3.2 Applications for sports and therapy

3.2.1 Special teaching methods and specific models for formal sessions

These steps can occur in this order during a typical session, which often varies in length, though generally never lasting more than 60 minutes:

- Preliminaries.
- Imagining.
- Micro-activations.
- Macro-activations.
- Additional tasks.

Preliminary practice provides the raw material for composing quality images and creating the right conditions for the representation. This preliminary practice can be performed using videos, spoken instructions or rationally. Watching videos, looking at photographs, stopping the image, fast-forwarding or looking at different executions are extremely useful. We can also add segments or parts to drawings made by the trainer, look at two photographs and detect the differences as in the “seven errors game”. Another way is to draw the critical phases of the movement.

We can use our voices to describe the complete movement, and emphasize the critical phases with the relevant expressions. It is important that descriptions follow a spatial, temporal and dynamic order, and that the differences between the executions and their reasons are explained properly.

Using rational thought for example, photographs can be arranged in a particular order according to some logical criteria, the trainer's questions answered (the trainer should ask them), and rational flowcharts cab be composed, like “if… so…”. It should be understood that motor thought obeys so-called inductive inferences, not deductive reasoning, and it is therefore necessary to compare executions and detect the different reasons for the differences.

We initially consider three broad variables that we can use to manipulate the growing complexity of the image prepared and maintained by the subject:

Subject environment:

- No context.
- Training.
- Competition: may be home or away.

Perceptual data:

- Visual only.
- Auditory.
- Combines: data can be combined, and include kinesthetic data or not.

Observer:

- External: may be fixed or mobile, paused or continuous, and from different planes, in the first or third person.
- Internal: I imagine what my body actually sees when I move.

In relation to observer perspectives, it is the combination of possibilities that modifies the difficulty of the mental representation task.

- External: the simplest way is to imagine the movement as if it was being "filmed".
- Internal: the most complex way is to imagine what I actually see when I execute the movement.

We should remember that there are many advantages to learning how to imagine ourselves in the first person (with ourselves as protagonists). This activates other areas in respect to the third person, has widespread cognitive and motivational effects, and improves body image.
The possibilities of mental representation can be expanded by working with different variants of internal or external means:

Fixed or Mobile

Speaking of external means, we can use the movement of the "camera", which gives us two broad possibilities: fixed camera or mobile camera. The fixed camera can be used with zoom or without. The mobile camera can use intermittent pauses or continuous recording. Training using a combination of all of these is very enriching. The aim is to be able to control the "cameras" at will.

Single-plane or multi-plane

The specifics of the plane on which we represent ourselves takes on special significance, above all given the nature of the gesture we are trying to improve. The choice of representation plane depends, among other things, on the specific technical failing we are trying to improve and on the overall technique of the movement. It is not unusual that athletes are capable of representing themselves more easily on the sagittal plane while gymnasts can achieve this on a variety of planes. The possibility of varying the representation planes enriches the potential of this tool. The versatile use of this resource is a great advantage.

The Environment of the Subject

Perhaps the simplest possibility refers to representing ourselves without any context; in other words, on a black or white background, or completely imprecise or vague. This allows the data of the movement we are trying to correct or the motivational aspects we are trying to control to come into focus in the image. We can also imagine ourselves in the training context, with perceptual data that are more familiar to the subject; devices that can be more complex, or other devices from competition with perceptual data specific to that context.

Some **other data** that we might include would be:

- *Visuals only:* for example, a pure mental representation can be included without perceptual data other than the information provided by the visual system.
- *Auditory also:* auditory data can include many possibilities: own data, the data of a rival, colleagues, the trainer or the public, as well as kinesthetic information. These are more complex to represent although, with training, even the deepest somatic sensations can be recalled.

