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### Recoil vs. Follow-Through

Which punching technique produces more force causing more damage to the recipient, the recoiled “snapping” punch or the follow-through punch? This is a topic of argument ages old among Martial Artists, thus the development of the many different styles of Martial Arts and punching techniques. Theories are abundant; however, I hope to use Physics to answer this timeless question.

What is the difference between a recoil and a follow-through punch? Any punch can use either the front arm, much like the jab, or the back arm, such as the reverse punch. The position of the arm is not what makes the recoil punch different from the follow-through. The recoil punch whips out (snaps) at the last moment before impact and withdraws instantly (recoil). Bruce Lee made this concept famous with his 1-inch punch. He also utilized the concept of putting your body into the punch to increase mass, but I will save that issue for another paper. Follow-through relies totally on the commitment of the punch. Contact is not broken until the receiving body has lost balance and fallen or moved beyond reach. Heavyweight boxers such as Tyson, Jim Jefferies, Joe Louis, Dempsey, Frazier, Foreman, and Marciano rely/relied on this type of punch for their TKOs. Follow-through jars opponents and if landing in just the right spot can win the fight. Recoils no matter where they land have the ability to break bones and cause internal injuries that can be fatal.

While it is not necessary to conduct an experiment to answer the above question, I feel that it is worth the time to demonstrate the effect and provide tangible proof supporting my statements. I used an accelerometer to measure the velocity and force of each punch. An accelerometer is an electronic device used to measure non-gravitational acceleration, in this case a linear straight punch. It can measure vibrations, shocks, impacts, and motion. With the use of an accelerometer and graphing program, I am able to chart the differences in velocity and force between the two punches. The accelerometer I am using measures the force of the punch in g-force. \*Note: The numbers shown on the graphs attached is the score the accelerometer gives. The score is G-force \* 2.

The first table shows five separate follow-through punches over a time period of 25 seconds at a distance of 24 inches (0.6m) from target and the second table shows the recoil punch. Time = Time to Reach the Target + Reaction Time. Velocity = Distance/Time. I obtain an average time, force and velocity for each type of punch by dividing the sums by five. I also converted g-force into Newtons using a conversion chart provided by the makers of Herman (accelerometer used in experiment). See attachments for conversion chart and graphs.

### **Follow-Through Punch**

	1 <sup>st</sup> Punch	2 <sup>nd</sup> Punch	3 <sup>rd</sup> Punch	4 <sup>th</sup> Punch	5 <sup>th</sup> Punch	Averages
Time (s)	.67	.99	.65	.74	.72	0.8
Velocity(m/s)	0.9	0.6	0.9	0.8	0.8	0.8
Force (G)	22.1	23.8	27.5	17	23.8	22.8
Force (N)	~215.6	~230.3	~269.5	~166.6	~230.3	~222.5

### Recoil Punch

	1 <sup>st</sup> Punch	2 <sup>nd</sup> Punch	3 <sup>rd</sup> Punch	4 <sup>th</sup> Punch	5 <sup>th</sup> Punch	Averages
Time (s)	.68	.73	.70	.68	.82	0.7
Velocity(m/s)	0.9	0.8	0.9	0.9	0.7	0.8
Force (G)	30	29.9	28.5	30.5	31	30
Force (N)	~294.0	~294.0	~279.3	~298.5	~303.8	~294.0

Using the tables displayed above you can see that the recoil punch has much more force than a follow-through punch even though their velocities are approximately the same. But why?

The answer to this question lies in Newton's Second Law, the Law of Acceleration, when a force acts on an object, the object will accelerate:

$$\text{Acceleration } (\Delta \text{ velocity/time}) = \text{force/mass.}$$

Physicists have determined that the amount of force an object can produce is equal to its mass times its acceleration (Force = mass x acceleration). Equally so, the amount of force a punch can deliver is determined by the same two factors, the mass of the punch and the acceleration of the punch. It is likely that the mass of the punch remains constant whether or not the punch is a recoil or follow-through (assuming it is the same person).

How does this prove that the recoil punch is more effective (producing more damage) than the follow-through punch? Probably the most important factors to consider are momentum and impulse. Momentum is mass in motion:

$$\text{Momentum} = \text{Mass} \times \text{Velocity.}$$

Impulse is a measure of how much force is applied for a certain amount of time.

$$\text{Impulse} = \text{Force} \times \text{Time}$$

$$\text{Impulse} = \Delta \text{ momentum or Mass} \times \text{Velocity} = \text{Force} \times \text{Time}$$

Do not confuse momentum with force. They are related by the fact that force is the rate at which momentum changes with respect to time.

Applying this concept to the impact of the punches, we can see that with the recoil punch the target receives a larger amount of force for a very short amount of time, while the follow-through receives a smaller amount of force over a longer amount of time. It is because of this small amount of contact that the recoil punch packs a huge amount of force ( $V_m = F_t$ ). In other words, you have a fist that is traveling with a great velocity. It hits a body with a large amount of force, but this is not what causes the damage. It is the impulse that the punch delivers that breaks bones or causes internal damage. If the body stops the punch, or in the case of recoil, the puncher stops the punch in a very short amount of time this delivers a massive impact. You have heard the old adage; it isn't the fall that kills you it is the sudden stop at the end. The follow-through punch can generate considerable velocity and momentum in its own right, but because it relies on a longer amount of contact time, the force delivered to the body is lessened ( $V_m = T_f$ ).

A recoil punch is much like the concept of bouncing. The punch delivers a greater impulse if it bounces (recoils) from the target than it does if it continues to make contact over a longer amount of time. Follow-through relies more on pushing than an intense snapping action (deformation). Martial Artists are always trying to develop techniques that can maximize the amount of damage with the smallest amount of effort and time. They rely heavily on the understanding of body mechanics (Physics) to help them in their

endeavors. This is an important factor when the focus is self-defense and not sport. “Your mind is your best weapon, and if used cleverly and early enough in a conflict, can defeat all opponents” (Kloor, Henry T).

### References

- Accelerometer. (February 26, 2009). *Wikipedia: The Free Encyclopedia*. Retrieved February 26, 2009, <http://en.wikipedia.org/wiki/Accelerometer>
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