



# LIMITLESS

## Balance Training and Corrective Exercises

PRESENTED BY

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## Cody Sipe, PhD

25+ years industry experience

Co-Founder, Functional Aging Institute

Over 100 presentations internationally

Over 30 published articles

2005 IDEA Program Director of the Year

2019 IDEA Fitness Innovator of the Year Finalist

Advisory Boards for Curves USA, Act!vate Brain and Body, IDEA, others

Editorial Board - Journal of Physical Activity and Aging

Associate Professor, Director of Clinical Research in the Doctoral Physical Therapy Program at Harding University

Certified Lifestyle Medicine Professional





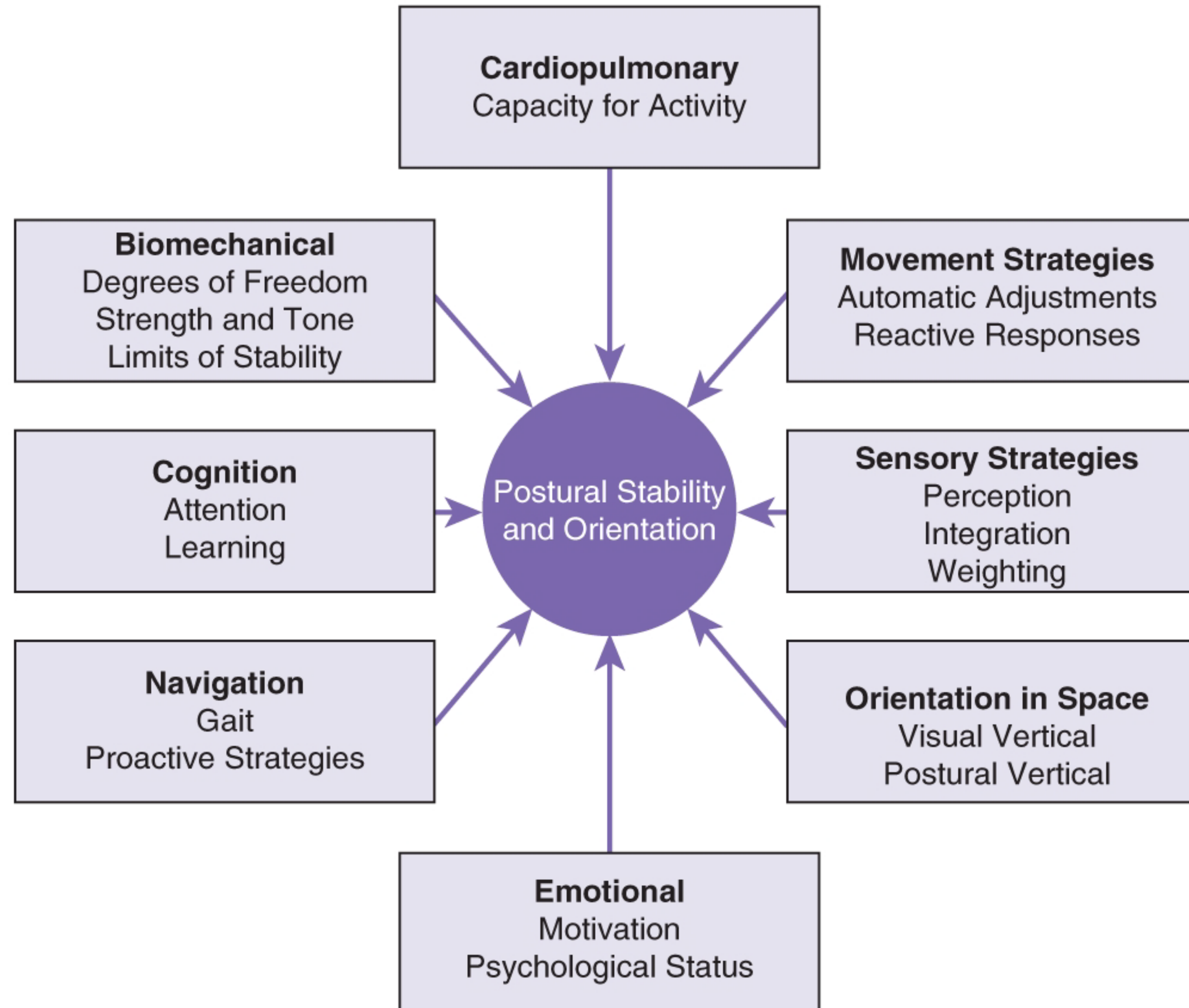








# Systems model of Postural Stability and Orientation



# Postural Stability

- Ability to maintain the COG within stability limits.
- Normal anterior/posterior sway – 12 degrees from most posterior-anterior position.
- Lateral sway 16 degrees from side to side.
- If sway exceeds boundaries, compensation is employed to regain balance.
- Often, with advancing age, a smaller envelope is created and tolerated.
- The sway envelope can get bigger with training
- Postural deviations can push the COG close to a stability limit or impair a person's ability to maintain COG

# Correctives for Postural Deviations

## **Trunk Alignment**

- Anterior stretches
- Thoracic mobility
  - Cat/Cow
  - T-rotations in quadruped
  - Open Book
  - Bretzel
  - Cobra
- Floor/wall angels
- Chin tucks

## **Trunk Stability**

- Isometric endurance
  - Plank
    - Front
    - Side
