

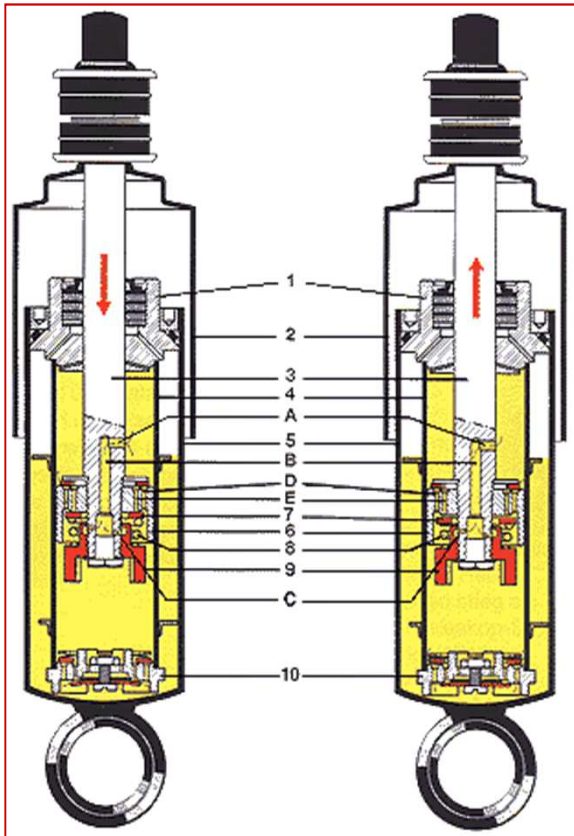
Perspectives on Innovation in Sport Engineering - Stochastic Resonance and their Application in Modern Training

Dietmar Schmidtbleicher / Christian T. Haas

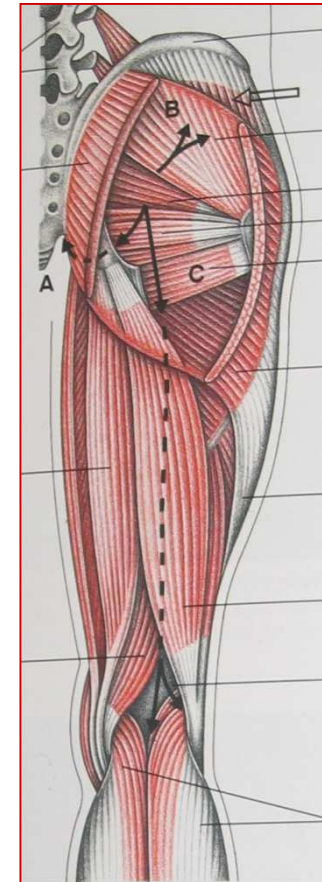
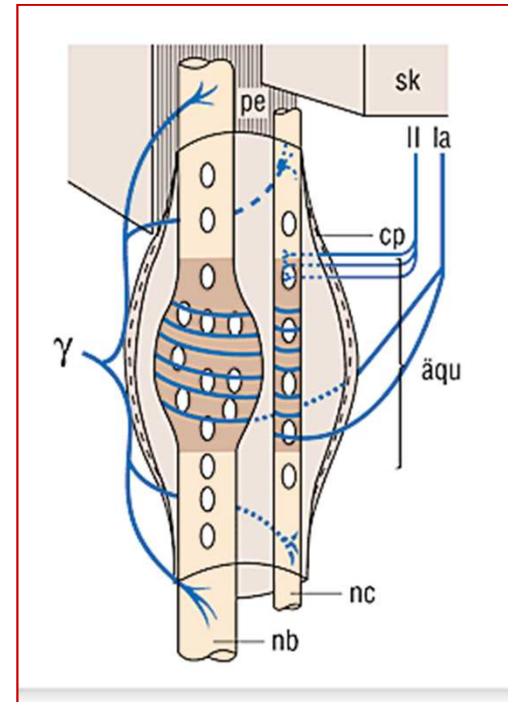


