The Importance of High Intensity Exercise In Neurological Rehabilitation: Giving Stroke a H.I.T.

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Statement of disclosure

I HAVE NOTHING TO DISCLOSE.
Strength training in neurological rehabilitation…

Is there a physiological threshold stimulus or dose for strength?

- **contractile intensity**?
- repetitions?
- time under tension?
- frequency?
- passage of time?
1894…
GUSTAV FECHNER (1801-1887)

Cross-education of strength and skill: an old idea with applications in the aging nervous system

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ALFRED VOLKMAN (1801-1877)
ON THE EDUCATION OF MUSCULAR CONTROL AND POWER,

BY

E. W. SCRIPTURE, THEODORE L. SMITH and EMILY M. BROWN.

In an article on the course of muscular training Fick's records the number of times a day after day that he was able to raise two dumbbells, about 9½ lbs. each, once a second from his side to over his head. The records extended over sixty days in succession. They show a steady general gain with small oscillations, the general course of the curve representing the increase of power owing to practice and the oscillations showing the conflicting effects of fatigue. The final conclusion, as stated by Fick's, is that during the first 14 days there were no permanent effects of practice visible, that up to the 40th day there was a gradual gain and that with the 41st day there was a great gain which increased rapidly with great oscillations till the 55th day, after which there was a sudden fall.

Volkmann's made experiments on the education of the fineness of space-discrimination as judged by the skin, using Weber's compass in the usual way. These experiments, however, are not quite comparable with Fick's, as each series was made at a single sitting. Volkmann's two series of experiments on sight extended over 12 days and gave curves similar in form to his touch curves. Volkmann's curves resemble Fick's if we omit the flat part of slow increase at the beginning on the supposition that both skin and eyes have already received their early training. In the same article Volkmann relates experiments showing that practice of the finger-tip of the left hand increases the fineness of touch of the finger-tip of the right hand but does not increase that of the left fore-arm. Further experiments show that practice on the third phalanx increases the fineness on the first phalanx. Thus, training of one portion of the body trains at the same time the symmetrical part and also neighboring parts.

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Increased spinal reflex excitability is not associated with neural plasticity underlying the cross-education effect

- 5 x 8 plantarflexion MVC
- 6 seconds
- 3 x per week for 5 weeks
- = 600 contractions
- = 3600 s TuT
Bilateral neuromuscular plasticity from unilateral training of the ankle dorsiflexors

- 5 x 5 dorsiflexion MVC
- 5 seconds
- 3 x per week for 5 weeks
- = 375 contractions
- = 1875 s TuT
High-intensity unilateral dorsiflexor resistance training results in bilateral neuromuscular plasticity after stroke

- 5 x 5 dorsiflexion MVC
- 5 seconds
- 3 x per week for 6 weeks
- = 450 contractions
- = 2250 s TuT

Katie Dragert, and E. Paul Zehr

DOI 10.1007/s00221-012-3351-x
Unilateral wrist extension training after stroke improves function bilaterally

- 5 x 5 wrist extension MVC
- 5 seconds
- 3 x per week for 5 weeks
- = 375 contractions
- = 1875 s TuT

Transcallosal inhibition was decreased after training.
Refining the dose for neurological rehabilitation...

- **contractile intensity**
  - maximal
- repetitions?
- time under tension?
- frequency?
- **passage of time**?
  - How long before changing stages of rehabilitation?
Time course “dose” of inter-limb strength transfer after handgrip training

1. TRADITIONAL
   - 3 x per week for 6 weeks
   - = 18 sessions

2. Daily
   - 18 consecutive days
A. ‘Traditional’ Resistance Training (18 Sessions; 3x/week; 6 weeks)

B. ‘Daily’ Resistance Training (18 Consecutive Days)
Strength gains …

… in the TRAINED hand required 12-15 sessions

… in the UNTRAINED hand required 12 sessions
“Restoring symmetry” hypothesis...

Cross education after stroke

More affected side (untrained)  Less affected (ipsilesional) side (trained)

Cross education from training the less affected side significantly increased dorsiflexion strength by ~31%.

Maximal effort dorsiflexion training significantly increased strength by ~34%.

Figure 2. Unilateral dorsiflexion training increased strength and muscle activation bilaterally after stroke.
The lingering effects of a busted myth — false time limits in stroke rehabilitation

Yao Sun, Joanne Boots, and E. Paul Zehr

Abstract: It was once falsely believed that neurological and functional recovery after stroke occurred only in the first 6 months after lesion. The perception of this “6-month myth” continues to negatively impact the attitudes of patients towards their rehabilitation and on the clinicians and therapists making optimal training plans. Here we briefly outline some evidence that debunked the 6-month myth, where the concept of this temporal limit may have originated, and the lingering misunderstanding that individuals with stroke reach a plateau of recovery after 6 months even with rehabilitation training. We present evidence that significant functional improvement can occur years after stroke when rehabilitation training is applied. We frame the concepts of active and passive neurological recovery and that active neurological recovery continues far beyond any temporal limit. Because the effects of this busted 6-month myth persist, we aim to remind active physicians, therapists, exercise professionals, and those with stroke to continuously seek opportunities for active rehabilitation training. Meanwhile, trained and certified exercise professionals can play critical roles in facilitating rehabilitative training for community-dwelling stroke survivors.

Key words: stroke recovery, rehabilitation training, neuroplasticity.
So what do we know now?

- 12 training sessions (traditional or daily) may be enough to produce cross-education with very low exposures
  - 300 contractions
  - 1500 s TuT

- Post-stroke nervous system presents a fruitful environment for strength training and cross-education using high intensity, maximal contractions

- Training and rehabilitation gains may be threshold or dose-dependent
  - Key features are frequency, repetition number, and intensity…

- Rehabilitation-induced neuroplasticity never expires…
Acknowledgements

Dr. Olle Lagerquist, Dr. Dave Docherty, Dr. Katie Dragert, Dr. Trevor Barss, Dr. Lara Boyd, Dr. Jon Farthing, Dr Jayne Garland, Dr. Taryn Klarner, Greg Pearcey, Yao Sun, Hilary Cullen, Noah Ledwell, Kristy Inouye, Lauren Smith, Andrew Woodward
QUESTIONS?

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