SPECIFICITY OF HORIZONTAL JUMPING PERFORMANCE

By Gary Bourne

In formation on structural and functional adaptation and neural functioning processes underline the importance of specificity in the training programs of horizontal jumpers. In the following text the author discusses the principles of specificity and suggests how specific muscular and neural adaptations should be incorporated in training programs. Re-printed with permission from Modern Athlete and Coach.

SPECIFIC ADAPTATION PROCESSES

The final aim of a long term training program is to alter the body structurally and functionally in such a way as to enable it to successfully meet all of the event specific demands which will be placed upon it in the process of achieving the desired performance.

Adaptation occurs in the healthy young athlete in response to appropriate stresses which are placed on specific aspects of the body through training. For the process of adaptation to be beneficial in terms of improving the event specific performance enhancing qualities of the athlete, the training stimuli must promote a variety of specific structural and functional changes within the body.

The structural changes will include the hypertrophic changes to muscles and tendons, various structural changes which occur to nerves which innervate these muscles, increases in the thickness and density of bones, and increases in the thickness of ligaments which support the joints under stress. These structural changes provide the essential building blocks for improved force output by the body.

Functional changes on the other hand are “operational” changes which occur in the receipt and speed of transmission of input by receptor nerves, the speed of processing of this input, including any variations which occur in the selection of a response by the motor cortex of the brain (the decision making process), and the transmission speed output by the effector nerves of this system.

The decision making processes in the brain and reflex systems (spinal cord), govern the recruitment of motor units in agonist (prime-movers), synergist (assistants) and stabilizer (joint/limb controlling) muscles, and the limitation of nerve impulses to motor units in antagonist (resistant) muscles (reciprocal inhibition).

These functional changes which we seek are neuromuscular in nature, as they involve input from nerve structures (receptors) located in joints, tendons and muscles, processing by the C.N.S., and output to muscle fibers, whose contraction characteristics are determined by the characteristics of the innervating motor nerve.

Any changes to the timing, frequency or intensity of muscle contraction (agonists, synergists and stabilizing muscles) and relaxation (antagonist muscles), are dependent upon “specific neural adaptations” being induced within the complex peripheral receptor input, central processing and central and peripheral effector output mechanisms of the nervous system.

These changes need to be moulded over an appropriate framework of time, ensuring that a proper foundation is laid in the process of building a performance. This foundation is important in avoiding weaknesses in the final product and to ensure against injury during the various stages of development.

IMPROVING NEURAL FUNCTIONING

The skeleton of the athlete provides the framework for mechanical movement, the muscular system provides the engine and the energy systems provide the fuel. The performance levels of the human body however, are controlled by the electro-chemical impulses generated within the nervous system.

It is the nervous system which coordinates performance. The rate and intensity of the nerve stimulus determines the rate and extent of contraction and therefore force development in the agonist muscles. The nervous system simultaneously controls co-contraction in synergist and stabilizer muscles and through a process, known as reciprocal inhibition, which limits the stimulation of fibers in muscles which may oppose or resist the movement.

The timing of movements of the limbs and the timing of contraction of the whole range of muscles, which generally are responsible for a series of movements, is all controlled by the nervous system.

Improvement of neural functioning is the most significant consideration in training for horizontal jumping events, because the limbs must be operated at maximum speed, the muscles must be contracted at maximal force, visual and auditory input must be processed at high speed, and the movements involved entail the high speed coordination of the arms, legs and trunk.

Achieving improvements in neural functioning is by no means a simple task. In order to elicit the appropriate improvements and contraction intensities, a number of considerations relating to specificity of both the movement and the load must be taken into account.

SPECIFIC JOINT AND MUSCLE LOADING

Horizontal jumpers perform all of their movements in the run-up and take-off with only one leg supporting on the ground at any one time. Many common leg strength training exercises (squat, leg press, calf raise etc), on the other hand, involve the simultaneous use of both limbs.

In a review of this area (Sale, 1992), indicated that several studies had shown that the total force produced in a bilateral exercise was less than the sum of forces which could be produced when the two limbs were tested separately. This difference in the force output of the limbs is known as the “bilateral deficit”. It is most pronounced in athletes who train for activities which have alternating (leg) movements, while the deficit is less pronounced in events such as rowing or weight lifting, where the athletes train with bilateral movements.

The bilateral deficit is an important consideration in the strength training of jumpers because neural training of the maximum specific strength parameters in the muscles can only be achieved through specific activities. Single leg squats, single calf raises, single hip and leg extension work, single sided rotational sit-ups and back extension work, all offer considerable advantages over their corresponding bilateral exercises. This is partly because they will allow better selective recruitment of fast twitch “B” fibers, by facilitating a higher force output by the muscles, and partly because of the more specific neural activation which accompanies the movements.