Damping Demands

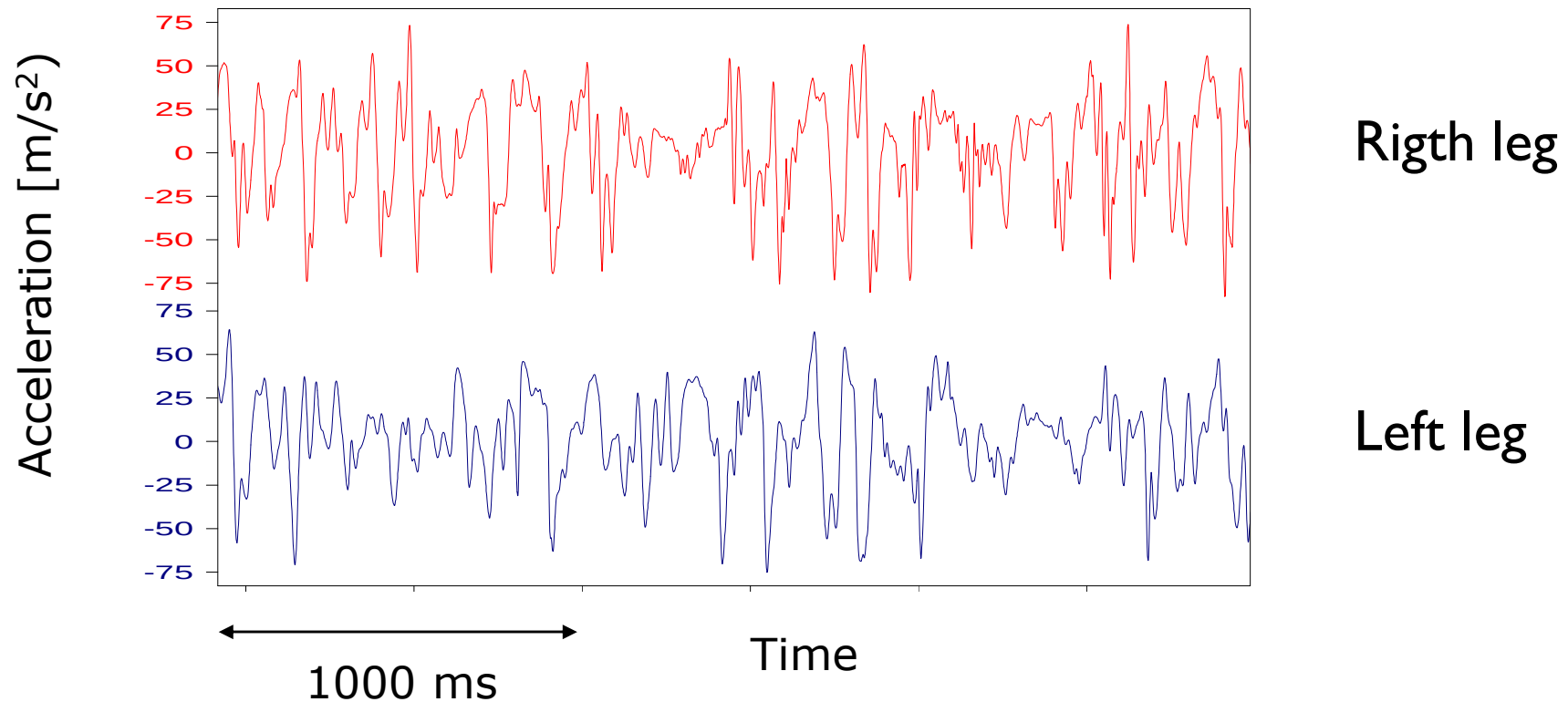
Machinery



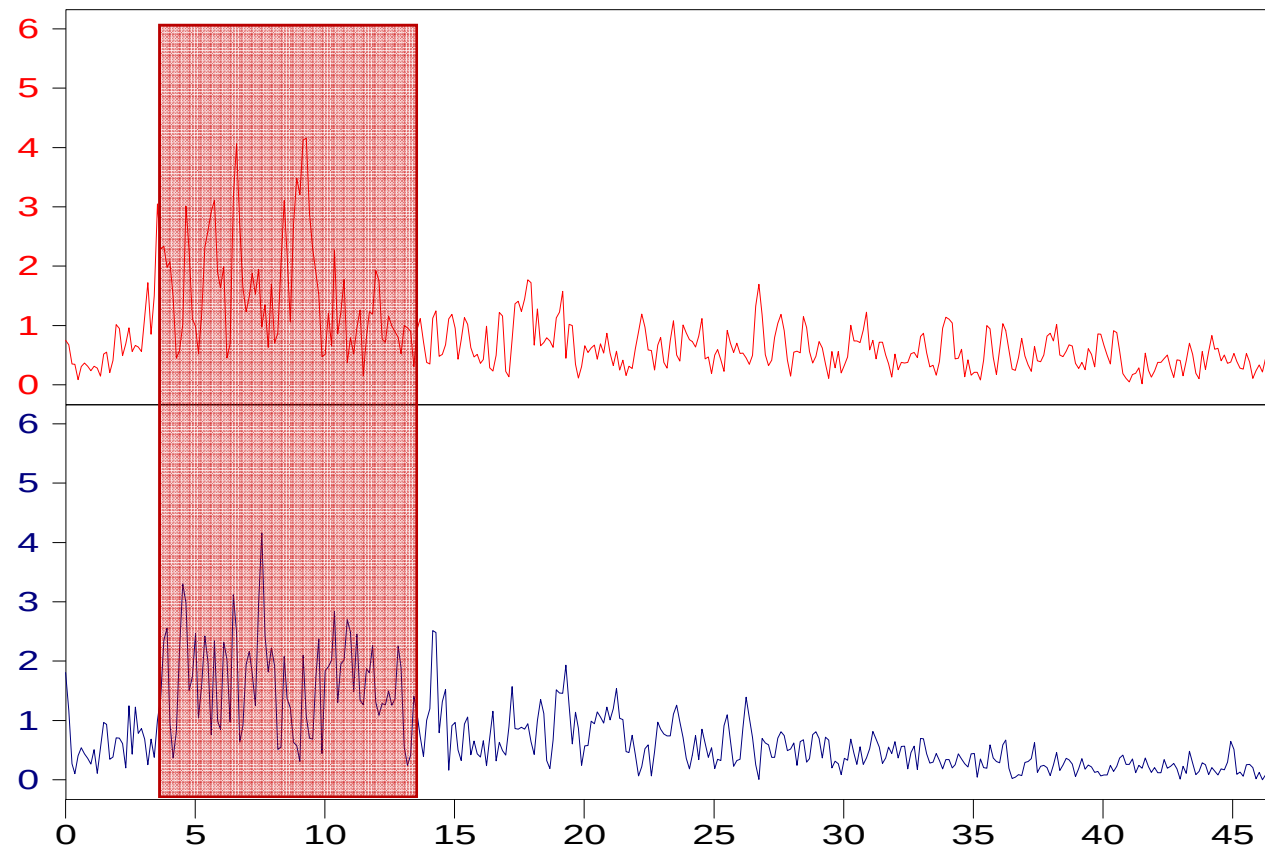
Men



Ballistic Perturbations



Predominant Frequencies

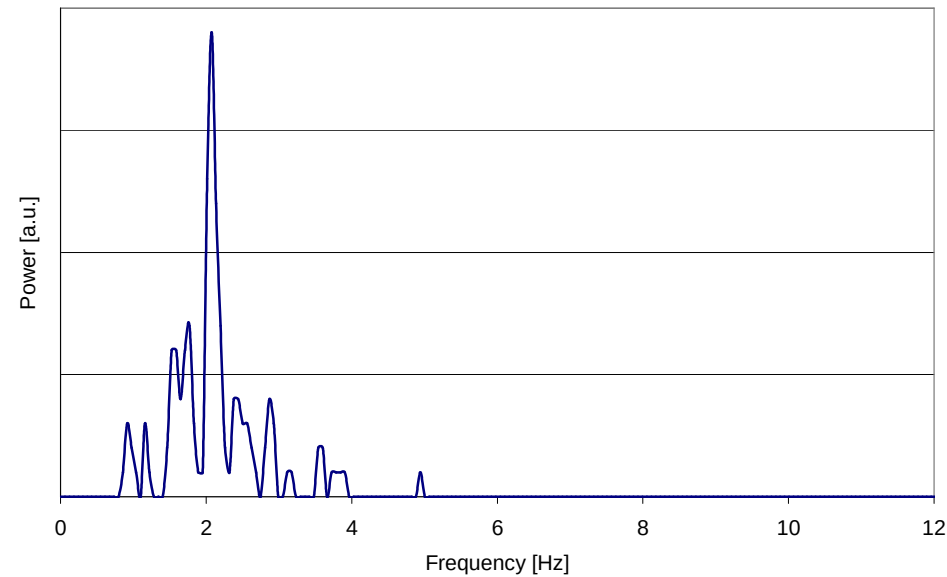


Theta – alpha
frequency range

Conventional Training



Conventional Training



delta frequency range

Prevention of ACL Injury

No reduced Risk of ACL Injury by Balance-Board-Training

- Football 228 player: 80% of ACL Ruptures in Innervation Group (Söderman et al. 2000)
- Volleyball 641 player: 3-fold higher injury frequency in innervation group (Verhagen et al. 2004)

