RELATIVE TIMING AND RHYTHM: A KEY TO MOTOR SKILL LEARNING

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ABSTRACT

Rhythm is needed for all coordinated movements to be performed accurately and, without exception, sports skills are considered rhythmic in nature. Mature motor skill patterns have a definite stable rhythmic structure. Rhythm, the critical piece of information needed in order to reproduce the correct motor skill, can be easily missed by learners. Unfortunately, apart from what we can draw from our own sport participation, finding information on how to teach rhythm is surprisingly difficult. To bridge the gap between relative timing enhancement and rhythm acquisition, recommendations from research studies on how to develop relative timing are interpreted for practitioners who are teaching rhythm.

THE PRACTICAL PROBLEM – VIGNETTE OF JOHNNY

It was the beginning of the school year: Johnny and Susan signed up for intermediate volleyball class. Having the experience of quickly learning to pass and set volleyball in the beginning class, they expected to learn the spiking skill easily. After the instructor demonstrated to the class what a proper spike looked like, Johnny and Susan practiced the spike themselves without the volleyball. Susan performed the step-step-close approach perfectly to get herself high in the air ready for spiking; however, Johnny was having a very difficult time getting the rhythm necessary to perform the technique. Instead of the "step-step-close" approach, Johnny performed two strides of even length. As he continued to have trouble with the rhythm of the spike approach, he became

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frustrated, making it difficult for him to enjoy the class. How could the instructor help Johnny master the critical segment of the volleyball spike approach? As a teacher or a coach, you may have encountered similar scenarios with different sport skills and with different levels of learners. John could be a college student, a 12-year old junior high-school pupil, or a 35-year old person with disabilities. Rhythm, the critical piece of information needed in order to reproduce the correct motor skill, was missed by John. Unfortunately, apart from what we can draw from our own sport participation, finding information on how to teach the volleyball spike approach rhythm (or for that matter any motor skill that requires rhythm) is surprisingly difficult.

WHAT IS RHYTHM?

Rhythm is needed for all coordinated movements to be performed accurately and, without exception, sports skills are considered rhythmic in nature (Bennett & Riemer, 1995; Gallahue & Donnelly, 2002; Kirchner, 1981). Mature motor skill patterns have a definite stable rhythmic structure (Fulop, Kirby, & Coates, 1992), this includes swimming (Colwin, 2003; Wang & Hart, 2005), hurdling (Hay & Schoebel, 1990), juggling (Beek, 1992), volleyball spiking (Coleman, Benham, & Northcott, 1993), and piano playing (Drake & Palmer, 2000). For example, in swimming, the arms and legs move rhythmically in all strokes to propel the swimmer forward; moving arhythmically is inefficient and slows down the swimmer. Additionally, professional athletes turn high-level performance into art by demonstrating the beauty of being rhythmic. In some cases (e.g. dance, gymnastics), students' abilities to move rhythmically are set as goals to achieve (National Dance Association, 1997). However, no information on how to teach the rhythmic component is mentioned directly in the literature. Information on enhancing relative timing can only be inferred from studies examining the effectiveness of a generalized motor program

(GMP). Furthermore, such evidence on methods to enhance relative timing acquisition has not been tested extensively in practical settings (Shea, Lai, Wright, Immink, & Black, 2001).

WHY IS RHYTHM A CRITICAL PIECE OF INFORMATION FOR MOTOR SKILL ACQUISITION?

The unique rhythm associated with one particular motor skill or shared by a group of motor skills is considered one of the key proponents of motor schema (Schmidt & Lee, 2005). Even researchers holding contrasting thoughts on how motor skills are acquired agree on the vital meaning of the rhythm of the skill as an attractive state for movement pattern organization (Kelso, 1995). As stated by Schmidt and Wrisberg (2008), the temporal pattern of a motor skill (rhythmic component of the skill), serves as a marker and separates one motor skill from another. For example, although both are even rhythms, a rhythm needed for walking can be considered very different from a rhythm needed for jogging when the speed is concerned. Rhythm needed for these two skills is even more different from an uneven, a rhythm needed for galloping. Some sport skills have similar temporal patterns, such as the swing pattern of a volleyball spike and the serve in tennis. Thus, when one is mastered, mastery of the second follows with ease. Not until one can perform a motor skill with its unique rhythm can he or she be confident about mastering the skill.

RELATIVE TIMING AND RHYTHM

Relative timing is the theoretical concept that corresponds with rhythm. Relative timing inclusively refers to the relative ratio of timing components of a skill (Schmidt & Lee, 2005). To illustrate, let's look at the rhythm of walking. The alternative pendulum motion of the two steps is equal, making the relative timing of walking a 1:1 ratio. Relative timing has been analyzed in theoretical experiments by having participants perform similar movements

such as finger tapping with the target goals of 1500ms (from the first point to the second point) and 750ms (from the second point to the third point), making the relative timing a 2:1 ratio. Relative timing is proposed in Schmidt's Schema Theory as one of the invariant features that distinguish one category of movement from another (Coker, 2009). In an effort to explain how motor skills were controlled and executed, Schmidt's schema theory has received the most attention and has been explored in a number of empirical studies from different disciplines (Shea & Wulf, 2005).