    - T-plank rotations
  - Standing chest press/row
    - Bilateral
    - Unilateral
  - Palof press

# Proactive Postural Control

- Also known as Anticipatory postural adjustments (APA)
- Postural activity when a disturbance is expected
- Requires experience/practice to develop correct expectations
- Examples: catching a weighted ball or getting hit/bumped in a sport

MOST balance exercises utilize proactive strategies – the movements are planned



# Reactive Postural Control

- Also known as Automatic postural reactions (APR)
- Occurs in response to unexpected external forces acting on the body (perturbations) displacing the COM or moving the BOS
- Examples: sitting on unstable therapy ball or standing on a moving platform or getting pushed from behind or tripping when walking
- Feedback systems provide sensory input required to initiate corrective responses
- Some muscle reactions occur very quickly (within milliseconds)

Reactive training may be the BEST strategy for improving balance in both older adults and athletes



# Reactive Postural Control on the ActiveStep Treadmill





# Postural Control Strategies

- There are 3 primary postural control strategies: ankle, hip and step
- Older adults tend to use hip strategies more than ankle strategies
- Older adults demonstrate significantly more stepping strategies compared to young adults who use more in place (hip/knee) strategies
- Unstable older adults use alternative strategies (bending knees or using arms to reach for an object)
- Injuries can also affect which postural strategy is used (for example, ankle sprains)

