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DOCUMENTACIÓN

Código curso 200823701

NUEVAS TENDENCIAS EN EL FITNESS: MATERIALES PEQUEÑOS

Control neurológico del movimiento

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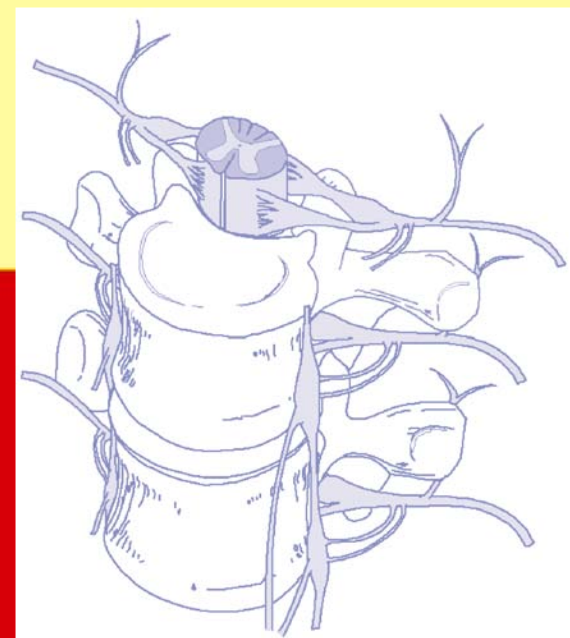
Sevilla
18 y 19 de septiembre de 2008

CONTROL NEUROLÓGICO DEL MOVIMIENTO



Impact of **sensorimotor training** on the rate of force development and neural activation.

Eur J Appl Physiol 2004 Jun;92(1-2):98-105

The purpose of the present study was to examine the functional adaptations of a specific sensorimotor training on the explosive strength qualities of the leg extensor muscles during maximum isometric actions.

The ability to generate high muscular strength within short time periods is of functional importance not only as a basic quality in many sports disciplines but also for active stabilization of joints. The rate of force development (RFD) is generally used to describe this ability.

The effects of a <u>**sensorimotor training**</u> and a **strength training** on postural stabilisation, **maximum** isometric contraction and jump performance

Int J Sports Med ***<u>2004 Jan;25(1):56-60</u>***

Bruhn S; Kullmann N; Gollhofer A
University of Freiburg, Institute for Sport and Sportscience, Freiburg, Germany.

Previous studies revealed that adaptations following ***<u>sensorimotor training</u>***, *performed to improve functional joint or postural stability, were characterized by improvements in the rate of force* development during **maximum** voluntary isometric contraction.

In <u>classical **strength training**</u> studies using intense loads it has been shown that improvements in rate of force development is mainly due to adaptations in the <u>**intramuscular coordination**</u>.

It is concluded :

that classical strength training with high loads basically

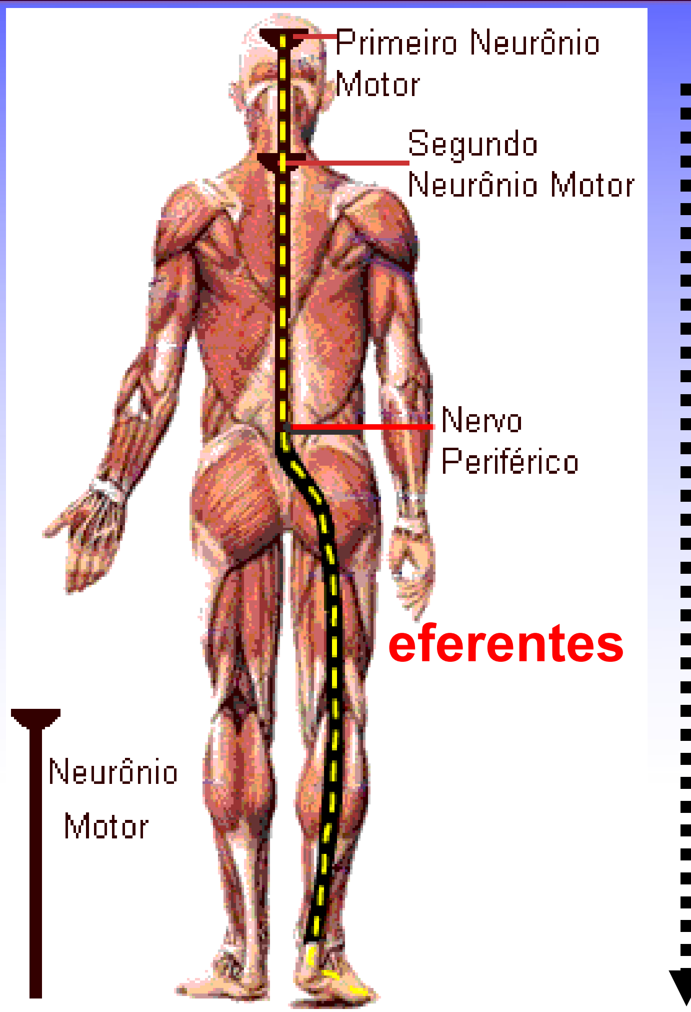
improves the mechanical efficiency of the efferent drive

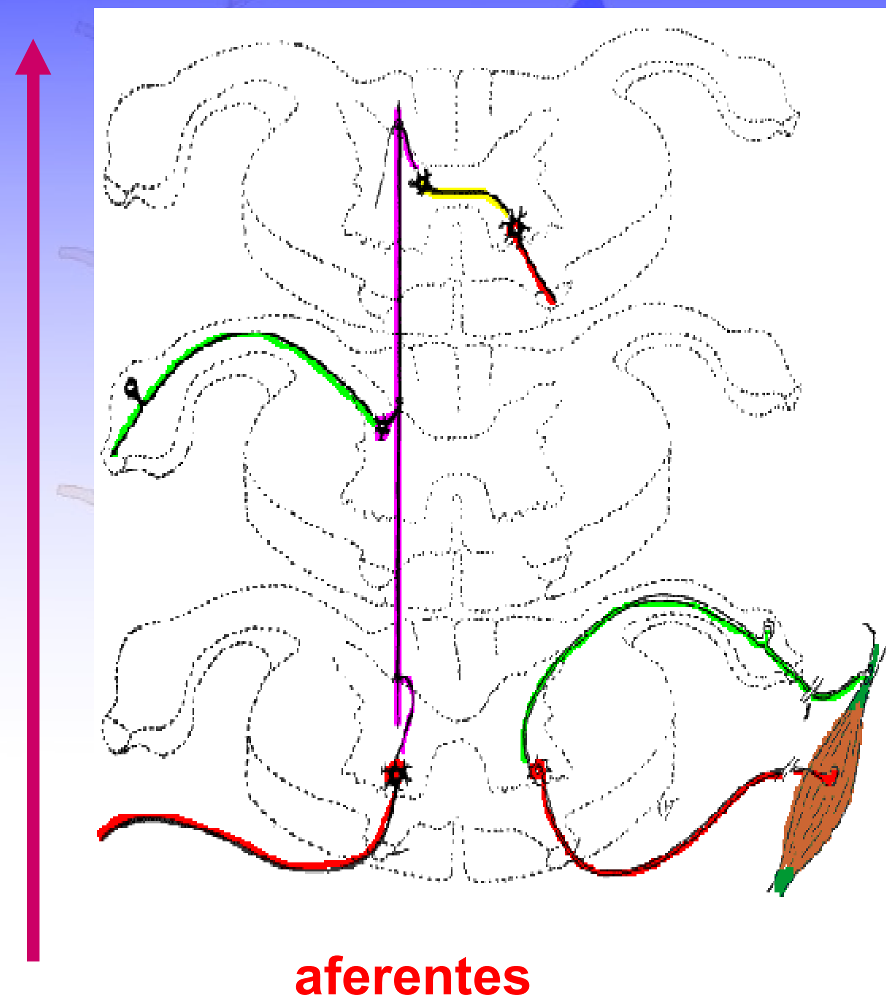
on the motoneurons,

whereas sensorimotor training

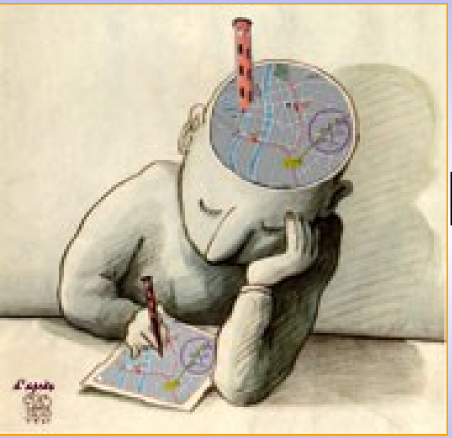
alters the afferent input on the central nervous system.

Vias nerviosas aferentes y eferentes



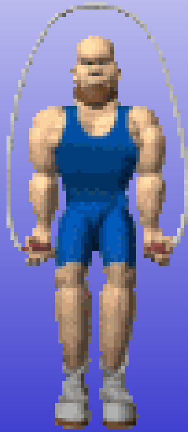


Brain Mechanisms for the formation of New Movements during Learning: The Evolution of Classical Concepts.



Conclusión Final

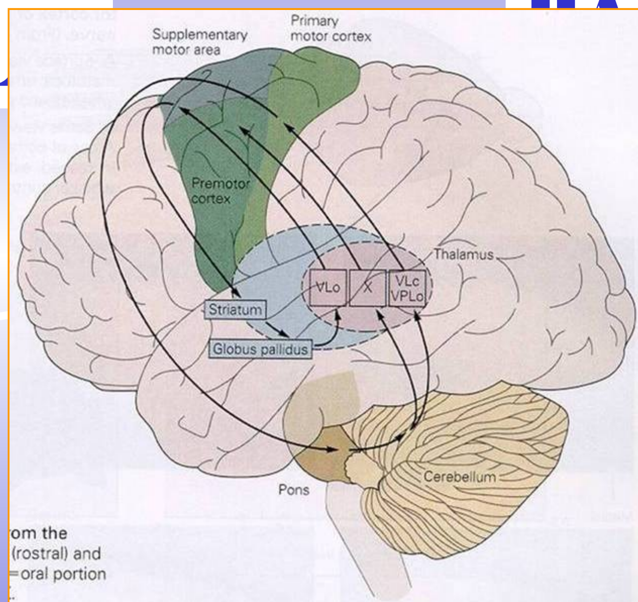
La estructura de la corteza cerebral está
Cambiando continuamente a el
Entrenamiento,
Las adquisiciones conductuales y
Motoras.



FACTORES CRÍTICOS

PLASTICIDAD CEREBRAL

CONSOLIDACIÓN DE LAS HABILIDADES MOTRICES



MECANISMOS CEREBRALE

PARA EL APRENZIZAJE MO

ENGRAMA MOTOR

ENGRAMA SENSORIAL

(Imagen de función motora hábil)

NEUROLOGICAL CONTROL OF MOVEMENT

Postura :

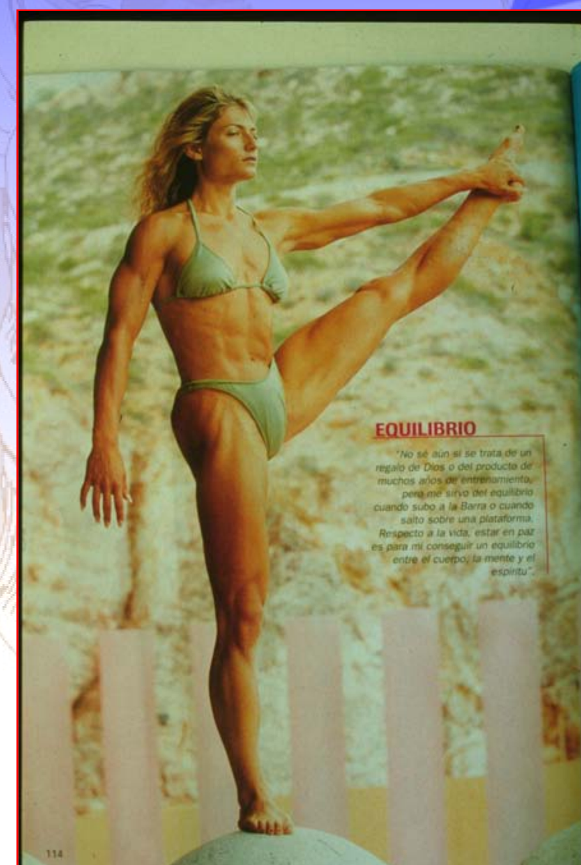
Representa la posición global del tronco y extremidades entre sí y respecto del espacio.

Ajustes motores Adaptativos :

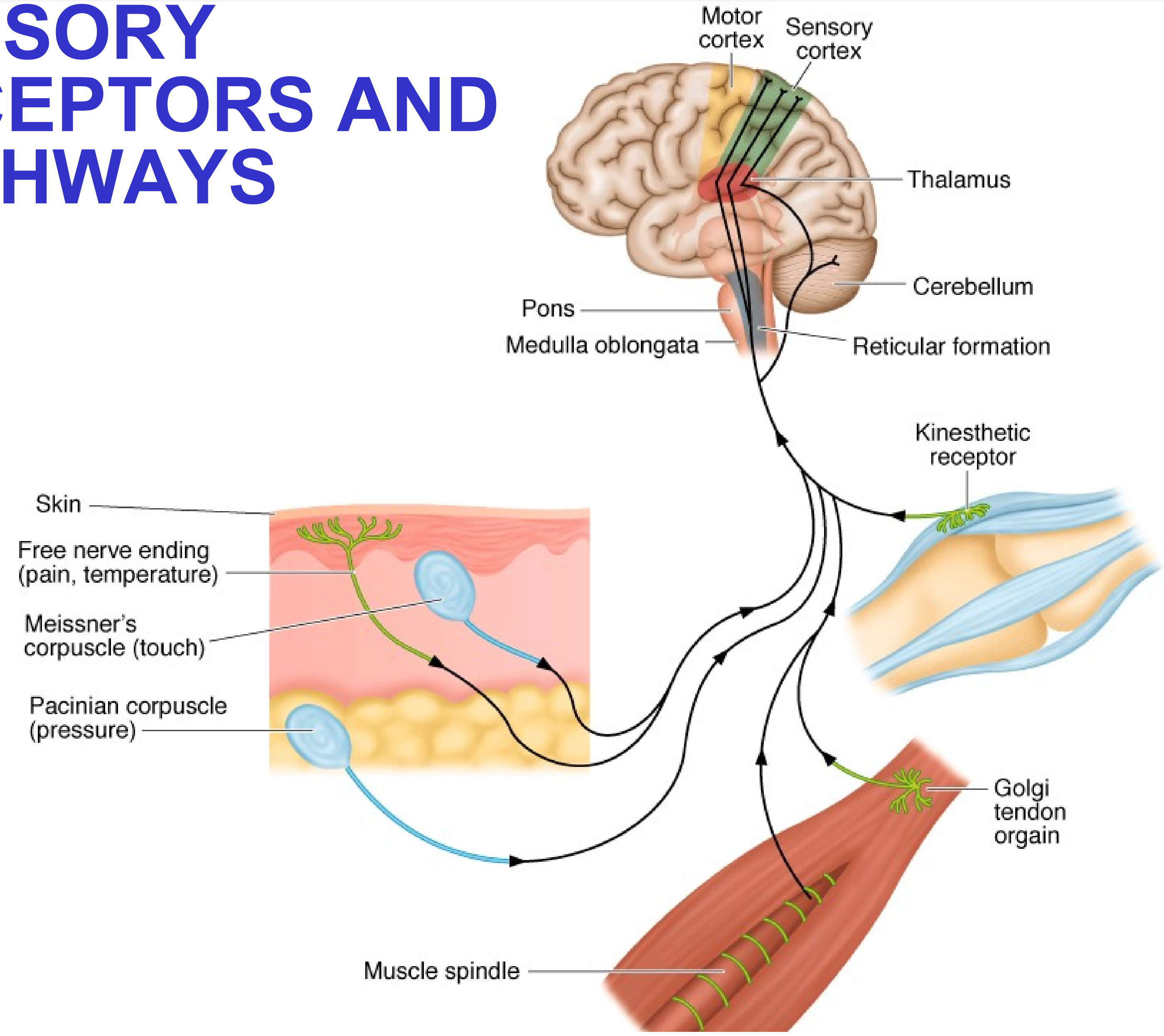
-Sostener cabeza y tronco contra FG

- Mantener CG dentro de base de Sust.

