TECHNIQUE AND PHYSICAL ABILITIES

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In the gym, coaches approach training skill technique and connections very differently than conditioning. This is a good practice because technical training and conditioning are based on very different underlying processes. Technique training, execution, or skill practice is teaching and learning, in scientific jargon “motor learning”. Conditioning is physical exercising to actually change the body and how it works, the body’s physiology and morphology. Of course, learning also changes the body, but in ways that are not easy to see or understand. Learning changes the network of connections between neurons, as well as the chemical composition of nerve cells, and their connections, but this is difficult to observe. But when a gymnast has become more muscular, this is easy to see, and guess that she or he has become stronger.

However, there is a problem with this distinction between learning and conditioning: skill learning **also** has a side-effect on the composition and function of the body. A young bird can learn to fly because it has wings, but learning to fly develops its wings too, making them more functional. Practicing gymnastics skills is physical exercise too, not only learning. Learning gymnastics skills is also physical exercise, just not as intense or effective at developing physical abilities. The physical abilities of a gymnast are hers or his strength, quickness, flexibility, and endurance. These are underlying qualities that can only be observed when the gymnast moves (Martin, 1991). Moreover, these abilities should be gymnastics specific, that is corresponding to the demands of gymnastics performance. For example, the relative strength of the gymnast, the most force she or he can exert, divided by their body weight, is more important than the absolute amount of force the gymnast can exert regardless of body weight because the gymnast must lift hers or his own body. Simillarialy, the quickness of a gymnast must be “tuned” to the recoil of the gymnastics apparatus: the spring floor, the springboard, the spring-steel high bar, parallel, or uneven bars. The level of development of these abilities is objectively defined by the gymnast’s performance during tests of, for example, strength, quickness, flexibility, and endurance. The alternative to field tests are tests of strength, quickness, flexibility, or endurance which are then compared to biomechanical data from skills (Knoll & Zocher, 1979). Force,

time, and therefore strength and power data from skills has been collected, even during FIG World Championships, using specially instrumented gymnastics equipment (Knoll, 2004).

Technical execution is what judges evaluate in competition. Ideal technical execution is described in the Code of Points, with additional expectations of dynamics, elegance, and amplitude. The execution should have an intrinsic rhythm and apparent economy of movement. Technical execution of gymnastics skills and combinations is the result of teaching, learning, and practice. During practice, coaches serve the role of judge, in addition to teacher. However, many technical execution errors are related to insufficient physical ability. In particular, the time course of the changes in performance due to learning and the time course of changes in performance due to a better performing physiology and morphology are very different. Learning can be almost instantaneous: we only need to think of the “A-Ha!” experience and performance change that can happen with just one repetition of a skill. In contrast, lasting changes in how the body functions, and its composition, happen only very slowly, and only after consistent repetition. Learning should be “practice without repetition” (Bernstein, 1967). Conditioning is sets of repetitions, of a limited number of specialized physical exercises at a time, for weeks and months. Variation in itself has its value in skill learning. Too much variation in conditioning can blunt the effect on the body. These differences can cause learning and fitness to get out of sync.

Physical abilities can also be **prerequisites** for learning. For example, if a child does not have at least sufficient strength in the arms and shoulders to support their body weight, they cannot learn a handstand. The famous head coach of Soviet and Russian Olympic teams, Leonid Arkaev, and gymnastics scientist and coach Nikolai Suchilin point out that unfortunately in practice even elite gymnasts begin learning new exercises, skills, or routines with specific insufficiencies. These specific insufficiencies are physical abilities insufficient for mastering that specific skill, for example landing a parallel bars double back somersault dismount. This happens very often with juniors. With juniors, the specific physical abilities needed to master exercises and skills are often developed <u>while</u> practicing those exercises and skills. Here the goals of the conditioning are worked on <u>during</u> the process of technical preparation, and not the other way around. As a result, the process of mastering the skills takes much longer than it should (Arkaev & Suchilin, 2004).

