tube, the ball rolls straight, because there's no longer anything preventing it from doing so.

Take another example. You're given that same billiard ball to hold, and you're asked to walk rapidly across the floor to a spot where there's an X marked, and without stopping, let the ball go so that it hits the X as you walk over it. When do you let it go: before you've reached the X or just as your hand with the ball is directly over it or just after you've passed it? Of a group of high school and college students surveyed, 50 percent thought you should let the ball go when you're right over the target.

The students' own accounts of what is happening reveal how they are still in the grip of the impetus theory. They explain that the ball would acquire some sort of horizontal motion if it were thrown, but not if it's passively carried. In their minds, a ball held in the hand acquires no impetus or velocity, and will drop straight down no matter how fast you're walking. Of course they are wrong. The ball is travelling at the same speed forward as you are, and you must let it go before you are over the X because it will continue to travel forward as it falls.

One of the curious things about this phenomenon is that children are actually better at coming up with the modern concepts when they're in kindergarten than they are later on. The combination of learning in the formal setting and becoming more familiar with the world around them somehow takes them away from modern physics and back to the Middle Ages — a little odd when you consider that children, of all people, have to know these things in their daily lives. Whether it's innocent activities, like running and bouncing a ball at the same time, or delinquent, like figuring out the ballistics of stones from a slingshot, knowledge of the movement of things is part of every kid's life. Yet while they're perfecting these actions daily, the understanding of them is slipping away.

What does this all mean? Well, obviously people can live their lives perfectly well without having the vaguest idea of how things move. It also proves that Galileo and Isaac Newton, two of the most outstanding scientists of all time, have made almost no impression at all on most people. Newton might be remembered for his apple, Galileo for dropping things from the Tower of Pisa, but that's about as far as it goes.

Let's not be depressed, though — there is a positive

side to this. If you are one of those people who drops the ball directly over the target or thinks that you could run straight off a cliff, coast for a while and then drop straight down, you can at least take heart from the fact that you would have been right at home discussing concepts of motion with some of the most prominent philosophers of the Middle Ages. The ideas of Avicenna, Albert of Saxony, and even Aristotle, live on in your thoughts.

If you enjoyed this chapter, there are more like it on different topics in *The Science of Everyday Life* by Jay Ingram. You may check the book out of our library.