Practical Use of Regional Interdependence: Contralateral Exercise Benefits

Lucas Bianco, DAT, LAT, ATC

- I would like to thank the Mid Atlantic Athletic Trainers' Association Education Committee.

Conflict of Interest/ Disclosures

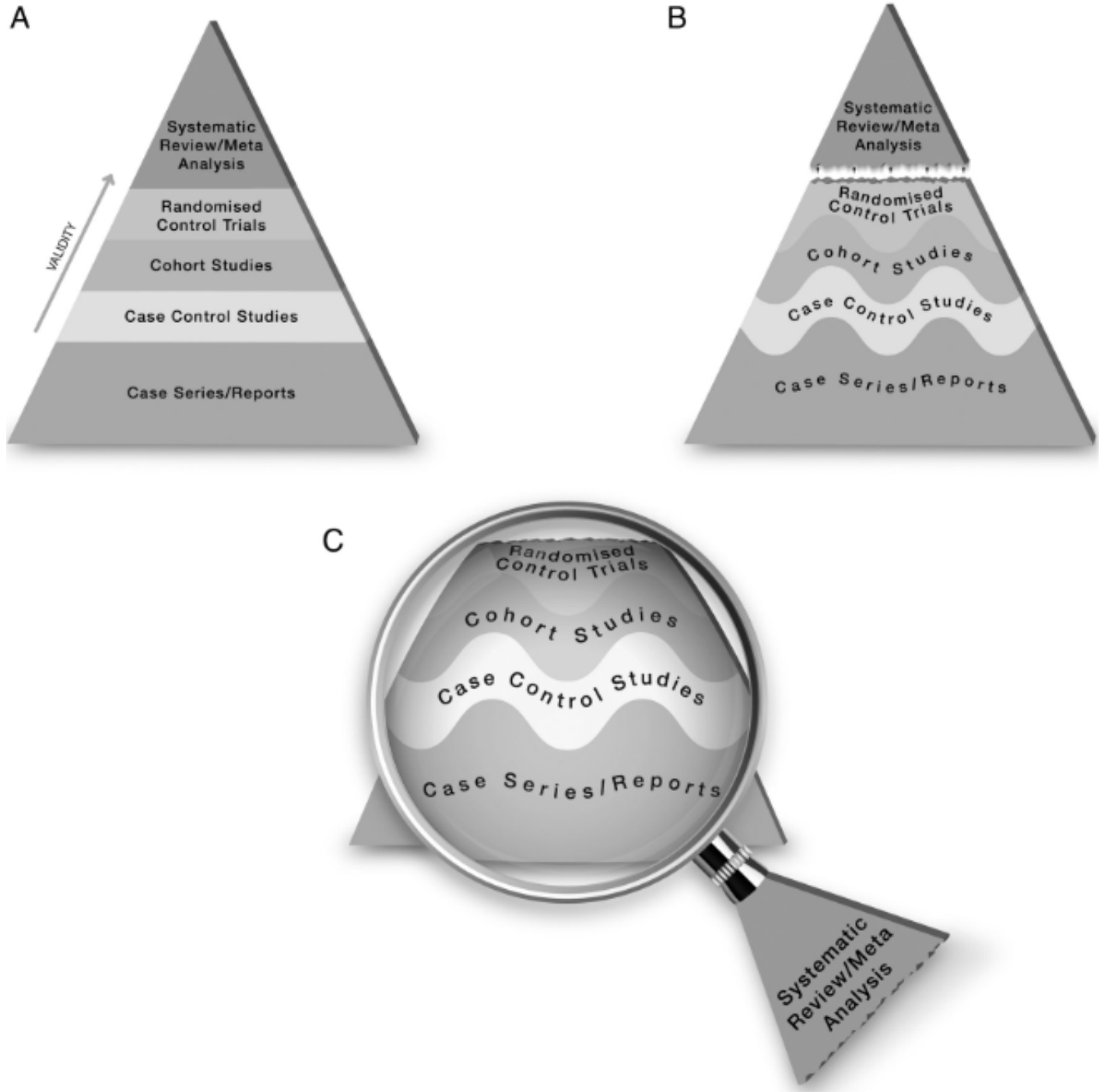
- No conflicts of interest.

- Disclosure: I am an athletic trainer in the industrial setting. I am a father of a 5 month old.

EBM

- Evidence-Based Medicine is not “cookbook” medicine.

- Defining Clinically Relevant Questions
- Searching for Best Evidence
- Critically Appraising the Evidence
- Applying the Evidence
- Evaluating the Performance of EBM


A
Systematic Review/Meta Analysis
Randomised Control Trials
Cohort Studies
Case Control Studies
Case Series/Reports
VALIDITY
B
Systematic Review/Meta Analysis
Randomised Control Trials
Cohort Studies
Case Control Studies
Case Series/Reports
C
Randomised Control Trials
Cohort Studies
Case Control Studies
Case Series/Reports
Systematic Review/Meta Analysis

The Effect of Contralateral Exercise on Patient Pain and Range of Motion

Smokey Fermin, Lindsay Larkins, Sarah Beene, and David Wetzel

Position Statements

- Ankle Sensorimotor
- Shoulder Hip Relationship
- Single Leg Balance
  Proximal Control

National Athletic Trainers' Association Position Statement: Conservative Management and Prevention of Ankle Sprains in Athletes

Thomas W. Kaminski, PhD, ATC, FNATA, FACSM*; Jay Hertel, PhD, ATC, FNATA, FACSM†; Ned Amendola, MD‡; Carrie L. Docherty, PhD, ATC, FNATA§; Michael G. Dolan, MA, ATC||; J. Ty Hopkins, PhD, ATC, FNATA¶; Eric Nussbaum, MEd, ATC#; Wendy Poppy, MS, PT, ATC§; Doug Richie, DPM**

*University of Delaware, Newark; †University of Virginia, Charlottesville; ‡University of Iowa, Iowa City; §Indiana University, Bloomington; ||Canisius College, Buffalo, NY; ¶Brigham Young University, Provo, UT; #Freehold (New Jersey) Regional High School District; **California School of Podiatric Medicine, Samuel Merritt University, Oakland

National Athletic Trainers' Association Position Statement: Evaluation, Management, and Outcomes of and Return-to-Play Criteria for Overhead Athletes With Superior Labral Anterior-Posterior Injuries

Lori A. Michener, PhD, PT, ATC*; Jeffrey S. Abrams, MD†; Kellie C. Huxel Bliven, PhD, ATC‡; Sue Falsone, PT, MS, SCS, ATC‡; Kevin G. Laudner, PhD, ATC§; Edward G. McFarland, MD||; James E. Tibone, MD*; Charles A. Thigpen, PhD, PT, ATC¶; Timothy L. Uhl, PhD, PT, ATC, FNATA#

National Athletic Trainers' Association Position Statement: Prevention of Anterior Cruciate Ligament Injury

Darin A. Padua, PhD, ATC*; Lindsay J. DiStefano, PhD, ATC†; Timothy E. Hewett, PhD‡; William E. Garrett, PhD, MD§; Stephen W. Marshall, PhD*; Grace M. Golden, PhD, ATC, CSCS||; Sandra J. Shultz, PhD, ATC, FNATA, FACSM¶; Susan M. Sigward, PhD, PT, ATC#

Purpose

- Enrich your connection with the evidence on contralateral exercise

- Two ways you can incorporate contralateral exercise

Outline

- Background on Regional Interdependence
- Regional Interdependence Theory Defined
- Key Terms
- Theories on Mechanisms
- Research on Theories
- Clinical Evidence Examples of Contralateral Exercise
- Practical Application