On the other hand, an important concept for a gymnastics coach to have in mind, if not <u>the</u> most important, is the idea that their students’ technical execution and their students’ physical abilities are a unity, an integrated, organic whole. How a gymnast performs a skill is highly determined by the gymnast’s physical abilities (Knoll & Zocher, 1979). Performance of the skill, in particular with many repetitions during learning and over-learning, also develops the physical abilities of the gymnast in a way

specific to that skill. The technical execution of a skill by a gymnast and that gymnast's physical abilities make a functional whole. This concept is valid for every level of gymnastics student.

Together, physical abilities and technical execution reflect the gymnast's performance capacity. But a gymnast's technical execution of a skill is highly related to his or her physical abilities, in particular strength and flexibility. Skill repetition alone can eventually improve strength and flexibility, but this method takes a long time and many repetitions, with an unacceptable risk of overuse injury. Moreover, many technical execution errors are related to a lack of strength or flexibility. The gymnast compensates for his or her lack of strength or flexibility with a variation of the correct skill execution that is usually less than ideal (Arkaev & Suchilin, 2004). A more rational method would be to develop the requisite strength or flexibility with effective, efficient exercises, for example weight lifting, and then do the technical skill practice. This is an important aspect of correct periodization of technical sports like gymnastics.

Quite aside from the learning process, practicing skills also stress the muscles and connective tissues that participate in the execution of that skill, which then adapt accordingly. For example, learning a back walk-over: from beginner to expert, performance of a back walk-over is very affected by the joint mobility of the gymnast's hips and shoulders. If the gymnast already has good joint mobility in the shoulders in (hyper-) flexion, and the hips in (hyper-) extension, then the gymnast is able to learn a back-walkover with relatively little compression of the lower back. The backward move of the body is more aesthetically pleasing because the shape of the body is a more

even, round line, without sharp bends. In this case, repetitions of the back walkover will tend to increase the active mobility of the shoulders and hips as the executing muscles get used and therefore stronger. If, on the other hand, the gymnast has limited joint mobility in the shoulders and hips, the gymnast will not be able to distribute the backover bend evenly from shoulders to hips. Instead, the limited mobility of the shoulders and hips will cause the spine to make most of the movement. Repetitions might increase the active joint mobility of the shoulders and hips, but, because the surrounding musculature of the hips and shoulders is so much greater and stronger than that of the spine, the movement will tend to work the spine more and in particular the lower back. In this case, the back walkover is performed with a pronounced angle in the lower back. Practice shows that repetitions of back walkovers by gymnasts with limited mobility in the shoulders and hips tends to cause lower back hypermobility. This is serious because lower back hypermobility is often associated with low back pain in gymnasts.

This example of the back walkover is also instructive about how the integration of execution and physical abilities influences the learning and training process. In the case of the gymnast who begins to learn a back walkover with good active and passive joint mobility in the hips and shoulders, the learning and practicing process will also improve the active mobility of the shoulders and hips as well as develop a movement coordination that involves the entire back in an evenly distributed extension movement. In the case of the gymnast who begins this process without sufficient active and passive joint mobility in the hips and shoulders, the learning and training process will tend to develop hypermobility in the lower back and the gymnast's coordination of hers or his movements will be based on a sharp bend in the lower back instead of active shoulder and hip mobility. This gymnast will have difficulty executing a back walkover with an aesthetically pleasing shape because the technical execution of a skill by a gymnast and that gymnast's physical abilities make a functional whole. Her physical abilities, hyper-mobile lower back and limited movement in shoulders and hip, do not facilitate a different execution of the skill. Such side effects of practicing skills can be important. In this example of a back walk-over, the gymnast's flexibility influences her technical execution of the skill, and repetitions of that skill change her physical abilities, for better or worse.

