

Sensory Systems & Somatosensory Training

AWC Episode 16

Christian Thompson, Ph.D.



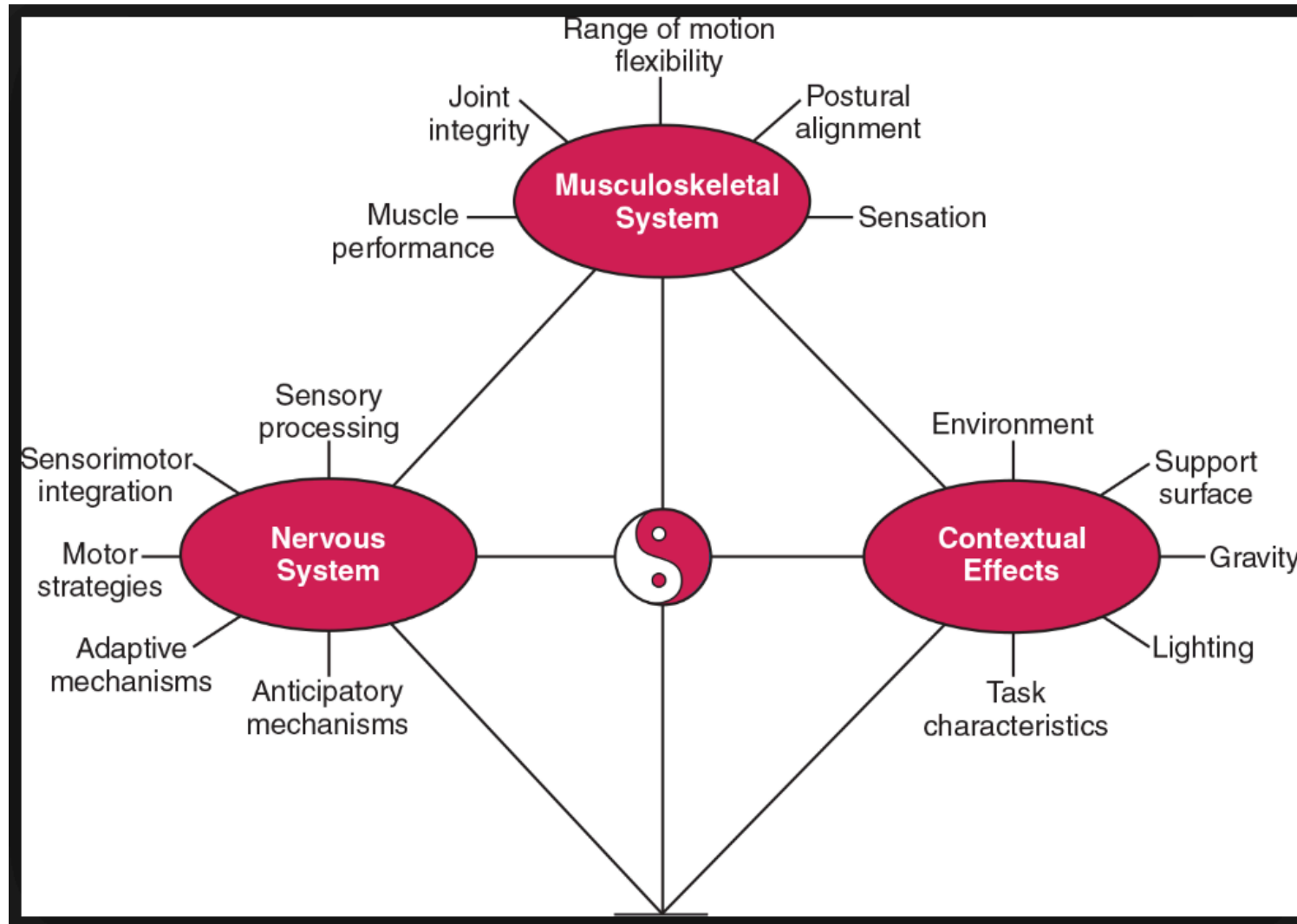
Objectives

- Identify the neural structures and pathways involved with sensorimotor integration
- Describe the various sensory receptors in the skin, joints, and muscle and how they affect balance, coordination, and overall function
- Understand the age-related changes in somatosensory function
- Describe the elements of an exercise training program for enhancing somatosensory function and its relationship to other training elements
- Employ progression and regression strategies to modify exercises for clients of differing levels of function