Background on Regional Interdependence

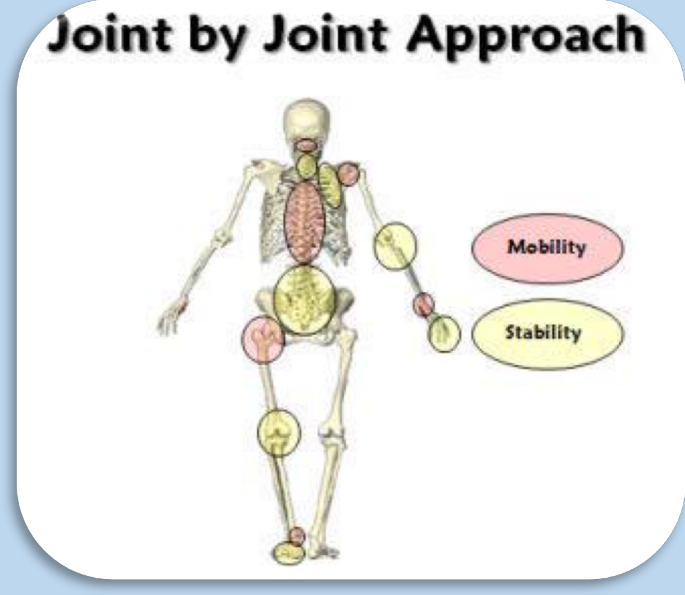
Regional Interdependence: A Musculoskeletal Examination Model Whose Time Has Come

ROBERT S. WAINNER, *PT, PhD, ECS, OCS, FAAOMPT*[1]
JULIE M. WHITMAN, *PT, DSc, OCS, FAAOMPT*[2]
JOSHUA A. CLELAND, *PT, DPT, PhD, OCS, FAAOMPT*[3]
TIMOTHY W. FLYNN, *PT, PhD, ECS, OCS, FAAOMPT*[3]
J Orthop Sports Phys Ther 2007;37(11):658-660. doi:10.2519/jospt.2007.0110

A regional interdependence model of musculoskeletal dysfunction: research, mechanisms, and clinical implications

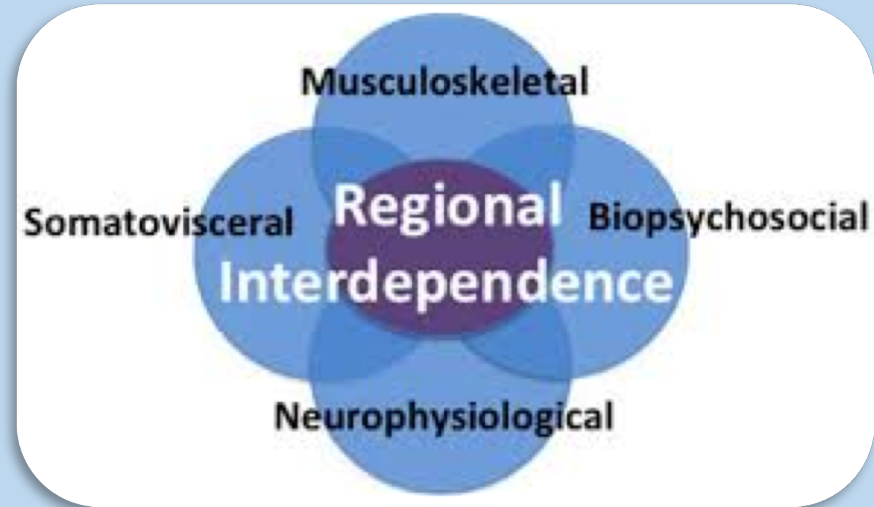
Derrick G. Sueki[1], Joshua A. Cleland[2], Robert S. Wainner[3]

Regional Interdependency



- Describes the interconnectedness of regions and/or systems within the body when considering the source of a patient's symptoms (Seuki, Cleland, & Wainner, 2013)

- Biomechanical & neurophysiological principles (Seuki et al., 2013)