Simulation



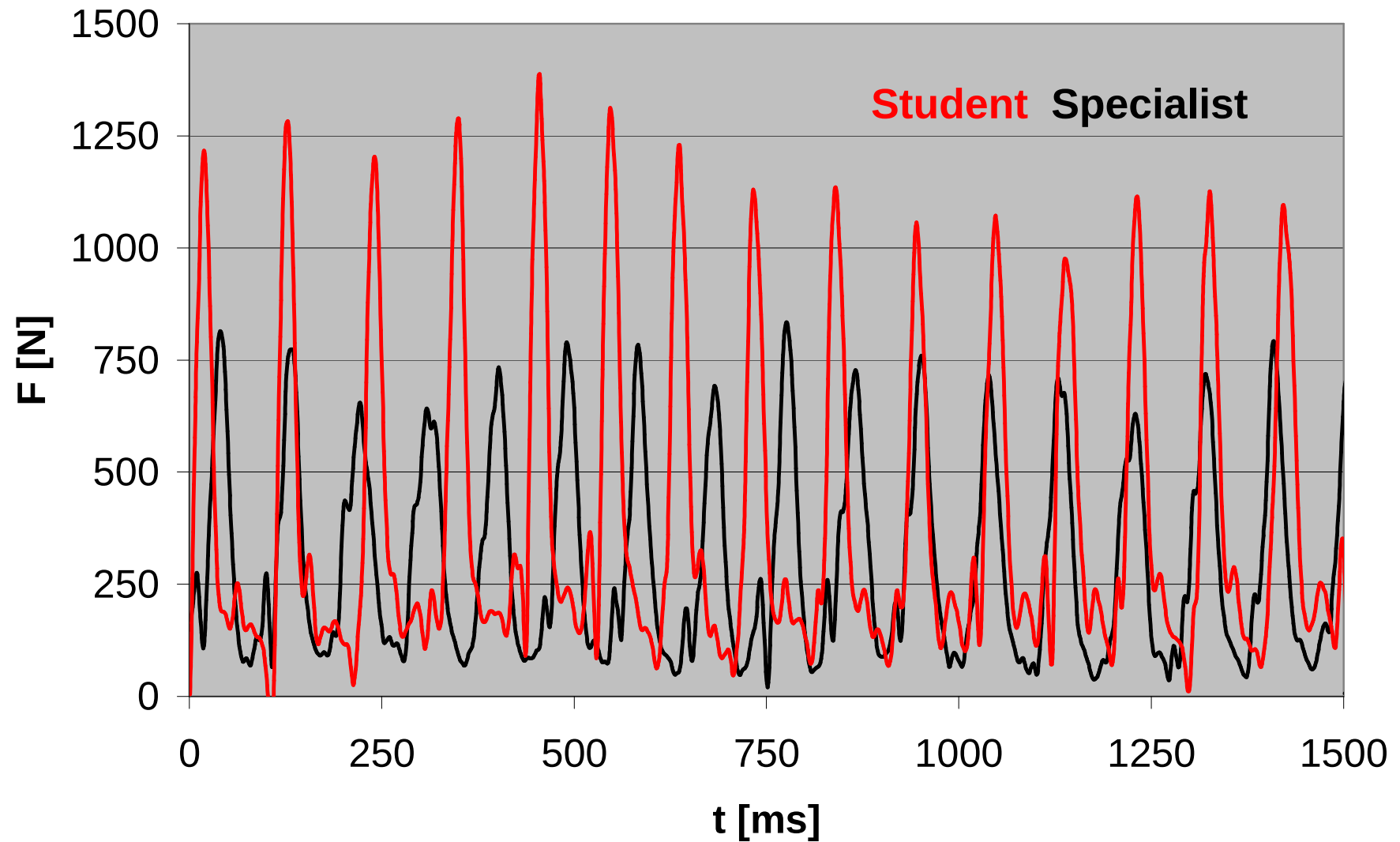
Simulation



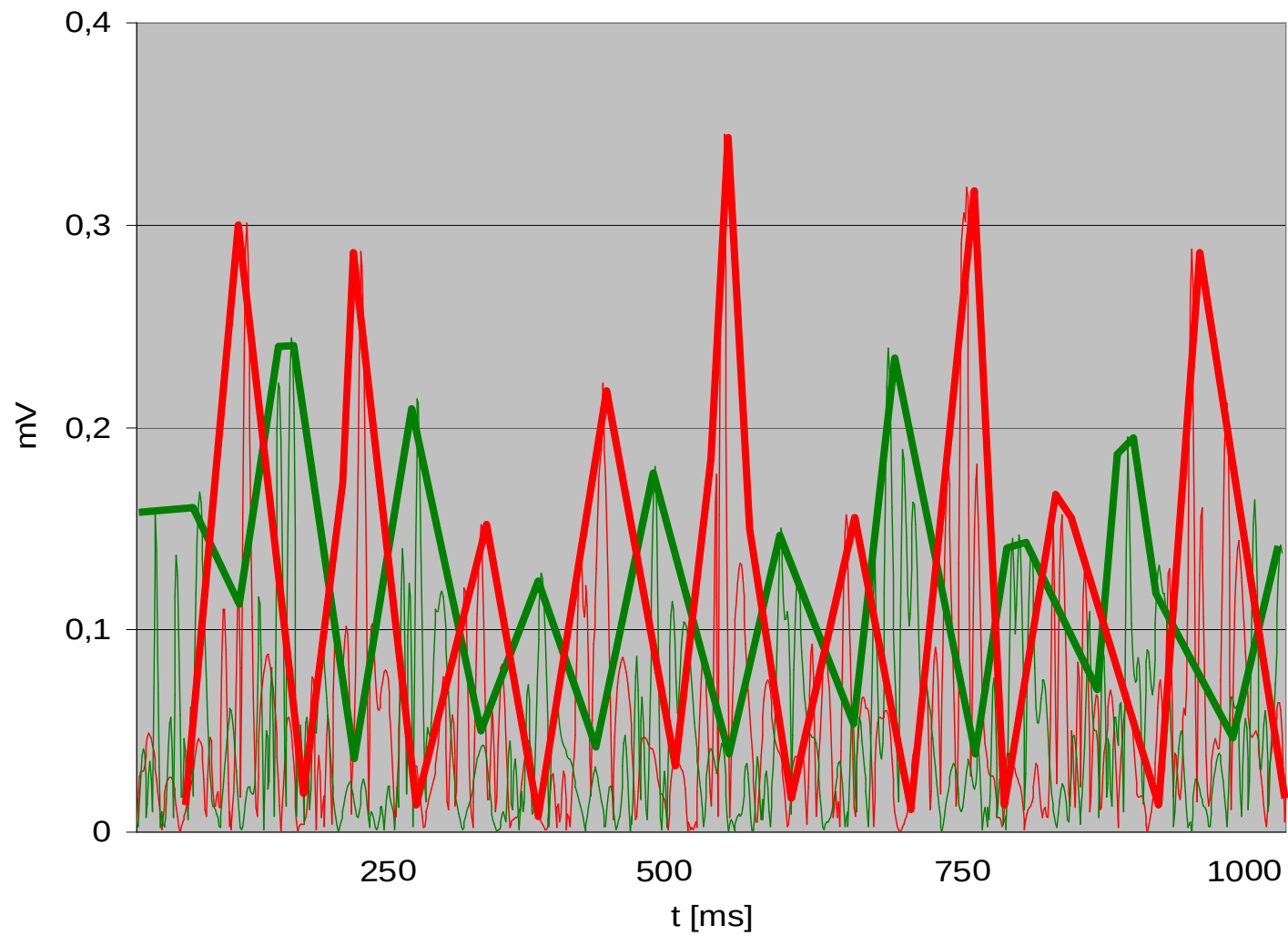
Stochastic Resonance Training



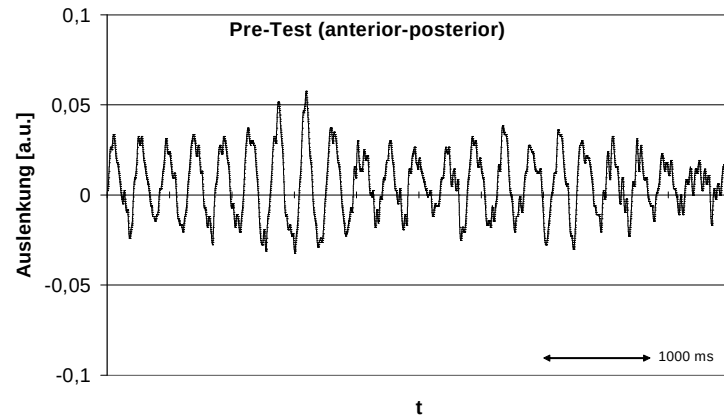
Ground Reaction Forces



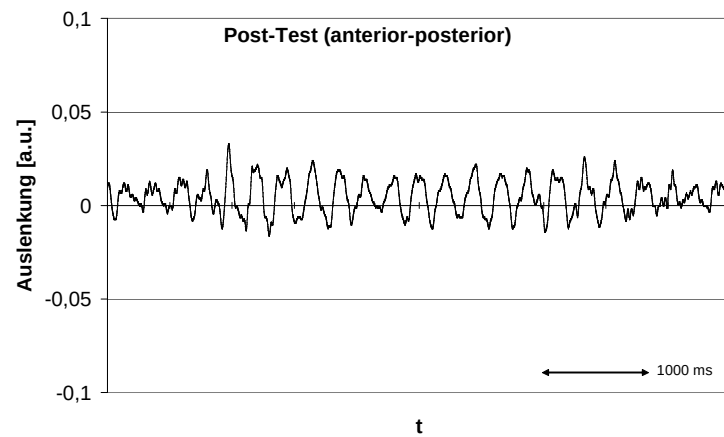
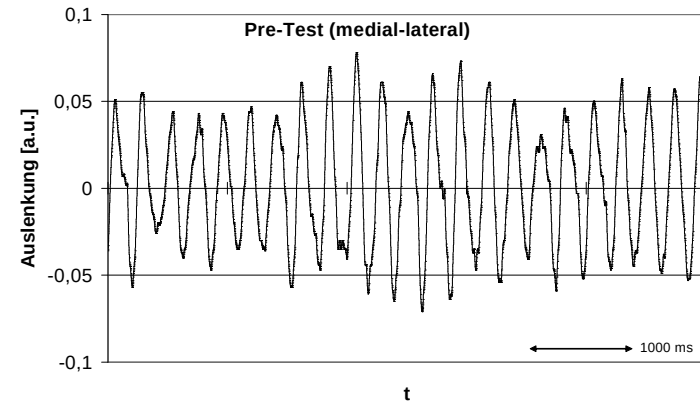
Reflex pattern