- Estabilizar regiones proximales para movtos. distales.



SENSORY RECEPTORS AND PATHWAYS



Mecanismos de Ajuste posturales

1.- Mecanismos **ANTICIPATORIOS** : Predicen el desequilibrio (feedforward)

Respuestas preprogramadas

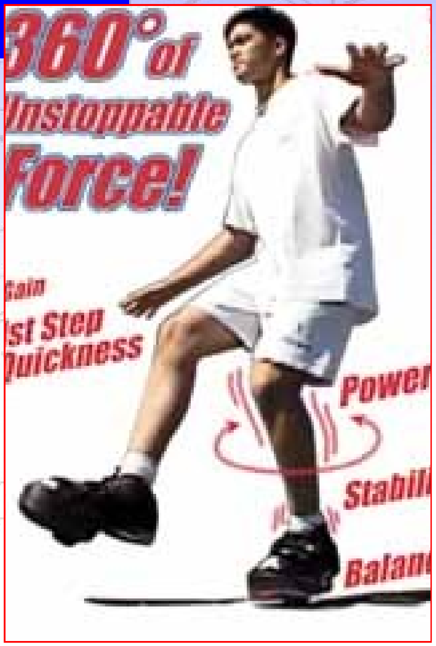
Modificadas por la experiencia

Mejoradas por la práctica

2.- Respuesta **COMPENSATORIA** (feedback)

Inducida por eventos sensoriales luego de la pérdida del equilibrio

Ambas son respuestas similares a reflejos,
son moduladas para estabilizar adaptativamente
la postura. Son “refinadas” por práctica y aprendizaje



Receptores

Cutáneos

Propioceptivos

Visuales

Deformidad de Fuerzas

Posición de extr.
Orientación de cabeza

Orientación relativa
horizonte

The effects of a **sensorimotor training** and a **strength training** on postural stabilisation, **maximum** isometric contraction and jump performance

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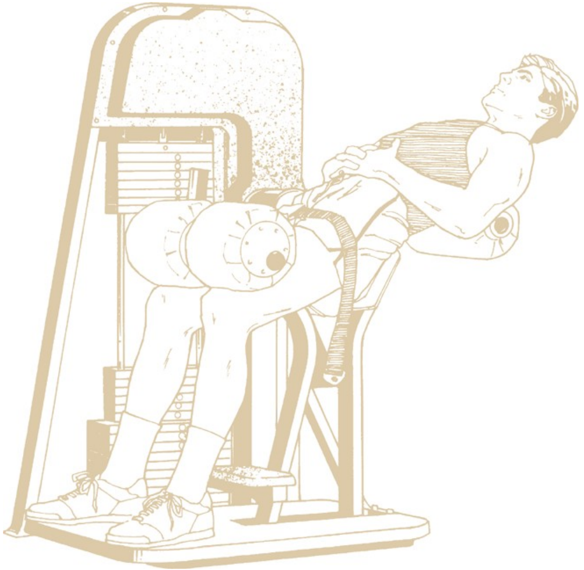
Results of Resistance Training

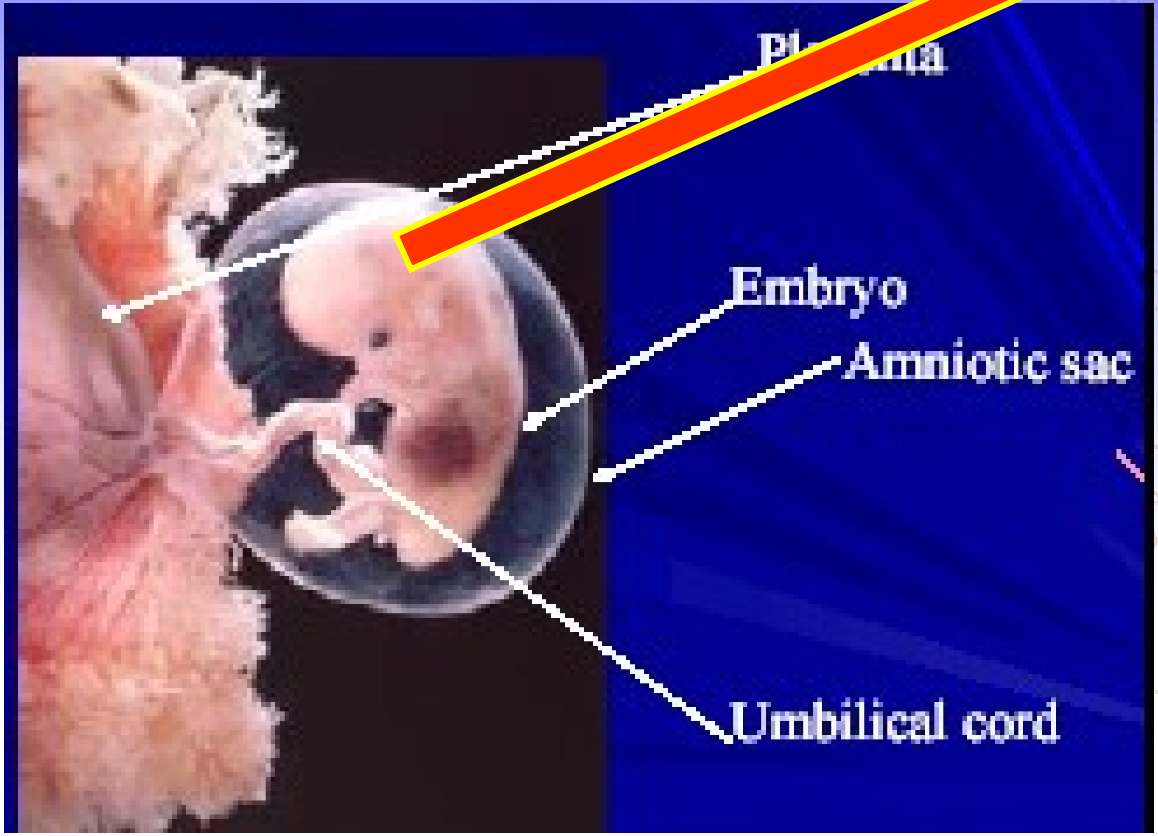
- Increased muscle size (hypertrophy).
- Alterations of neural control of trained muscle.
- Studies show strength gains can be achieved without changes in muscle size, but not without neural adaptations.



Possible Neural Factors of Strength Gains

- Synchronization and recruitment of additional motor units for greater force production
- Counteraction of autogenic inhibition allowing greater force production
- Reduction of coactivation of agonist and antagonist muscles
- Changes in the discharge rates of motor units
- Changes in the neuromuscular junction

Desarrollo Cerebral

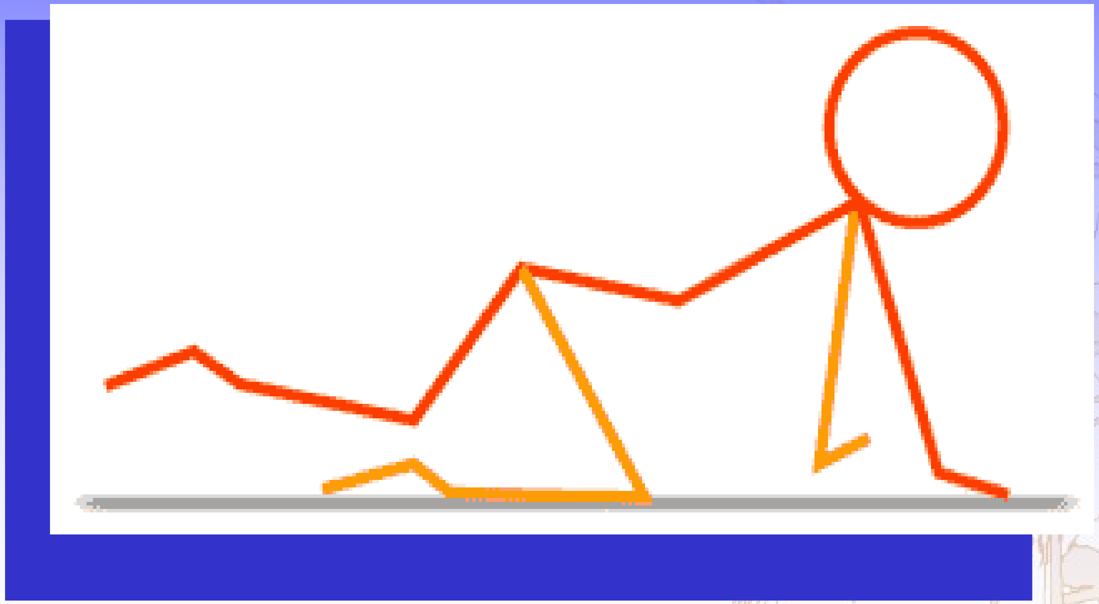


Desarrollo Cerebral

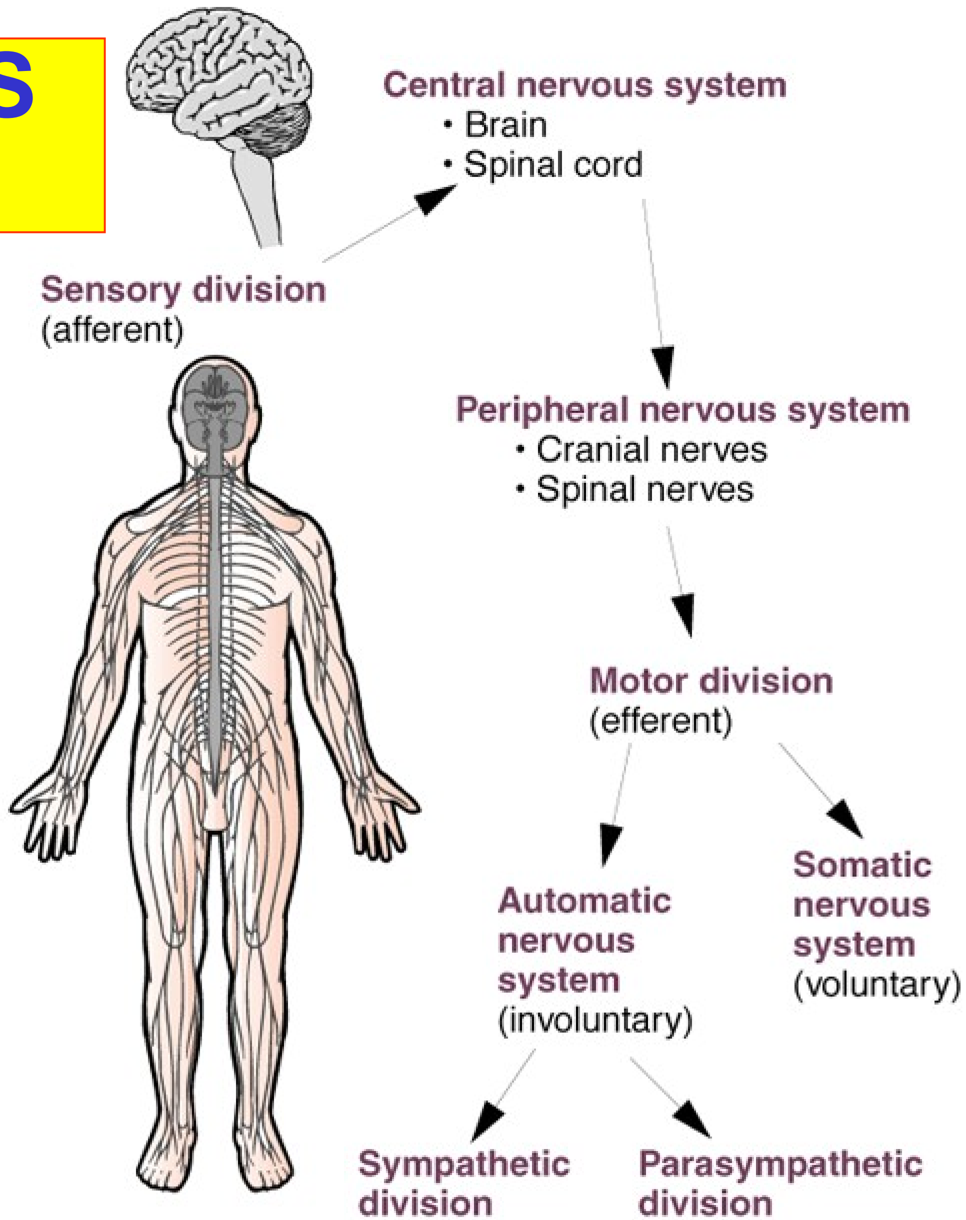
Logistics of Locomotion

- Initiation
- Coordination of rhythmic circuitry
- Adjustments to perturbations
- Feedback to central systems
- Postural control