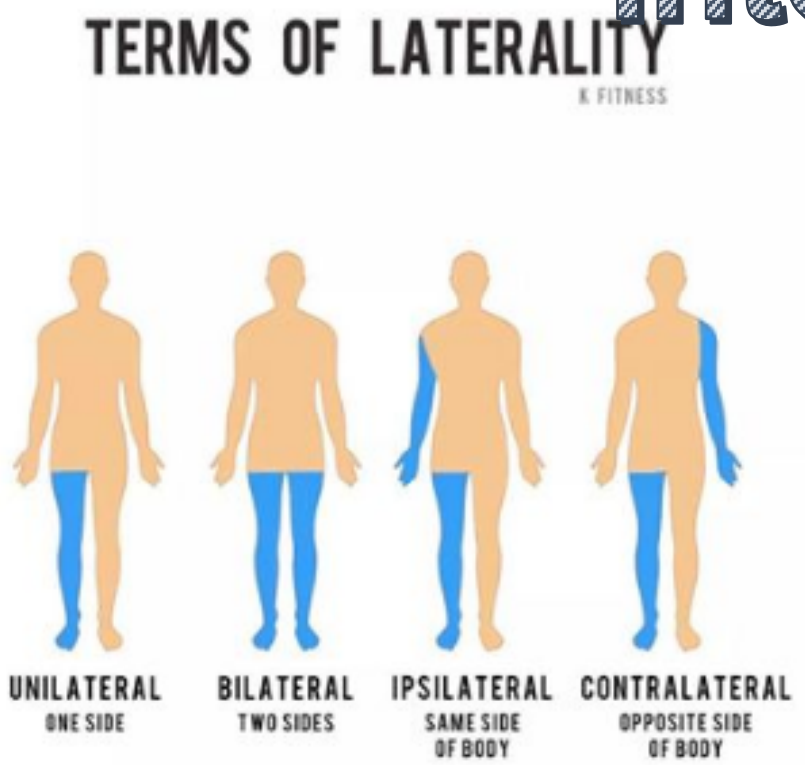


Contralateral Exercise

Cross-exercise

Cross-Education

Inter-limb Transfer



Contralateral Learning

Cross-Transfe

Cross-over Effect

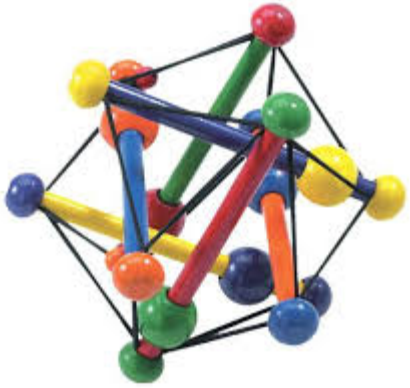
Turbulence

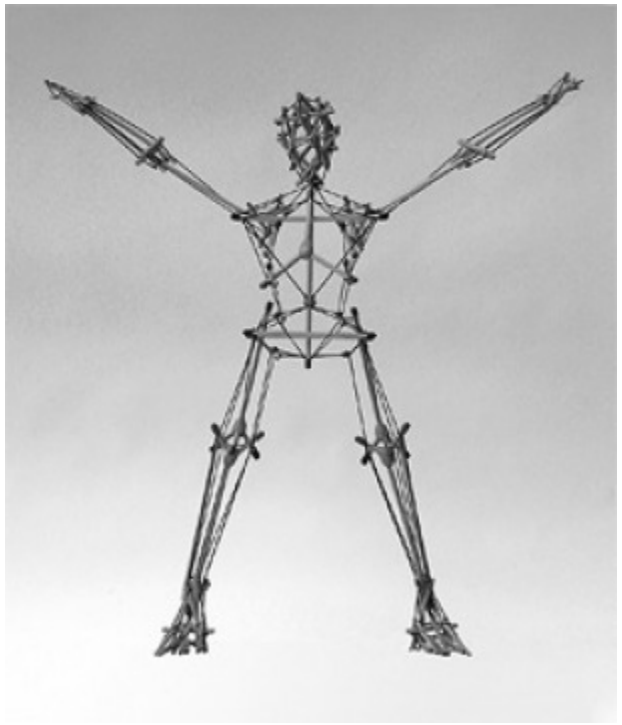
Rough Air

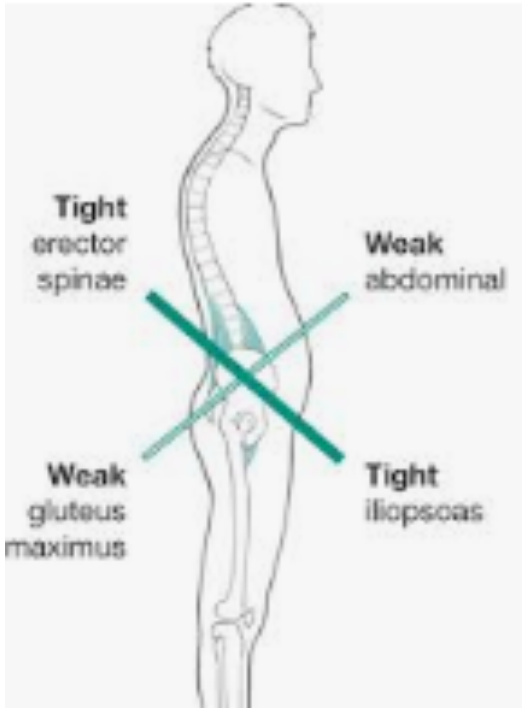
THEORIES

BIOMECHANICAL: Connections and Compensations

- Biomechanical tensegrity/bio tensegrity (Page, Frank, & Lardner, 2010; Levin & Martin, 2012; Ingber, 2008)
- Fascial lines – postural and/or functional (Myers, 2009)

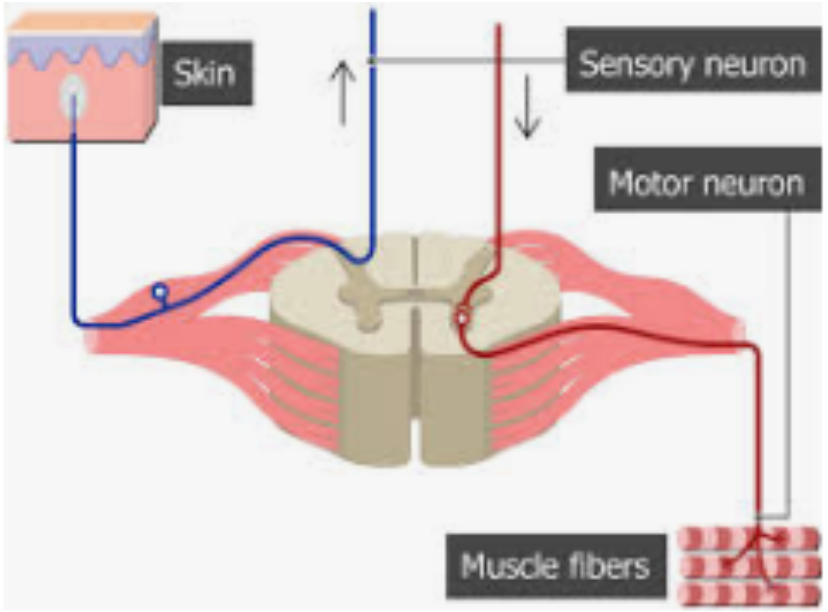






NEUROPHYSIOLOGICAL: Neural Mechanisms

- Joint receptors, muscle spindle, and GTO
  (Burgess, Wei, Clark, & Simon, 1982)
- Contralateral muscle activation proportional to strength of contraction
  (Sherrington, 1905)



Supraspinal Mechanisms: Brainstem and Above

- Ideomotor theory/ Anticipation

  (Massen & Prinz, 2009)
- Motor Irradiation

  (Abreu, Lopes, Sousa, Pereira, & Castro, 2015)
- Neural coupling

  (Balter & Zehr, 2007)

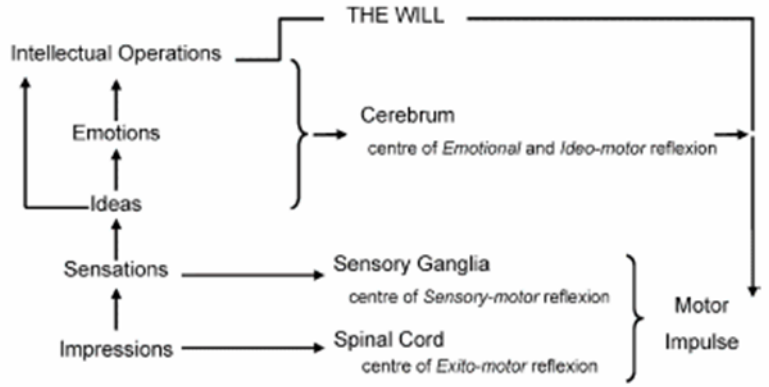


Fig. 1 Internal processing of external impressions according to Carpenter (1852, 1874)

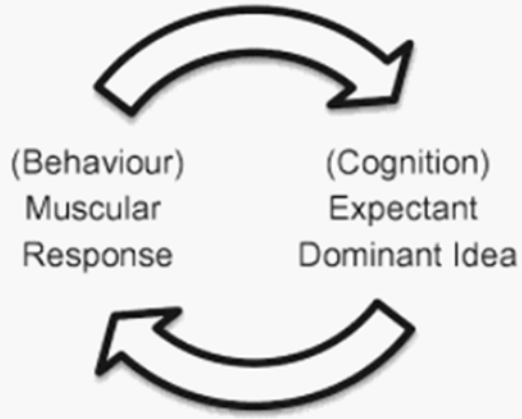


Figure 2. Braid's model of reciprocal cognitive-behavioural (ideo-motor) interaction.

Research on Theories

- Biomechanical
  - Tensegrity
  - Fascial Lines
- Neurophysiology
  - Reciprocal Innervation
  - Neuromuscular Control
- Supraspinal Mechanisms
  - Ideomotor Phenomenon
  - Motor Irradiation
  - Neural Coupling