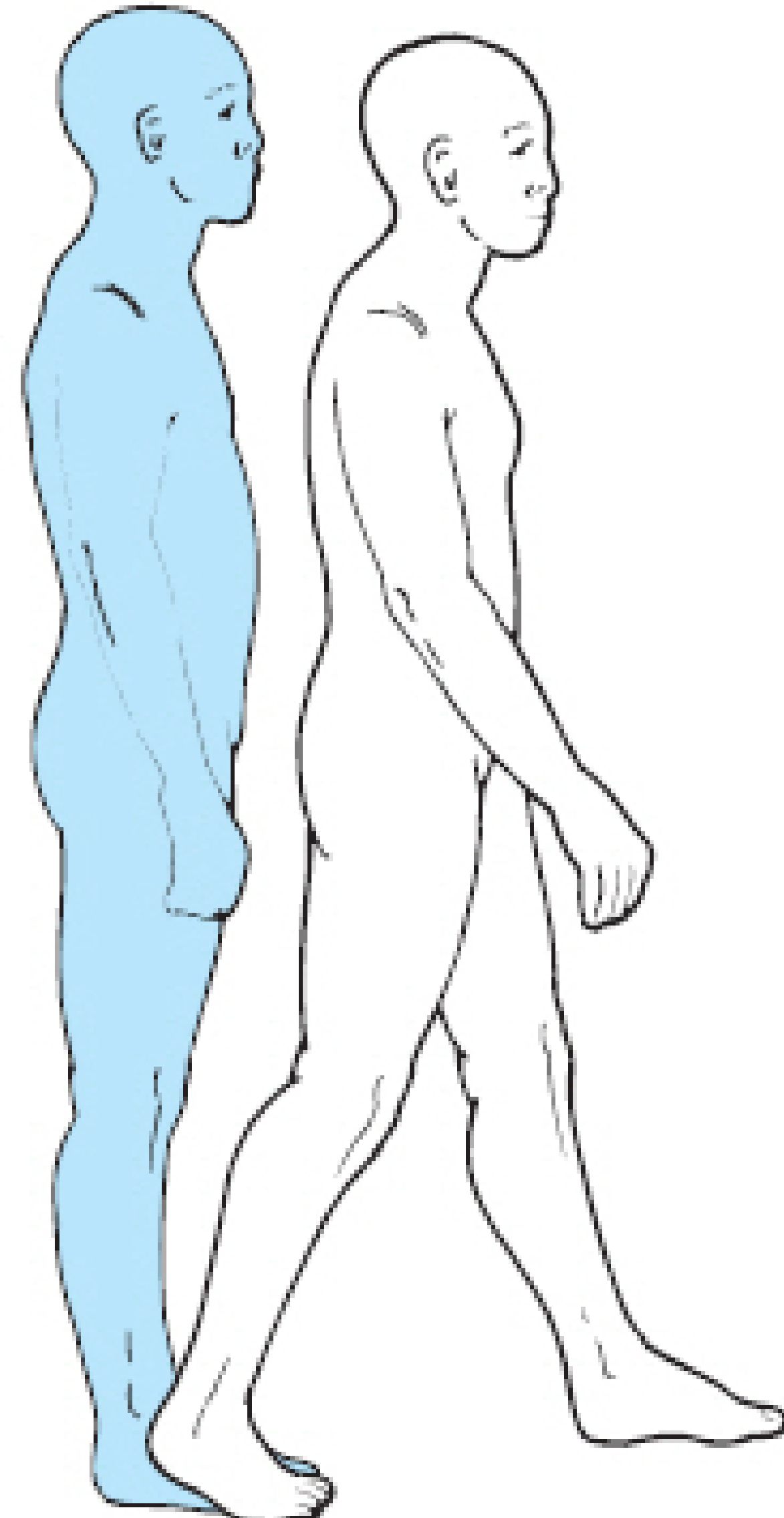




Ankle strategy



Hip strategy



Stepping strategy



# Ankle Strategy

- Used when displacements are small.
- Should be the FIRST strategy used when COG moves.
- Displaces COG by rotation about the ankle joint.
- Posterior displacement of COG (leaning back) – Dorsiflexion at ankle, contraction of anterior tibialis, quadriceps, abdominals.
- Anterior COG displacement (leaning forward) – Plantar flexion at ankle, contraction of gastrocnemius, hamstring, trunk extensors.
- Ankles need to be mobile to provide proprioceptive feedback to the CNS and to facilitate proper biomechanics



# Biomechanical Considerations

- An individual's LOS is a function of size of their base of support and impairments in biomechanical, sensory, or neural structure or function of lower extremities.
- Important constraint on balance is size and quality of their base of support – which is their feet and ankles.
- Any limitation in size, strength, range of motion, pain, or **control of the feet or ankles** will result in impaired balance
- E.g. – diabetics with neuropathy have poor balance and increased fall risk because their foot sensation and control is reduced
- E.g. – those with past serious ankle sprains may have lost ankle ROM and reduced proprioception