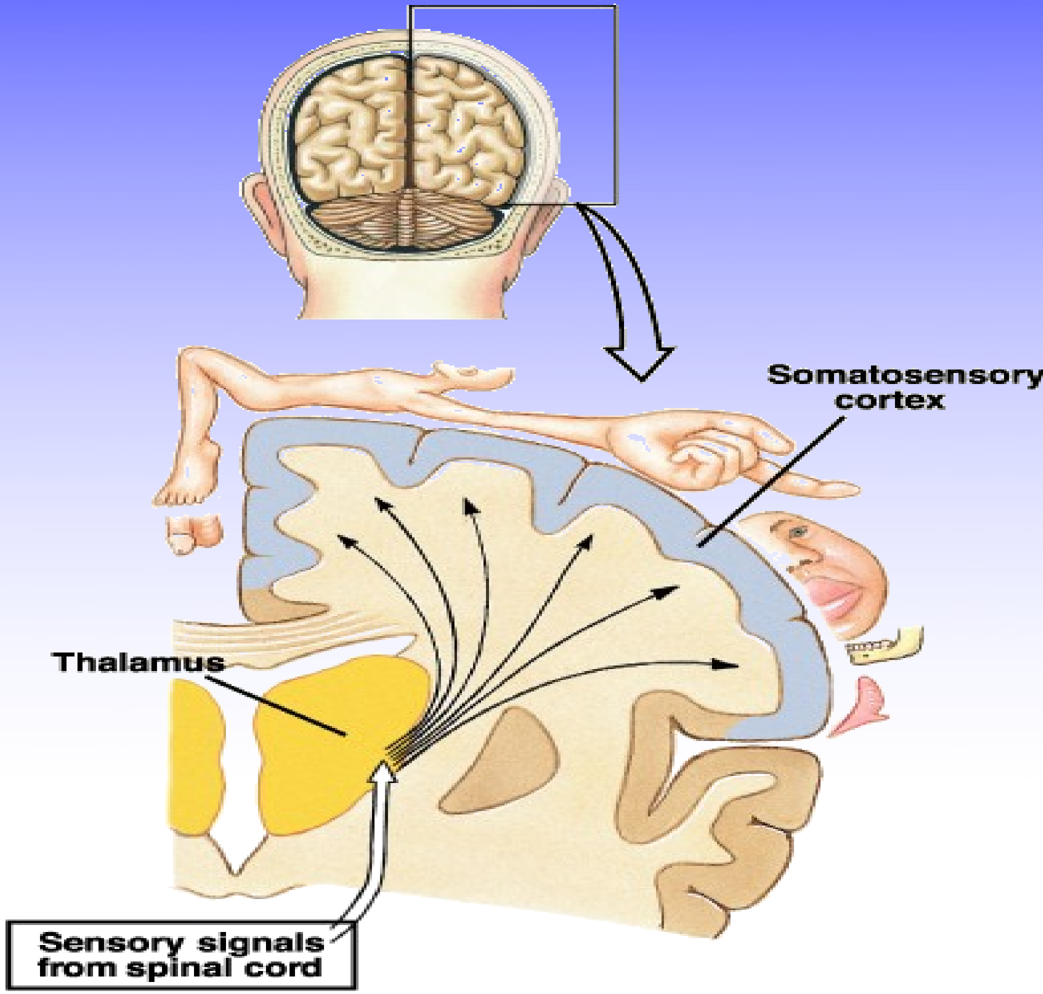
Balanceo y gateo organizan en el cerebro los inicios vitales de la coordinación y el equilibrio.



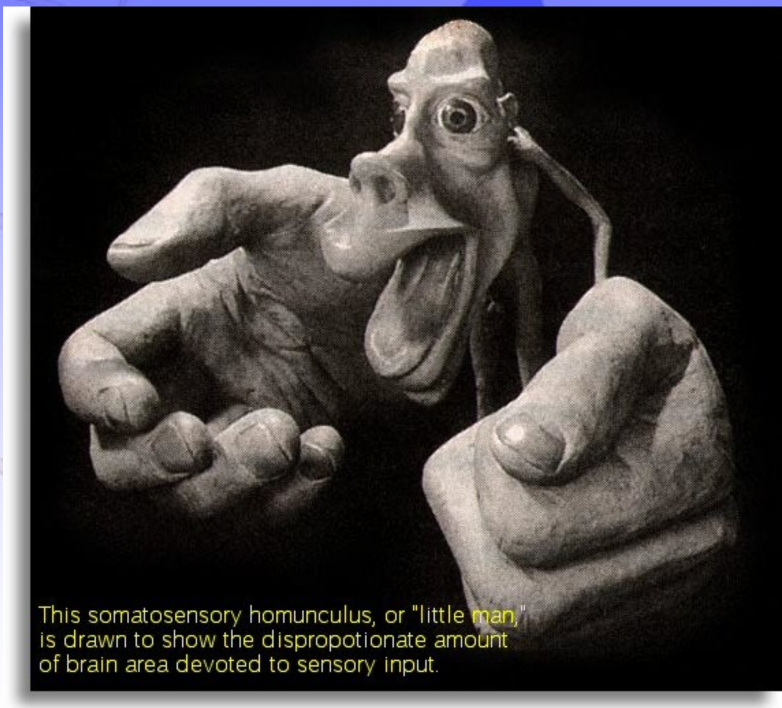
THE NERVOUS SYSTEMS



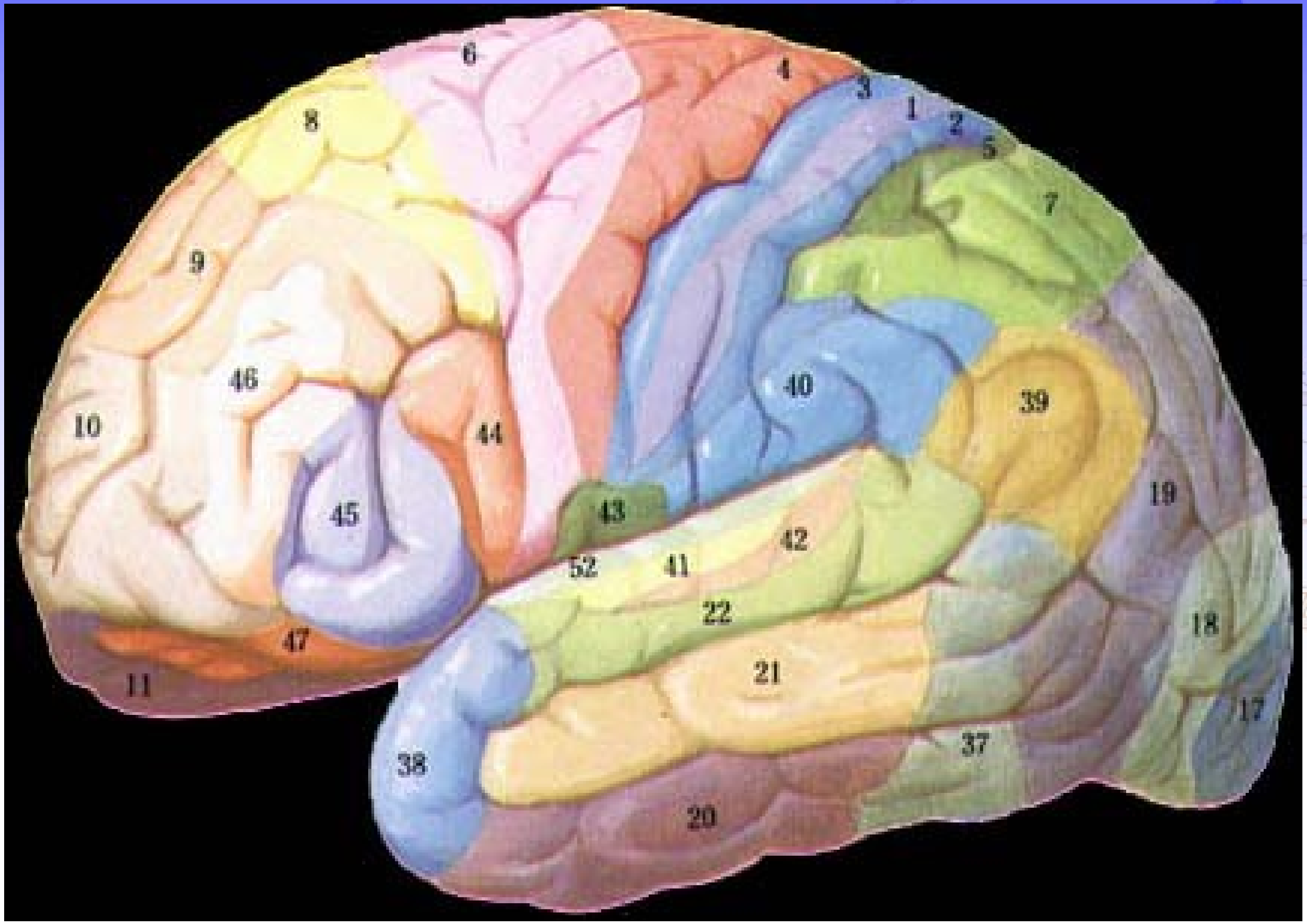
Somatosensory Homunculus



Cross section of the right cerebral hemisphere and sensory areas of the cerebral cortex

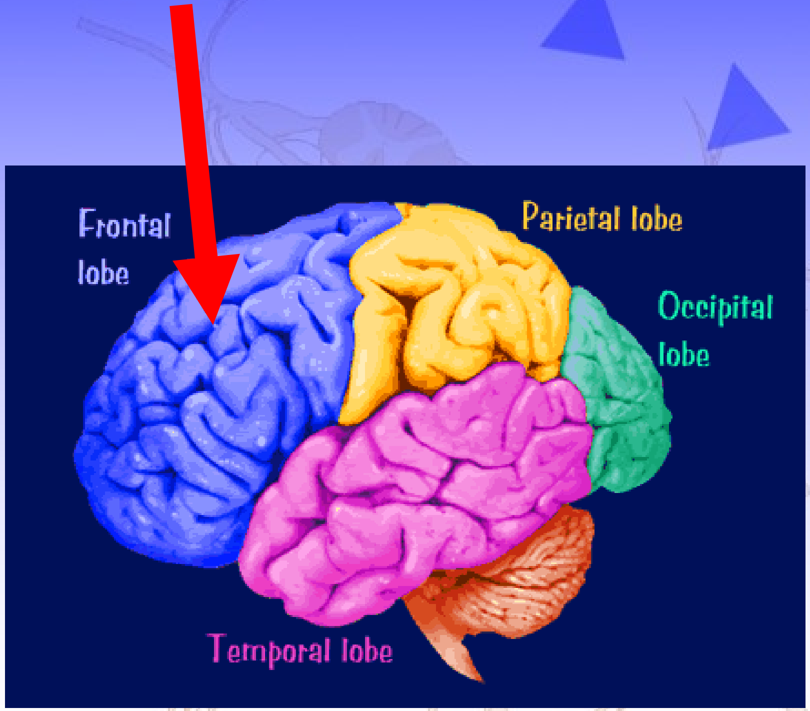


Áreas de Brodmann



Frontal lobe

- Primary motor cortex
- Involved in logical thinking
  - Planning
  - Decision making
  - Behavior inhibition



3 Clases de Movimientos

VOLUNTARIO

REFLEJO

AUTOMÁTICO

3 Classes of Movement

- ***Reflexes***
  - involuntary, rapid, stereotyped

    eye-blink, coughing, knee jerk
  - graded control by eliciting stimulus
- ***Rhythmic motor patterns***
  - **combines voluntary & reflexive acts**

    chewing, walking, running
  - initiation & termination voluntary
  - once initiated, repetitive & reflexive ~

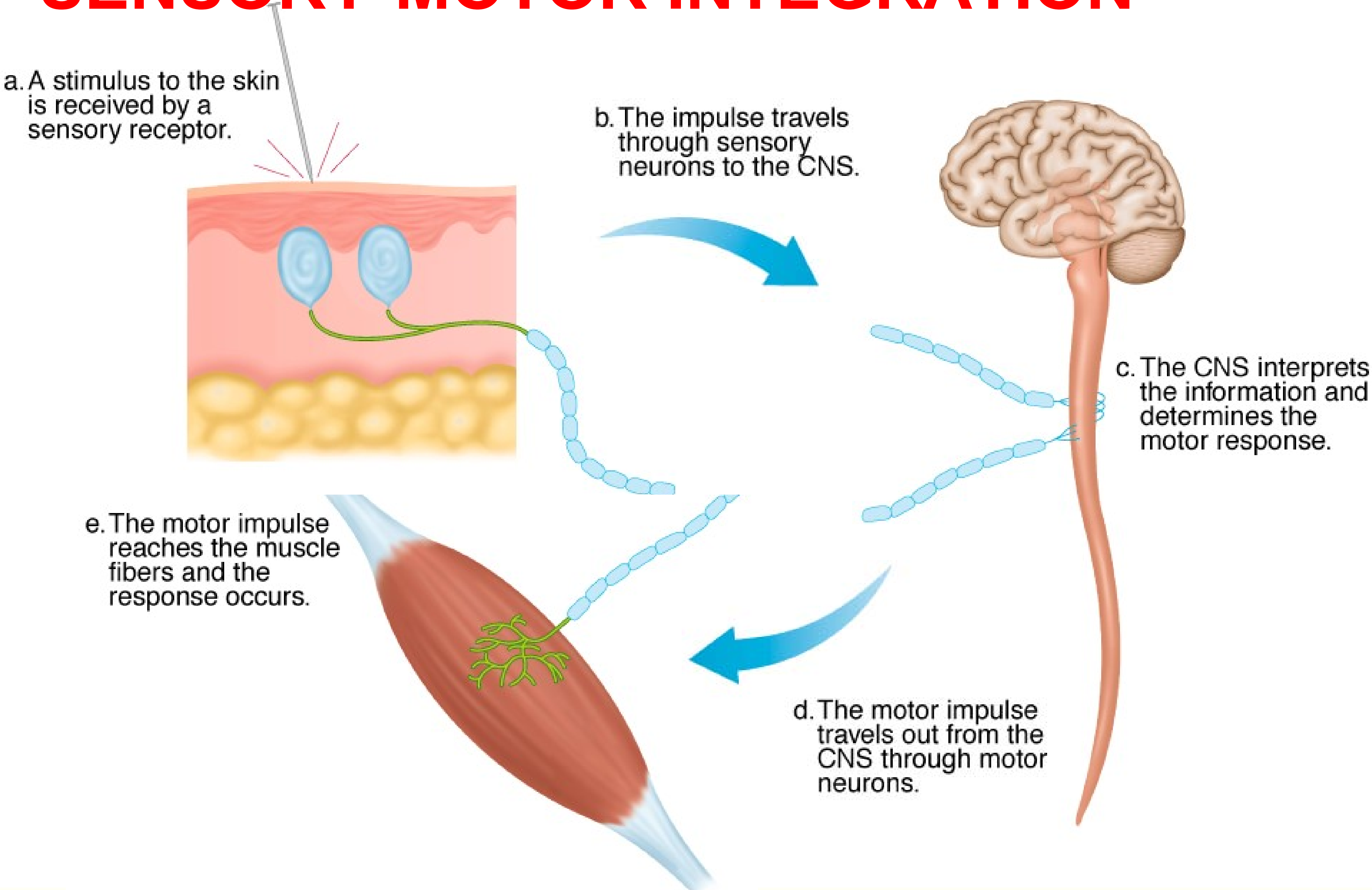
Movimiento. Voluntario :

Los sistemas motores pueden utilizar estrategias dependiendo de la circunstancia.