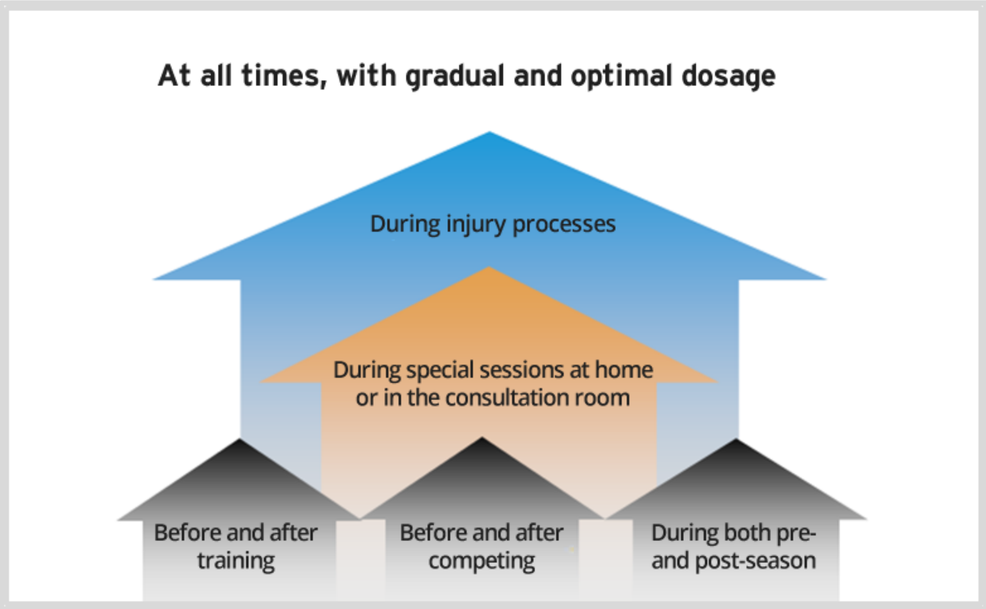
Accompanying the image with small contractions; words can be very useful in the initial stages to cancel out the visual analyzer as the images are combined with small movements. These words can have a mechanical, energetic, sensory, or motivational reference. These, for example, are ideal as a component of the mental activities during recovery pauses; in other words, the words constitute a link between the image and the kinesthetic experience. Another possibility is what is known as **neuromuscular sensitization**: this involves mental executions accompanied by global gestures. The full movements need not be executed at this stage, only most of it. They are preferably performed under facilitated conditions, generally assisted or using alternate positions and, generally, at much slower speeds and with assistance, where necessary.

Final Additional Tasks.

We can conclude these sessions by using:

- Transmission of knowledge.
- Dialog with the trainer.
- Sharing the experience.
- Group reflection.

Figure 2. Contexts for Using Mental Imagery



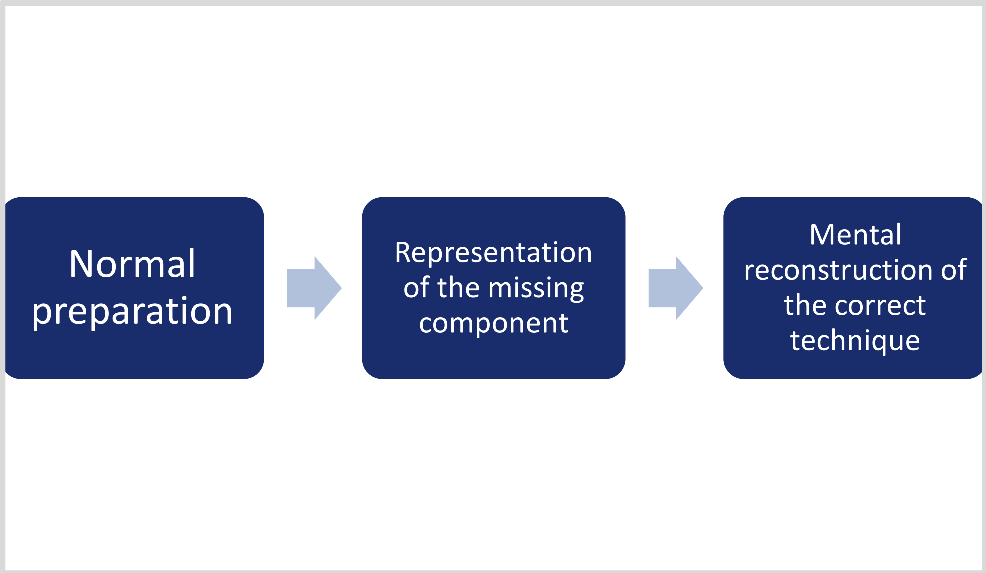
Source: prepared by the author

3.2.2 Ideomotor representational times

Mental representation should not be the only tool that we use for movement, instead we can look closer at other higher cortical functions. Improving movement and motivation requires us to use and control brain functions.

