

The Science of the One-Inch Punch

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{ Brother Steve Todd sent this in. Thanks Steve! }

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The Science of the One-Inch Punch

Physiology and neuroscience combine to explain Bruce Lee’s master move.

By William Herkewitz

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Forget all those broken boards and crumbled concrete slabs. No feat of martial arts is more impressive than Bruce Lee's famous strike, the [one-inch punch](#). From a single inch away, Lee was able to muster an explosive blow that could knock opponents clean off the ground. Lee mastered it, fans worldwide adored it, and [Kill Bill "borrowed" it](#). But if you're like us, you want to know how it works.

While the biomechanics behind the powerful blow certainly aren't trivial, the punch owes far more to brain structure than to raw strength.

Biomechanical Breakdown

To understand why the one-inch punch is more about mind than muscle, you first have to understand how Bruce Lee delivers the blow. Although Lee's fist travels a tiny distance in mere milliseconds, the punch is an intricate full-body movement. According to Jessica Rose, a Stanford University biomechanical researcher, Lee's lightning-quick jab actually starts with his legs.

"When watching the one-inch punch, you can see that his leading and trailing legs straighten with a rapid, explosive knee extension," Rose says. The sudden jerk of his legs increases the twisting speed of Lee's hips—which, in turn, lurches the shoulder of his thrusting arm forward.

As Lee's shoulder bolts ahead, his arm gets to work. The swift and simultaneous extension of his elbow drives his fist forward. For a final flourish, Rose says, "flicking his wrist just prior to impact may further increase the fist velocity." Once the punch lands on target, Lee pulls back almost immediately. Rose explains that this shortens the impact time of his blow, which compresses the force and makes it all the more powerful.

By the time the one-inch punch has made contact with its target, Lee has combined the power of some of the biggest muscles in his body into a tiny area of force. But while the one-inch punch is built upon the explosive power of multiple muscles, Rose insists that Bruce Lee's muscles are actually not the most important engine behind the blow.

"Muscle fibers do not dictate coordination," Rose says, "and coordination and timing are essential factors behind movements like this one-inch punch."

Because the punch happens over such a short amount of time, Lee has to synchronize each segment of the jab—his twisting hip, extending knees, and thrusting shoulder, elbow, and wrist—with incredible accuracy. Furthermore, each joint in Lee's body has a single moment of peak acceleration, and to get maximum juice out of the move, Lee must layer his movements so that each period of peak acceleration follows the last one instantly.

So coordination is key. And that's where the neuroscience comes in.

Martial Arts Neuroscience

In a 2012 study, Ed Roberts, a neuroscientist at Imperial College London, compared the punching strength (at a range of slightly less than 2 inches) between practitioners of karate and physically fit people with similar amounts of muscle who do not practice martial arts.

“The first thing we found was that karate experts can punch much harder than normal, untrained people. Which isn't exactly what you'd call Nobel Prize-worthy work,” he says.

But Roberts also discovered that for the karate practitioners, muscle alone didn't dictate strong punches. Rather, when he used motion-tracking cameras to track the puncher's joints, he found that strikes that synchronize the many peak accelerations in one complex move—like Bruce Lee's—were also the most powerful.

And when Roberts took brain scans of his study's participants, he also found that the force and coordination of each participant's two-inch punch was directly related to the microstructure of white matter—the substance that manages communication between brain cells—in a part of the brain called the supplementary motor cortex. This is important, because this brain region handles the coordination between the muscles of the limbs, which close-range punches rely on. The altered white matter allows for more abundant or complex cell connections in that brain region, Roberts says, which could increase the puncher's ability to synchronize his or her movements.

So Bruce Lee owes his master feat in part to a beefed-up glob of white matter. But that doesn't diminish the grandeur of the one-inch punch one bit. Like his muscles, Lee earned his brainpower the hard way, with many years of practice. Roberts says the white matter changes in his study's participants can be traced to the concept of neuroplasticity—the brain's ability to fundamentally rewire itself to cope with new demands. The more karate experts practiced these coordinated moves, the more the white matter in their supplementary motor cortex adapts.

Of course, neuroplasticity diminishes with age, so it's better if they start young. In the words of an ancient Chinese proverb, “The best time to plant a tree was 20 years ago. The second-best time is now.”