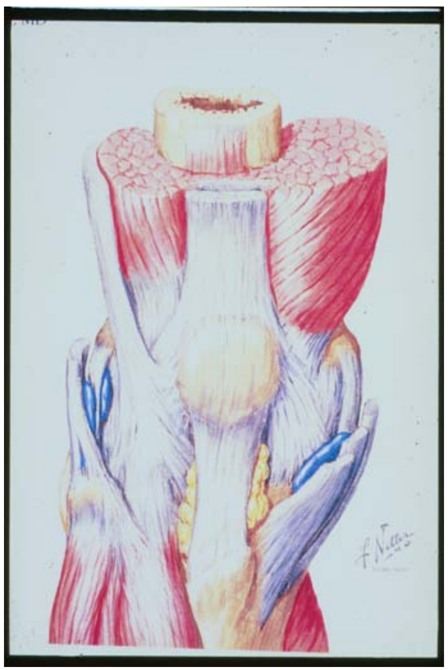
Existe mejora con la experiencia y el aprendizaje

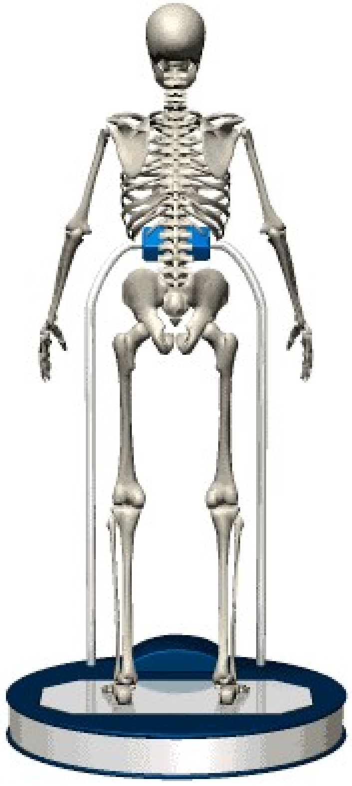
No necesariamente los precede un estímulo externo.

SENSORY-MOTOR INTEGRATION



CONTROL NEURAL DEL MÚSCULO





ENGRAMA MOTOR

ENGRAMA SENSORIAL

(Imagen de función motora hábil)

Brain Mechanisms for the formation of New Movements during Learning: The Evolution of Classical Concepts.

Factor Crítico : CONSOLIDACIÓN

"Consolidation in human motor memory"

T. Brasher – Krug, E Bizzi

Nature , 382, 1996

- Consolidación gradual de hab. Motrices luego de 4 horas apredizaje

•Nuevos aprendizajes antes de finalizadas las 4 hrs disrumpe lo aprendido previamente

- Memoria de tipo "Explicita"

Brain Mechanisms for the formation of New Movements during Learning:
The Evolution of Classical Concepts.

Factor Crítico : CONSOLIDACIÓN

"Consolidación Temprana en corteza primaria"

Wolf Muellbacher and col.

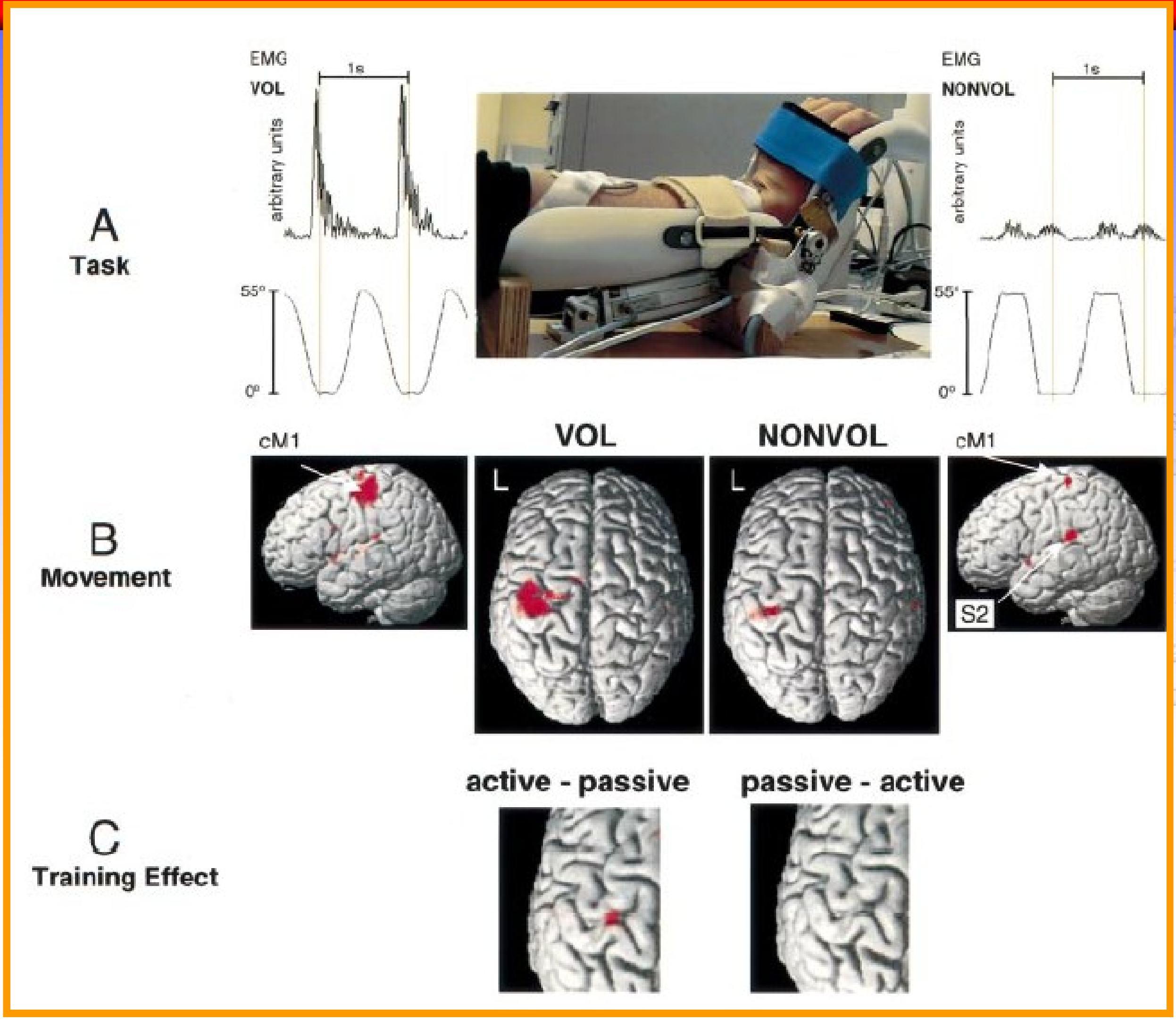
Nature , 415, 2002

- Consolidación pre frontales- premotora- corteza motora
- CMP involucrada en la adquisición de habilidades Motrices tempranas
- Estímulos de baja frec. con EMT en áreas diferentes de mvto. señalan la alteración de la consolidación de lo aprendido.

Motor learning elicited by voluntary drive

Martin Lotze and col. *Brain, 2003, 116*

Factor Crítico : Plasticidad cerebral

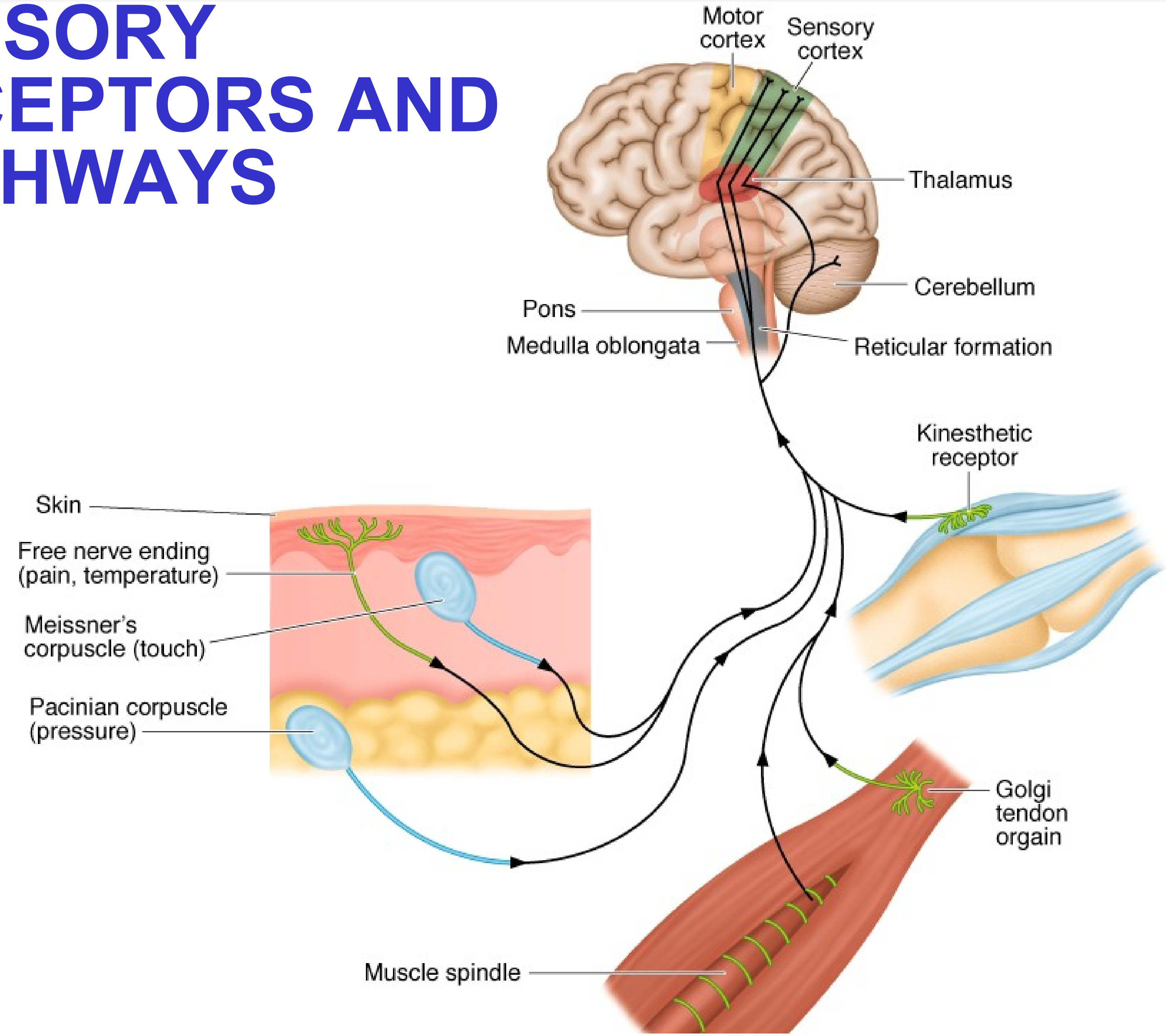


Brain Mechanisms for the formation of New Movements during Learning: The Evolution of Classical Concepts.

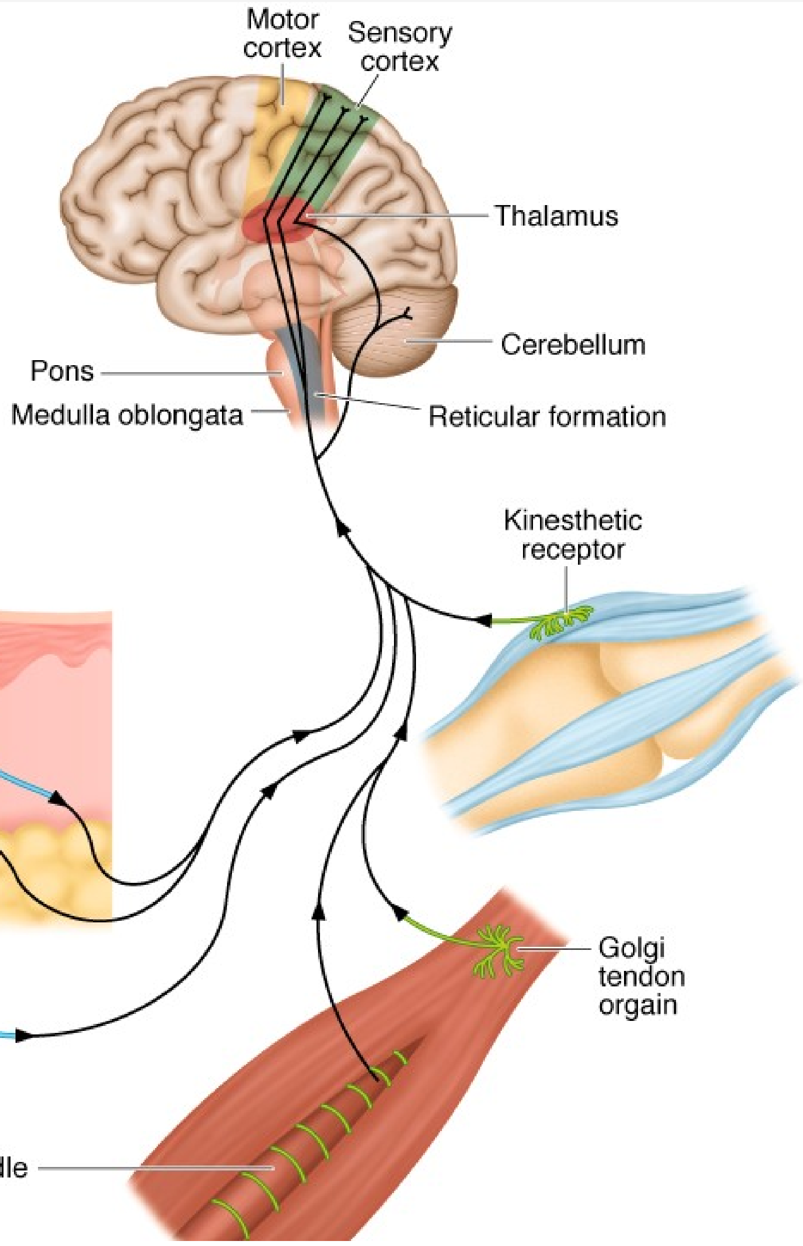
CONTROL DEL MOVIMIENTO

NIVEL	FUNCION	ESTRUCTURA
ALTO	ESTRATEGIA	CORTEX (AREAS ASOCIATIVAS)
MEDIO	TACTICA	CORTEX MOT. CEREBELO
BAJO	EJECUCION	BULBO, MEDULA