The path a person must overcome to correctly use motor imagery techniques starts with observation before moving on to representing the image and pursuing its process through training the capacity to imagine, with the aim of improving practical execution.

Figure 3. Effective Correction of Imperfect Movement



Source: prepared by the author

3.2.3 Mental fatigue: conditions, risks, and analysis of experiences

During the 1970s, I trained as a gymnast, progressively, as a natural activity without any special instruction. Little by little, our great professor, Juan Carlos Higa, taught us about what it meant to "think" in order to improve performance and motor control. He would tell us of gymnasts who claimed they could accurately reproduce an entire routine in their mind, uninterruptedly, before mounting the apparatus. Back then, there were no specifications other than the imagination. So we would spontaneously close our eyes to try and imagine what we were about to do. We would use the technique more and more as competitions approached. During these competitions, our anxiety would wrest quality from the process of generating the motor images. Another of my memories as a gymnast related to using this tool was the generation of positive emotions. One of my most powerful memories is: "if you doubt, if you think you are going to fall, there is a greater chance that you will".

The repercussions of this in my particular experience with students of the Provincial Institute of Physical Education (Instituto Provincial de Educación Física, IPEF) primarily involved managing anxiety and motor control. Performing simple activities with IPEF students, such as imagining single arm gestures before performing them with both arms, or the detection of large differences between the both hemibodies drew a lot of interest so we immediately began a closer study. More specifically, for a couple of minutes in each class I would ask students to lie face-down in prone position and imagine themselves doing onearmed push-ups; that their mind was like a camera that zoomed in and filmed the effort of a single arm to later execute the push-ups with both arms. The results expressed were "greater weight on the unimagined side". These experiences help us realize that this is an extraordinarily powerful tool which, from a functional standpoint, does not only refer to cortical events. It was not only mental, but also involved peripheral functions that we could specifically detect anatomically.

As a physical trainer, I started to use this tool from the very first time I engaged in professional practice. During the 1990s, we conducted systematic rehearsals with athletes: experiences in rugby, soccer and gymnastics, without using it in adapted or therapeutic exercise. We found a great deal of acceptance among rugby players and achieved positive sports results, although there was no reference as to whether they detected any differences as a result of the mental exercises. Let's take a closer look at two different sports with very interesting experiences owing to their versatility: soccer and rhythmic gymnastics.

My experience in Belgrano de Córdoba soccer club in the Argentinian first division was with Luis Fabián Artime; together we would perform mental exercises prior to each game, before the coach's pep talk. We would focus closely on images related to marking or scoring gestures. The results became evident immediately: the player scored the highest number of goals per championship, described a large number of goals that, one way or another, he had previously imagined during the mental exercises. These tasks lasted between 5 and 10 minutes.
We also used it in training gymnasts and ballerinas to expand their range of movement. We develop the mental aspect as a key component of flexibility training. Our experiences with gymnasts and ballerinas show how controlling images can help expand range of movement, from brain waves to the impact of images on reducing internal resistance to stretching.

We use this tool in Adapted Physical Education (APE) together with observation and self talking. For more than ten years now we have trained professors and interns to use this tool as a general work assignment. We have obtained good results in cases of Parkinson's Disease and equilibrium disorders due to cerebral-vascular problems which is why we have applied it to the learning or re-learning of basic posture and locomotor skills. We are extending this type of learning to the other cases.

During body awareness and motor imagery sessions, the tendency is to direct the subject to beach or forest contexts; this is a tendency that has always raised questions and doubts. Does it really matter whether we are in a different place, at the beach or someplace similar, and hear the sounds of nature instead of representing your own body in the motor situation you require? Of course it does. We believe it does not work. We have to try and place the subject in the context of their practice environment (court, pommel horse, with the element) and use this as the basis for improving neuromotor skills.

3.2.4 Current research status

In the annex of this reading material we have included some papers that reflect the current status of research into ideomotor representation.

A short summary of each of these papers can be found below.

