The Hudson River Illusion:

How the Optical Illusions behind "Anti-Gravity Hills" Affects the River that Flows Two Ways

by,
David J. Jackowe, MD

The Hudson River looks tilted. Stand on top of Main Street in Irvington—or the many other hill tops along the Hudson Valley— and look out across the river. From the heights, the level Hudson seems to slant up to the opposite shore. (Figs. 1 and 2) This phenomenon, where level surfaces appear to slope, has been described on almost every continent around the world, and its effects are often bewildering: Cars roll uphill. Streams flow up mountainsides. Known as "Spook Hills" or "Anti-Gravity Hills," these places have been explained by local lore often embellished with scientific or supernatural undertones. At the "Gravity Hill" outside San Francisco, California, cars left in neutral are pulled uphill by subterranean iron deposits that augment the Earth's magnetism, while on a roadway outside Philadelphia, Pennsylvania, gravity is altogether absent. In Hawaii, there is a "Spook Hill" in the Pali Mountains, where for locals, the explanation is more religious: The roadway paved over a holy site, and angry spirits now push cars off the sacred ground.

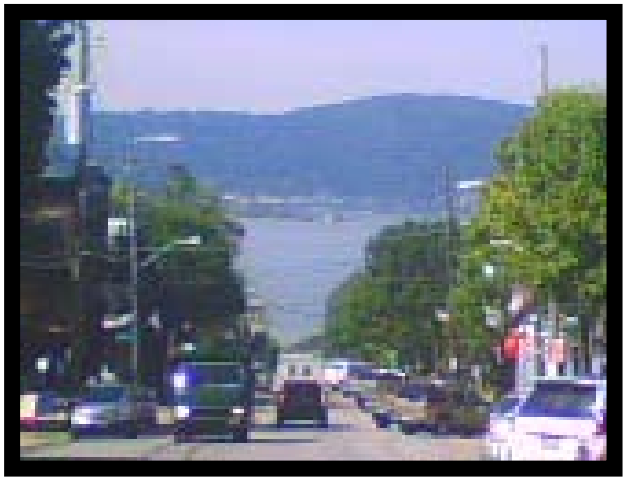

Figure 1. Looking west from the top of Main Street in Irvington, the Hudson appears to slant uphill from its east bank.

Science offers a different theory: Optical illusions. A person determines slant by referencing eye level relative to the direction of gravity, a process known as Gravity-Referenced-Eye-Level (GREL). For example, when looking out at the ocean from the beach, the brain processes the horizon, as perceived by the eyes, with the pull of gravity, as determined by the inner ear, and the result is—omitting the occasional wave and swell—a level sea. But sometimes, things get complicated. Topographic cues, such as nearby hills, the angle of tree trunks, and distant mountains convoluting the horizon line, all influence how the eye judges horizontal. Processing these topographic cues is known as Surface-Referenced-Eye-Level (SREL). When SREL sufficiently influences GREL, the result may be curious optical illusions, such as a slanted Hudson River.

