ARCHAEOPROPRIOCEPTION
What is it and how can we train it

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What it is and how to train it. From the observations of great champions to the discovery of the archaic structures that everyone can reactivate to improve the strategies of managing disequilibrium.

One reads and hears, always more often, of proprioceptive training and rehabilitation, but frequently the exercises proposed are not absolutely adequate for the scope. Their effect is limited to a modest positive action on the “proprioperception”, that is the representation at a conscious level of the sense of the position and movement of a joint. This aspect, though, interests only a millionth part of the internal flow of proprioceptive signals deriving from the periphery and has a negligible effect on the quality of movement and functional stability of the limbs.

It is necessary, instead, to act on the “archaeoproprioception”, that is on those flow of signals that involve, together with the peripheral receptors, the more primitive structures of the nervous system: spinal cord, brainstem and primordial part of the cerebellum (figure 1), common not only to inferior mammals, but also to the other vertebrates. Such structures are defined as subcortical, as they do not enter the dominion of the conscious.

Our nervous system in fact, thrown in an always more technological future, carries within itself the history of life. During foetal life and during the successive first phases of birth the nervous system rapidly runs all the philogenetic stages that have required millions of years to pass from the nervous organisation of an anemone to that of man.

As if he were an archaeologist, man in the third millennium will have to readapt himself to an efficacious use of the archaic structures to avoid the future of a humanoid with an enormous head and a body almost unable to move.

At every instance, for the whole life, millions of information deriving from various peripheral receptors present in skin, muscle, tendons, joints, eyes and internal ear are at the disposal of the nervous centres. The look-out sentries are therefore always active and efficient, but the capacity to interpret these signals to produce adequate motory responses tends to progressively reduce itself. It is as if the sentries and command centres no longer speak the same language. A person
who has been abroad for many years without speaking his own language, will progressively see
his capacity to understand and speak the language weaken. The capacity to interpret the signals
(or a language) and produce a response tends therefore to adapt itself to the habitual use. The
weakening of the motory experience that regards the whole population progressively reduces the
capacity of interpreting the peripheral signals.
The “proprioceptors-spinalcord-brainstem system” maintains, if opportunely stimulated, an
extraordinary capacity to reprogram itself.
Some writers have pointed out a reduced proprioceptive sensibility in elderly people. Studies
carried out by Riva et al., at the Department of Research of the University School on Motor
Sciences of Torino, Italy, seem to confirm that the functional decline of the structures involved
in the archaeoproprioception is much slower than that of the osteoarticular structures delegated
to movement and that this reduced proprioceptive sensibility is the consequence of a functional
regression caused by non-use. The subcortical system of movement control would maintain
therefore very high functional potential even in advanced age and after peripheral traumatic
lesions or vascular lesions of the cortical areas.
The choice of means and methods to stimulate it will be determinant. For example, to go from
Milan to Naples it is possible to use a utility car or a high powered car: the duration, comfort and
safety of the journey will change, but the final result will be the same. To go from Milan to New
York it would be necessary, instead, to use different means of transport. In the same way to
stimulate the archaeoproprioception and not limit itself to a modest action at the conscious
perception level, it is necessary to use adequate means.

The evolution of means

In contrast with the rapid technologic developments that has revolutionised the various fields of
medicine and science, in the rehabilitative sector concerning the proprioceptive assessment and
training the operators for over thirty years have had an only methodology at disposition: that tied
to the use of the classic equilibrium board.
To render an equilibrium board electronic represents therefore, apparently, the natural evolution
of an instrument largely used. In reality the physiologic presuppositions on which the use of the
instrument is based are greatly modified. The necessity to create situations of disequilibrium-
instability and to use a means biomechanically characterised by a rolling surface that allows to
be controlled at every inclination is in fact confirmed (table 1).