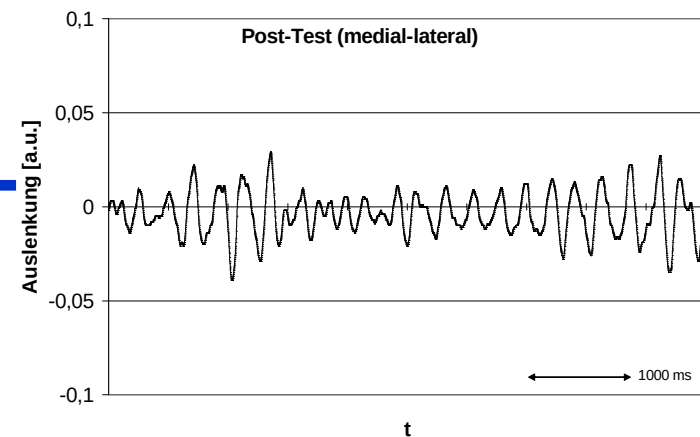
Effects in Balance



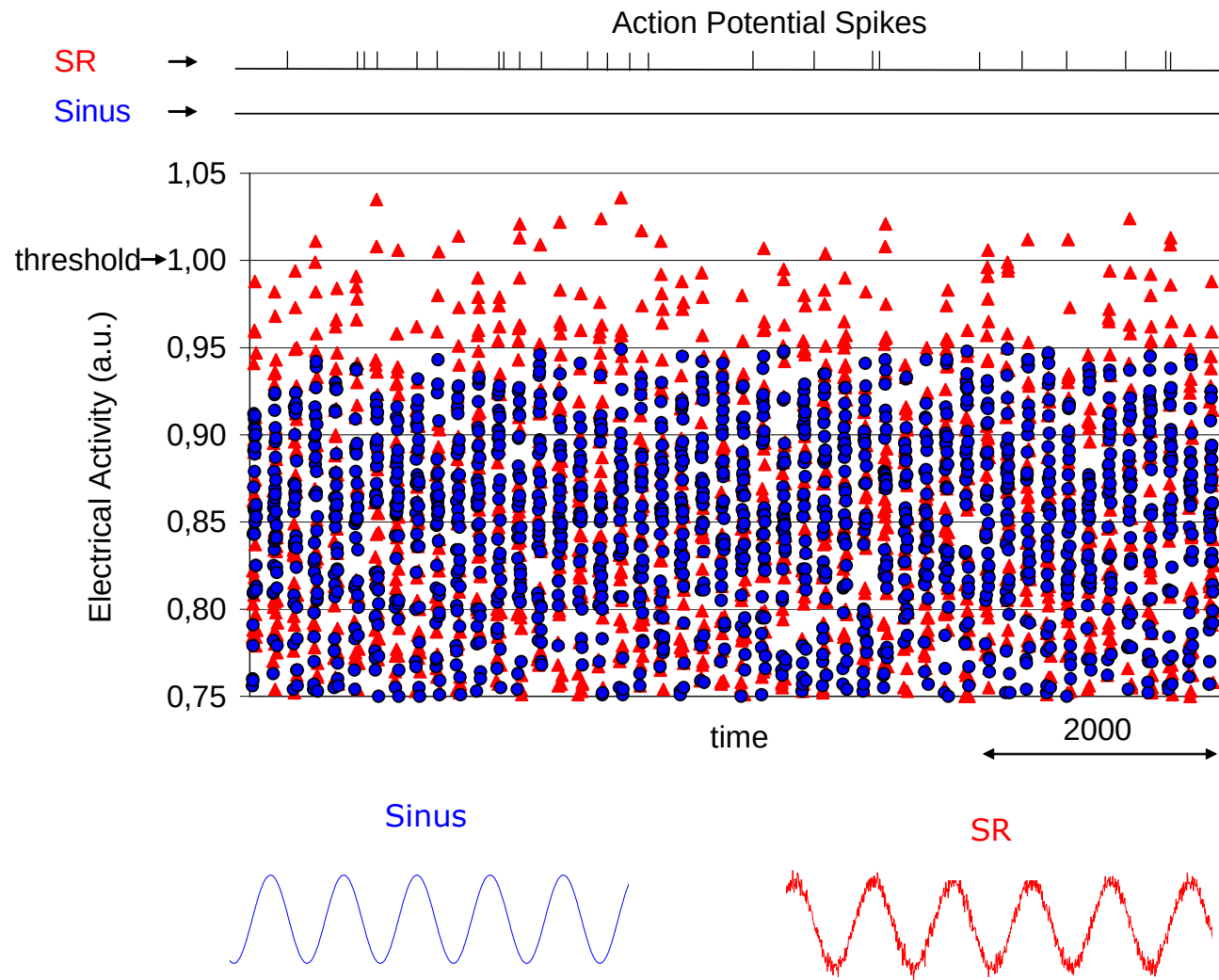
PRE



POST

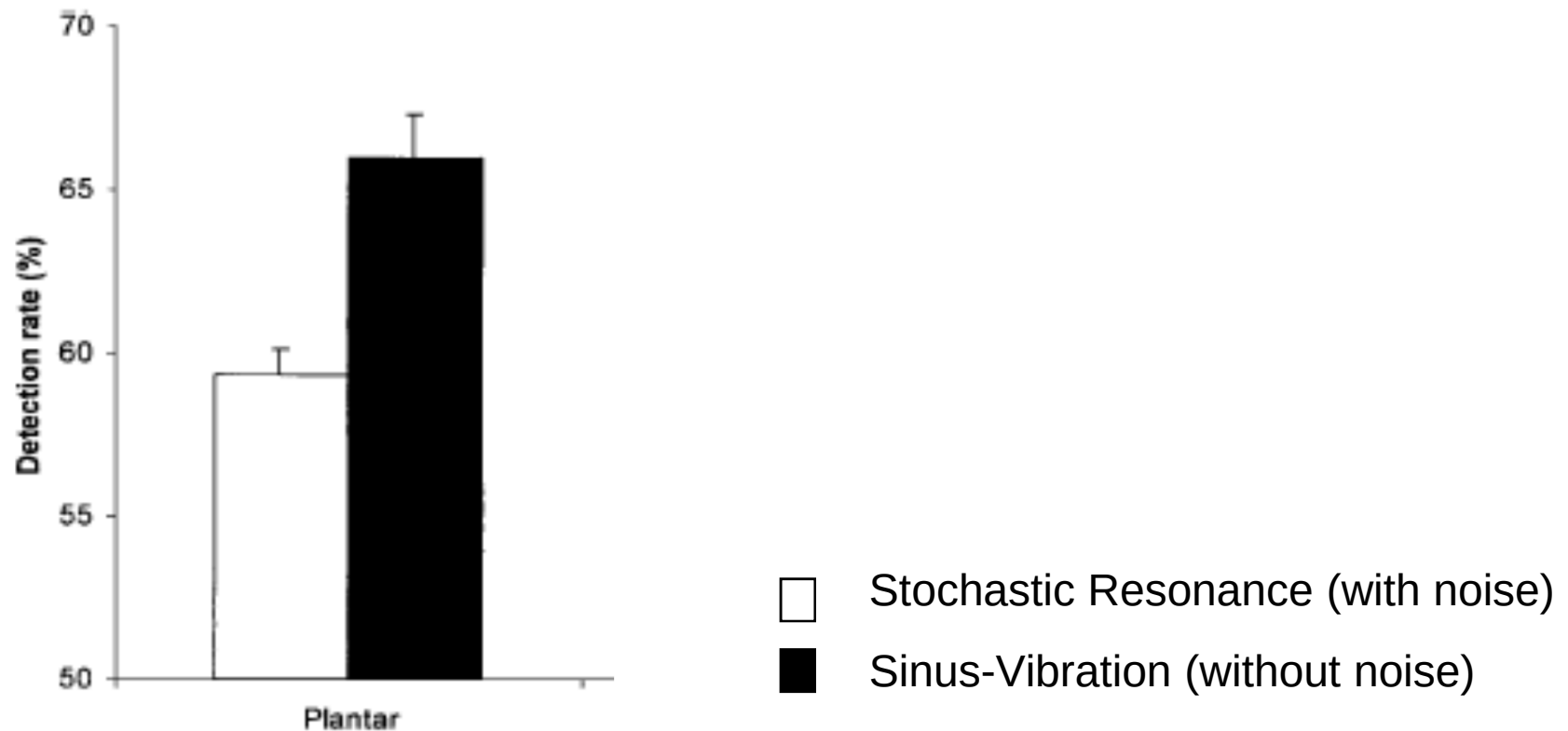


Model of Nerve functioning



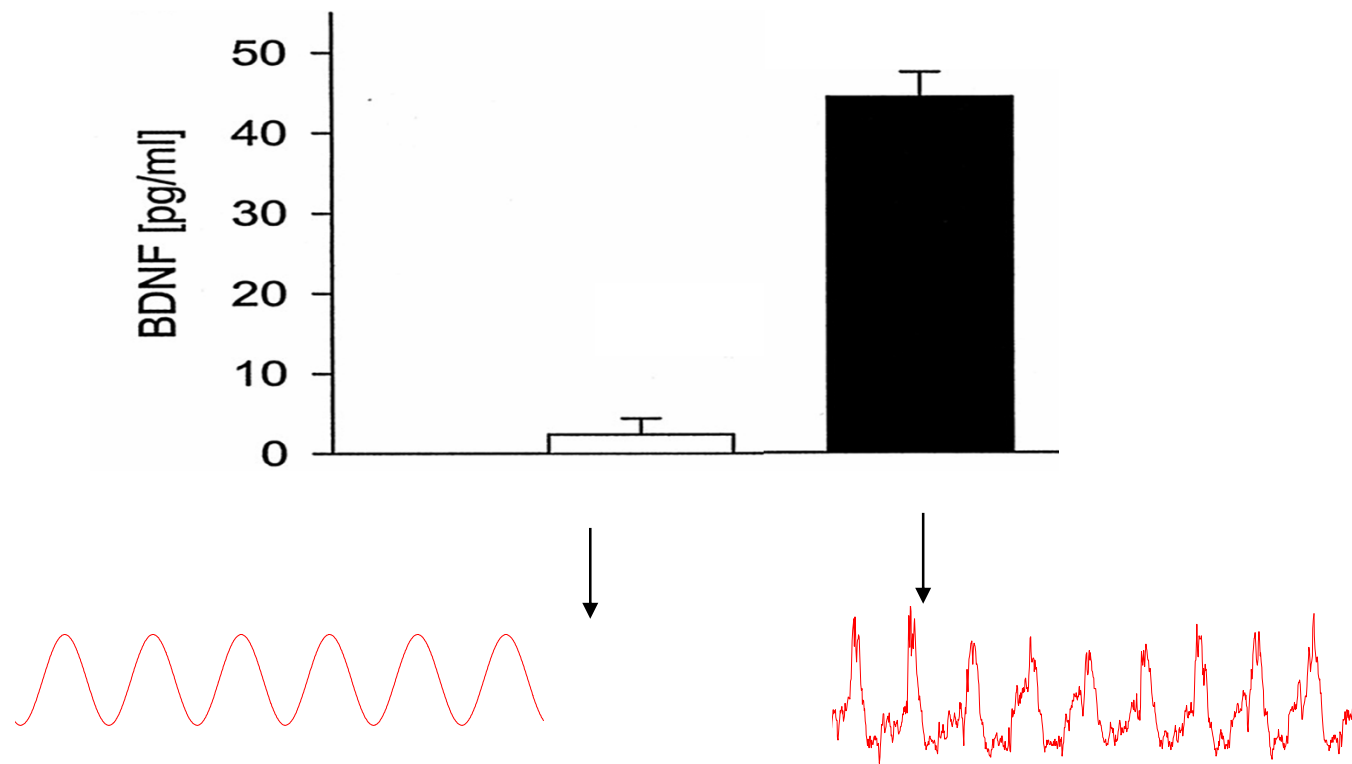
Haas / Schmidtbleicher Isokinetics and Exercise Science 2006