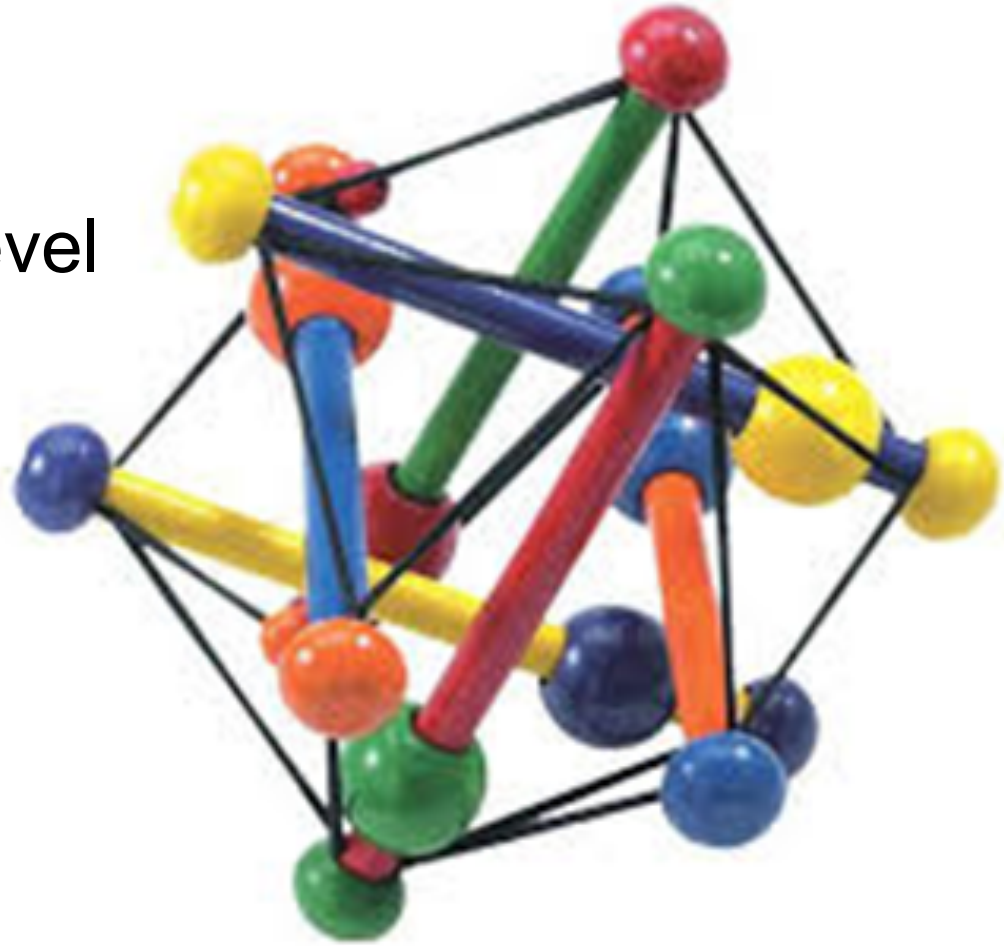
TENSEGRITY

FASCIAL LINES

Tensegrity and Mechanotransduction

Donald E. Ingber

- Tension dependent building model
- Mechanical forces at the cellular level



- Review of Cadaver studies
- Physical evidence
- Fascia/ fascia sheath connecting body

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2016;97:454-61

REVIEW ARTICLE

What Is Evidence-Based About Myofascial Chains: A Systematic Review

Jan Wilke, MA, Frieder Krause, MA, Lutz Vogt, PhD, Winfried Banzer, PhD, MD

Journal of Experimental Biology

Rats do not appear to have force changes

No functionally relevant mechanical effects of epimuscular myofascial connections between rat ankle plantar flexors

Chris Tijs, Jaap H. van Dieën, Huub Maas

Humans do appear to have force changes with hip movement

ELSEVIER

Journal of Biomechanics

Volume 63, 3 October 2017, Pages 55-60

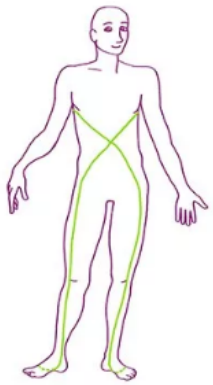
Myofascial force transmission in the lower limb: An in vivo experiment

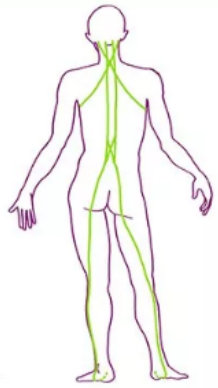
- Patients with
- Increased co

Scapular Motion and the Kinetic Chain. Alterations in scapular movement have been reported in overhead athletes with shoulder pain[74,107–109] and found to predict the development of shoulder pain in handball players.[74] It is not clear if these alterations are a causal or a compensatory impairment. Assessment for scapular dyskinesis of dysrhythmia and winging can be performed visually[109,110] but should be combined with symptom-alteration tests to determine if deficits of scapular motion and control contribute to shoulder pain. Specifically, the scapular retraction or reposition test[111,112] and the scapular assist test[113] can be conducted; if symptoms are altered, then muscle-performance and -length tests should be carried out to determine their contribution to shoulder symptoms. Motor control and performance along with stretching focused on related impairments to the scapula may be warranted. Assessments of lower extremity strength and core stability during lower extremity balance tasks such as the single-legged squat, single-legged balance, and Y-balance test suggested that alterations in the kinetic chain were associated with shoulder and elbow injuries in the throwing athlete.[114–116] These assessments may help to direct treatment at deficits in core stability and lower extremity strength and flexibility to improve shoulder performance.

FUNCTIONAL LINES

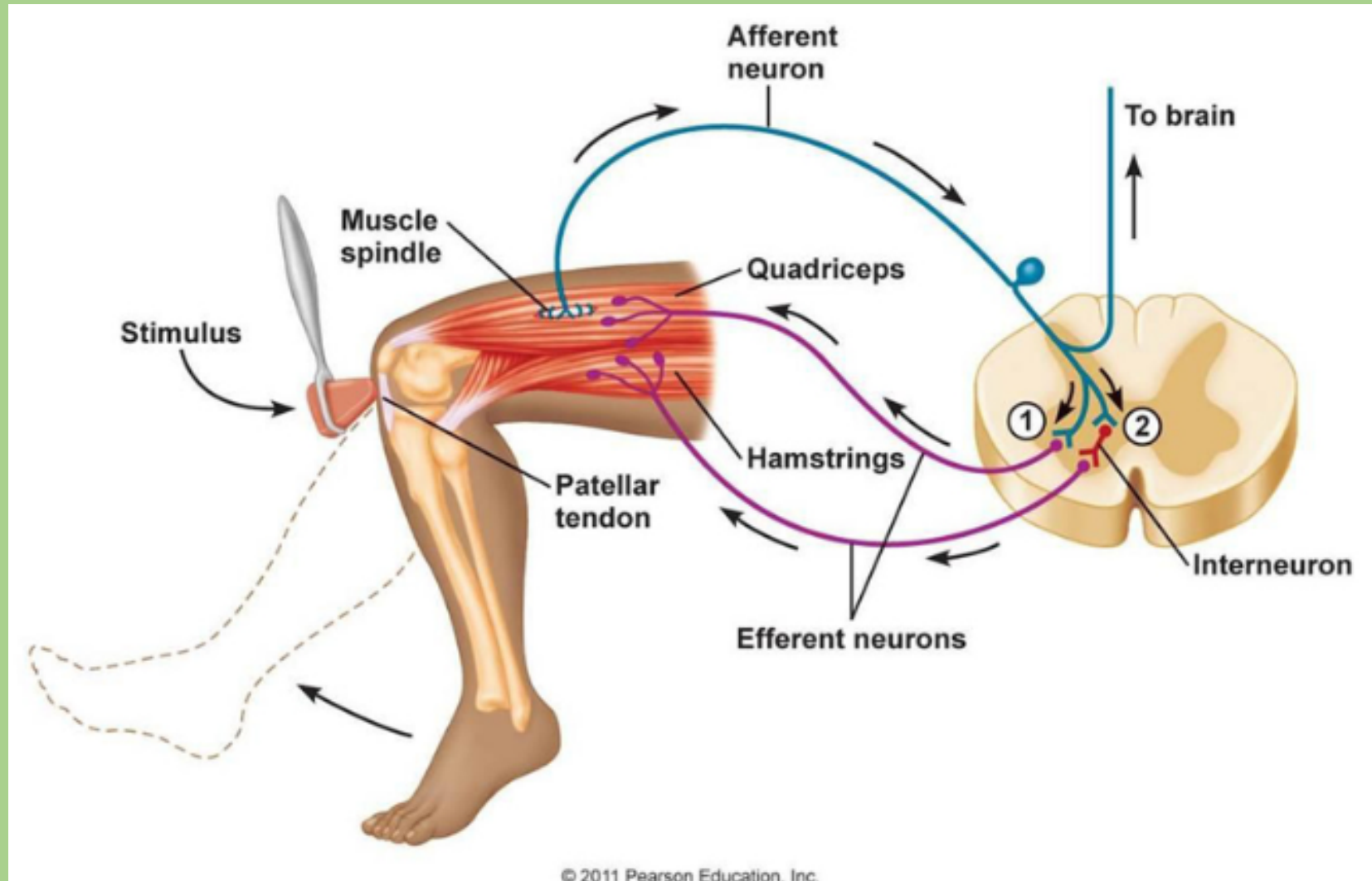
SPIRAL LINE





Research Neurophysiological

- Reciprocal Innervation
- Neuromuscular Control



Sherrington: “The Father of Neurophysiology”