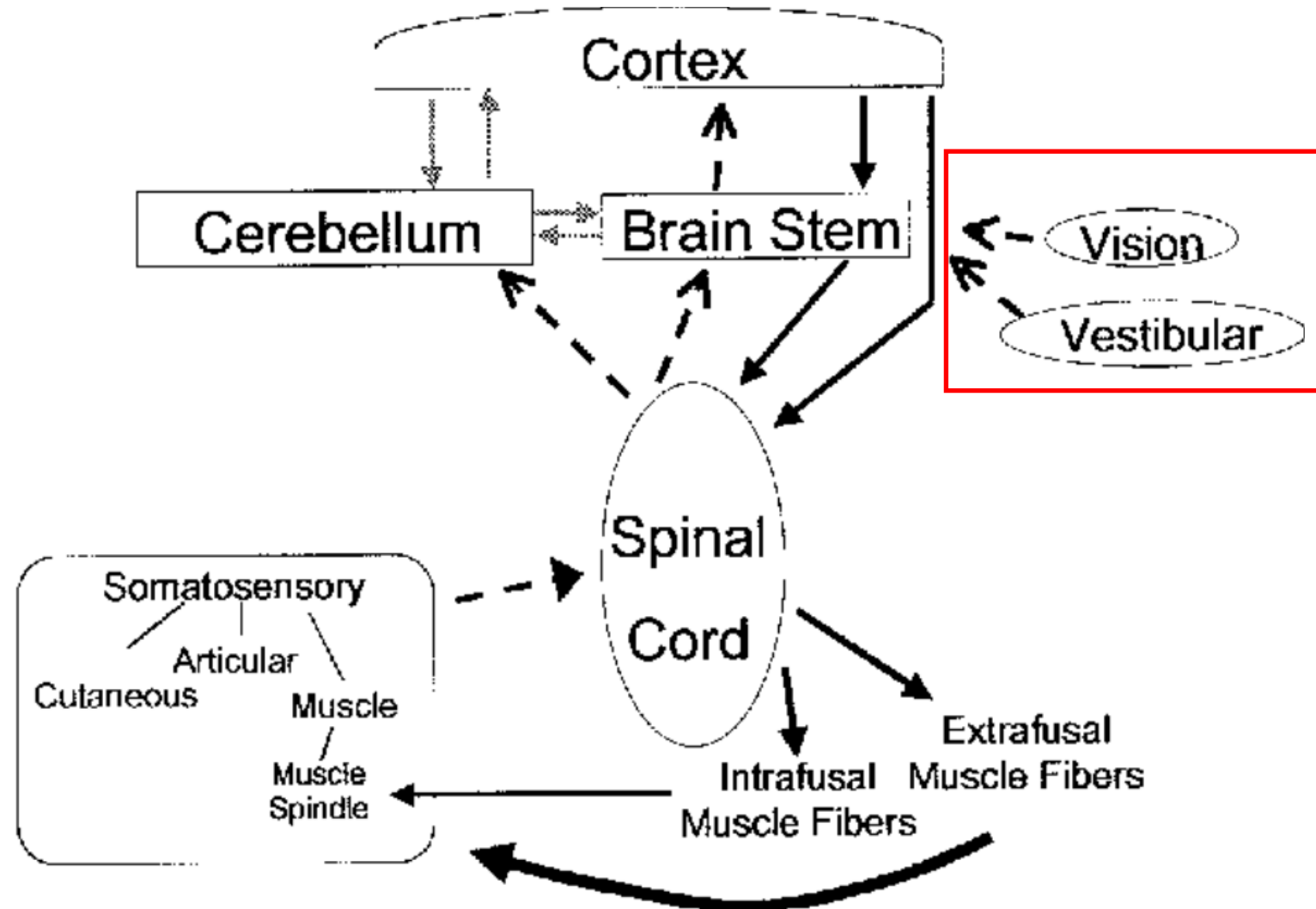
Exploring Somatosensory Function and It's Impact on Balance



Balance: A Complex Phenomenon



The Somatosensory System – The Very Definition of Sensorimotor Integration!!