Unilateral exercises bring into play the whole range of muscles which contribute to single leg support movements. In these activities it is not only the agonists and antagonists which are recruited, but also the synergists (muscles which assist in the movement) and the stabilizers (muscles which stabilize a joint, limb or other body part to allow the agonists to perform effective work around that area).

It is generally well recognized that the single hip and knee flexion movement which occurs during landing from a sprint stride or in planting the foot for the take-off in a jump, involves the quadriceps muscles in eccentric contraction. Not so well recognized is the synergistic and stabilizing role played by the adductors, abductors and inward and outward rotators of the thigh in controlling this movement. The recruitment patterns and loadings of these muscles is different in a double leg movement. These muscles will therefore receive a disproportionately smaller amount of training compared to the agonists and antagonists.

The same is true of the critically important hip and knee extension during the take-off movements in a sprint stride or a jump takeoff. The hamstring and gluteal muscles work concentrically in hip extension and the quadriceps works concentrically in knee extension. The gluteals, however, are also hip stabilizers at the bottom of the movement and also hip abductors.

They serve an important synergistic and stabilizing role in single leg support movements by guiding, as well as assisting, with hip extension. If they are not strengthened in balance with the hamstrings, additional stress will be placed upon the hamstring muscles during these movements.

Other hip abductors along with adductors and the inward and outward rotators of the thigh will become also comparatively weaker if bilateral exercises are employed as the basis of the strength training program. Apart from the potential for injury which can result from this work, the resulting muscle strength imbalances are likely to lead to poor technique, particularly under stressful performance conditions.

ACTION TYPE SPECIFICITY

In any given movement, a certain group or groups of muscles are preferentially recruited by the nervous system to contract. Within this muscle group, individual muscles may be preferentially recruited as the agonists in a movement, while others perform a synergistic role. Preferential recruitment also extends to individual motor units controlling groups of fibers within a muscle.

Fast twitch muscle fibers are usually preferentially recruited for movements which involve large force outputs or movements which require a fast contraction relaxation sequence. Eccentric contractions usually also result in the preferential recruitment of fast twitch fibers. The greater the speed of muscle lengthening in eccentric contraction, the greater the preference for this fiber type in recruitment.

The coordination between muscles which act in a movement and their relative degree of involvement is specific to the movement being performed. Different muscles, groups of fibers within muscles and different fiber types may be recruited according to the joint angle, the range of operational movement, the contraction type and the speed of the movement.

Information gleaned from research into action type and velocity specificity in muscle contraction highlights the importance of specificity in training activities which seek to induce specific neural adaptations. This suggests that the only truly neurally specific training activity will be skills practiced along with some movement specific drills. The role of skill training in eliciting the expression of muscular strength in performance is therefore underlined.

However, it is important not to narrow the training base too much. Ongoing changes in the nervous system depend on variations in stimulus, as well as simply increasing the load. Variations in the training stimulus need to be achieved without ignoring important specificity criteria.

The stimulus of additional load may be introduced through weight training exercises, plyometric exercises over boxes, up or down stairs or hills, towing a sled, or with medicine ball activities. To meet important specificity criteria in these cases, the activities should simulate the range of motion encountered in the event (with a margin no more than 30 degrees greater than the event movement range) and the force output of the muscles should be close to maximum in each case.

In this way, it is likely that all the muscles used in the event will be recruited in a broadly similar manner in the training exercise, even though the actual speed of the movements will vary between activities. Increasing the movement range beyond plus or minus 30 degrees is likely to cause a totally different neural response, with possibly different muscles within a group being preferentially recruited, or different fibers within a muscle being selected to perform the work.

High speed eccentric contractions in a movement stimulate the recruitment of more motor units and the preferential recruitment of fast twitch “B” fibers in the contraction. Training activities such as bounding over boxes, horizontal bounding, depth jumping, explosive squats, jumping split squats, acceleration sprinting, and stride frequency sprints, all meet the recruitment criteria.

Provided that the movement range is monitored, these activities provide very useful variations in the stimulus to the nervous system and may fulfill an important role in facilitating neural adaptations through training.

CONCLUSIONS

The development of strength in horizontal jumpers requires different approaches at different stages of maturity of the jumper. Ensuring that young athletes achieve their long term potential requires an intelligent and patient approach to training, especially with regard to skill development and other aspects of neural adaptation.

This approach is vital because of the very large forces which may be encountered during the take-off phases of these events, with the resultant potential for injury.

Research which has been conducted in the areas of muscle fiber development and neural adaptation underlines the importance of specificity when designing strength training programs for mature horizontal jumpers. It is important that the mature horizontal jumper’s training program is designed to elicit specific muscular and neural adaptations which will build into the athlete the capability to meet the performance demands for elite level athletes.