TECHNICAL NOTE

Self-defense is not an emotional reaction. It is a conditioned and measured response to a threat.

The Force Equation

by Don Adams

Throwing a Self-Defense Strike

It's natural, when training, to throw a strike in self-defense, to judge the result by how much force we generate on impact – whether perceived or measured. A seemingly reasonable conclusion would be that to improve our strike quality, we need to develop the corresponding muscle group to generate more force.

The Haymaker

If you have ever watched a You Tube video of a street fight or seen one in person, you will notice that most strikes in this situation take on a wide rounded arcing path on its way to the target. This is called a Haymaker. The thinking is that a closed hand traveling on a wider arc toward its target has more time to generate a greater speed thus maximizing its impact. That's what most people might think, but is it true? A Haymaker is often thrown with aggression immersed in emotion.

The Shortest Path Between Two Objects

To throw a strike we have a choice: a wide arcing path or a "straight" more direct path. The shortest route between two objects is a straight line. The straight path is the shortest, but some might conclude that it will generate a weaker strike.

There's a time component to this, but it might not be the one you're thinking.

The path around a circle (the circumference) is calculated as $2\pi r$. Where π is measured for our purposes as 3.14 and "r" is equal to the radius of the arch. A semicircle, whose angle is measured as 180º, is $2\pi r/2$ or πr. The straight-line distance of the strike is simply the radius of the arch "r." So, we have to ask, how many direct strikes (straight-line) strikes could a person theoretically throw in the time one person could throw a Haymaker? That answer would be $\pi r/r$ or simply π or 3.14 strikes…theoretically. So, does that mean we sacrifice power for quantity?

F=ma

F=ma is known as the force equation. "F" is the force we generate, and "m" is the mass of an object traveling at a certain rate of acceleration, "a".

When looking at this from a self-defense perspective, what are the variables we can control to make our strike have a greater impact? We can certainly strike quicker, thus generating more acceleration and thereby generating more force. But can we change the mass of what we are striking with, i.e. a foot or a hand? I would suggest the answer is yes *and* no. While we certainly can't instantaneously increase the mass of our individual hand or our foot, we can control the totality of the mass that is accelerating toward our target.

More Mass Equals More Force

The arm is made up of the hand, forearm, and the brachium (that section of the arm between the elbow and the shoulder). The mass component of the generated force is the mass that is traveling in a direct path to make an impact with the target. So, in a Haymaker, it is essentially the mass of the hand. The

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arm in this example helps to just generate acceleration. The mass of the hand is finite.

Remembering that the resulting force generated is determined by the mass traveling in the direct path to make an impact with the target. In a direct self-defense strike, what mass are we measuring? The hand, certainly, but also the forearm, the brachium, and we can even extend that mass to include the shoulder, the upper torso, the hips, and the legs as well. Intuitively, we know that's a lot of mass, and much more than what's generated by haymaker. Which type of strike do you think will generate more force?

Acceleration is the Rate of Change in Velocity

Have you ever watched an ice skater start a spin as part of their routine? Their arms are outstretched gracefully. Their head is hung back and as they begin to bring their arms closer to their body, they spin faster and faster until they reach a dizzying rate of spin.

The scientific principle of this is the conservation of angular momentum. Explaining that principle would take more words and then we would still be right where we are now, so for our purposes all we need to know is that an ice skater will spin faster as she moves her arms inward and generate a greater angular velocity, and when we speak of a change in the rate of angular velocity we are talking about angular acceleration. [OK - Angular momentum is conserved by an increase in the moment of inertia and a decrease in angular velocity or a decrease in the moment of inertia and an increase in angular velocity.]

So, going back to our definition of acceleration, can we develop a greater change in velocity with a hay maker or a shorter direct strike? I think the answer is obvious, a direct strike. But we don't rotate like ice skaters…but, then again, we do in a way.

Bodily Rotation

Look at yourself in a mirror and imagine a red line down the center of your body starting at the middle of your forehead, down over your nose, over your sternum, down your belly and to the floor exactly in the middle of the distance between your feet.

We mentioned earlier, in a direct strike we can increase the mass in the Force Equation by adding our shoulders/upper body, our hips, legs and feet to deliver a strike. All that movement rotates around the center line of our bodies.

Thus, we can harness the physics of angular momentum in our self-defense.

**This is physics. It's theoretical in a perfect world without any outside influence. Humans don't live in a perfect world, and we *are* subject to external influences. Therefore, our results will never be perfect, but by using these principles, we can achieve maximum impact given current conditions.

Take-Aways

1. Throw a strike as close to your body as possible for the greatest acceleration.
2. Use as much of your body as available to the specific technique.
3. Rotate around the centerline of your body.
4. Using all the mass available will, with the greatest amount of acceleration, will yield a strike with the greatest impact.