Difference Between Mechanoreceptors and Proprioceptors

- Mechanoreceptor: Detects external stimuli affecting the body
- Proprioceptor: Monitors internal condition/position
- Somatosensory system function dependent on BOTH MR and PR function

Somatosensory Receptors

PAIN

Location

TOUCH

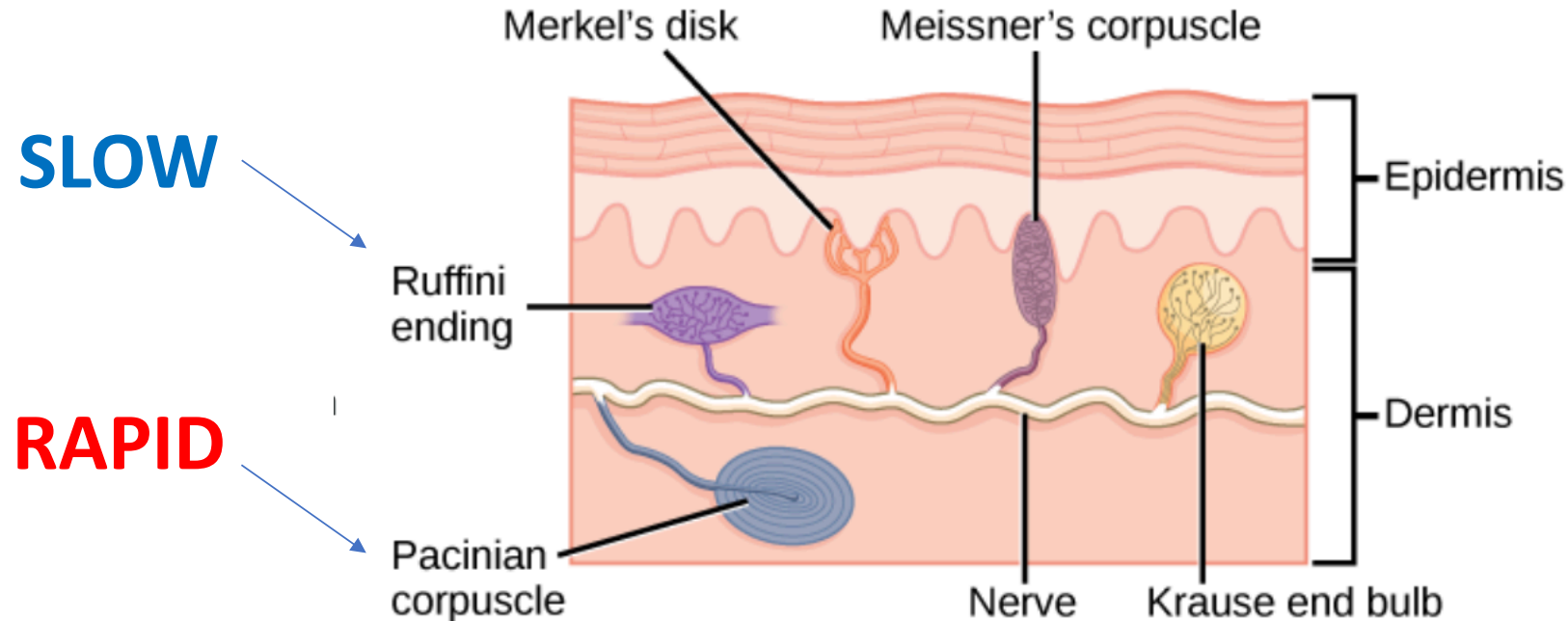
Intensity

THERMAL

Duration

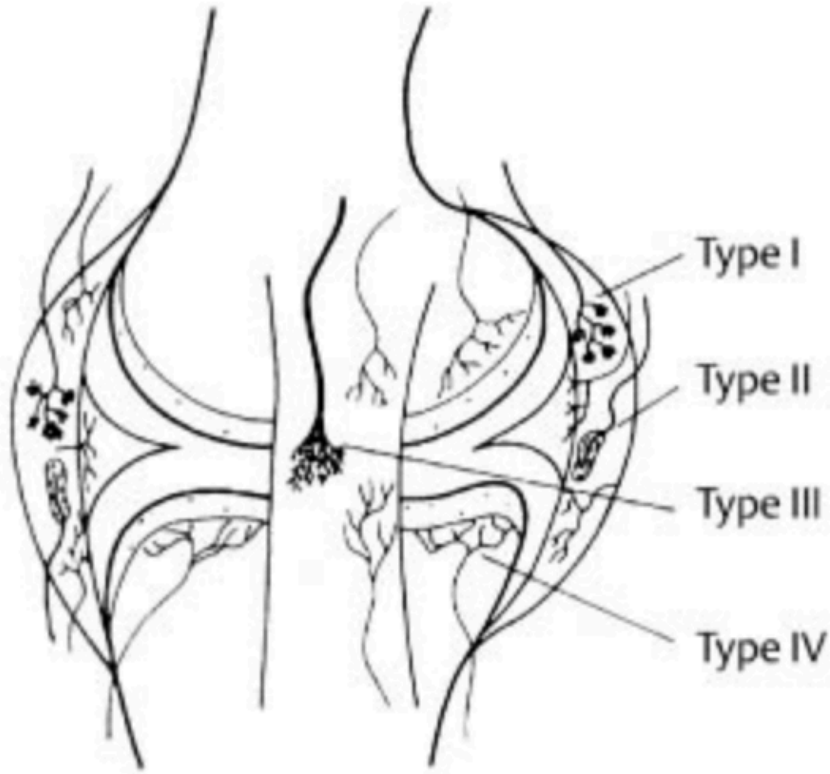
CHEMICAL

Skin Mechanoreceptors



- Sensitive to touch, pressure, movement speed, tension and stretch

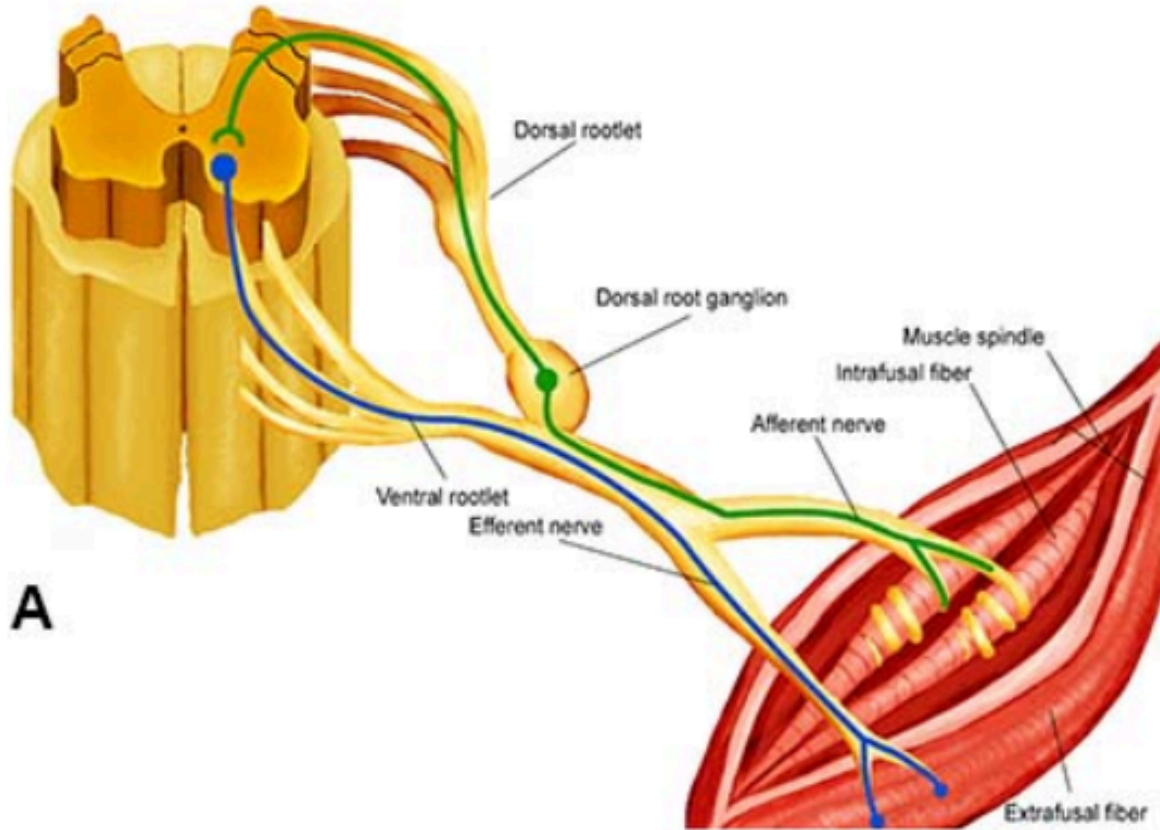
Articular Mechanoreceptors