When music tempo affects the temporal congruence between physical practice and motor imagery Ursula Debarnot a,b, Aymeric Guillot c,d

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Abstract

When people listen to music, they hear beat and a metrical structure in the rhythm; these perceived patterns enable coordination with the music. A clear correspondence between the tempo of actual movement (e.g.,walking) and that of music has been demonstrated, but whether similar coordination occurs during motor imagery is unknown.
Twenty participants walked naturally for 8 m, either physically or mentally, while listening to slow and fast music, or not listening to anything at all (control condition). Executed and imagined walking times were recorded to assess the temporal congruence between physical practice (PP) and motor imagery (MI). Results showed a difference when comparing slow and fast time conditions, but each of these durations did not differ from soundless condition times, hence showing that body movement may not necessarily change in order to synchronize with music. However, the main finding revealed that the ability to achieve temporal congruence between PP and MI times was altered when listening to either slow or fast music. These data suggest that when physical movement is modulated with respect to the musical tempo, the MI efficacy of the corresponding movement may be affected by the rhythm of the music. Practical applications in sport are discussed as athletes frequently listen to music before competing while they mentally practice their movements to be performed.

Mental Representation and Mental Practice: Experimental Investigation on the Functional Links between Motor Memory and Motor Imagery

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Abstract

Recent research on mental representation of complex action has revealed distinct differences in the structure of representational frameworks between experts and novices. More recently, research on the development of mental representation structure has elicited functional changes in novices' representations as a result of practice. However, research investigating if and how mental practice adds to this adaptation process is lacking. In the present study, we examined the influence of mental practice (i.e., motor imagery rehearsal) on both putting performance and the development of one's representation of the golf putt during early skill acquisition. Novice golfers (N = 52) practiced the task of golf putting under one of four different practice conditions: mental, physical, mental-physical combined, and no practice. Participants were tested prior to and after a practice phase, as well as after a three day retention interval. Mental representation structures of the putt were measured, using the structural dimensional analysis of mental representation. This method provides psychometric data on the distances and groupings of basic action concepts in long-term memory. Additionally, putting accuracy and putting consistency were measured using two-dimensional error scores of each putt. Findings revealed significant performance improvements over the course of practice together with functional adaptations in mental representation structure. Interestingly, after three days of practice, the mental representations of participants who incorporated mental practice into their practice regime displayed representation structures that were more similar to a functional structure than did participants who did not incorporate mental practice. The findings of the present study suggest that mental practice promotes the cognitive adaptation process during motor learning, leading to more elaborate representations than physical practice only.

Improving the TAMI for use with athletes

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Abstract

Athletes have been shown to have greater movement imagery abilities than non-athletes. However, since these differences were observed using questionnaires where participants subjectively judged the vividness of performing imagined movements, it is possible that responses could be biased by other factors such as social desirability. One possible solution is to use an objective test, such as the Test of Ability in Movement Imagery (TAMI; Madan, C. R., & Singhal, A. (2013). Introducing TAMI: An objective test of ability in movement imagery. Journal of Motor Behavior, 45, 153–166.).

Unfortunately, young adults perform relatively well on the TAMI, leaving little room for statistical sensitivity in observing higher scores. Here we propose an alternate scoring method for the TAMI that resolves this limitation by weighing items according to their difficulty. We apply this scoring method to existing data and show that this improves the TAMI's selectivity to measuring ability in movement imagery, rather than related imagery processes. Thus, we have successfully improved the TAMI to be more suited for use with athletic populations.

THE EFFECT OF MOTOR IMAGERY WITH SPECIFIC IMPLEMENT IN EXPERT BADMINTON PLAYER

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Abstract

Motor skill can be improved with mental simulation. Implements are widely used in daily life and in various sports. However, it is unclear whether the utilization of implements enhances the effect of mental simulation. The present study was designed to investigate the different effects of motor imagery in athletes and novices when they handled a specific implement. We hypothesize that athletes have better motor imagery ability than novices when they hold a specific implement for the sport. This is manifested as higher motor cortical excitability in athletes than novices during motor imagery with the specific implement. Sixteen expert badminton players and 16 novices were compared when they held a specific implement such as a badminton racket and a nonspecific implement such as a a plastic bar. Motor imagery ability was measured with a self-evaluation questionnaire.

Transcranial magnetic stimulation was used to test the motor cortical excitability during motor imagery. Motor- evoked potentials (MEPs) in the first dorsal interosseous (FDI) and extensor carpi radialis muscles were recorded. Athletes reported better motor imagery than novices when they held a specific implement. Athletes exhibited more MEP facilitation than novices in the FDI muscle with the specific implement applied during motor imagery. The MEP facilitation is correlated with motor imagery ability in athletes. We conclude that the effects of motor imagery with a specific implement are enhanced in athletes compared to novices and the difference between two groups is caused by long-term physical training of athletes with the specific implement.