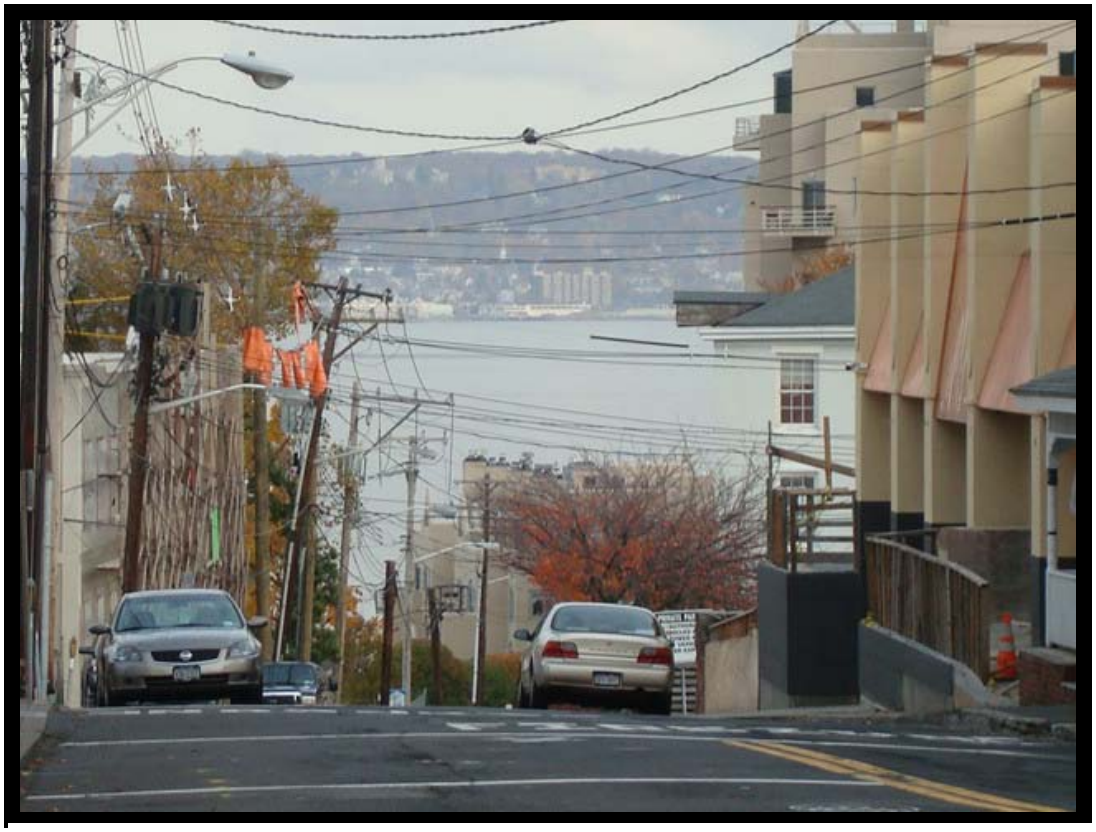

Figure 2. Looking east from Main Street in Nyack, one of many hilltops from which the Hudson appears tilted.

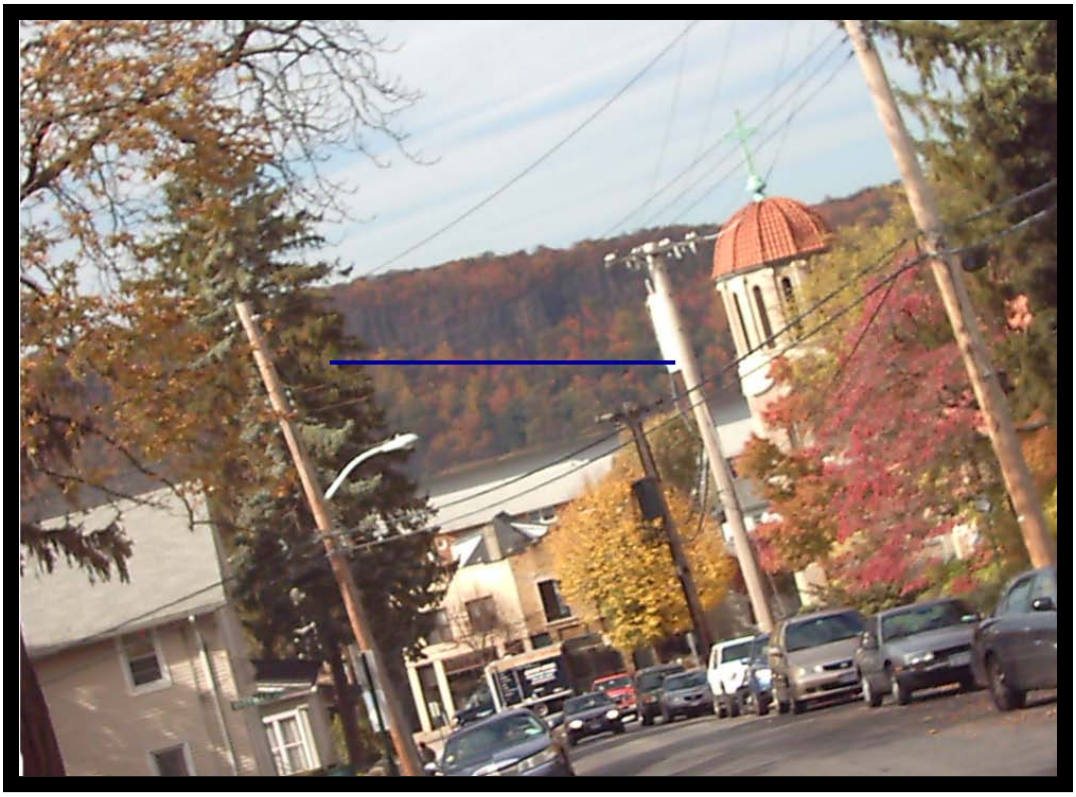

Figure 3. Which end of the blue line is higher? Based on the illusions designed by Shimamura and Prinzmetal, this photo of Villard Avenue in Hastings-on-Hudson has been rotated approximately 15 degrees. Although perfectly horizontal, it is easy to misperceive the blue line as slanted. Like the downhill cues that line Main Street in Irvington, the rotated photo makes its difficult to accurately gauge a level surface.