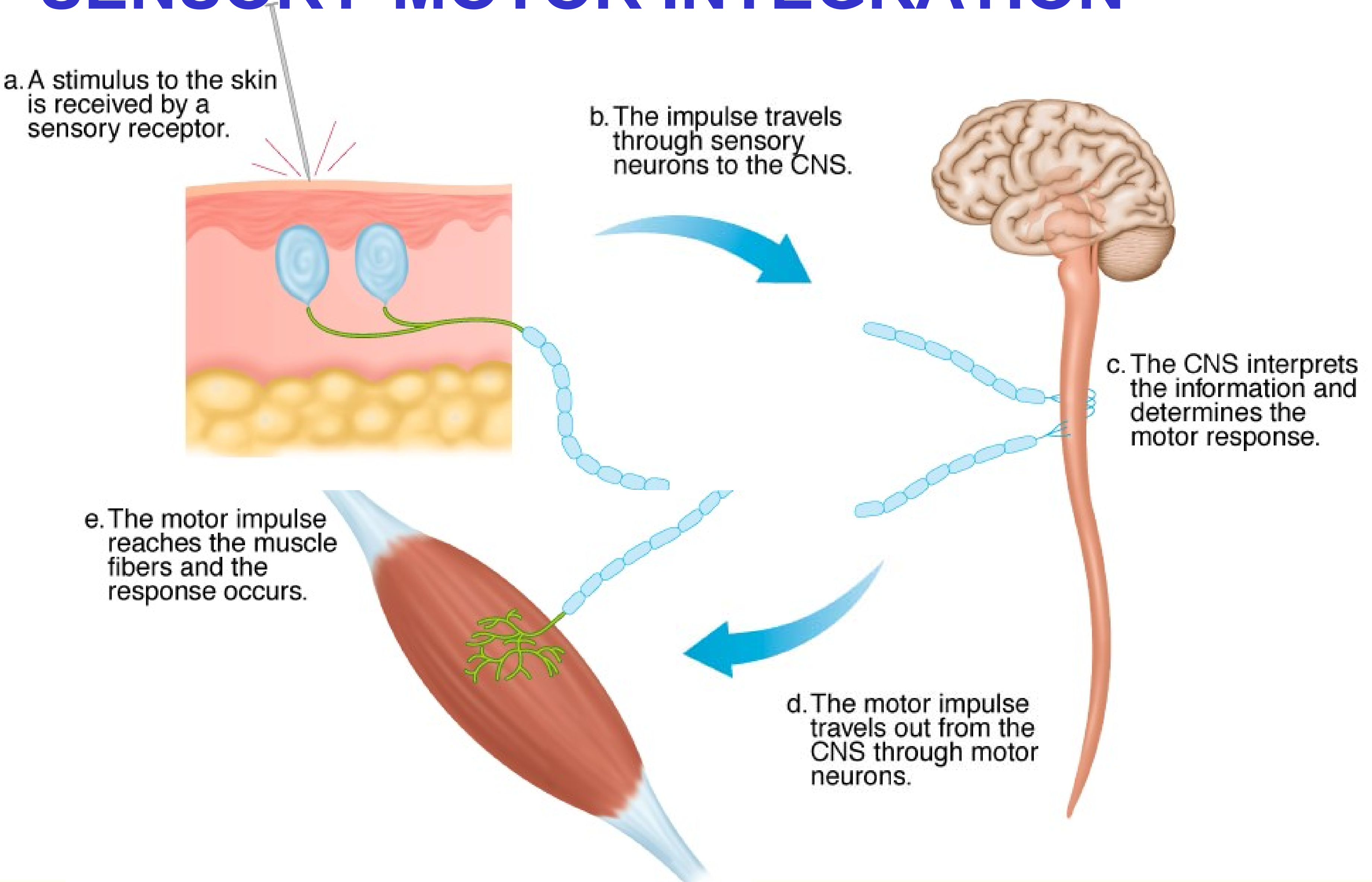
SENSORY RECEPTORS AND PATHWAYS



SENSORY RECEPTORS AND PATHWAYS



SENSORY-MOTOR INTEGRATION



Integration Centers

Spinal cord—simple motor reflexes such as pulling your hand away after touching something hot.

Lower brain stem—more complex subconscious motor reactions such as postural control.

Cerebellum—subconscious control of movement such as that needed to coordinate multiple movements.

Thalamus—conscious distinction among sensations such as feeling hot or cold.

Cerebral cortex—conscious awareness of a signal and the location within body of the signal.

Types of Sensory Receptors

Mechanoreceptors—respond to mechanical forces such as pressure, touch, **vibrations**, or stretch.

Thermoreceptors—respond to changes in temperature.

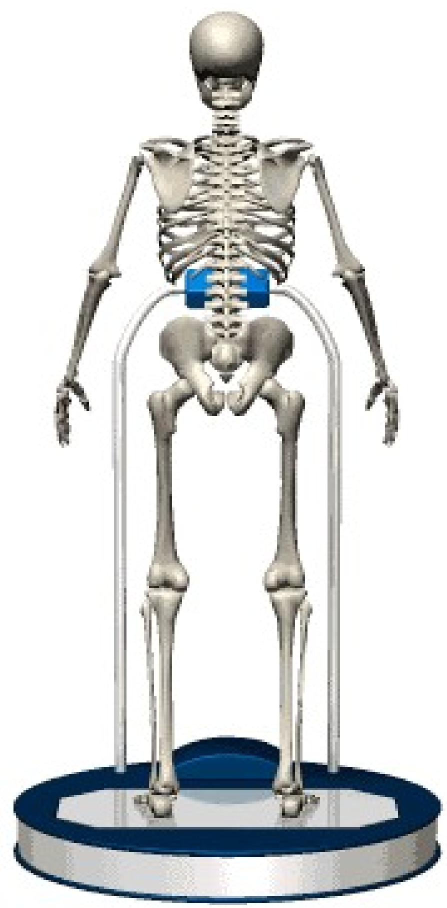
Nociceptors—respond to painful stimuli.

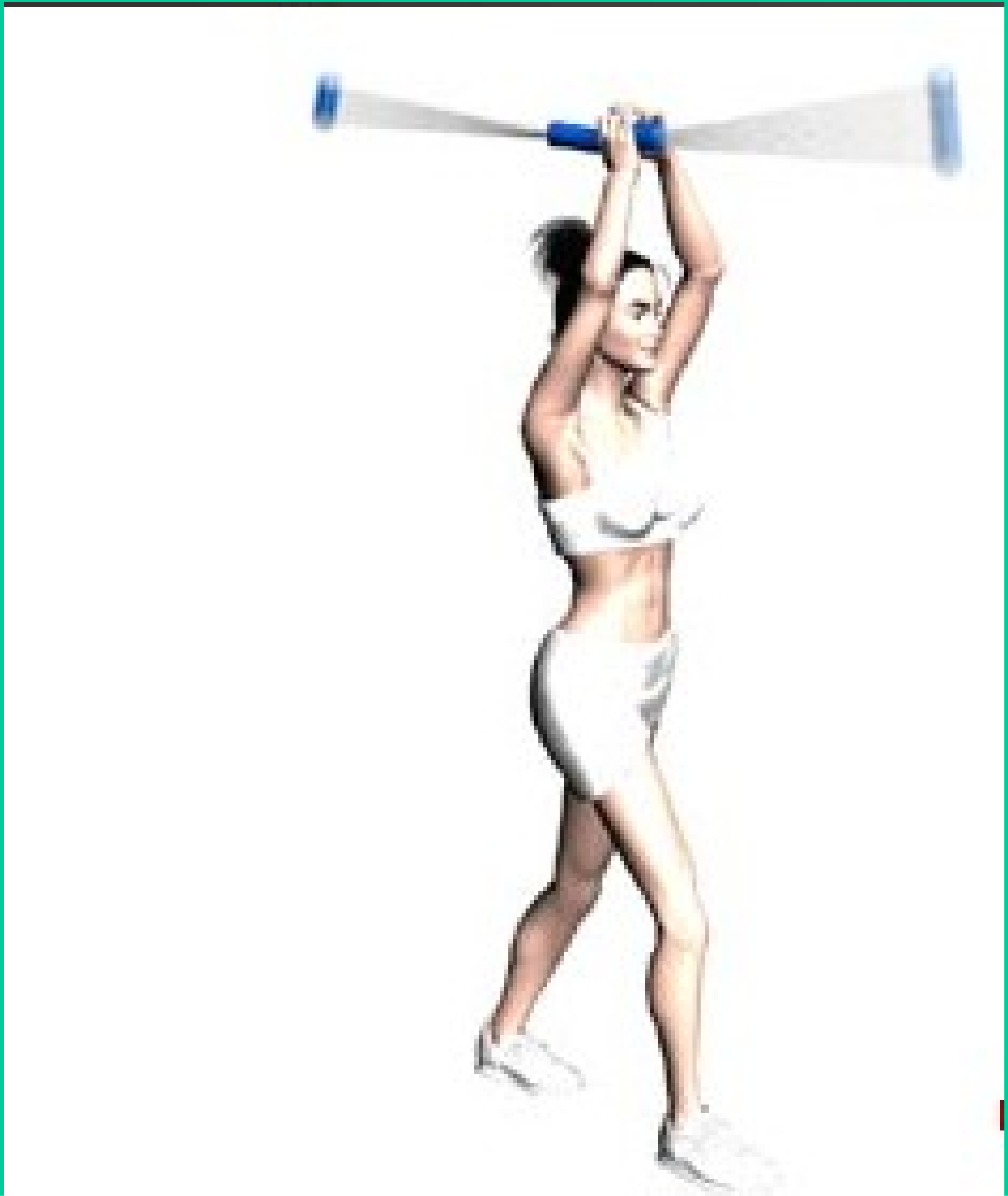
Photoreceptors—respond to light to allow vision.

Chemoreceptors—respond to chemical stimuli from foods, odors, and changes in blood concentrations.

VIBRATION TRAINING

Mechanisms and possible mechanisms relating to structural adaptations and acute effects

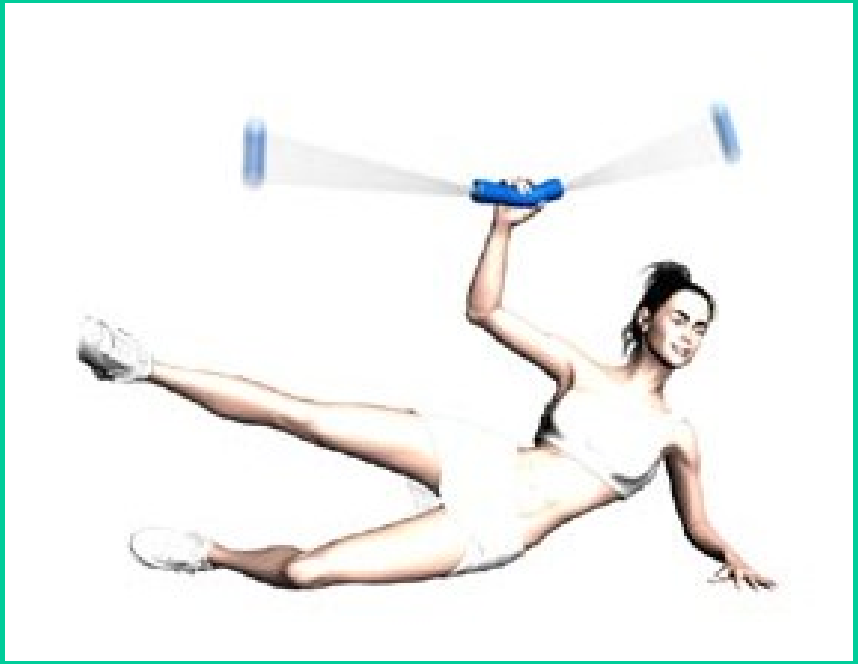


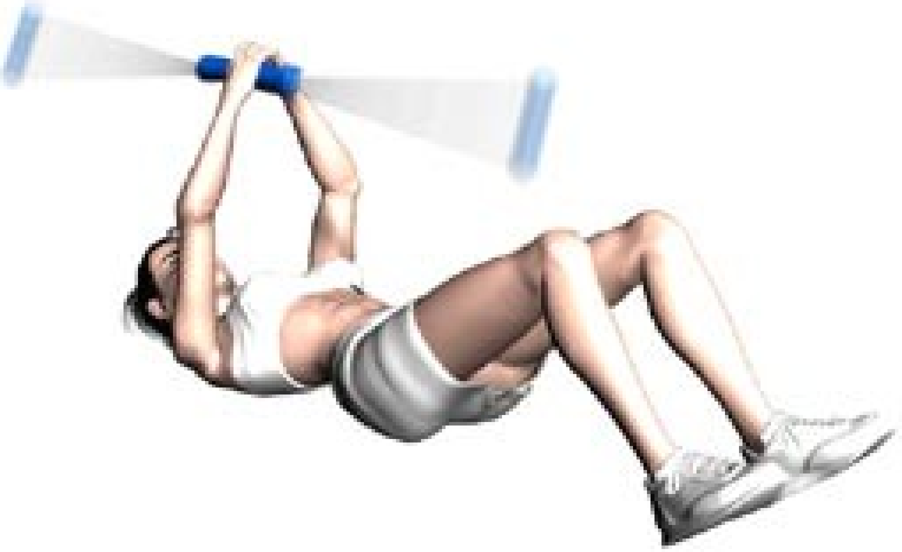
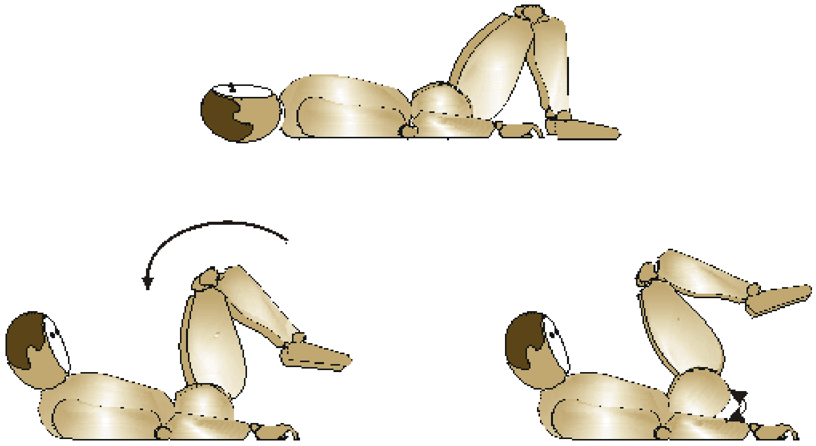