Back in 1979 (!), the gymnastics scientists Knoll and Zocher observed that a continuous increase in acrobatic difficulty is a characteristic of the structure of gymnastics performance in competition. Sound familiar today in our age of Simone Biles, Kenzo Shirai, and Epke Zonderland? Particularly airborne skills have developed immensely over the past decades. Complex airborne skills like dismounts, tumbling, or release moves on bars are performed with more and more flips and twists, as well as greater height. This development required ever greater vertical and angular impulses

that, in turn, demand greater strength in female and male gymnasts. At the same time, demands on the coordination abilities have also increased. Yet another aspect is preparing the athletes for the higher reaction forces from the gymnastics apparatus resulting from the higher speeds. A higher tolerance of the skeletal system for the greater dynamic forces must be achieved during the strength training (Knoll & Zocher, 1979).

In principle, development of necessary physical abilities should precede mastery of the skill(s). For example, one of the goals of the USA Gymnastics TOPS program back when it was first founded was to encourage coaches to develop physical abilities to a high level from the beginning of systematic training. This is not necessarily the goal of the current TOPS program that is much more focused on talent identification through skill performance. The current assumption is that the gymnasts must have the requisite physical abilities to perform the skills as required, however experience shows that this is not necessarily always the case. When gymnasts lack specific abilities, gymnasts learn skills with technical errors in execution. In this sense, a talent identification through skill performance is justified. However, when gymnasts lack specific abilities, at best they adapt their technical execution to their own specific physical insufficiency, thereby reducing their performance consistency and likelihood of success. At worst, they develop overuse injury, losing their future potential to master more complex routines, rapidly, and with virtuocity (Arkaev & Suchilin, 2004).

Ultimately, results in gymnastics can only come from performing skills. But these skills can be excellently executed only with a high level of gymnastics specific physical abilities. Some gymnasts seem to develop extraordinary gymnastics specific physical abilities with a minimum of physical preparation, but most gymnasts will need an optimal physical preparation. The word “optimal” is used by Arkaev and Suchilin in the sense that the level of the physical abilities must exceed the actual physical demands of those skills and routines that the gymnast performs in training and competition. The level of physical ability must be higher than that minimum of physical ability that is necessary for successful execution of skills in training and competition. Without a physical surplus, it is impossible to consistently perform today's elite routines. Arkaev and Suchilin then ask how much of a surplus above the minimum of physical abilities is needed? A gymnast needs the gymnastics optimum of gymnastics specific physical abilities. What is this optimum? Unfortunately, there is no accepted answer (Arkaev & Suchilin, 2004).

Arkaev and Suchilin (2004) recommend the combined actions method of Djatchkov and Ratov that develops the physical abilities together with execution of the skill technique. According to this method they recommend repeating gymnastics skills while wearing weights. For example, Stalder and Endo performed on the high bar wearing weights, repeated until failure. As a rule of thumb, 10% of body weight is used

as the extra weight; more for stronger, and less for weaker gymnasts. Of concern here is learning a different execution of a skill due to the extra weight. On the other hand, if the skill is performed with extra weight to failure, there are going to be changes in the execution of the skill anyway.

Repeating an exercise with weights to failure is an important training method in body building. In gymnastics, the problem with this method is that it can cause inappropriate muscle hypertrophy, decreasing the gymnast's relative strength that is believed to be very important for a gymnast. Sands (2003) reported that field testing of the US Women's Senior National Team prior to the 2000 Olympics recorded numbers of repetitions likely to cause muscle hypertrophy. The tests were repetitions of gymnastics skills, for example cast, handstands. If the guidelines for body building are correct, then traditional gymnastics conditioning, repeating skills using body weight resistance, becomes bodybuilding. Repeating skills for strength training could cause hypertrophy, the increased size, and body weight gain that gymnasts are trying to avoid (Sands, 2003).

The Djatchkov/Ratov method probably has its place in the preparation of an elite gymnast. However, this method should be used with attention to excessive muscle hypertrophy and body weight gain. Degradation of the skill execution is another concern. A sequential approach, in which first an appropriate, or surplus level of physical abilities specific to the skill or combination to be learned is developed, and only then is the technical training completed. Highly effective methods that do not directly change movement coordination and gymnastics skill execution, for example weight lifting, can be used to prepare the gymnast for skill training. Such a sequential approach is potentially very efficient.

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