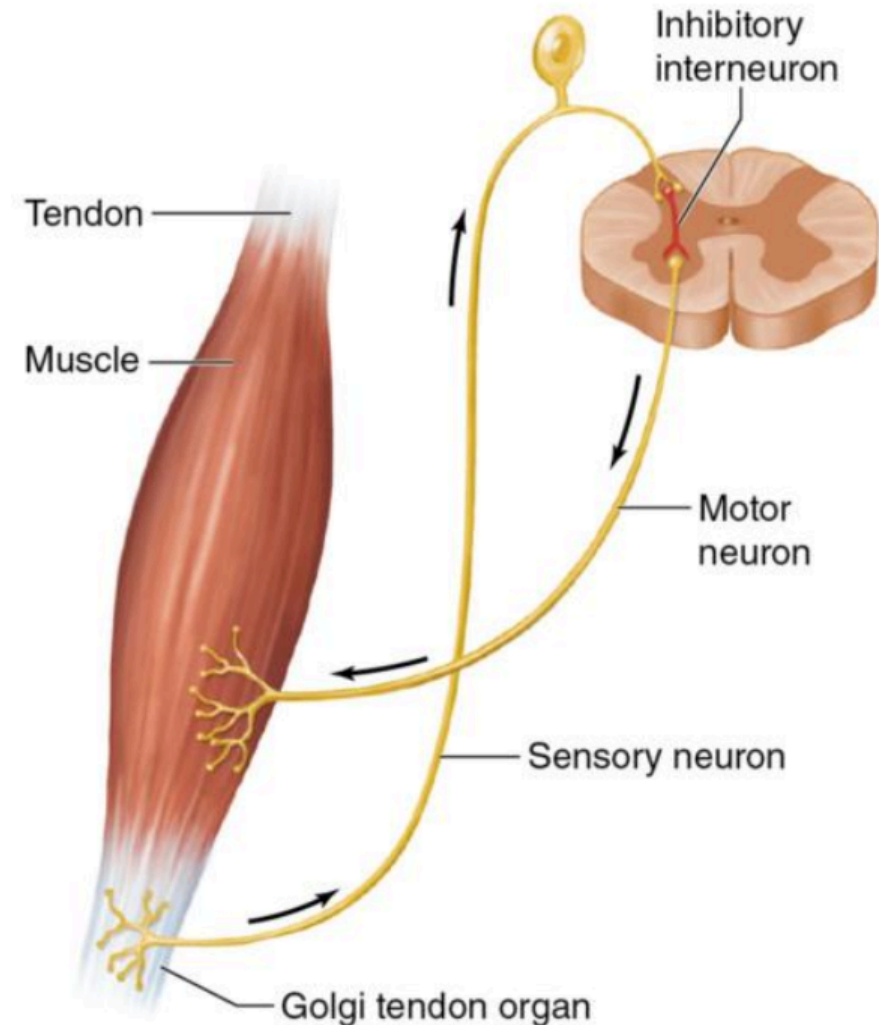
- Type I: Capsule, Joint Position & Joint Motion
 - Type II: Capsule (deep), Onset of Joint Motion
 - Type III: Ligaments, End-Range of Motion
 - Type IV: Deep Joint & Bone, Pain Sensation
- Detects initiation, cessation, duration and speed of movement