References

Asociación Educar (2015). http://www.asociacioneducar.com/.

Baddeley, A. (1983). *Working memory*. Oxford.

Bañuelo, F. S. (1990). *Didactica de la Educacion Fisica y el Deporte* [Physical Education and Sports Teaching]. Madrid: Gymnos.

Bermeosolo, J. (2012). *Working memory and procedural memory in Specific Learning and Language Difficulties: some findings*. Chilean Magazine of
Speech Therapy, 18.

Boulch, J. L. (1989). *El deporte educativo; psicokinetica y aprendizaje motor* [Educational Sports: the Mind in Movement and Motor Learning]. Buenos Aires: Paidos.

Boulche, J. L. (2002). *Hacia una ciencia de movimiento humano* [Towards a Science of Human Movement]. Barcelona: Paidotribo.

Corraze, J. (1988). *Bases neuro-psicologicas del movimiento* [Neuro-psychological Fundamentals of Movement]. Barcelona: Paidotribo.

Corraze, J. (1988). *Las bases neuropsicológicas del movimiento [Neuro-psychological Fundamentals of Movement]*. Barcelona: Paidotribo.

Cratty, B. (1974). *Motricidad y psiquismo* [Motor Function and the Psyche]. Madrid: Miñon.

Damasio, A. (2006). *El error de descartes* [Descartes' Error]. Buenos Aires: Critica.

Damasio, A. (2007). *En busca de Spinoza* [In Search of Spinoza]. Barcelona: Critica.

Davids, K., Button, C., & Bennett, S. (2008). *Dynamics of skill acquisition*. Canada: Human Kinetics.

Desarrollo y aprendizaje motor [Motor Development and Learning]. (2009). Córdoba, Córdoba, Argentina: IPEF.

Di Santo, A. (2016*). Sistema Sensorial* [Sensory System] (Recorded by N. Acosta). Córdoba, Córdoba, Argentina.

Di Santo, M. (2015). *Influencia de Antonio Damasio* [Antonio Damasio's Influence] (Recorded by N. Acosta). Cordoba, Cordoba, Argentina.

Di Santo, M. (2015). *Eferencia central* [Efferent Center] (Recorded by N. Acosta). Cordoba, Cordoba, Argentina.

Di Santo, M. (2015). *Imagen del movimiento* [Motor Imagery] (Recorded by N. Acosta). Córdoba, Córdoba, Argentina.

Di Santo, M. (2015). *Pensando en movimiento* [Thinking of Movement] (Recorded by N. Acosta). Córdoba, Córdoba, Argentina.

Di Santo, M. (2015). *Programación neuromotora* [Neuromotor Programming] (Recorded by N. Acosta). Córdoba, Córdoba, Argentina.

Di Santo, M. (2015). *Programación neuromotora* [Neuromotor Programming] (Recorded by N. Acosta). Córdoba, Córdoba, Argentina.

Di Santo, M. (2015). *Toma de decisión y lógica motriz* [Decision-making and Motor Logic]. Cordoba, Cordoba, Argentina.

Digby, E., & Khan, M. (2010). *Vision and goal-directed movement*. Canada: Human Kinetics.

Domjan, M. (2009). *Principios de aprendizaje y conducta* [Principles of Learning and Behavior]. Madrid: Rogar.

Ernst, M. (2002). Neural Systems and Cue-Induced Cocaine Craving. http://www.nature.com/npp/journal/v26/n3/full/1395814a.html, 7.

Etchepareboda, M., & Abad-Mas, L. (2010). http://www.lafun.com.ar/.

Fairbrother, J. (2010). *Fundamentals of motor behavior*. Canada: Human Kinetics.

Gardiner, P. (2011). *Advanced neuromuscular exercise physiology*. Canada: Human kinetics.

Grosser, M. (1988). *Principios del entrenamiento deportivo* [Principles of Sport Training]. Spain: Martinez Roca.

Guyton, C., & Hall, J. (2006). *Tratado de fisiología médica* [Treatise on Physiological Medical]. Barcelona: Elsevier.