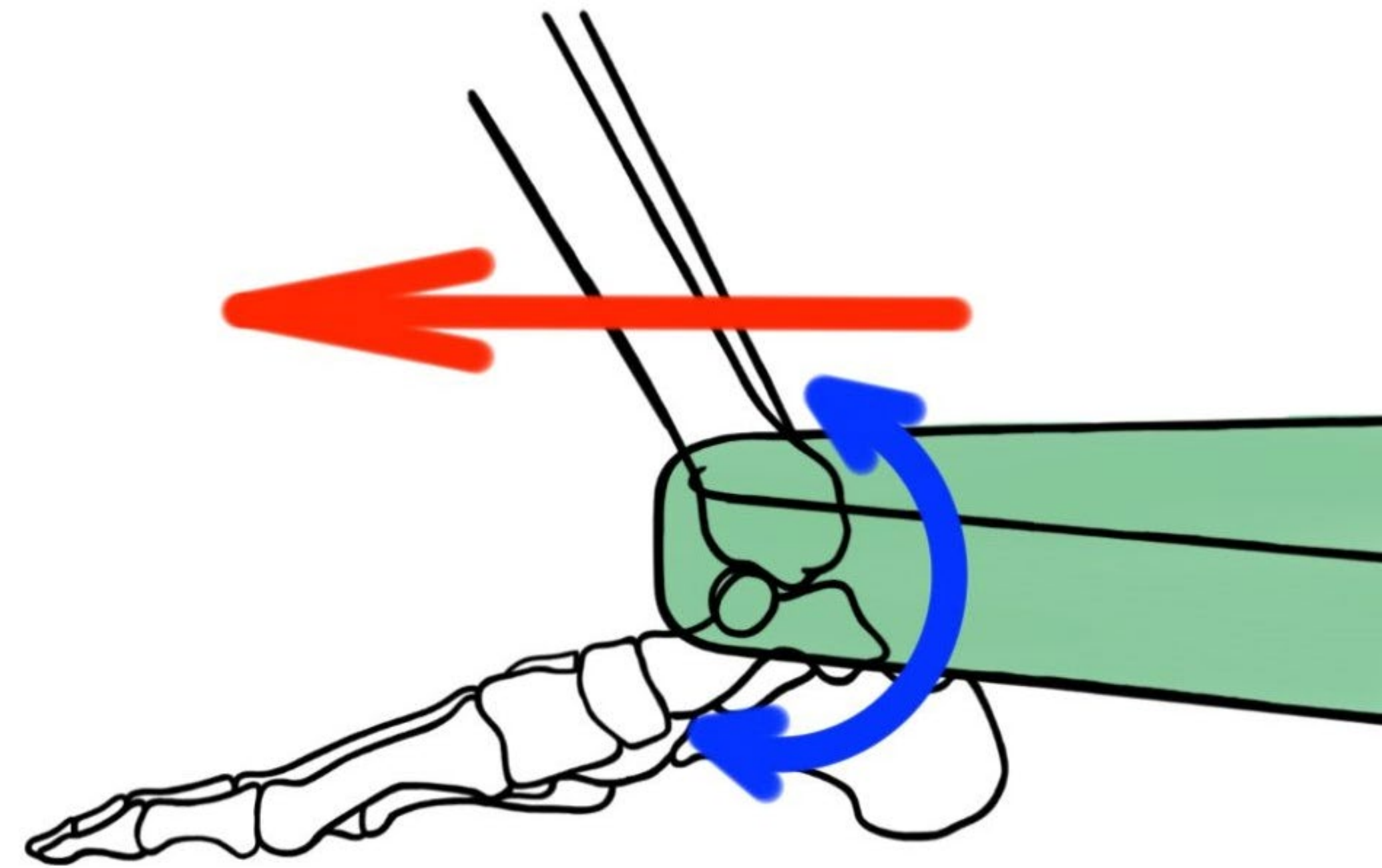
# Exercises to Improve Ankle Strategy

- Ankle leans/sways
- Ice cream cones (ankle circles in standing)
- Small perturbations (outside force)
- Calf raises/Toe raises
- Single Leg Stance
  