SR Effects – Detection Threshold



Khaodhiar et al. Diabetics care 2003

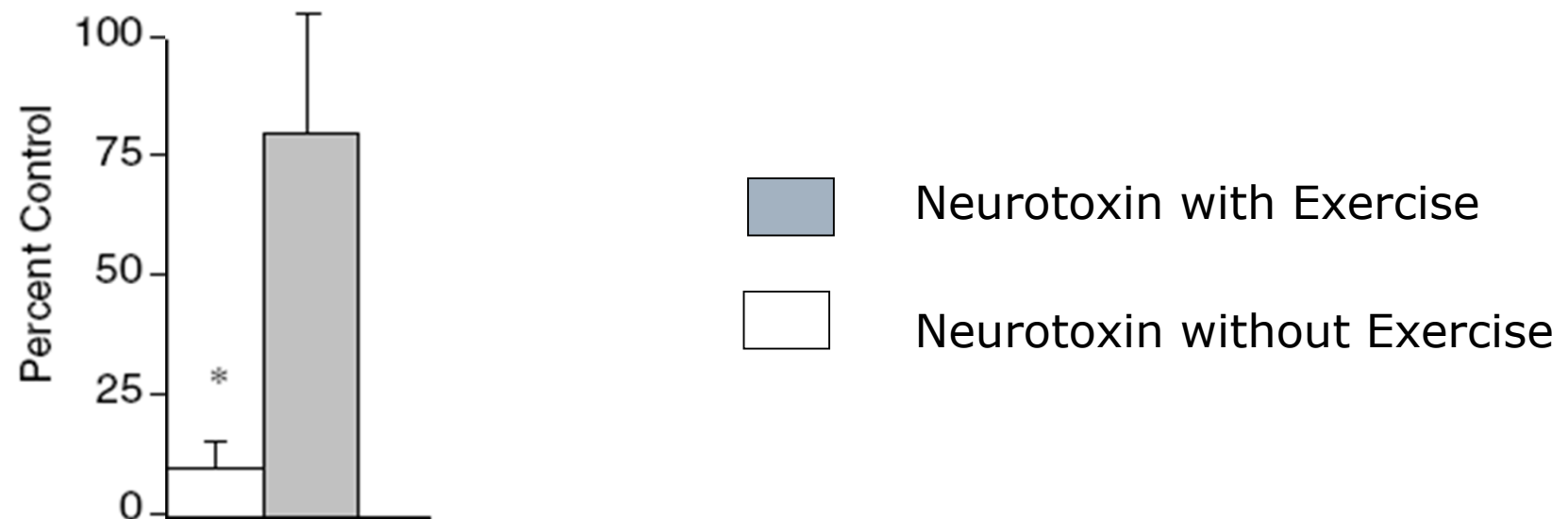
SR and Neurotrophic Factors



Balkowiec, Katz 2002 J Neurosc.

Neurotrophic Factors

Survival of dopaminergic Neurons



Cohen et al. J. Neurochemistry 2002