Muscle & Tendon Proprioceptors

Brain/Spinal Cord Modulation



- Sensitive to tension and stretch

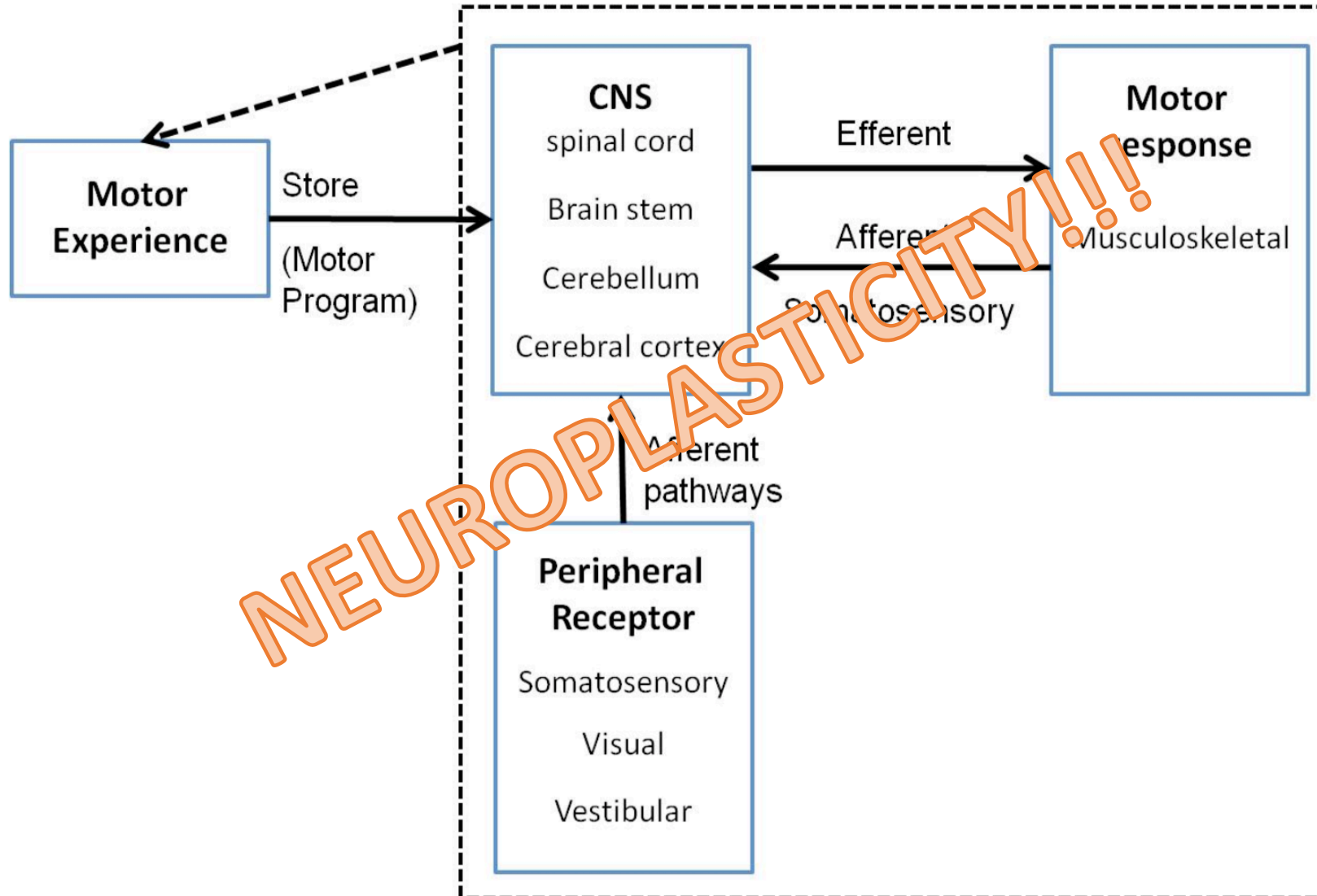


Age-Related (maybe...) Physiological Changes to SS System

- CNS and PNS changes
 - Loss of sensitivity (more stimulation needed to signal motor response)
 - Reduced nerve transduction speed
- Stiffness of muscle, connective tissue & joint structures
- Potential disease processes – Neuropathy, Cognitive Impairment
- Previous musculoskeletal injury

Mechanism of Adaptation

Clinical Kinesiology, Kim, Van Rysseghem, Hong, 2011



Developing an Effective Somatosensory Exercise Program

Most Importantly: Meet Them Where They're At!!!