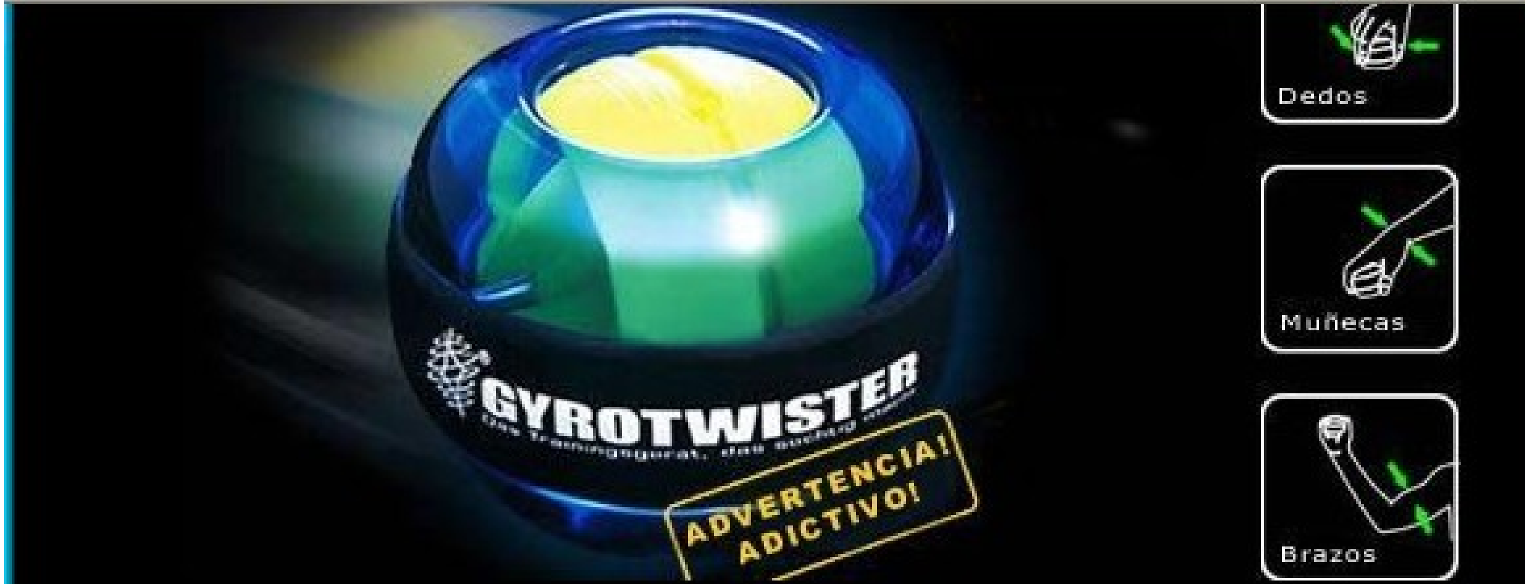





Infoscreen




GYROTWISTER
ADVERTENCIA!
ADICTIVO!
Dedos
Muñecas
Brazos


Nuevo!
Xbeam
powered by GYROTWIS
Danger:
Addictive!
Genera luz propia

ENTRENAMIENTO MEDIANTE VIBRACIONES MECÁNICAS

UN NUEVO MÉTODO EN LA ACTIVIDAD FÍSICA Y EL DEPORTE

Dpto. Fisiología. Facultad de Medicina
Facultad de Ciencias de la Actividad Física y el Deporte
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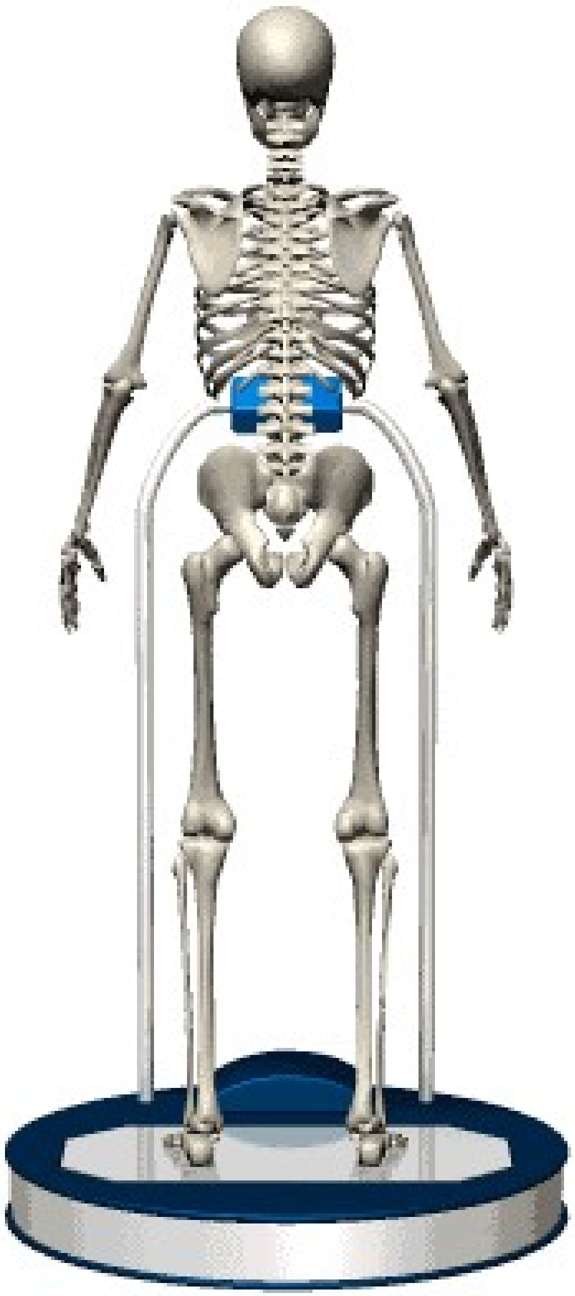
ENTRENAMIENTO MEDIANTE VIBRACIONES MECÁNICAS

¿QUÉ ES?

EV: aplicación de estímulos vibratorios sobre el músculo esquelético, lo que provoca una contracción activa del mismo denominada *reflejo tónico vibratorio* [1,2].



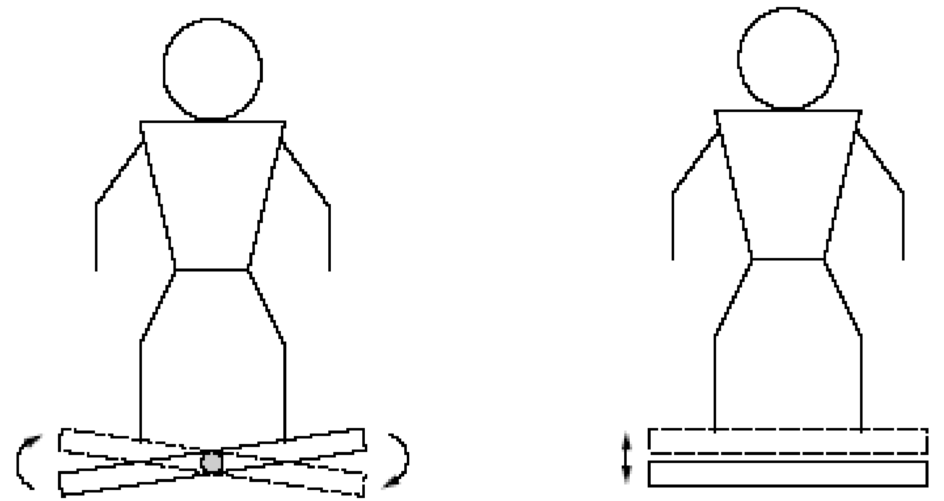
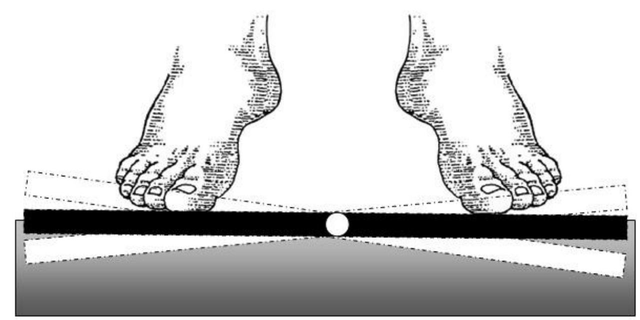
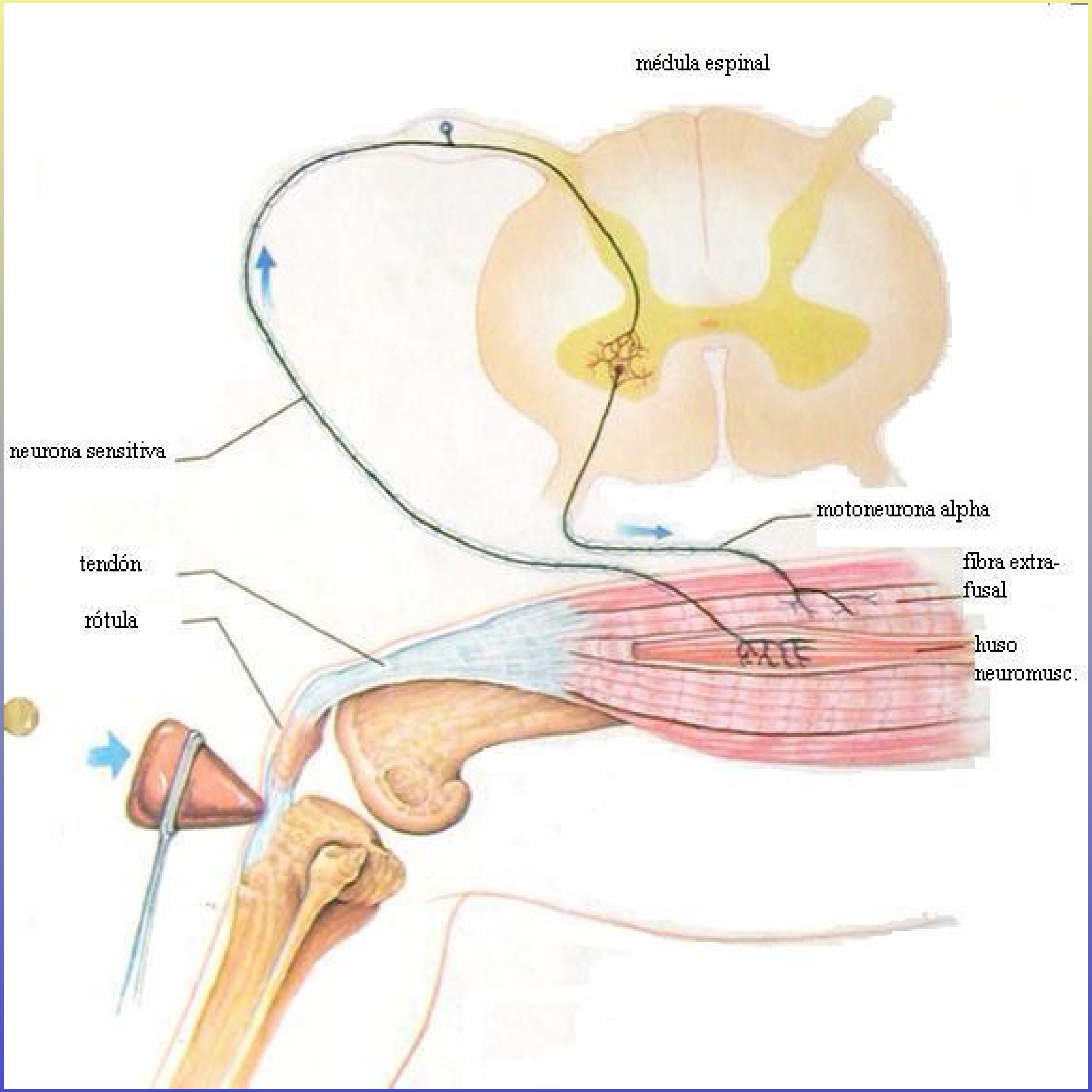
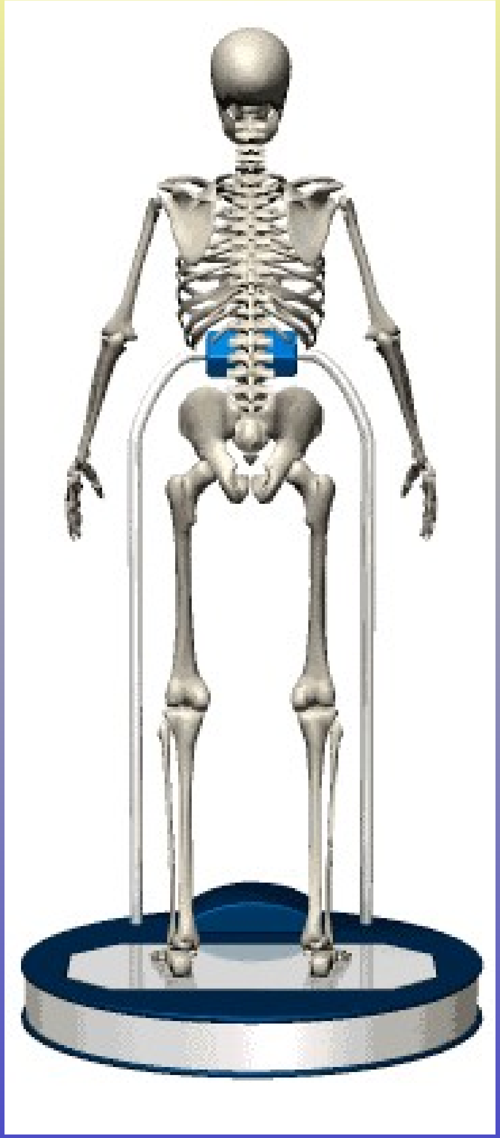


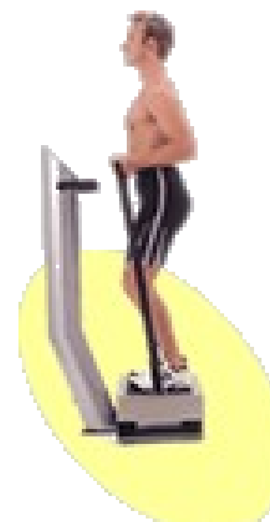
Figure 1 Different designs of whole body vibrating plates.




médula espinal
neurona sensitiva
motoneurona alpha
tendón
fibra extra-
fusal
rótula
huso
neuromusc.