This phenomenon has been the subject of several scientific studies, with researchers agreeing that optical illusions are at work. In 1999 a group from the Department of Psychology at the University of California, Berkely, determined that the ability of subjects to accurately judge a level surface is distorted when shown pictures with a tilted background.[1] (Fig. 3) In 2003, a team lead by the self-proclaimed mysteries investigator and organic chemist, Luigi Garlaschelli (the same scientist who, in 2009, recreated the shroud of Turin in his lab using only materials available in medieval Europe) went so far as to build models of spook hills.[2] In Garlaschelli's experiments, two wooden boards were placed in sequence inside a viewing box whose interior had been painted with a realistic landscape. It was even fitted with model trees and bushes. A viewing hole was cut directly in front of the boards, and a horizon painted on the opposite

wall. The boards were then positioned at different angles relative to one and other. The Hudson River illusion seems to be a case covered by Garlaschelli's experiment in which a horizontal stretch preceded by a downhill was perceived as uphill by all subjects: When the first board was angled steeply down, and the second, placed either horizontal or slightly down, observers watched in amazement and in some cases, terror, as objects seemed to roll "up" the second board.

Figure 4. A real "Spook Hill" in Arricia, Italy. The horizontal farther stretch of road is misperceived as running uphill. *From Bressan, et. al.*

Like a "Spook Hill," the Hudson is a long horizontal stretch preceded by a downhill. Looking west from the top of Main Street in Irvington, the steep slope of the tree-lined road, the rooftops, and the looming Palisades, all prompt SREL to perceive a false horizon at the foot of the hill, and eye level to be at the river's western shore. True eye level, about half-way up the Palisades, is distorted, and as the only thing that is

normally found beyond any horizon is the sky, the river slants "up" to meet the brain's expectations. (Fig. 5)

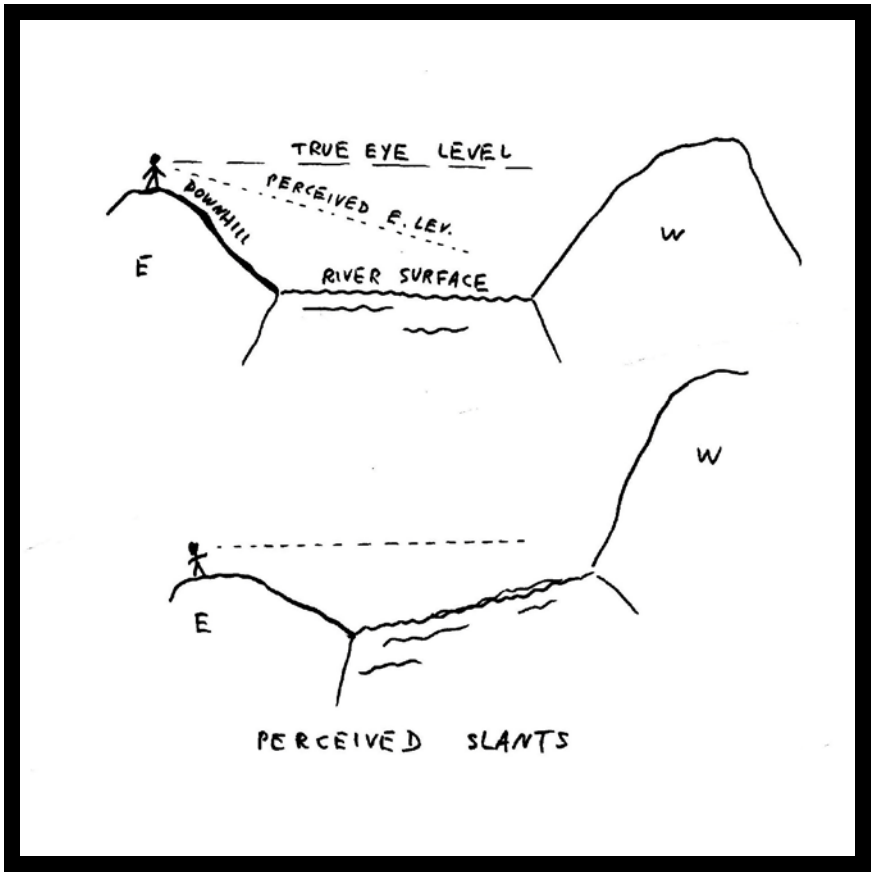

Figure 5. When an observer looks across the river from a downhill, the perceived eye level is biased. The result is that the downhill stretch looks slightly less slanted, and the river surface looks like an uphill.

It is easy enough to experience this for yourself: Just drive down Irvington's Main Street—or any other hill in the Hudson Valley with a clear view of the river. As you do, pay attention to how the Hudson seems to level off as the downhill cues vanish. And of course, remember this, too: although ghosts and geomagnetic disturbances may be more thrilling, it is the synergy of brain and topography that creates the illusion of an uphill where it does not exist, and another curious dimension to a river that already flows two ways.

References

1. Shimamura AP and Prinzmetal W. The Mystery Spot Illusion and its Relation to Other Visual Illusions. *Psychology Science*, 10 (1999), 501-507.

2. Bressan P, Garlaschelli L, Barracano M. Anti-Gravity Hills are Visual Illusions. *Psychology Science*, 14 (2003), 441-449.