Core Concepts of Kinesiology

These concepts are the basis of communication about movement that facilitate the progression from lowly skilled to highly skilled performance.

JACKIE L. HUDSON

Are you interested in skillful movement? Do you, as a teacher, coach, or spectator, observe and evaluate movement in terms of its effortlessness or effectiveness? Do you try to elicit more skillful movement from yourself or others? If so, you probably have developed some tried and true methods of assessment and adjustment. And you probably have encountered frustration when the mover or the movement is outside vour domain of confidence. Chances are that when you are successful, you are applying the core concepts of kinesiology. Likewise, when you are frustrated, you might want to give the core concepts a try.

What are core concepts? According to Kline (1988), they are the underlying structure of our knowledge about a subject. In most cases, they are not clear to the person who has them because they are part of the background of experience. And even though we do not see them when we use them, they are the means by which we organize our thoughts and actions on a topic. Thus, the quality of our responses depends in part on the breadth and depth of our core concepts.

Many of us are less aware of the core concepts of movement than we are of the core concepts of music. For that reason, I will begin with an overview of how we use core concepts in music: When we play or listen to music we often are concerned with volume, pitch, pace, and rhythm. In other words, we may pay attention to whether the volume is too loud or too soft, or if the pitch is too flat or too sharp, or if the pace is too fast or too slow, or if the rhythm is sporadic or smooth. From the background or foreground of our experiences, we recognize that volume, pitch, pace, and rhythm *matter* in music. And we realize that these characteristics can be *measured* and *manipulated* in many situations to improve the quality of the music. For example, not only can we assess the volume but usually we can adjust it as well. In effect, all music has a "volume knob."

Do we have the equivalent of a volume knob in movement? Yes, about ten of them. Similar to music, gross human movement seems to be organized around several core concepts. The most obvious and important concepts appear to be range and speed of motion, number and nature of segments, balance, and coordination. Unless a movement is slow or simple, compactness is a relevant concept. Finally, when an object is to be projected, extension at release (or at contact), path of projection, and spin are applicable concepts (see table 1).

Moreover, each of these core concepts of kinesiology can be conceived of as operating like a volume knob. For instance, if we assess volume as too soft, we try to turn the knob to make it louder. Likewise, if we assess range of motion as too small, we try to "turn the knob" to make it larger. Thus, movement knobs can be turned up or down in varying degrees to improve the quality of movement.

Just as with music, these core concepts of kinesiology are part of our background or common-knowledge understanding of movement (Bird & Hudson, 1990). Each of us, as movers and observers of movement, has used the core concepts. At some level we recognize that these characteristics matter in movement. And we realize that these characteristics can be measured and manipulated in many situations for the improvement of movement. The purpose of this article is to bring these concepts from the background to the foreground so we can use them more effectively.

As we gain familiarity with the core concepts, we can apply them to a variety of movements from dance to sport and from familiar to unfamiliar. Some of these concepts are more important than others in certain situations, and a few of these concepts are important in limited situations. Depending on our circumstances, our use of these concepts can be either qualitative or quantitative, as well as obvious or obscured. In addition, these core concepts apply to a wide variety of movers from lowly skilled to highly skilled. Perhaps best of all, these concepts are the basis of communication about movement that facilitate the progression from lowly skilled to highly skilled performance. For example, if you believe that a mover is using too much range of motion, you have a natural language for explaining this to the mover. And the mover has an excellent opportunity for both turning the knob and improving the movement.

In this article, each of the ten core concepts of kinesiology is defined, explained, and exemplified. Also, some reasons and results for turning the knobs that represent these concepts are discussed. As a general rule, the force-production phase of movement is emphasized, and the widest or most holistic possible view of the mover is taken.

