WORLD JKA KARATE ASSOCIATION

Instructor Trainee's Report #11

Reaction Force in Karate

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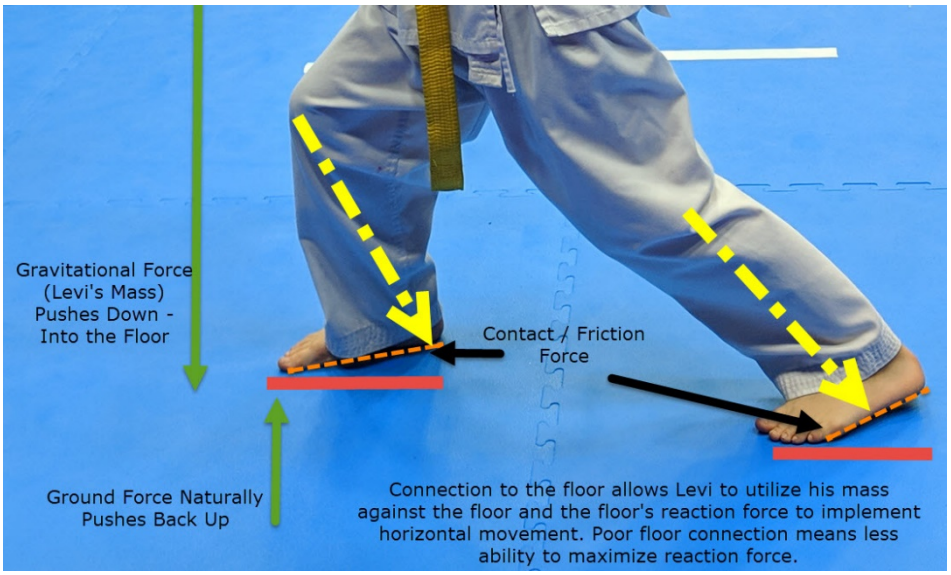
Reaction Force in Karate is a two-component phenomenon: reaction force from a base and reaction force from the target or opponent. In essence, being a tactile art, karate practitioners must understand and master a force they can't see, but rather can feel.

The ground or floor to a karateka about to deliver a punch is similar to the diving board to a swimmer about to do a dive. The down force creates an up force that helps propel the body. In essence, the martial artist and the diver are both utilizing Newton's third law of action/reaction[1].

For every action, there is an equal and opposite reaction. Forces always come in pairs - equal and opposite action/reaction force pairs. The more mass the diver delivers to the springboard, the more upward reaction the springboard creates.



Similarly, as Levi[2] demonstrates in Figure one, his mass creates a natural force downward, into the floor. Conversely, the floor produces a ground reaction force that pushes Levi back up (seen by the green arrows).

The more downward force Levi pressures into the floor (using his Mass) with both legs, the more reaction force he gets back from the floor.

Figure 1 Levi demonstrates utilizing Ground Reaction force in front stance

[1] In every interaction, there is a 'pair' of forces acting on two objects

[2] Levi Quann is a student of Power Karate Academy and is very effective at power generation from his defined stances

J.D Swanson[3] states:

> *To make proper use of stances, the practitioner needs to be aware that a stance is much more than a set leg and body position. It is a more dynamic relationship with the floor that allows quick movement through the use of ground reaction force.*

In Karate, *dynamic movement*, as mention in Swanson's quote is essential. In Figure one, Levi is able to produce forward energy and movement (illustrated by the yellow arrows) by exerting force backward into the floor, while the floor naturally pushes forward with equal force.

The dotted orange lines denote Levi's physical connection to the floor, creating a *contact interaction*[4]. This is *contact* or *friction force* and is essential in movement. We can envision Levi trying to produce forward momentum this same way while standing on ice: lack of friction would mitigate Levi's ability to use ground reaction force to propel forward. Poor ground/floor connection means less ability to maximize and utilize reaction force in your favor.