Neurotrophic Factors

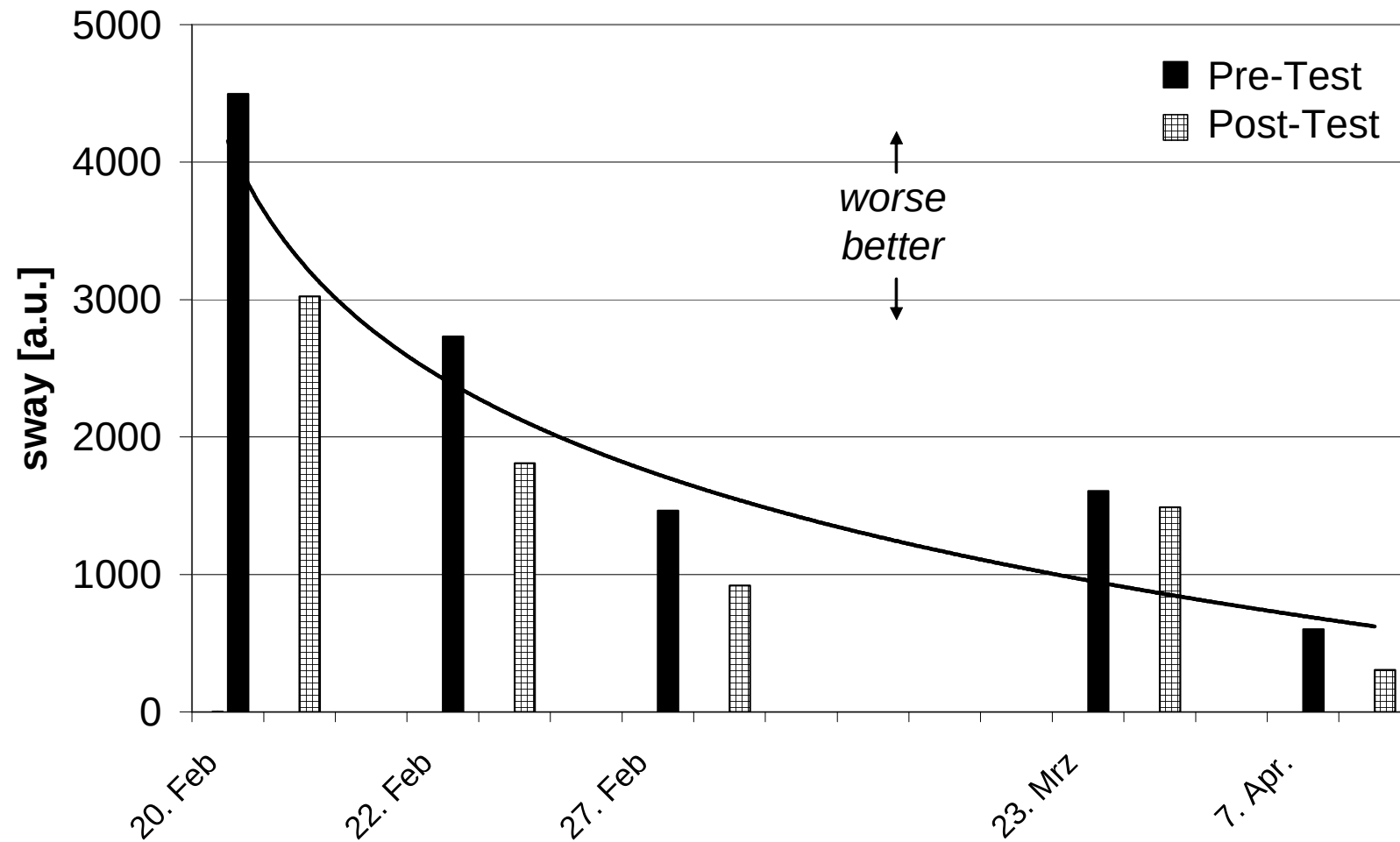
- ▶ No release through standing or isometric contractions
- ▶ Small release by swimming
- ▶ Huge release after running (la afferences)
- ▶ Implementation of spatial demands and time variations