Range of Motion

For our purposes here, range of motion is defined as the distance that a body, a body part, or an object moves during a time interval of interest. Usually, a greater range of motion either generates or requires a greater force. When we notice the backswing and the follow-through of a tennis shot, we are using the core concept of range of motion. That is, the arm and racket move through a particular distance in the backswing before initiating the force-producing phase of a ground stroke or volley, and they move through another distance after the ball has been struck. If we note how far the ball traveled before it bounced, we have used range of motion again. We expect the ground stroke to have a greater range of motion than the volley, and we expect it to generate greater force as well.

Similarly, we may observe how far a jumper crouches down in preparation to jump up, and we may observe how high the jump was. If we watch a weight lifter, we can estimate how far the weights were lifted. In these activities, too much range of motion may require more force than the mover has available.

Not only is range of motion relatively easy to observe, it is relatively easy to alter: A tennis player can increase the backswing in a ground stroke and decrease the backswing in a volley. A weight lifter may instinctively reduce the range of motion when becoming fatigued. Sometimes when we adjust the range-of-motion knob we get other results as well: A tennis player who takes a longer backswing or allows a longer follow-through should hit the ball farther. In addition, some changes in range of motion are associated with improvements in movement: Jumpers who took a shallower-than-average crouch were more skilled than those who took a deeper-than-average crouch (Hudson & Owen, 1982).

Speed of Motion

When range of motion is combined with time we have speed of motion.

Table 1. Core Concepts At a Glance

1. Range of motion
2. Speed of motion
3. Number of segments
4. Nature of segments
5. Balance
6. Coordination
7. Compactness
8. Extension at release
9. Path of projection
10. Spin

That is, if an object, such as a served tennis ball, has a large range of motion over a brief period of time, it is considered to have a fast speed of motion. Alternatively, if an object, such as a heavy barbell, has a small range of motion over a longer period of time, it is considered to have a slow speed of motion. In general, greater speed either generates or requires greater force. Just as you can adjust the range-of-motion knob, you can adjust the speed-of-motion knob. For instance, as you move from strolling to fitness walking to jogging to sprinting, you are increasing your speed of motion (and your force requirement). Similarly, there is a decrease in speed of motion from a fastball to a curve ball to a change-up pitch.

For many movers and movements the speed- and range-of-motion knobs seem to be interconnected: If a tennis player increases range of motion by taking a bigger backswing, there mav be a concomitant increase in the speed of motion of the racket and the speed of the ball as it leaves the racket. Also, if we want throwers to increase range of motion, we may achieve this by asking them to increase the speed of throwing (Broer, 1960).

Number of Segments

As we observe movement we may note how many segments or parts of the body seem to be actively involved in the movement. Active involvement of a segment is indicated by its range of motion: Minimal range of motion denotes an inactive segment, and moderate or maximal range of motion denotes an active segment. In the case of archery, most of the parts of the body are stationary by intention. Conversely, javelin throwers involve most of their body segments.

Typically, a greater number of segments is associated with greater force and complexity. As novices try new movements such as throwing, they may “freeze out” certain segments to make the movement more simple (Roberton & Halverson, 1984). With improvement in skill, more and more segments are incorporated into the movement. For big, strong movers (e.g., professional basketball players) and simple or submaximal movements (e.g., the free throw), it may be possible to use too many segments. Thus, adjusting the number-of-segments knob up or down may lead to better performance or greater skill.

Nature of Segments

Each active segment has a basic nature or direction of movement. For example, the arms and legs move forward or backward in running, jumping, bowling, and punting. There is movement to the right or left in the basketball hook shot and putting in golf. Finally, there is twisting motion of the whole body in the spins of figure skaters and dancers; twisting in the trunk in throwing and

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batting; twisting in the plant leg in soccer-style kicking; and twisting in the racket arm in top-spin tennis shots. In general, the twisting or long-axis rotations generate the greatest speed.

Perhaps the biggest difference between lowly skilled and highly skilled throwers is that the nature of segments in the former is primarily forward/backward and in the latter twisting. But the long-axis motions are not always preferable: A free throw shooter who twists the trunk or the forearm is likelv to miss to the left or right of the goal. Similarly, golfers with inappropriate long-axis motion may have trouble with pushing or pulling the ball. To change the amount of long-axis motion, it is sometimes easier to adjust the nature-of-segments knob indirectly by adjusting the speed-of-motion knob. For instance, as one tries to throw faster and faster, the twist-type motions will naturally emerge. Also, sacrificing some speed and distance on a golf drive may lead to less long-axis motion and greater accuracy.