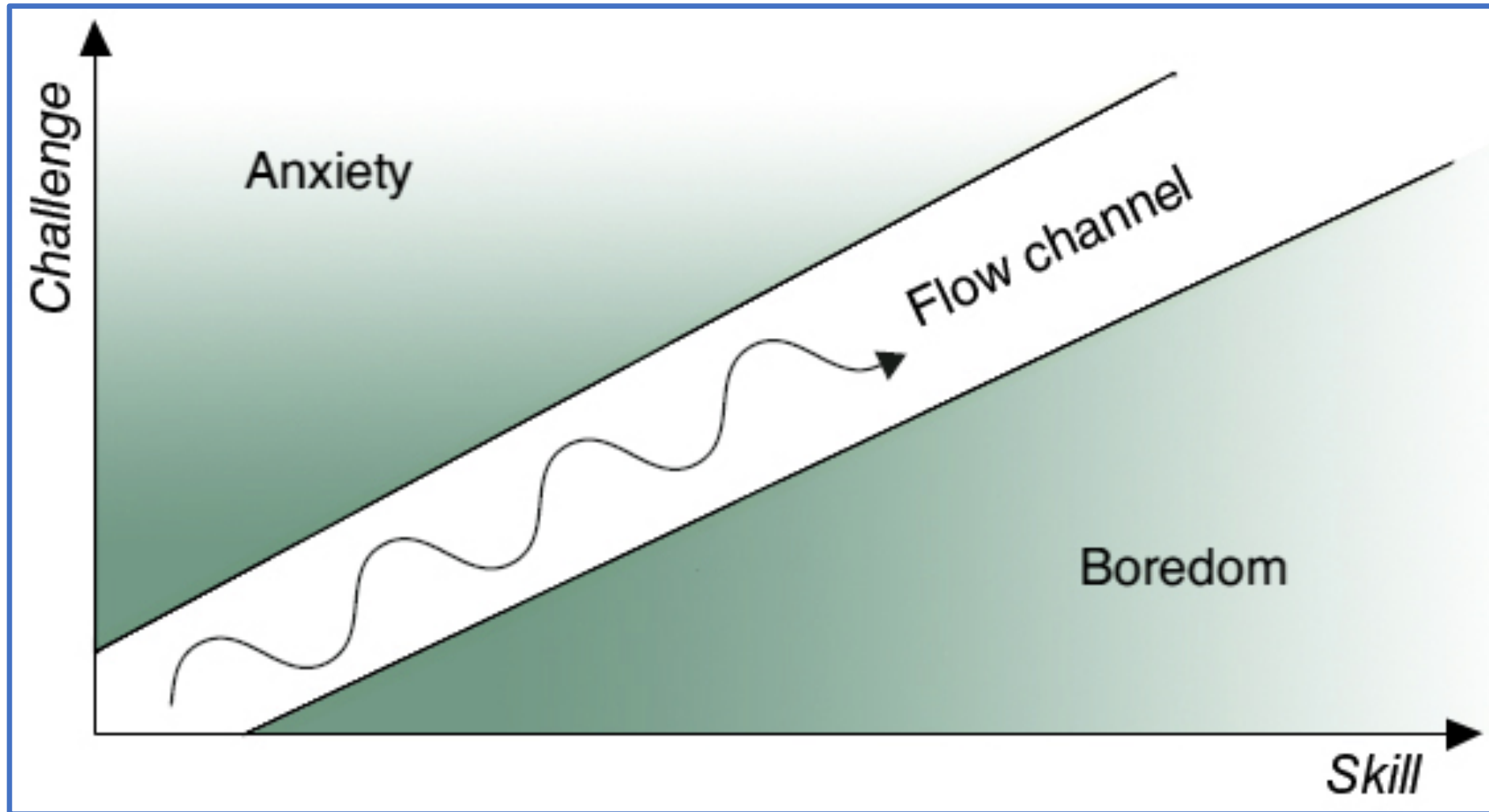


Fall Prevention Always Active Classes in San Francisco

Research Results Presented at ACSM 2010, ACSM 2011

Translational Journal of ACSM, February 2019

Optimal Adaption: The Flow Channel



Joint Mobility Exercises

- The ANKLE & HIP are KEY!
 - Strategies used to recover balance during standing & movement
 - Menz (2005) found reduced proprioceptive input from inflexible joint structures with aging
- Include both ISOLATED OPEN CHAIN EXERCISES (neural drive) and INTEGRATED CLOSED CHAIN EXERCISES (gravity)
 - Develops BOTH mobility and stability (MOSTABILITY)
 - OC: Ankle Circles, Hip Steps
 - CC: Rotating Punches, Reach Backs



Joint Mobility



Joint Mobility

Sensory Stimulation Exercises

- Our Falls Defense Mechanisms CAN IMPROVE!
 - Ricci (2010) & Hansson (2007) reviews found that vestibular training reduces falls risk & improves static/dynamic balance
 - Rose (2010) recommends visual tracking exercises
 - Although each system deteriorates with age, we can train them to help each other out and integrate better
- Include exercises that challenge 1 or 2 mechanisms at a time
 - Head Turns from Staggered Stance
 - Eye Tracking from Staggered Stance
 - Progress With Surface Stability, Ambulation, Other Tasks



Sensory Stimulation



Sensory Stimulation

Balance & Gait Exercises

- Why not just stand still on one foot??
 - Falls occur during MOVEMENT (Tinetti, 1986)
 - Proprioception is a DYNAMIC PROCESS and is most responsive to motion
 - These exercises increase balance confidence and self-efficacy
- Exercises should be CHALLENGING - 75% success rate is good target
 - Tandem Stance Forward Reach (static)
 - Step/Return Patterns (dynamic)
 - High Knee Side Stepping (gait)



Static Balance



Dynamic Balance



Gait Enhancement

Basic Progression/Regression Strategies for Somatosensory Challenges

- Joint Mobility – Seated, Standing, Single Leg, Multijoint, Sensory/Balance Challenge
- Sensory Stimulation – Stationary, Moving, Direction, Sensory/Strength Challenge
- Muscle Strength/Power – External Assistance, Loading, Body Positioning
- Static Balance – External Assistance, Displacement, Direction
- Dynamic Balance – External Assistance, Displacement, Direction, Speed
- Gait Enhancement – External Assistance, Step Complexity, Sensory/Strength Challenge

Thanks & Stay Tuned!!



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Next: Episode #17 – Sensory Neuroscience
w/ Ryan Glatt – Thursday October 15th 5:30pm PDT





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COLLECTIVE

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