- Reciprocal Innervation
- Nobel Peace Prize in 1932

Discover a lot about Neurophysiology

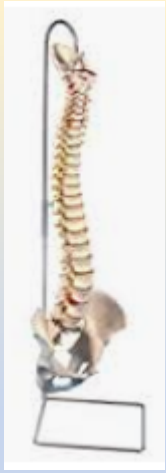
HILTON’s LAW

- Nerves innervate muscles surrounding a joint
- The skin superficial to the muscle
- Also innervate the inner joint

Research

- Ideomotor Phenomenon
- Motor Irradiation
- Neural Coupling

s u p r a

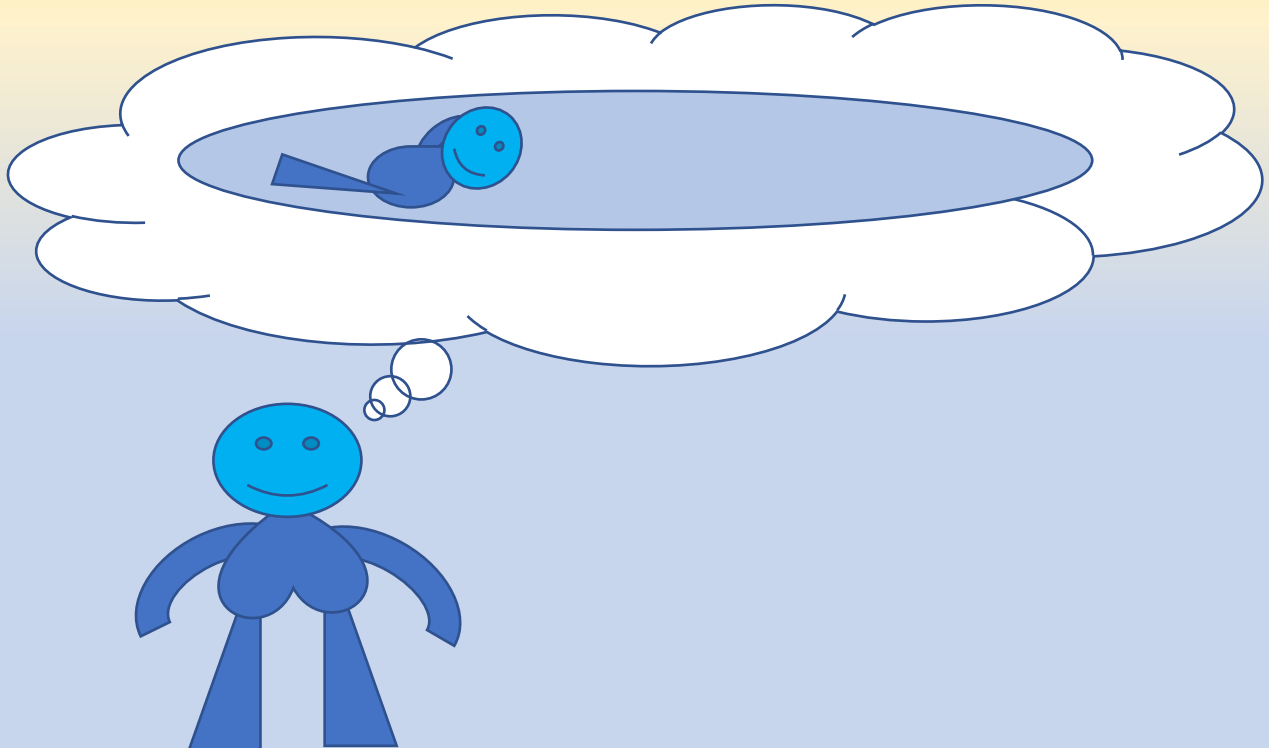


Mechanisms

Ideomotor Phenomenon (Massen & Prinz 2009)

- Perception of the action guides the planning for that motion

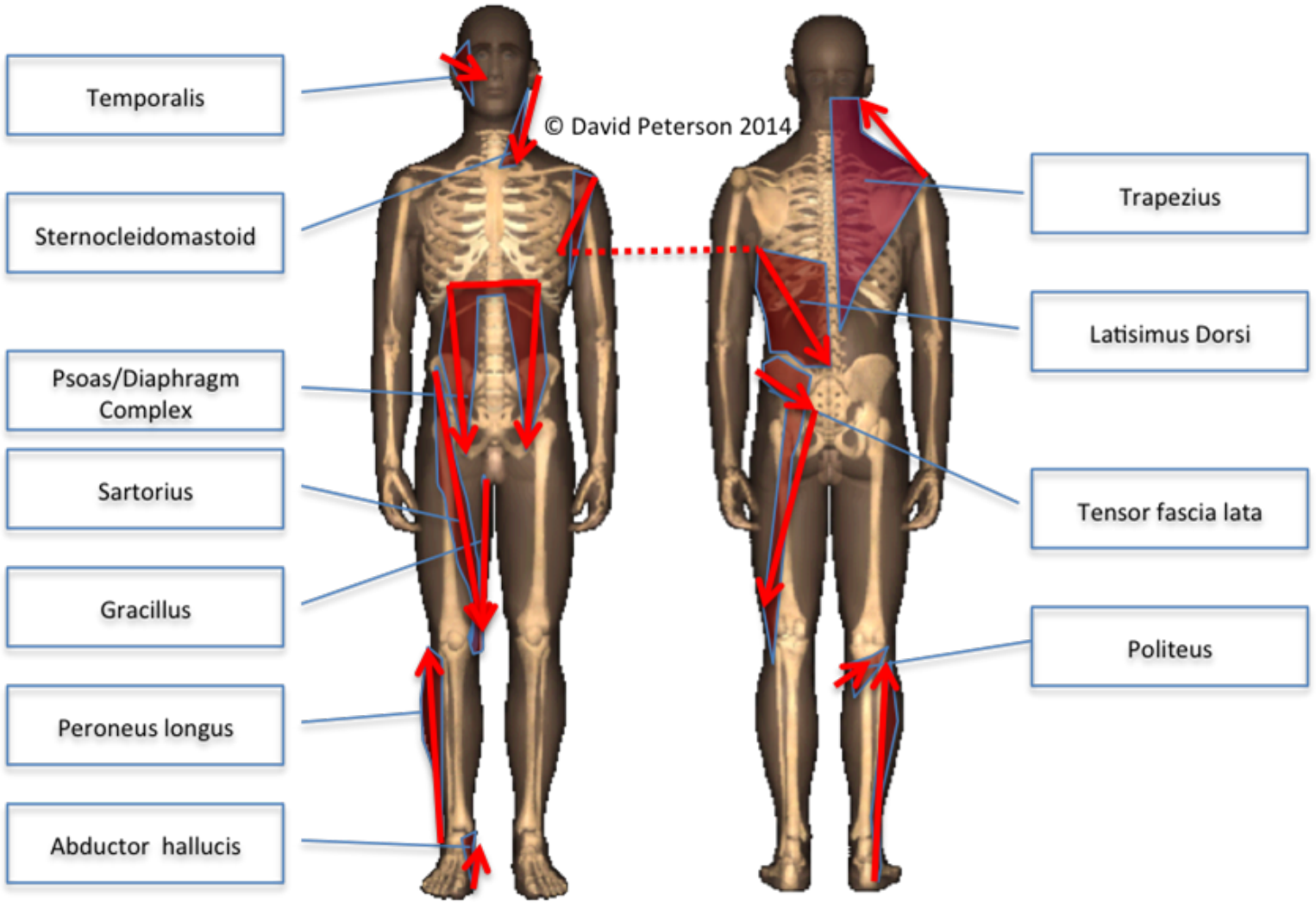
- Consequences for your action as shown on MRI