Balance

The degree of stability or mobility is referred to here as balance. As a person moves, she or he can be very stable, very mobile, or somewhere in between. Typically, the greatest stability is achieved by maintaining the line of gravity near the middle of the base of support. Skilled gymnasts are very stable on the balance beam, while novice gymnasts often lose their balance and become mobile as thev fall off the beam. A runner would be more mobile than a walker because the walker has periods of stability with both feet on the ground and the runner has periods of flight, the ultimate in mobility. Golfers have a degree of mobility as they shift their weight during the swing, and they have a degree of stability because both feet remain on the ground.

To increase mobility one must either move the line of gravity as golfers do or reduce the base of support as runners do. If accuracy is desired, increasing stability may help. For example, greater stability is associated with skillful and successful free throw shooting (Hudson, 1985). Sometimes the balance knob works in conjunction with other knobs: As the speed of motion in bicycling decreases, it becomes harder to maintain balance. And a thrower is more apt to use a large range of motion if the base of support is enlarged in the direction of the throw (Broer, 1960).

Coordination

The manner in which our bodily actions are timed and sequenced is known as coordination. In terms of timing, a movement which looks jerky or sporadic is considered uncoordinated, and one which looks smooth and graceful is considered coordinated. As for sequencing, skilled movers tend to move body segments in unison or simultaneously in heavy activities such as weight lifting and sequentially from large segments to small in ballistic activities like throwing and striking.

During skill development in ballistic activities, coordination tends to progress from more simultaneous to more sequential. Conversely, in heavy activities, coordination tends to progress from more sequential to more simultaneous. Jumping is similar to weight lifting in that skilled jumpers move more smoothly and simultaneously compared to less skilled jumpers who move more sporadically and sequentially (Hudson, 1986). For as much as we would like to turn the coordination knob and eradicate clumsy movement, it is probable that the best way to adjust coordination is by adjusting one or more of the other knobs.

Compactness

Often a mover can arrange all or some of the body segments to take up less space or to be more compact. The advantage of turning the compactness knob is that when the bodv takes up less space, it increases its speed of motion (Wells, 1950). This is seen when a gymnast or diver assumes a tuck position as compared to a pike or lay-out position. The tuck position is more compact and faster than a pike position which is more compact and faster than a lay-out position.

Sections of the body also can be positioned to take up less space: The leg is made more compact when initiating the forward swing in kicking or sprinting. (In extreme cases the leg is made so compact that the heel touches the buttocks.) Also, the arm is made more compact when initiating the propulsive phase of striking. In tennis this is referred to as the "back scratch" position (see figure 1).

In many complex movements, such as the tennis serve, a novice or low intermediate may have difficulty adjusting compactness. So there may be more important knobs to turn in the initial stages of skill acquisition. For movements where speed of motion is not desired, or when there are too few active segments to compact, the compactness knob is mostly irrelevant.

Extension at Release/Contact

If it is advantageous for a mover to be compact at the beginning of the propulsive phase of a movement, it also is advantageous to be extended or stretched at the end of the propulsive phase. An example of this is shown in figure 1: The tennis server has moved from the compact, back

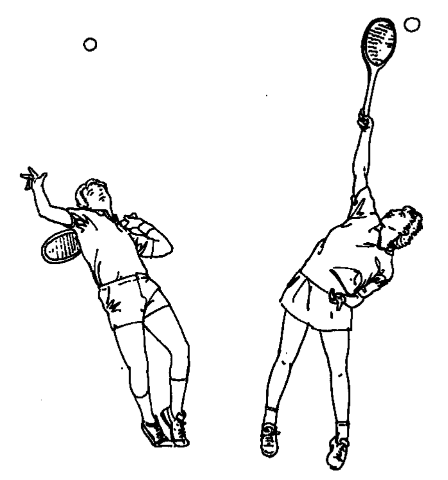

Figure 1. The tennis server on the left is demonstrating compactness or the "back scratch" position. The server on the right is demonstrating extension at contact.