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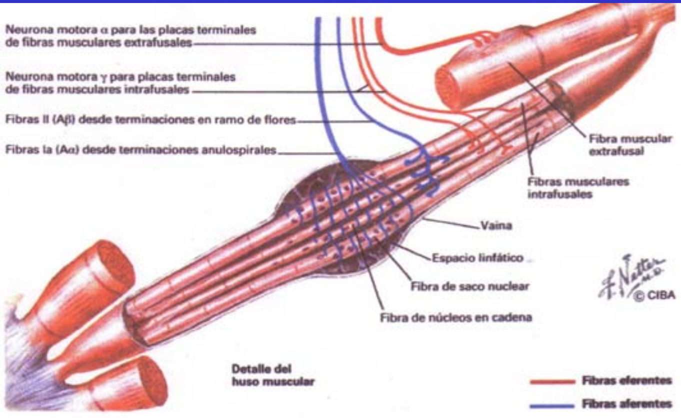
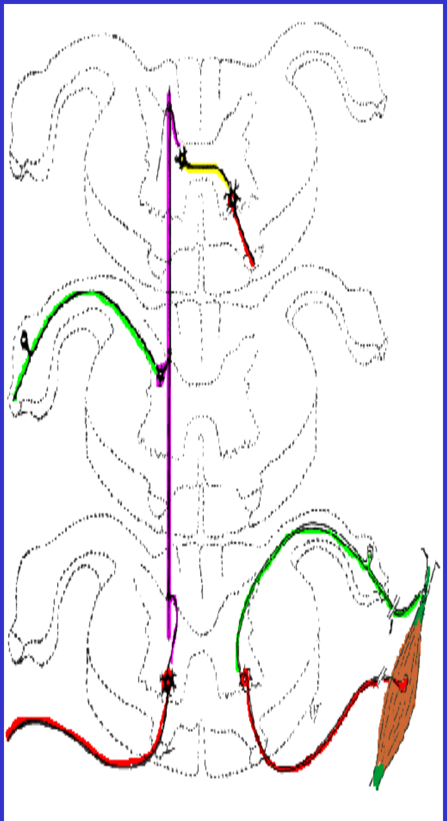


BASE FISIOLÓGICA

- Fibras aferentes Ia husos neuromusculares (3,4)
- Fibras aferentes II husos neuromusculares (3,4)
- Fibras aferentes Ib órgano tendinoso de Golgi (3,4)
- Receptores cutáneos (5,6)

ENTRENAMIENTO MEDIANTE VIBRACIONES MECÁNICAS



Mayor excitabilidad

de la corteza motora [7]

↓

Aumento en la activación

de las α-motoneuronas [4,7]

↓

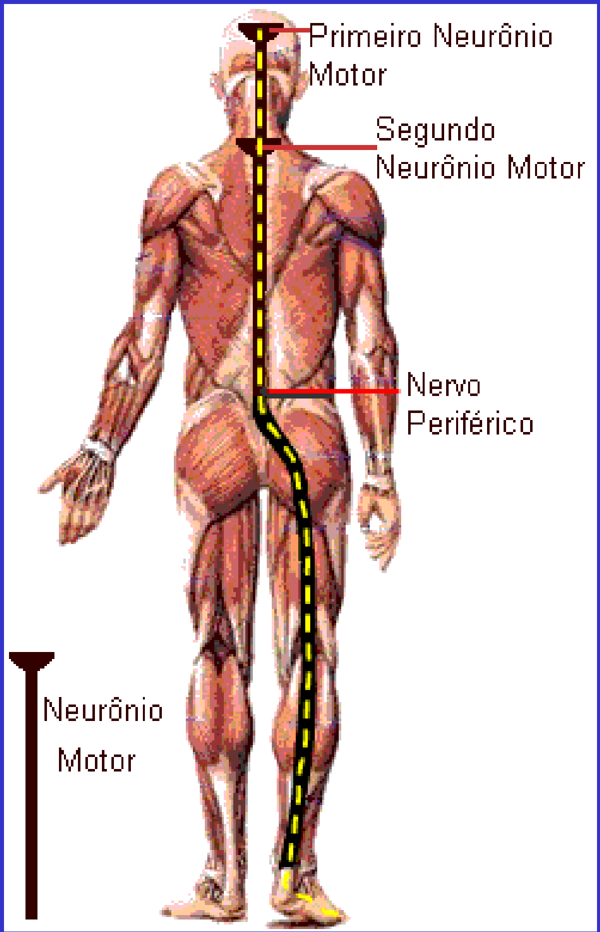
Aumento de los potenciales

motores evocados [8,9]

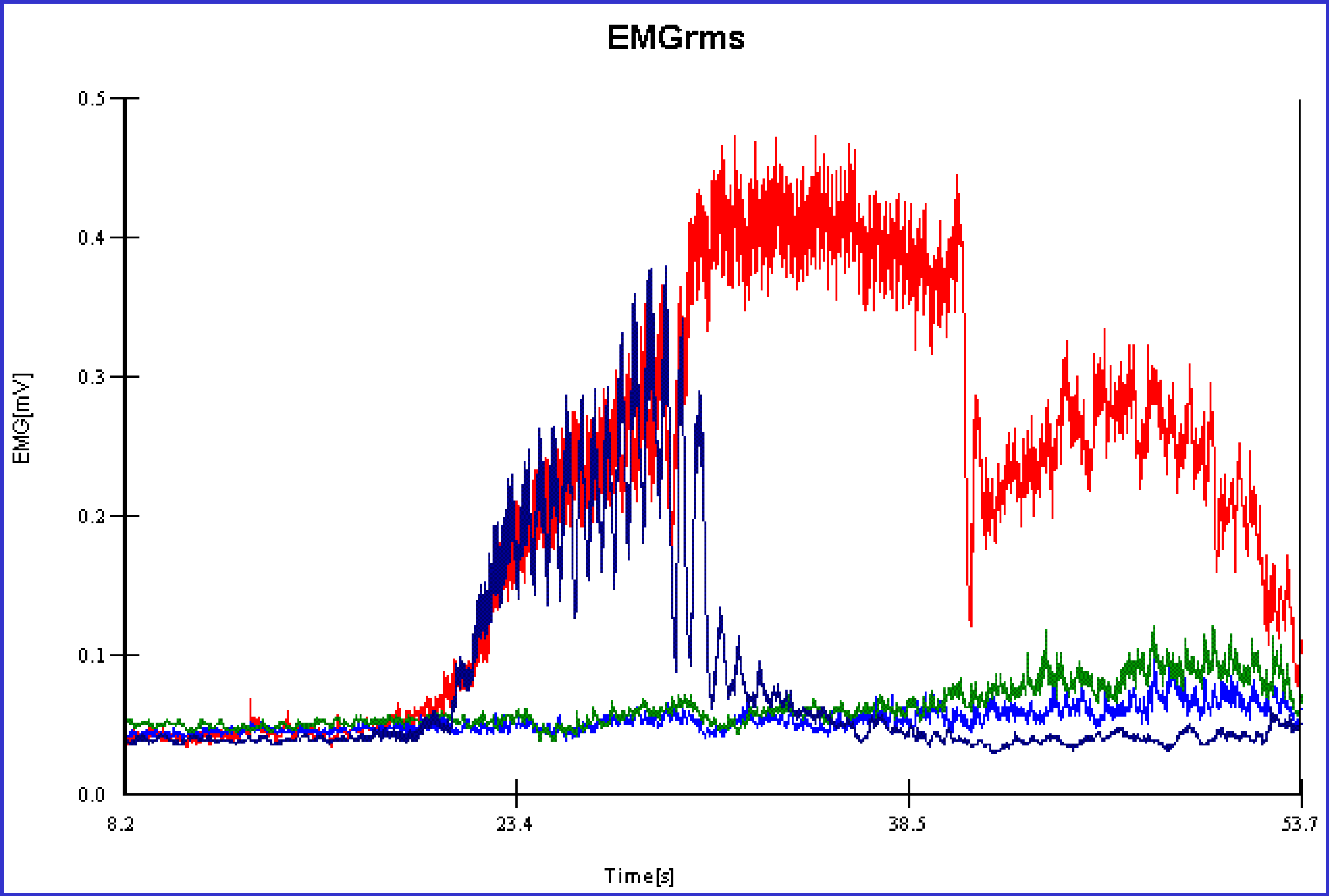
↓

Reclutamiento

de UM adicionales



Aumento señal EMG miembros superiores e inferiores



(Fuente: **TOUS** y **MORAS**, 2004. *Lecturas: Revista Digital efdeportes,* nº 79, Diciembre)

FACTOR		IDÓNEO
Frecuencia	**(Hz)**	**25 – 45**
Amplitud	**(mm)**	**4 - 6**
Tiempo (min)	**serie**	**hasta 1’-1,5’**
	total sesión	**hasta 20’ – 25’**
Protocolo de ejercicios		**dinámicos variados angulación específica con sobrecarga externa (en estado avanzado)**
Tipo de atletas		**mayores efectos cuanto mayor sea el nivel de entrenamiento**

Efectos agudos

SISTEMA	MODIFICACIÓN
Neuromuscular	↑ P ↓ EMG ↑ EMG (estimulaciones extenuantes) ↑ MCVI, ↑ MCVC ↑ CMJ ↑ equilibrio estático ↑ perímetros musculares
Cardiorrespiratorio	↑ FC, ↑ TA sistólica, ↓ TA diastólica ↑ [lact], ↑ QR ↑ flujo sanguíneo, vasodilatación, eritemas
Endocrino	↑ GH, ↑ T, ↓ C ¿?

Efectos Crónicos

SISTEMA	MODIFICACIÓN
Neuromuscular	↑ MCVI, ↑ 1 RM ↑ CMJ ↑ capacidad de salto (saltos repetidos 5'') ↑ equilibrio estático

ENTRENAMIENTO MEDIANTE VIBRACIONES MECÁNICAS

EFECTOS DEL EV

AGUDOS

- ↑ potencia muscular [10,15,16,18]
- ↑ fuerza máxima dunámica [15,17]
- ↑ fuerza máxima isométrica [19,20]
- ↑ capacidad salto [16,20]
- ↑ flujo sanguíneo [21,22,23]
- ↑ GH ↑ T ↓ C : pefil anabólico [16]

ENTRENAMIENTO MEDIANTE VIBRACIONES MECÁNICAS

EFECTOS DEL EV

CRÓNICOS

- ↑ potencia muscular [24]
- ↑ fuerza máxima dunámica [26,27,28]
- ↑ fuerza máxima isométrica [25,26]
- ↑ capacidad salto [24,25,26,27]

ENTRENAMIENTO MEDIANTE VIBRACIONES MECÁNICAS

EFECTOS DEL EV

CRÓNICOS

- mejora sistema propioceptivo y control postural sujetos sanos [29,30], infartados [31] y lesionados medulares [32]
- personas mayores: mejora de la función neuromuscular [33,34,35,36] y densidad mineral ósea cadera [37]
- relación positiva EV - LBP [38]

Whole body **vibration** exercise: are **vibrations** good for you?

Br J Sports Med 2005 Sep ; 39(9):585-9; discussion 589

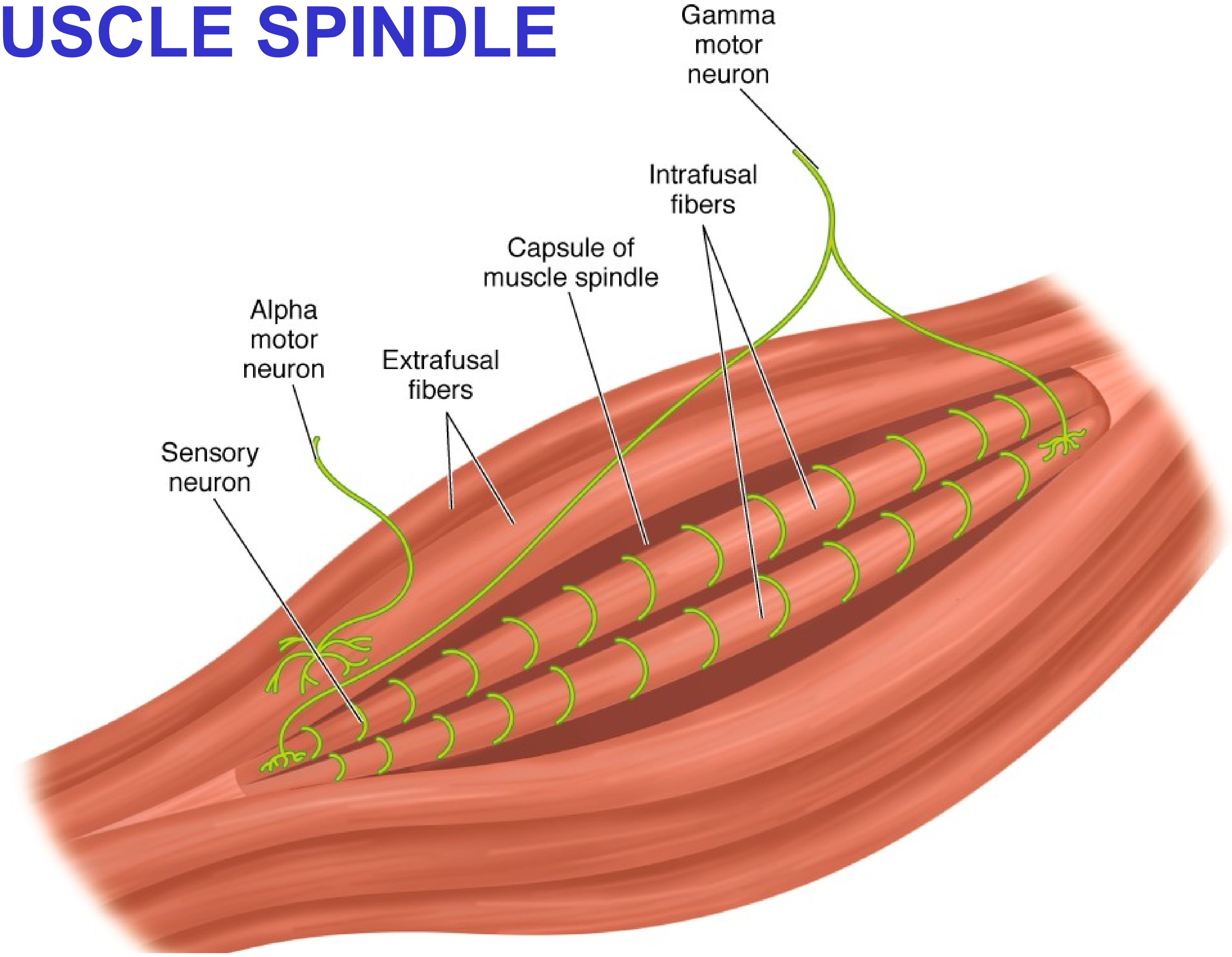
Cardinale M; Wakeling J
College of Life Sciences and Medicine, University of Aberdeen, Aberdeen AB25 2ZD, Scotland, UK. m.cardinale@abdn.ac.uk.

Whole body **vibration** has been recently proposed as an exercise intervention because of its potential for increasing force generating capacity in the lower limbs.

Its recent popularity is due to the combined effects on the *neuromuscular* and *neuroendocrine* systems.