Wirth et al. Eur. Journal of Neuroscience 1998
Garraway et al. Europ. J. of Neuroscience 2003
Molteni et al. Eur. Journal of Neuroscience 2002
Hutchinson et al. Brain 2004

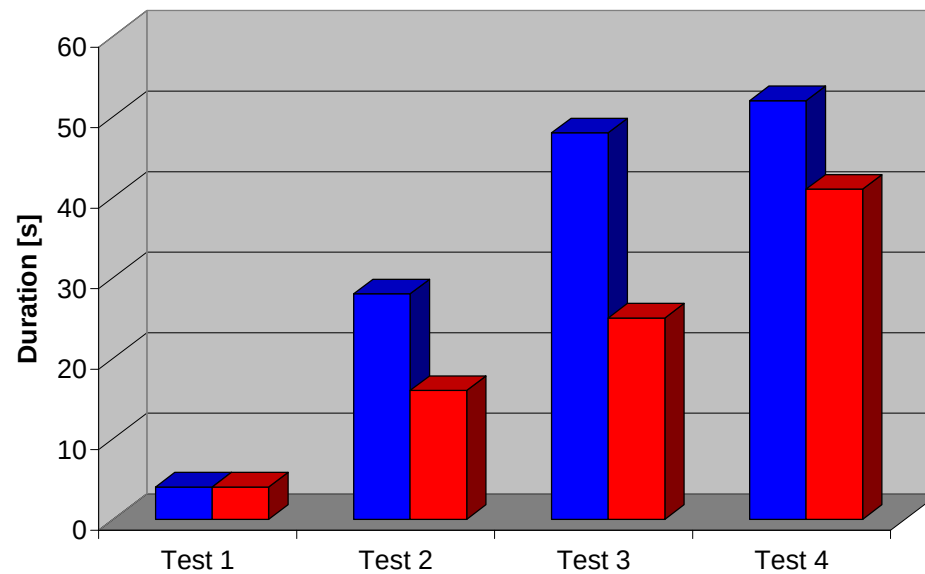
SRT in MS

Postural Control

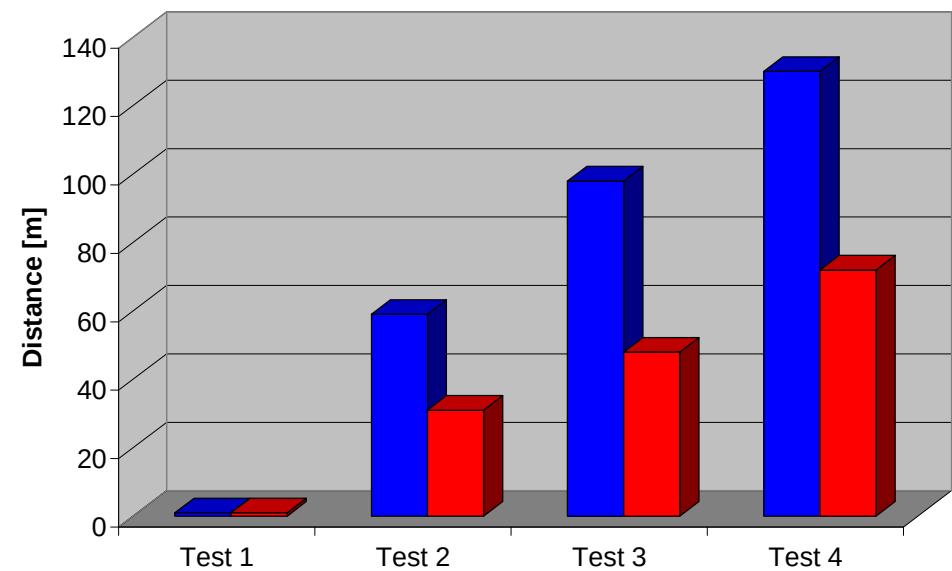


SRT in SCI

Balance



Gait



Experimental Group
Control Group

SRT in SCI

Pre-Test

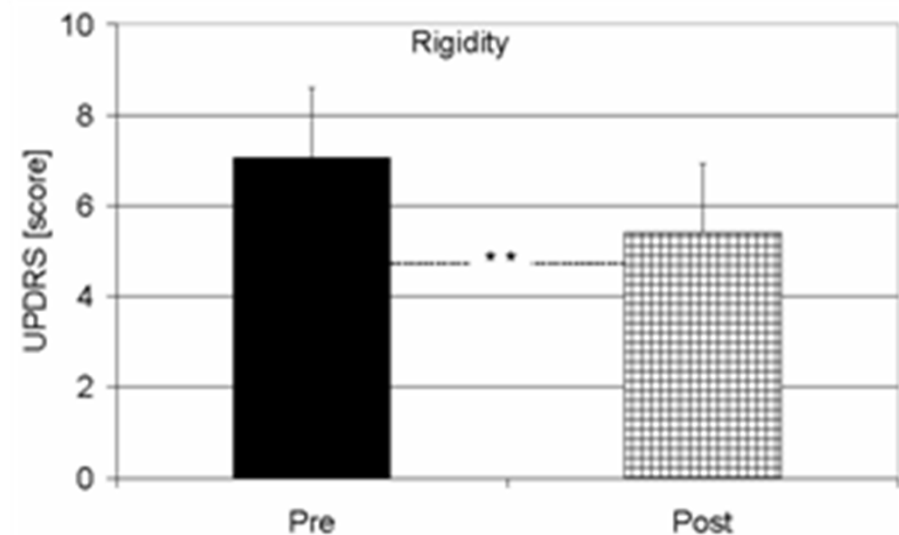
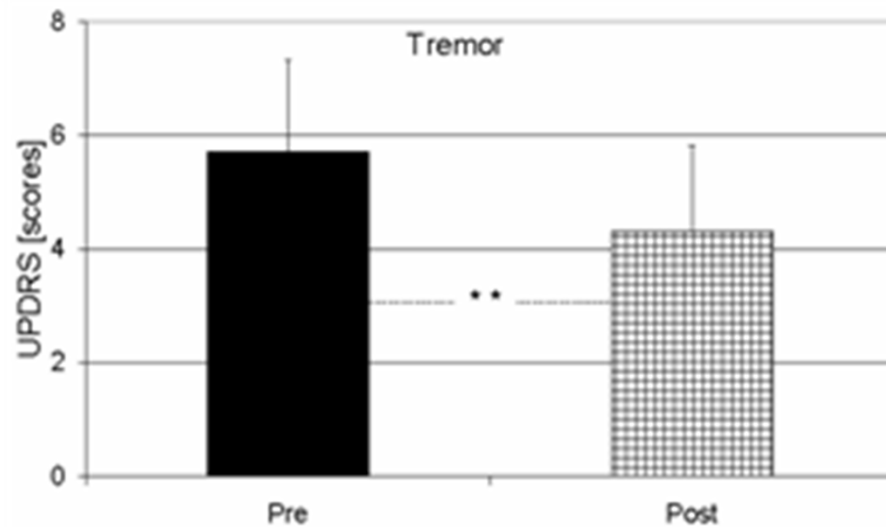


Post- Test



SRT in Parkinson's disease

- ▶ Tremor - 25%, Rigidity -24% after 5 series



Schmidtbleicher et al. 2005 ISBS

Haas et al. 2006 Neurorehabilitation