Motor Irradiation (Sherrington 1907)

- Motor response that spreads through the body after contraction
- Contralateral effects from adaptive neural circuits
- Frontal Cortex and Temporal Lobe

Motor Irradiation



Neural Coupling

- Storytelling
- Rhythmic Pattern of Activities (Balter & Zehr 2007)
- Bimanual Hand Movements (Garbarini & Pia 2013)

- Strength
  - Type of Contractions
  - Neural Adaptations
- Pain
  - Hypoalgesia effects
  - Pain Behaviors
- Function
  - Prevention
  - Flexibility
  - Return to activity

CONTRALATERAL EXERCISE

Strength

- Contralateral strength gains from unilateral resistance training
  (Munn, Herbert, Gandevia, 2004)

- Neural Adaptations of strength training
  (Zhou, 2000)

- Isometric contractions

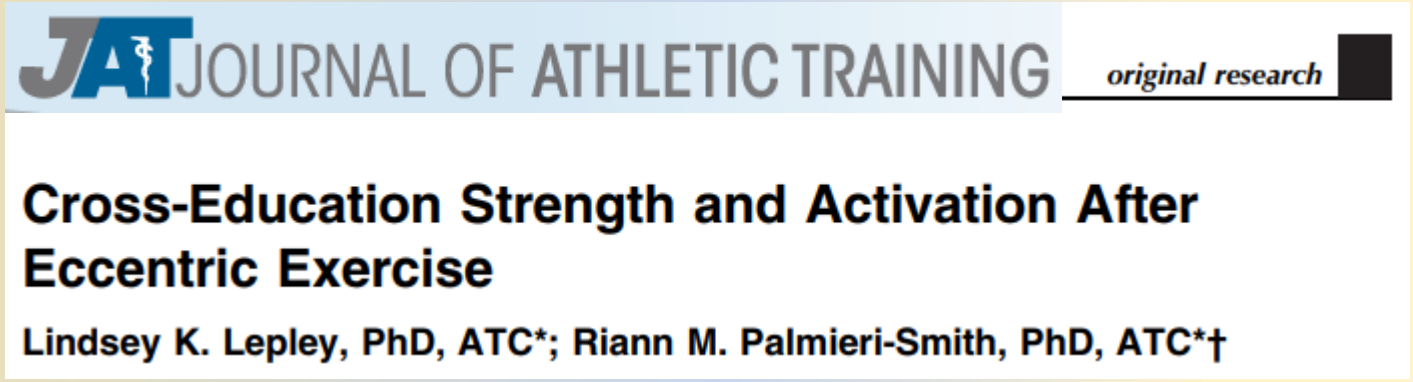
Electromyographic Activity Recorded from an Unexercised Muscle During Maximal Isometric Exercise of the Contralateral Agonists and Antagonists

KATHLEEN L. DEVINE, MS,
BARNEY F. LeVEAU, PhD,
and H. JOHN YACK, BS

- Muscle activation in Contralateral limb

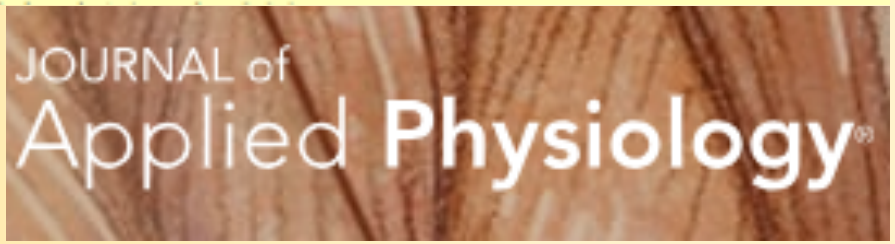
- Counter rotational force

- Healthy Subjects completed Eccentric Exercise
- 4 sets of 10 reps at 60°/s
- Increased muscle activation
- Neural Activity



Training with unilateral resistance exercise increases contralateral strength

Joanne Munn, Robert D. Herbert, Mark J. Hancock and Simon C. Gandevia



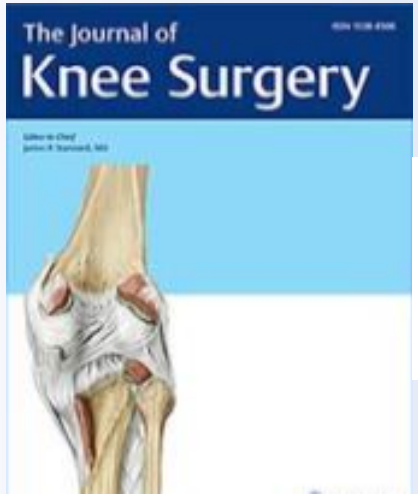
- 115 Subjects with control group
- Differences in speed of sets
- 7% increase in strength after 3 sets fast
- Unexercised elbow flexors

European Journal of Applied Physiology

Cross-education does not accelerate the rehabilitation of neuromuscular functions after ACL reconstruction: a randomized controlled clinical trial

- Added Contralateral Exercise
- Post-surgery 26 weeks outcomes
- No significant change in strength percentage

