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

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Damping Demands

Machinery

Men
Ballistic Perturbations

Acceleration [m/s²]

1000 ms

Time

Righ leg

Left leg
Predominant Frequencies

Theta – alpha frequency range
Conventional Training
Conventional Training

![Images of conventional training exercises]

Graph showing power (a.u.) vs. frequency (Hz)

**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

![Graph showing ground reaction forces over time for Student and Specialist]
Reflex pattern
Effects in Balance

PRE

POST

Pre-Test (anterior-posterior)

Pre-Test (medial-lateral)

Post-Test (anterior-posterior)

Post-Test (medial-lateral)
Model of Nerve functioning

Action Potential Spikes

SR

Sinus

Electrical Activity (a.u.)

threshold

0.75

0.80

0.85

0.90

0.95

1.00

1.05

0,75

0,80

0,85

0,90

0,95

1,00

1,05

0,75

0,80

0,85

0,90

0,95

1,00

1,05

threshold

time

2000

Sinus

SR

Haas / Schmidtbleicher Isokinetics and Exercise Science 2006
SR Effects – Detection Threshold

![Graph showing detection rate for Stochastic Resonance (with noise) and Sinus-Vibration (without noise).]

- Stochastic Resonance (with noise)
- Sinus-Vibration (without noise)

Khaodhiar et al. Diabetics care 2003
SR and 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 (Ia afferences)
- Implementation of spatial demands and time variations

Hutchinson et al. Brain 2004
SRT in MS

Postural Control

sway [a.u.]

- Pre-Test
- Post-Test

worse better

SRT in SCI

Balance

Gait

Experimental Group

Control Group

Duration [s]

Distance [m]

Test 1  Test 2  Test 3  Test 4
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
Pre

Würde ich so sprach dich nicht
und würde es für den Vater
und für mich, gleich

Post

wer sei der So sprach du dich

noch zu mir, und würd es ist der

Vater mit sein sein Ich.
Stochastic Resonance and cortical activity

Take home message

*Stochastische Resonance enables…*

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