Figure 2 Levi demonstrates the Nukite while in front stance

In addition, also illustrated by Levi's stance, is the fact both his legs are bent to some degree, enhancing Levi's ability to active force in to the floor. In Karate Science: Dynamic Movement[5] J.D. Swanson says:

A strong stance requires proper weight distribution, foot position and connection to the floor, leg tension, and hip position and tension.

Here Swanson mentions 'leg tension' as it relates to the ability to exert downward and backward pressure. Straight or locked legs in a stance mitigate the ability to use muscle tension to drive from the surface below you (red and

[3] Taken from *Karate Science: Dynamic Movement*
[4] Some forces result from contact interactions (normal, frictional, tensional, and applied forces are examples of contact forces) https://www.physicsclassroom.com/class/newtlaws/Lesson-4/Newton-s-Third-Law
[5] Chapter 5, *The Dynamics of Stances*

orange lines in figure 2). It also eliminates the ability to absorb reaction force coming back from the target (see green lines in Figure 2).

Reaction force form the opponent can mean a karateka can punch the opponent and break his or her own fist.

Therefore, in addition to manipulating reaction force from the ground, the karateka has to consider the opponent's reaction force, or the force coming back from the impact to the opponent. In Figure 2, Levi's ability to have a significant effect on the bag is dependent on his acceleration as well as the stability in his stance. His well-defined stance, then, serves to assist with the delivery of power to the bag, as well as to absorb the reaction force form the bag. How Levi has tensed his hand, arm, shoulder and body muscles upon impact greatly effects the outcome of the strike.

The karateka has to understand reaction force as it relates to the part of the body delivering the attack. For example, an open hand slap to the opponent's face has a different effect than a tight hand punch. The reason being that the surface area used to hit with is smaller with the punch, meaning it is more focused, and there is less of it to absorb the reaction force coming back from the strike.

In my own observations while training kicks on the heavy bag, it becomes obvious that a ball-of-the-foot front kick has more penetration on the bag than does an instep kick. This, I believe, has to do with acceleration, as well as the surface area of the body part hitting the bag.

Similar to this is being hit with a padded glove in sport karate. The padded glove means the opponent doesn't get hurt because the force of the attack is delivered over a larger surface area, and the attacker is protected as reaction force from the opponent also dissipates into the glove. Whereas, getting hit with a tight, unprotected fist means more force is absorbed by the body.

This notion is summarized nicely here:

> *Net force is proportional to acceleration; so the less the object deforms; the more force it applies to your hand*[6]*.*

The padded glove deforms to absorb the force of the blow, meaning less force transfers into the opponent and vice versa.

[6] Physics Stack Exchange is a question and answer site for active researchers, academics and students of physics.

Hence, the karate practitioner, in understanding action force and reaction force pays particular attention to how, where, when, and how fast an attack is applied to the opponent. Due to interacting forces, an opponent with a soft abdomen is akin to punching a pillow, whereas an opponent with a tight or flexed abdomen is like punching stone.

In conclusion, a karateka that uses stances that have a 'feeling' of connection to the floor has a better ability to deliver fast, effective attacks, as well as absorb counterattacks. Correctly engaging core body muscles as well as leg and feet muscles mean the communication with the ground or floor is dynamic, meaning the karateka can maximize reaction force to deliver powerful techniques, as well as to move efficiently.

When the karateka ties reaction force to body mass and acceleration, his or her effectiveness magnifies. The feeling is then that the karateka can attack with the body…and the floor.

Bibliography

Newton's Laws - Lesson 4 - Newton's Third Law of Motion, Taken from: *www.physicsclassroom.com/class/newtlaws/Lesson-4/Newton-s-Third-Law*

Personal Interaction with student, Levi Quann

YMAA Publication Center, Inc., Apr. 1, 2017 , Swanson, J.D., Karate Science: Dynamic Movement, Chapter 5

https://www.physicsclassroom.com/class/newtlaws/Lesson-4/Newton-s-Third-Law, Lesson 4, newton's Third Law

https://physics.stackexchange.com/questions, Article 373051