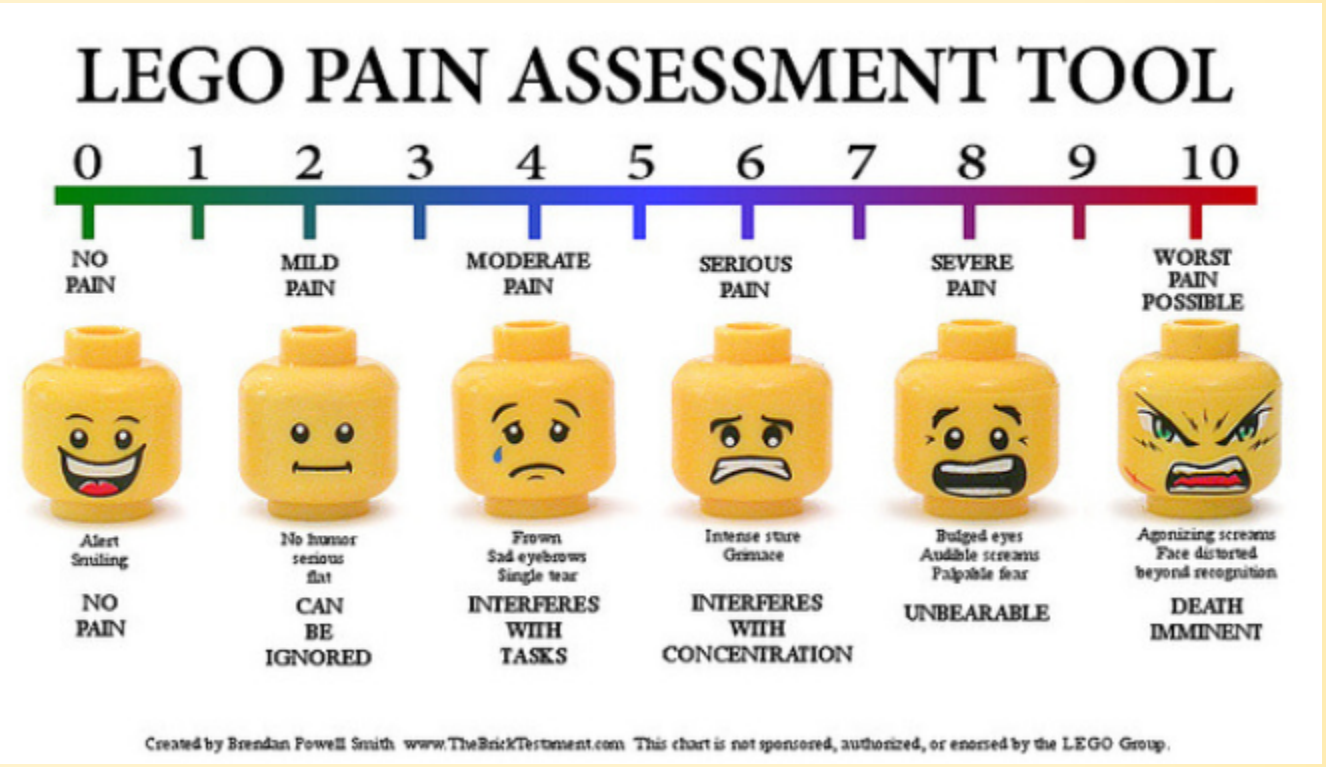
- Post-Surgery 9-weeks
- Quad strength deficit
- Absolute strength changes



Cross-Exercise on Quadriceps Deficit after ACL Reconstruction

Maria Papandreou, Evdokia Billis, George Papathanasiou, Panagiotis Spyropoulos, Nikos Papaioannou

Pain



Athletic tape removal chamber.

- 2 minute grip hold
- Pain pressure threshold decreased
- Hypoalgesic effects of isometric exercise

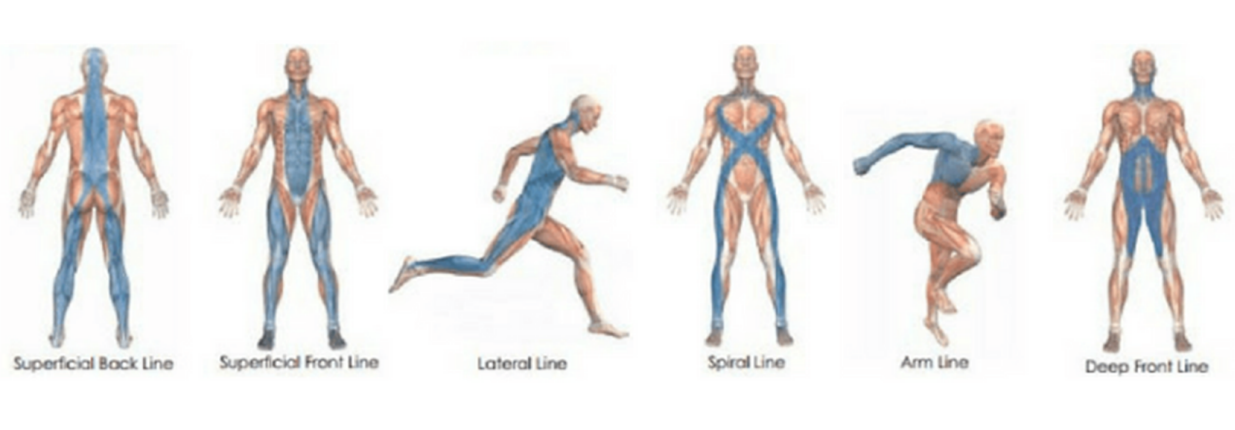
Original report

Contralateral Attenuation of Pain After Short-Duration Submaximal Isometric Exercise

Kelli F. Koltyn, Masataka Umeda

- Electrical stimulation to deltoid
- Pain thresholds lower leg
- Descending endogenous-opiate theory

- High Intensity Eccentric Exercise
- Decreased activation and work capacity in contralateral limb
- Immediate, 24h, and 48h effects



- Case Study
- Female Cheerleader diagnosed with “Frozen Shoulder”
- Numeric Rating of Pain Scale 10 to 0 over 5 weeks
- Contralateral Exercise, Breathing, and Electrical Stimulation

FUNction

- Unilateral static and dynamic hamstrings stretching

- Increased contralateral hip flexion range of motion
  - 5.7% with static stretch
  - 8.4% with dynamic stretch

Unilateral static and dynamic hamstrings stretching increases contralateral hip flexion range of motion

Anis Chaouachi[1], Johnny Padulo[1], Sofien Kasmi[1], Aymen Ben Othmen[1], Moktar Chatra[1] and David G. Behm[2]

- Increased contralateral muscle fatigue
- Four separate bouts of unilateral cycling
- Central Nervous System Recruitment and Decruitment

Physiological Reports ISSN 2051-817X

ORIGINAL RESEARCH

Unilateral fatiguing exercise and its effect on ipsilateral and contralateral resting mechanomyographic mean frequency between aerobic populations

Nathan P. Wages[1], Travis W. Beck[1], Xin Ye[2] & Joshua C. Carr[1]

- Contralateral warmup in baseball players
  - 5 TMR
  - 5 TWG

- Improved IR and ER ROM (Gamma et. al. 2014)
  - 19.2° ± 10.78°
  - 13.6° ± 5.98°

IJSPT INTERNATIONAL JOURNAL OF SPORTS PHYSICAL THERAPY

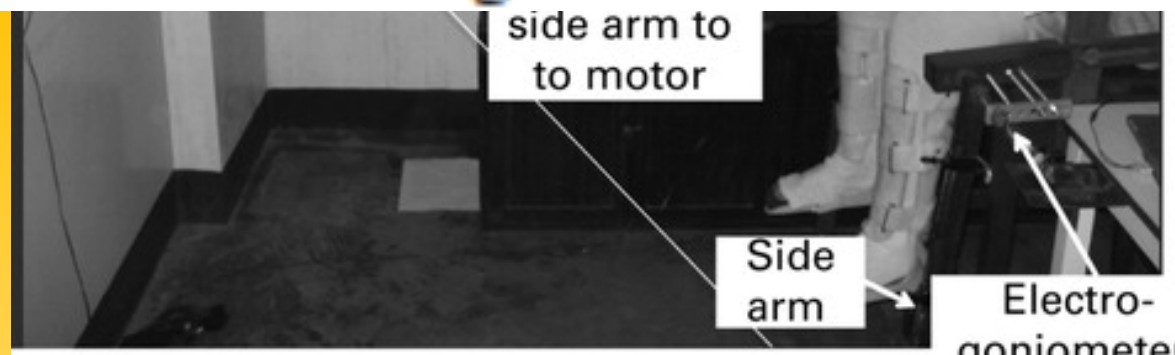
Joint Receptors

- Proprioceptive knee balance improved balance in contralateral leg
  - (El-Gohary et al. 2016)
- Thermal hypoesthesia decreases sensation on contralateral side (Enax-Krumova Enax et al. 2017)