SRT in Parkinson's disease

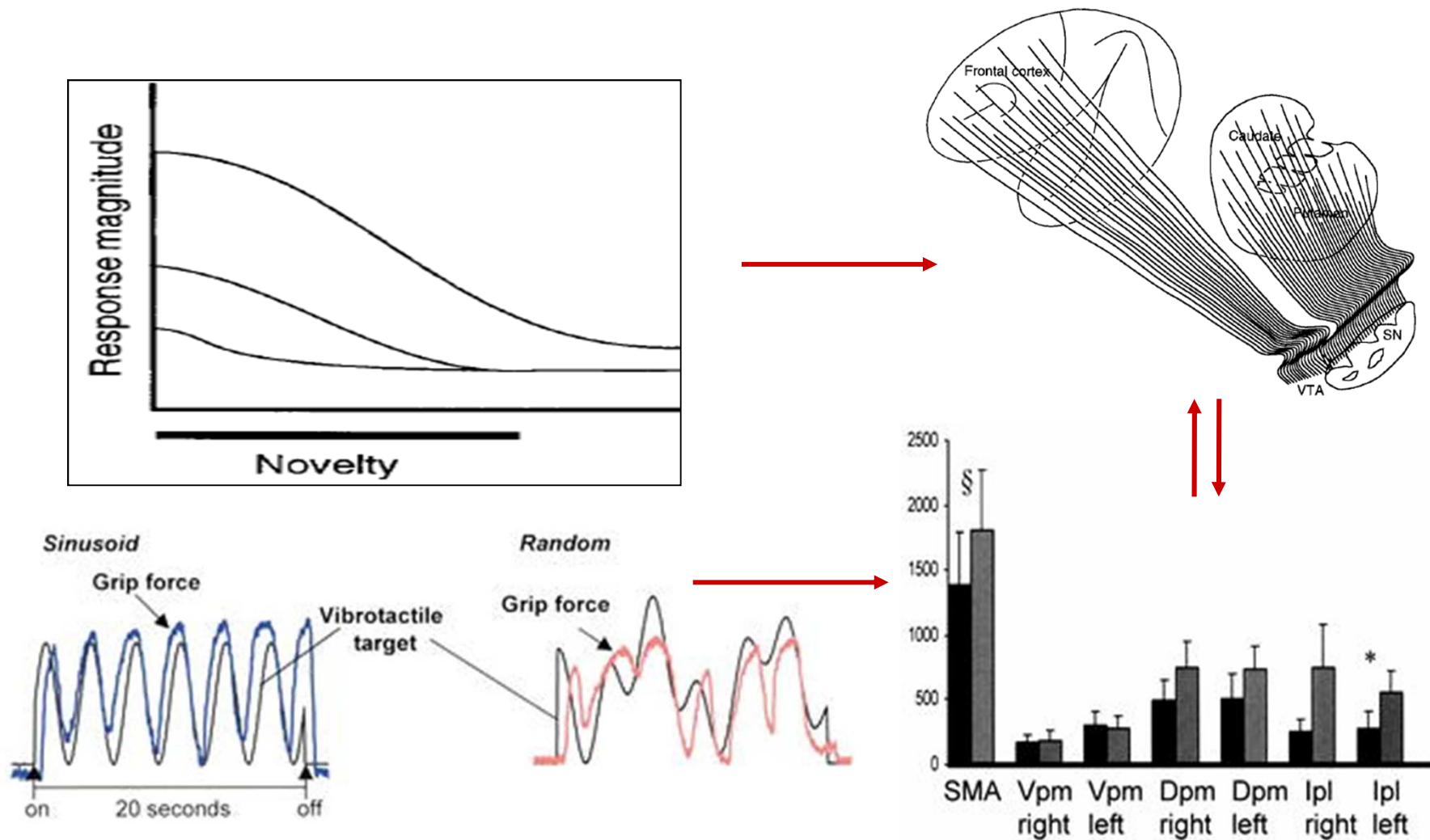
Pre

Wer reißt so spät durch Nacht
und Wind, es ist der Vater
mit seinem Kind

Post

Wer reißt so spät durch
Nacht und Wind, es ist der
Vater mit seinem Kind.

Stochastic Resonance and cortical activity



Nelson et al. Exp Brain Res 2004, Schultz et al. (1997) Science

Take home message

Stochastische Resonance enables...

- *Increased neuromuscular activity*
- *Reduced neuro-degenerative effects*
- *Enhanced neuroplasticity*
- *Improved selection of Information,*
- *Improved postural control and locomotion*

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