Table 1 The more significant differences between the classic rocking board and an electronic rocking board

<table>
<thead>
<tr>
<th>TASKS</th>
<th>ELECTRONIC ROCKING BOARD</th>
<th>CLASSIC ROCKING BOARD</th>
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</thead>
<tbody>
<tr>
<td>Instability</td>
<td>Controllable</td>
<td>Controllable</td>
</tr>
<tr>
<td>Management of the inclination of</td>
<td>High frequency of tasks (tied to visual feedback in real time</td>
<td>No request</td>
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<tr>
<td>the board and of the translation of</td>
<td>and to comparisons assignable through the visual analyser)</td>
<td></td>
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<tr>
<td>the point of support</td>
<td></td>
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<tr>
<td>Visual feedback</td>
<td>Trains the nervous centres to interpret the proprioceptive</td>
<td>Absent</td>
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<tr>
<td></td>
<td>signals (reviving the efficient proprioceptive reflexes) in a</td>
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<tr>
<td></td>
<td>correct and rapid way</td>
<td></td>
</tr>
<tr>
<td>Proprioceptive feed-back</td>
<td>Assessable and improvable with the function of visual feedback exclusion</td>
<td>Assessment impossible</td>
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Visual feedback and task frequency

The matching of an equilibrium board (at a grade of liberty) and an electronic apparatus that supplies in real time visual feedback on the inclination of the board, greatly increases the number of biomechanical situations that the subject has to manage in a time unit (figure 2). The subject has to therefore continually try to realign his baricentre (figure 3) at the vertical line that contains the support point, the centre of rotation of the board and the centre of the ankle that are already constantly aligned. The presence of visual feedback greatly multiplies the frequency of inclination-translation of the board, which the subject has to manage. This situation can happen only with an electronic equilibrium board.

Moreover from a biomechanical point of view, only if the instrument allows times of brief stop-inversion (possible when the mechanical latency is null) is it possible to manage a high task frequency in the time unit. This condition is necessary to activate the archaeoproprioception in the best way and in particular the proprioceptive spinal reflex indispensable for the functional stability of the joints.

On the contrary to what one could think, the visual feedback in real time comports a flow of proprioceptive signals notably superior as regards to a situation carried out with the eyes closed. The exclusion of a sensory canal certainly determines a greater undertaking on the part of the other sensorial analysers, but in the absence of visual feedback the number of biomechanical situations that are managed in the time unit reduces drastically, with a consequent reduction of the flow of proprioceptive signals. The management of the vertical position therefore becomes more clumsy.

Management of disequilibrium: is it exclusive of sport champions?

The observations made about the behaviour on the electronic equilibrium board of great sport champions (for example, a figure-skating world champion, an olympic and world ski champion, top international soccer players etc.) have allowed to discover a common characteristic that distinguishes them from other people or other athletes at a lower level: they all privilege
immediately and instinctively the control of the vertical position of their body, as regards to the control of the horizontal position of the board. They tend that is to keep their body in a state of stillness, moving as little as possible from the vertical position and leaving the board free to rock. From this observation a question arises to if this refined management of disequilibrium is a characteristic exclusive of champions or represents, instead, a functional level reachable also by normal people and how this can be reached. The hypothesis was then to supply the subject with a potential point of support and safety, that would induce him to limit the movement of the arms and upper parts of the body as much as possible and, at the same time, to use it as little as possible. A metal support was then predisposed equipped with an infrared sensor (figure 4) able to point out the user’s hand contact and signal it by means of visual feedback: the yellow trace produced on the monitor by the inclination of the board at the moment of hand contact on the horizontal bar changes colour and becomes red (figure 5).

This structure of potential support allows even a subject of low motory levels, or elderly, or with problems, to rapidly and spontaneously reach the total autonomy in managing the situation of instability proposed by the equilibrium board in monopodalic and bipodalic support. The management of the vertical position that is reached also in subjects with important movement problems or with an advanced age is superimposable to that which the champions already spontaneously present at the first use of the board: superior mass of the body in a state of stillness and microcorrections at the level of the districts nearer to the support foot. This management of the vertical position involves a maximum flow of propioceptive signals starting from the lower limb in monopodalic support and therefore the maximum efficacy in the stimulation of the reflexes.
The archeoproprioceptive feedback

To refine further the management of the proprioceptive signals at the level of the filogenetically older nervous structure, responsible of the reflex and automatic responses and of the control of posture and equilibrium, it is necessary, after the phase of training with visual feedback, to limit the information that it supplies.