Contralateral Changes Post-ACL Reconstruction

- Deficit in joint angle proprioception in contralateral knee

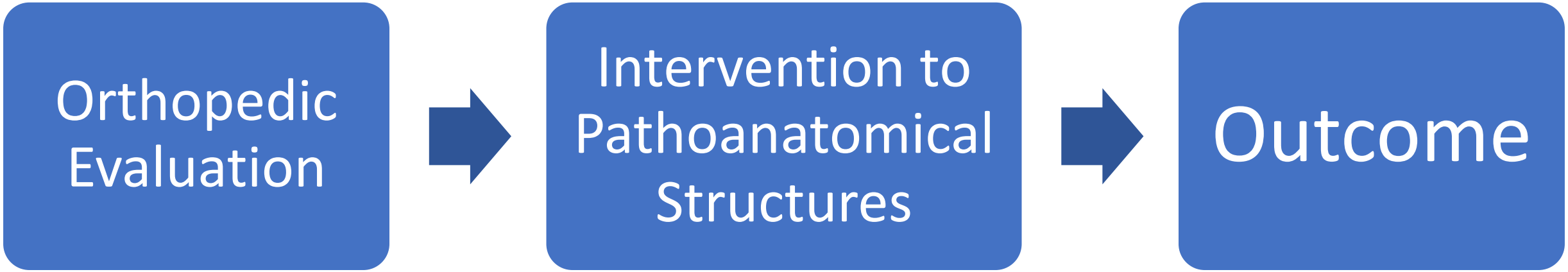
17. Because a history of ACL injury is one of the strongest predictors of future ACL injury, individuals with such a history, especially younger individuals who return to sport-related activities, should be targeted for injury-prevention training.[22,99,101–106] *SOR: A*

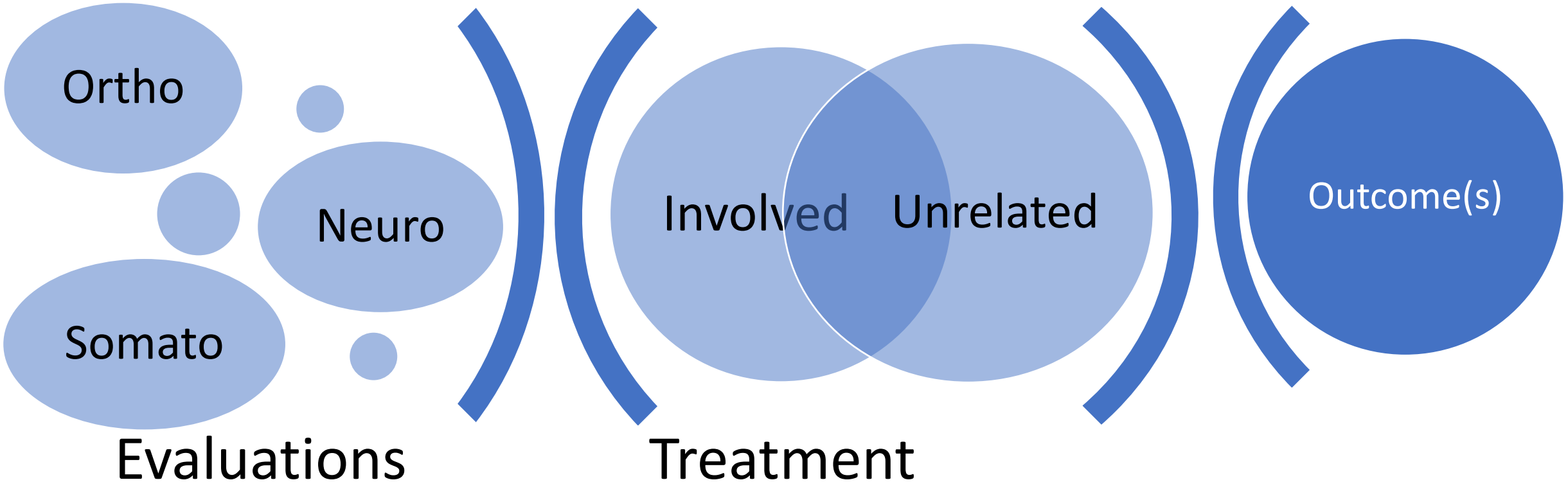


Practical Application

- Evidence to incorporate contralateral exercise
- Pain, Strength deficits, and decreased ROM
- Kinetic Chain to More Global View

Practical Progression

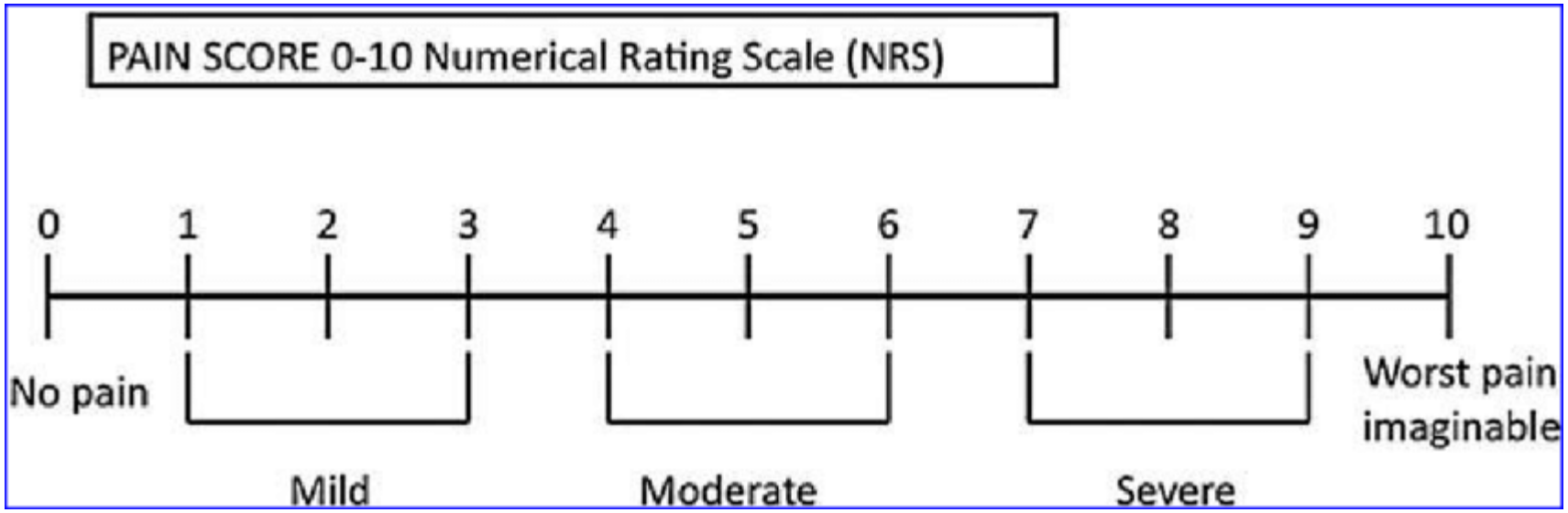

Orthopedic Evaluation
Intervention to Pathoanatomical Structures
Outcome


Ortho
Neuro
Somato
Involved
Unrelated
Outcome(s)
Evaluations
Treatment

Patient Outcomes

Electronic Patient-Reported Outcome Validation: Disablement in the Physically Active Scale

Diane Stankevitz, DAT, ATC, CSCS*; Lindsay Larkins, DAT, ATC, CSCS†; Russell T. Baker, PhD, DAT, ATC, CMP†



Patient-specific activity scoring scheme (Point to one number):

0 1 2 3 4 5 6 7 8 9 10

Unable to perform activity

Able to perform activity at the same level as before injury or problem

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