Preliminary results seem to recommend **vibration** exercise as a therapeutic approach for **sarcopenia** and possibly **osteoporosis**. This review analyses state of the art whole body **vibration** exercise techniques, suggesting reasons why **vibration** may be an effective stimulus for human muscles and providing the rationale for future studies

MUSCLE SPINDLE



Strength Increase after Whole-Body Vibration Compared with Resistance Training

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[1]*Exercise Physiology and Biomechanics Laboratory, and* [2]*Laboratory of Motor Control, Faculty of Physical Education and Physiotherapy, Department of Kinesiology, Katholieke Universiteit Leuven, Leuven, BELGIUM*

ABSTRACT

DELECLUSE, C., M. ROELANTS, and S. VERSCHUEREN. Strength Increase after Whole-Body Vibration Compared with Resistance Training. *Med. Sci. Sports Exerc.*, Vol. 35, No. 6, pp. 1033–1041, 2003. **Purpose:** The aim of this study was to investigate and to compare the effect of a 12-wk period of whole-body vibration training and resistance training on human knee-extensor strength. **Methods:** Sixty-seven untrained females (21.4 ± 1.8 yr) participated in the study. The whole-body vibration group (WBV, $N = 18$) and the placebo group (PL, $N = 19$) performed static and dynamic knee-extensor exercises on a vibration platform. The acceleration of the vibration platform was between 2.28 *g* and 5.09 *g*, whereas only 0.4 *g* for the PL condition. Vibration (35–40 Hz) resulted in increased EMG activity, but the EMG signal remained unchanged in the PL condition. The resistance-training group (RES, $N = 18$) trained knee extensors by dynamic leg-press and leg-extension exercises (10–20 RM). All training groups exercised $3\times$ wk^{-1}. The control group (CO, $N = 12$) did not participate in any training. Pre- and postisometric, dynamic, and ballistic knee-extensor strength were measured by means of a motor-driven dynamometer. Explosive strength was determined by means of a counter-movement jump. **Results:** Isometric and dynamic knee-extensor strength increased significantly ($P < 0.001$) in both the WBV group (16.6 ± 10.8%; 9.0 ± 3.2%) and the RES group (14.4 ± 5.3%; 7.0 ± 6.2%), respectively, whereas the PL and CO group showed no significant ($P > 0.05$) increase. Counter-movement jump height enhanced significantly ($P < 0.001$) in the WBV group (7.6 ± 4.3%) only. There was no effect of any of the interventions on maximal speed of movement, as measured by means of ballistic tests. **Conclusions:** WBV, and the reflexive muscle contraction it provokes, has the potential to induce strength gain in knee extensors of previously untrained females to the same extent as resistance training at moderate intensity. It was clearly shown that strength increases after WBV training are not attributable to a placebo effect. **Key Words:** MUSCLE STRENGTH, TONIC VIBRATION REFLEX, COUNTER-MOVEMENT JUMP, STRENGTH TRAINING

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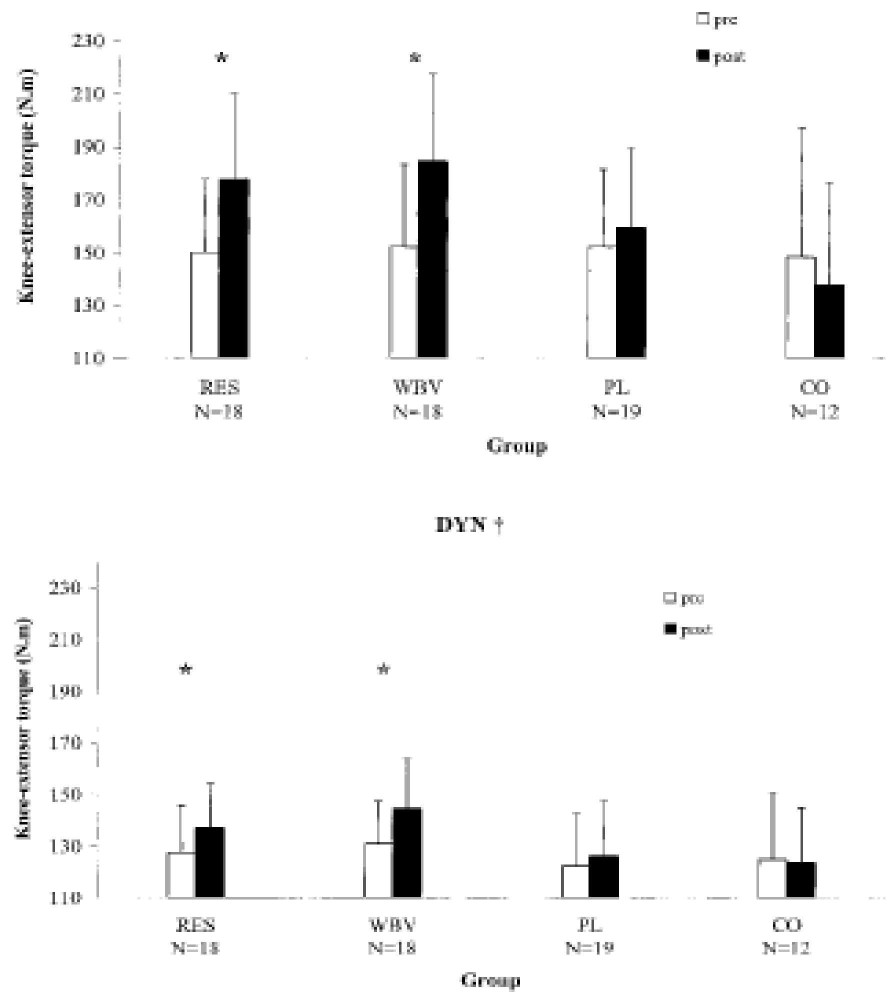

FIGURE 2—Mean and SD before (pre) and after (post) 12 wk in the RES, WBV, PL, and CO groups. Top: maximal isometric knee-extensor torque (ISO). Bottom: maximal dynamic knee-extensor torque (DYN). † refers to a significant interaction (group × time) effect at $P < 0.05$. * indicates that posttraining values are significantly higher than pretraining values at $P < 0.05$ (contrast analysis).

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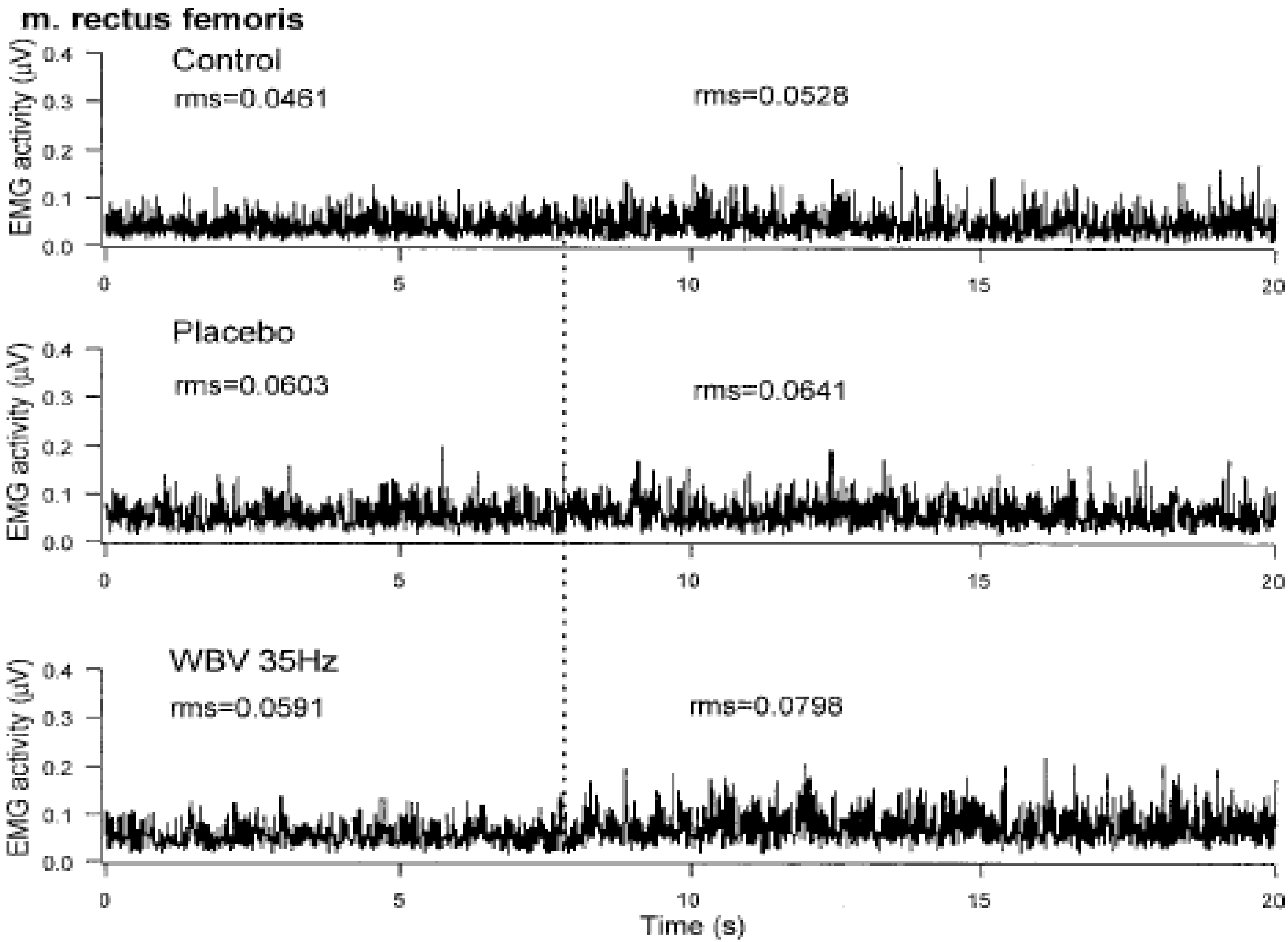

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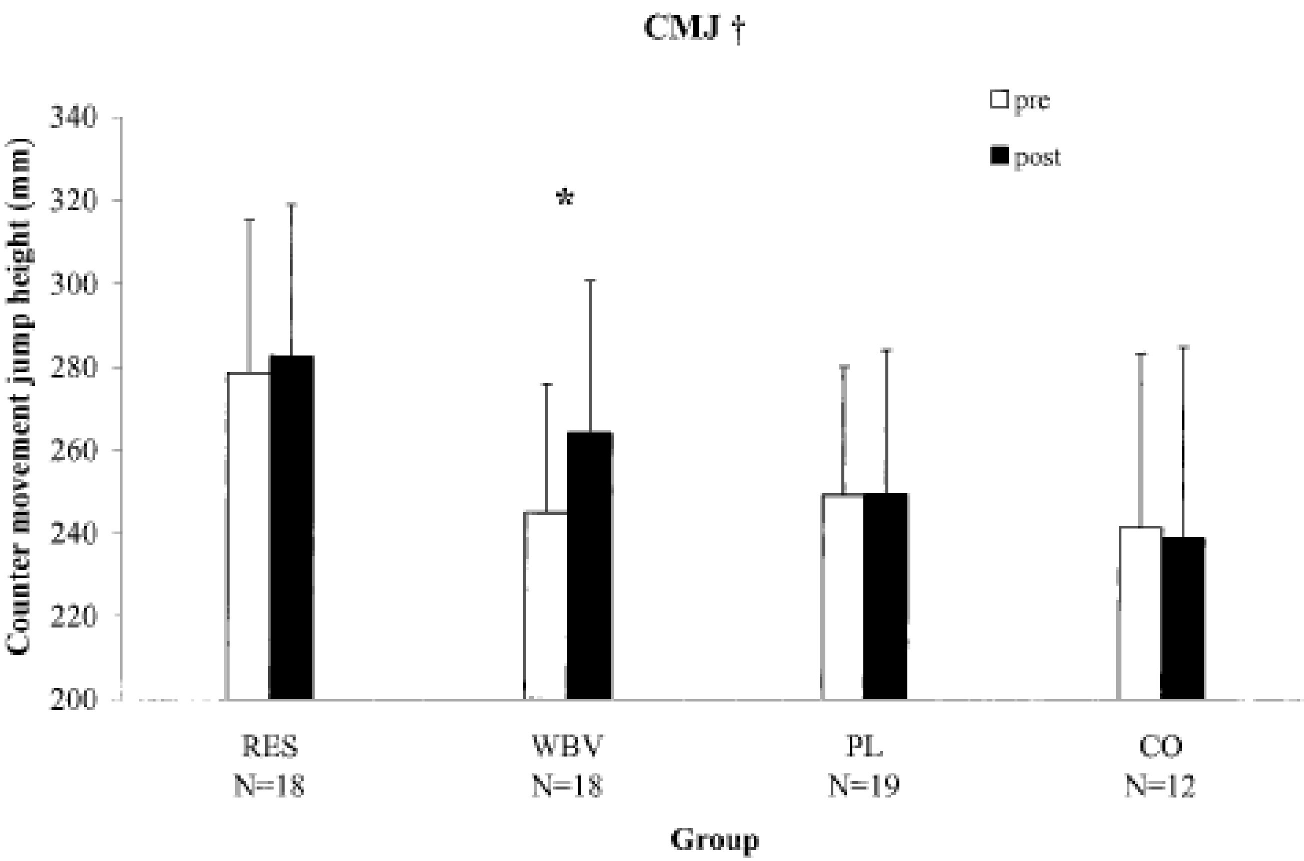


FIGURE 4—Counter movement jump height (CMJ). Mean and SD before (pre) and after (post) 12 wk in the RES, WBV, PL, and CO groups. † refers to a significant interaction (group × time) effect at $P < 0.05$. * indicates that posttraining values are significantly higher than pretraining values at $P < 0.05$ (contrast analysis).

Arch Phys Med Rehabil. *Dec 2003* ;84(12):1854-7.

High-frequency vibration training increases muscle power in women.

Russo CR, Lauretani F, Bandinelli S, Bartali B, Cavazzini C, Guralnik JM, Ferrucci L.

Laboratory of Clinical Epidemiology, INRCA Geriatric Department, Florence, Italy.

OBJECTIVE: To test whether training on a high-frequency (28Hz) vibrating platform improves muscle power and bone characteristics in postmenopausal women. **DESIGN:** Randomized controlled trial with 6-month follow-up. SETTING: Outpatient clinic in a general hospital in Italy. **PARTICIPANTS**: Twenty-nine postmenopausal women (intervention group, n=14; matched controls, n=15). **INTERVENTION**: Participants stood on a ground-based oscillating platform for three 2-minute sessions for a total of 6 minutes per training session, twice weekly for 6 months. The controls did not receive any training. Both groups were evaluated at baseline and after 6 months. **MAIN OUTCOME MEASURES:** **Muscle power,** calculated from ground reaction forces produced by landing after jumping as high as possible on a forceplate, cortical **bone density**, and biomarkers of bone turnover.

Prevention of postmenopausal bone loss by a low-magnitude, high-frequency mechanical stimuli: a clinical trial assessing compliance, efficacy, and safety.

J Bone Miner Res 2004 Mar;19(3):343-51

Rubin C; Recker R; Cullen D; Ryaby J; McCabe J; McLeod K
Department of Biomedical Engineering, State University of New York, Stony Brook, New York, USA.

A 1-year prospective, randomized, double-blind, and placebo-controlled trial of 70 **postmenopausal** women demonstrated that brief periods (<20 minutes) of a low-level (0.2g, 30 Hz) **vibration** applied during quiet standing can effectively inhibit **bone loss** in the spine and femur, with efficacy increasing significantly with greater compliance, particularly in those subjects with lower body mass.

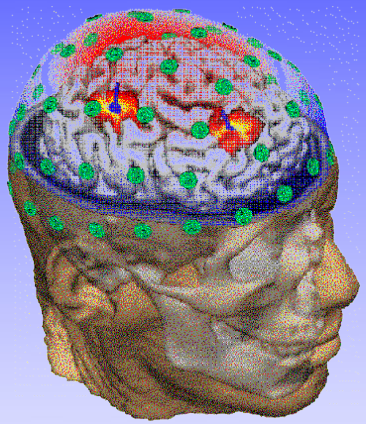
Plantar **vibration** improves leg fluid flow in perimenopausal women.

Am J Physiol Regul Integr Comp Physiol 2005 Mar;288(3):R623-9 (ISSN: 0363-6119)

Stewart JM; Karman C; Montgomery LD; McLeod KJ
Depts. of Pediatrics and Physiology, The Center for Pediatric Hypotension and Division of Pediatric Cardiology, Suite 618, Munger Pavilion, New York Medical College, Valhalla, NY 10595, USA. stewart@nymc.edu.

The results suggest that plantar **vibration** serves to significantly enhance peripheral and systemic blood flow, peripheral lymphatic flow, and venous drainage, which may account for the apparent ability of such stimuli to influence **bone** mass.

The Effects of Exercise on the Brain



All types of aerobic exercise provide benefits:

Neurogénesis

Mood enhancement,

Endorphin release