- Correctives
  - Ankle mobility
  - Foot control



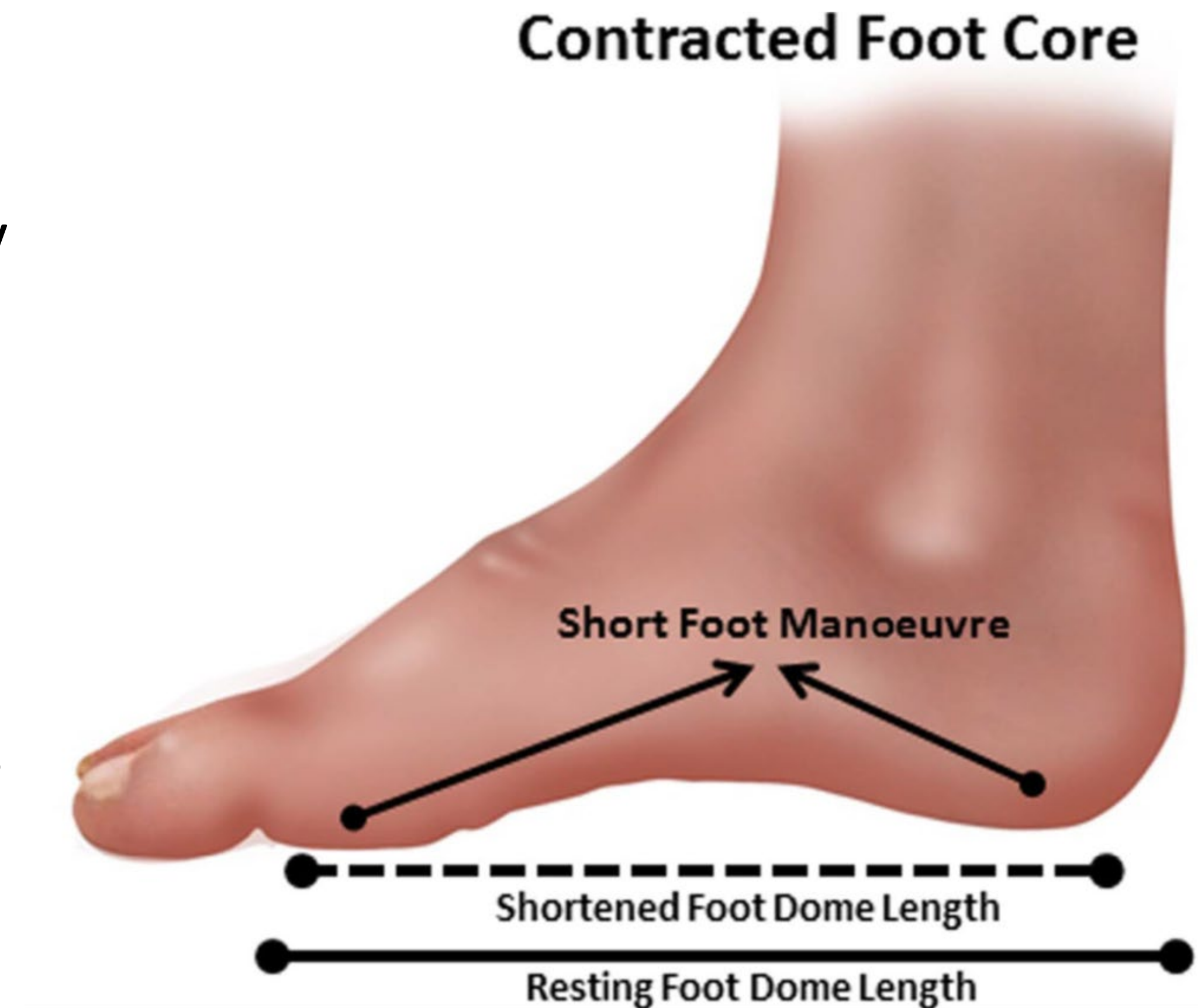
# Correctives for Limited Ankle Dorsiflexion