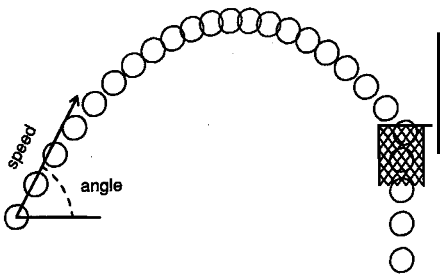

Figure 2. Path of projection is based on speed and angle of projection.

scratch position to a full stretch at the time of contact with the ball. The advantage of greater extension at contact is that greater speed will be imparted to the ball. (This is due in part to greater leverage and to the larger range of motion which affords more opportunity to build up speed.) Therefore, extension at release/contact is of primary importance when an object or a body is being projected and a certain amount of speed is desired. For instance, many home run hitters like the pitch to be over the outside part of the plate so they can fully extend their arms at contact.

The extension-at-release knob is slightly easier than the compactness knob for many movers to turn, so beginners and low intermediates might experience success when trying to adjust this knob. For example, beginning tennis servers often make contact with the ball when it is barely above head level. If they could hit the ball when it was at a higher point, they could have greater extension at contact.

Path of Projection

When an object or a body becomes airborne, it starts out on a particular path and then it deviates from that path as gravity pulls it back to earth. As seen in figure 2, the characteristics that determine the path of projection are the angle (usually taken with respect to the horizontal) and the speed or velocity at which the object is projected. By now we should be familiar with the concept of speed, but the angle or initial path of movement may be less familiar. In basketball we project a ball downward when we dunk, nearly horizontally when we pass, at about 45 degrees when we shoot a field goal or free throw, and straight upward in celebration at the end of a close game.

A basketball player can adjust the path-of-projection knob by changing the amount of arch on a shot: Usually, a flat arch or an exaggerated arch are not as successful as a moderate arch. Changing the path of projection also changes the range of motion. To observe this, Glassow (1932) recommended projecting balls toward different rafters in a gymnasium and then noting where each ball lands.

Spin

When an object or body is projected, it typically rotates or spins about its center. The magnitude and point at which the propulsive force was applied dictate the amount of spin. If we do not want much spin, such as when hitting a line drive or pitching a knuckle ball, we must hit the ball at the center or remove all our fingers at once. If we hit the ball on its edge or remove our fingers from one edge before the opposite edge, we will create spin. Certain movers including baseball and softball pitchers and tennis and volleyball servers might want to experiment with turning the spin knob.

For divers, tumblers, and long jumpers the duration of the take-off phase and the speed of movement before projection contribute to the amount of spin. Divers and tumblers may want to increase spin and long jumpers may want to decrease it. In other projectile situations, such as running or hitting a racquetball, spin may not be very influential.

Adjusting the Knobs

As we move or watch others move we can pay attention to the core concepts of kinesiology. Because they seem to be a natural way to observe and organize movement, we can begin to use them without prior practice. As we gain experience with the core concepts, we should become more skillful in their application. And as we communicate through core concepts to movers, they, too, should become more skillful.

So, if you feel lost and confused in a particular movement situation, consider assessing and adjusting one or more of these ten knobs. And while you are deciding which knobs to turn and how much to turn the knobs, keep in mind the wisdom of Penick and Shrake (1992, p. 27):

> When I ask you to take an aspirin, please don't take the whole bottle. In the golf swing a tiny change can make a huge difference. The natural inclination is to begin to overdo the tiny change that has brought success. So you exaggerate in an effort to improve even more, and soon you are lost and confused again.

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Jackie Hudson is an assistant professor in the Department of Physical Education at California State University-Chico, Chico, CA 95929-0330.