An exercise carried out at first with visual feedback, can be repeated excluding the instantaneous information (fig. 6) relative to the inclination of the board and supplying only the information relative to the task to be carried out at every instance (the subject is not informed on what he is doing). It is a question of conditions similar to those in which a pilot would find himself when carrying out an instrumental landing in fog: the tower control communicates to the pilot, at brief intervals, at what distance he is from the landing strip, but he must govern the plane on the base of the information given by the instruments on board. The direct visual information on the correlations between the plane and environment is nil.

The absence of visual information on the inclination of the board, instant by instant, involves the maximum use of the proprioceptive signals to carry out adequately the assigned task (maintenance of a specific inclination or carrying out of dynamic tasks assigned through the video interface).

Excluding visual feedback, the subject has to use signals deriving from the peripheral proprioceptors. The use of the afferent signals at conscious level and the capacity of producing voluntary motory responses on the base of information exclusively proprioceptive, in such way are optimised.

The meaning of restraints

To start off the maximum flow of proprioceptive signals from the lower limb in monopodalic support on an electronic rocking board, and obtain therefore the maximum efficacy in the stimulating of the proprioceptive reflexes, it is necessary to reduce at the most the movements of the upper mass of the body (trunk, upper limbs) and of the free limb. In this way, the nervous centres that control the afferent signals arriving from the lower limb in support and afferent muscular responses have to respond to the maximum frequency, with a refined play of agonistic and antagonistic microcontraction to assure the management of the vertical position. In practise the maximum activation of the proprioceptive system and of the muscular reflex responses are obtained when we are able to

Fig. 6 Anticipating the trace by some instants, the green spots (the “hare”) reduce the conscious tasks of the subject (as the navigator in a rally advises the pilot where to go), allowing him to concentrate on the management of the tasks and of the instability that characterise every instant.

Fig. 7 The yellow spots (“pace-maker”) or “temporal indicator”) that appear on the video inform the subject at which height of the trace he should find himself at every instant. The lack of visual feedback involves the maximum activation of the proprioceptive feedback.
manage a multisegmental system, like the human body, like a rigid system with an only joint point at the ankle level (fig. 7). Even if the ankle is the joint mechanically more stressed, all the joints of the lower limb send out a very high flow of afferent signals and the frequency of the reflex responses is maximum also at the level of the knee and of the hip. This is because the joints of the lower limb represent a functional unit in which the deficiency state of a district reduces the functionality of the others also when these are absents of structural lesions.

The meaning of the restraints is therefore that of limiting the intervention of the upper parts of the body or, better still, the districts that are not part of the supporting limb. As an example we can distinguish some means of execution in the tests on the electronic equilibrium board in monopodal support:
- without restraints;
- with total restraint (fig. 8): hands on the hips and a sheet of paper between the thighs;
- with restraint of the upper or lower limbs (partial restraint);
  with “virtual restraint” (the subject tries to maintain the free limb, the trunk and the shoulders passive and in maximum relaxation).

The tests with a maximum level of restraint are suitable above all to have homogenous conditions of valuation, while the training effect is maximum in conditions of “virtual restraint”. The objective of the various levels of restraint and of the “virtual restraint” is that of inducing the subject to using micromovements at the level of the segments near to the support point to maintain the vertical position of his body and control the inclination of the board, eliminating the macro-movements of the upper masses (using that is, an ankle strategy).

In conclusion, the electronic equilibrium boards radically modify the biomechanical and physiologic presuppositions on which the use of the disequilibrium-instability situations is based. These rocking-transferring boards allow the introduction of new methodologies at high efficacy for the valuation, the rehabilitation and the development of the sensibility and of the proprioceptive reflexes. The matching between the rocking movement (that is inclination and translation) and the visual feedback in real time, possible through the electronic monitoring of the inclination, allows to reactivate the archeopropriocetion in a maximum way. The primordial structures of the conscious, readapt so the capacity of managing the situations of disequilibrium in an effective way.

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