- Test ankle dorsiflexion
  - Poor ankle dorsiflexion is a common issue among adults
- Correctives:
  - Foam roll calves
  - Ankle pumps, circles and letters
  - Straight leg calf stretch
  - Bent leg calf stretch
    - kneeling knee to wall
    - standing knee to wall with toe on wall
  - Bent leg calf stretch with posterior resistance\*
  - Lateral tibial glide (foot on box; stabilize foot; knee goes forward and out)
  - Squat to heels with heels off ground



# Correctives for Poor Foot Control

- **Short Foot**
  - Do in bare feet on a solid surface
  - Shift weight to one foot
  - Find foot tripod (heel, ball of big toe, ball of pinky toe)
  - Spread out your toes
  - Grab the ground with your toes
  - “Pull” toes and heel together (no movement)
  - Feel the arch of your foot lift
- **Exercises**
  - Single leg stance (30-60 sec) with and without UB movement
  - Single leg kickstand squats
  - Squats, deadlifts



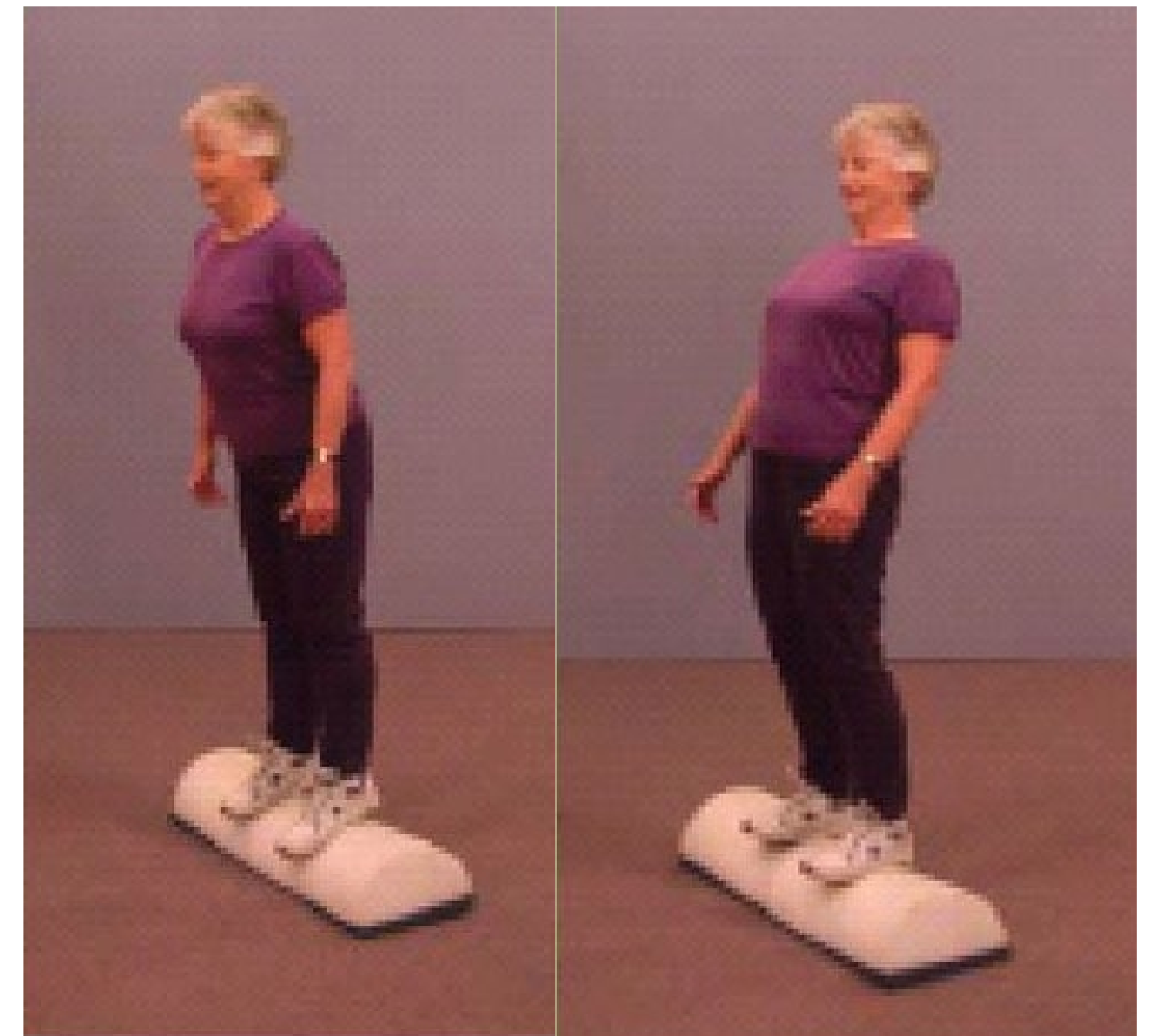


# Hip Strategy

- Employed when ankle motion is limited or displacement is greater or when standing on unstable surface that disallows ankle strategy.
- Preferred when perturbation is rapid and near LOS
- Anterior Displacement of COG (e.g. a push from behind) – Backward sway is initiated by hamstring and paraspinals.
- Posterior Displacement of COG (e.g. a push from the front) – Forward sway is initiated by abdominals and quadriceps.

# Exercises to Improve Hip Strategy

- Teach hip hinge
  - Loaded deadlift
- Multi-directional reach
  - Play catch
- Balance on a half-round foam roll (flat side down)\*
  - Multi-directional reach
  - Play catch
- Balance on disc, BOSU or wobble board
- Medium perturbations
- Correctives
  - Mobilize
  - Strengthen





# Corrective stretches for Poor Hip Mobility

## **Seated**

- Quad/hip flexor