Temporal structure, relative timing, or phasing, is the marker of motor patterns supported by studies conducted to help researchers find ways to facilitate effective learning of motor skills in the laboratory and in practical settings (Schmidt & Lee, 2005). Franks and Stanley (1991) used computer-generated waveform tracking was chosen as the task to examine what is learned during motor skill acquisition. Results of the study supported the notion of "invariant relative timing" among the content acquired. Similarly, Hay and Schoebel (1990) used the track event hurdles to examine the temporal invariants concept in a real world activity. With empirical support of relative timing as one of the invariant features learned though practice, it was proposed that mastering the rhythmic component (or relative timing) of a skill is a critical step toward skill acquisition (Singer, 2000).

SUGGESTIONS FROM RESEARCHERS TO ENHANCE RELATIVE TIMING LEARNING

Researchers have devoted time and effort to test the generalized motor program (GMP, a class of abstract representation of similar movement plans stored in memory) theory (Coker, 2009). Relative timing, as a primary invariant feature, has been tested in several studies. Empirical data support the notion that relative timing can be strengthened by use - constant practice, use - blocked practice, reduced feedback frequency, and provision of visual and

auditory models (Han & Shea, 2008; Lai, Shea, Bruechert, & Little, 2002). The use of auditory models has been generalized to several practical settings, rapid pistol shooting (Rose & Tyry, 1994), rhythmical dance routine learning (Wuyts & Buekers, 1995), swimming (Wang & Hart, 2005), and football kicking(Butcher, 2003) and has been to shown to be an effective teaching strategy. Clearly, teaching rhythm, especially for beginners, helps students acquire sport skills which have a rhythmical component. The following general guidelines explain how each of these suggestions can enhance relative timing/rhythm acquisition.

1. Demonstrate the skill and provide auditory cues to invite students' attention to the rhythm (e.g. in performing the flutter kick swimming skill, ask students to close their eyes and listen to the splashing water sound).
2. Practice the skill for certain period of time with short resting intervals (e.g. golf driving skill practice is arranged to be about 10-15 drives for one set with 2-3-min rest in between sets).
3. Practice independently the skill to be learned (e.g. introduce only the target skill to be learned to beginners, add others skills later, teach skill one at a time).
4. Decrease total feedback and also minimize the amount of feedback being provided to enhance the rhythmical component learning (e.g. limit comment on students' performance except motivational feedback such as "good job" or "excellent try"). If feedback is needed to correct a movement, use precise and simple cue word to re-introduce the skill.

GUIDELINES TO TEACH VOLLEYBALL SPIKING APPROACH SKILL

How can the volleyball spiking approach skill be taught more effectively? When the spiking skill is introduced, especially with beginners, the approach skill should to be taught as a special session.

1. Introduce the movement by demonstrating the step-step-close movement. At the same time, direct students' attention to the rhythm of the movement by having them close their eyes and listen to the rhythmic sound of the footsteps.
2. Have students practice the movement (step-step-close) by itself for certain trials (e.g. 10 practice trials in a row for 5 times with 1 min rest in between).
3. Do not interfere the movement acquisition by introducing other skills. By organizing practice using the aforementioned guidelines, we are constructing the learning environment with constant practice in a blocked fashion.
4. Withhold feedback on how students' performance as much as possible at the beginning stage of learning. That is limit feedback providing frequency to a very low level (use general positive feedback for encourage purposes) and re-visit the correct rhythm. If possible, have students listen to their own footsteps and compare with the modeled rhythm. In total, these efforts facilitate organizing the blueprint of the movement.

Let's help John with his volleyball spiking approach skill. As the instructor, ask John to concentrate only on the spiking approach skill rather than also working on serving, passing, or spiking skills.

1. To start off, ask John focus his attention to instructor's feet (please wear bright colored shoes if possible) while listening to the instructor's foot-steps.
2. Have John clap his hands to the step-step-close pattern. Then have him stomping his feet (while standing in place) in performing the correct step-step-close pattern.
3. Then have John practice the step-step-close approach for 10-15 repetitions per set for the first 5 trials, have him repeat step=step-close as he does the movement. Practice the spiking

approach skill repetitions for 5 sets with a 1-2 minute rest in between sets.

4. If John is still having difficulty grasping the rhythm of the skill, ask him to again observe the instructor or another model's spiking approach performance. Direct his attention to the rhythm of the skill (sound of the foot-steps).
5. If equipment (e.g. a cell phone with recording function) is available, record John's foot-steps and compare with the model.
6. Motivate John's efforts by telling him "Good try, John!" Limit the feedback on his performance; however, repeat the approach skill rhythm by verbally counting 1-2-3 while clapping hands with and stomping feet with the same rhythm.

Relative timing, an invariant feature, is one of the critical factors establishing a GMP (Coker, 2009). Perception with regard to the importance of rhythm is shared in the area of exercise and sport. To enhance relative timing/rhythm acquisition: (a) design the practice including both auditory and visual models; (b) introduce rhythm of the skill to be learned by itself; and (c) practice the skill for set periods of time with short intervals. These recommendations are supported by data collected among college age participants. The applicability for younger age groups requires further empirical exploration.

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