Jacques, C. (1987). *Las bases neuropsicológicas del movimiento* [Neuropsychological Fundamentals of Movement]. Barcelona: Paidotribo.

Jeanne, L., & Seidler, R. (2011). Age differences in callosal contributions to cognitive processes https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3137668/

Kandel, E. (1997). *Neurociencia y Conducta* [Neuroscience and Behavior]. Madrid: Prentice Hall.

Kurt, M., & Günter, S. (1987). *Teoria del movimiento; motricidad deportiva* [The Theory of Movement; Sports Motor Skils]. Buenos Aires: 1987.

Lacey, S., & Lawson, R. (2013*). Multisensory imagery*. New York: Springer.

Latash, M. (2008). *Neurophysiological basis of movement* (2 ed.). United States: Human Kinetics.

Latash, M. (2012). *Fundamentals of motor control*. United States: AP.

Loyber, I. (1988). *Funciones motoras del sistema nervioso* [Motor Functions of the Nervous System]. Córdoba: El galeno.

Loyber, I. (2012). *Funciones motoras del sistema nervioso* [Motor Functions of the Nervous System]. Córdoba: El Galeno.

Loyber, I. (2012). *Introducción a la fisiología del sistema nervioso* [Introduction to the Physiology of the Nervous System]. Córdoba: El Ganelo.

Mark, L. (2008). *Synergy*. England: Oxford University.

Neumaier, A. (2002). *Entrenamiento de la técnica* [Technique Training]. Barcelona: Paidotribo.

Cardinali, D. (2007). Neurociencia aplicada: sus fundamentos [Applied Neuroscience: the Fundamentals]. Buenos Aires: Panamericana.

Purves, D. (2007). *Neurociencias* [Neurosciences]. Buenos Aires: Panamericana.

Rachel, S., Jin, B., & Anguera, J. (2013). Neurocognitive Contributions to Motor Skill Learning: The Role of Working Memory http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3534841/.

Richard, S., & Timothy , L. (2014). *Motor learning and performance.* Canada: Humanic Kinetics.

Richardson, J. (1996). *Working memory and human cognition*. Oxford: Oxford University.

Rigal, R. (1979). *Motricidad Humana* [Human Motor Skill]. Madrid: Pila Teleña.

Ripoll, R. D. (2014). *Neurociencia cognitiva* [Cognitive Neuroscience]. Madrid: Panamericana.

Roger M, E. (2008). *Neuromechanics of human movement.* Canada: Human Kinetics.

Ruiz Perez, L. (1994). *Deporte y Aprendizaje* [Sports and Learning]. Visor: Madrid.

Snell, R. (1999). *Neuroanatomía [Neuroanatomy].* Fourth Edition. Buenos Aires: Panamericana.

Stefano, T. (2009). *Neurociencias y deportes* [Neuroscience and Sports]. Barcelona: Paidotribo.

Tamorri, S. (2004). *Neurociencia y deporte [Neuroscience and Sports].* Barcelona: Paidotribo.

Tamorri, S. (2004). *Neurociencia y deporte [Neuroscience and Sports]. Psicología deportiva procesos mentales del atleta* [Sports Psychology of the Athlete's Mental Processes]. Barcelona: Paidotribo.

Universidad de Cantabria, (S.F.), source: http://2.bp.blogspot.com/-EdC6hSDAQWw/VAvxXE0438I/AAAAAAAABGU/_7rz97u55Z4/s1600/anatomia%2Boido.png

Universidad de Murcia, (S.F.), source: http://ocw.um.es/gat/contenidos/palopez/contenidos/motoneuronas.jpg

Universidad de Costa Rica, (S.F.), source http://163.178.103.176/Fisiologia/neurofisiologia/pract_bas_1/FG13_03a.jpg

Universidad Nacional de Tucumán, (S.F.), source http://www.herrera.unt.edu.ar/bioingenieria/temas_inves/sist_nervioso/Image52.gif

Weineck, J. (2006). *Entrenamiento total* [Total Training]. Barcelona: Paidotribo.

Zhou. (2000). El entrenamiento cruzado: una posibilidad del mantenimiento de la forma ante lesiones unilaterales [Cross Training: Potential for Keeping Fit during Unilateral Injury]. *Medicina Esport*, 15.