- Knee to chest
- Figure 4 (sit “like a man”)
- Single leg hamstring
- Low box sit (like SL box stretch)

## **Floor/Standing**

- Quadruped Rocking
- Pigeon/Box Pigeon
- Butterfly
- Hip flexor/couch
- Lying knee to chest
- Perfect stretch/Spiderman
- Single leg box stretch
- 90/90 rotation
- Lying Figure 4

Think Extension, Flexion, Abduction, Adduction, Internal and External Rotation

# Correctives for Weak Gluteus Medius

Gluteus medius is a critical hip muscle responsible for pelvic stability during any single leg movements such as walking or running

## Exercises

- Clamshells and Side leg raises
- Lateral resisted walking
- Lateral/diagonal walking with bands around knees
- Spread the floor squat
- Squats with bands around knees
- Goblet squat (with or without band around knees)
- Glute bridges (with or without band around knees)



# Step Strategy

If displacement is large enough, a forward, backward or lateral step is used to regain postural control.

A successful step strategy is:

- Fast
- Powerful
- Big (enough)
- Accurate

# Exercises to Improve Stepping Strategy

## **Planned**

Bug stomps

Multi-directional stepping/lunging

Carioche/Grapevine

## **Reactive**

Sprinter Starts

Fake falls

Red Light, Green Light

“What time is it?”



# Power Training for Balance

Muscle power is critical to having good balance at all levels of function

- For older adults it can prevent a serious fall
- For middle-aged adults it can prolong functional ability and stave off the effects of aging
- For athletes it can enhance athletic performance and help prevent injury

ALL populations should include power training to enhance balance and function (either daily or sports)

# What is Power?

Power (W) = Force (N) x Velocity (m/s)

Rate at which work is performed

“Explosive strength”

“Speed strength”

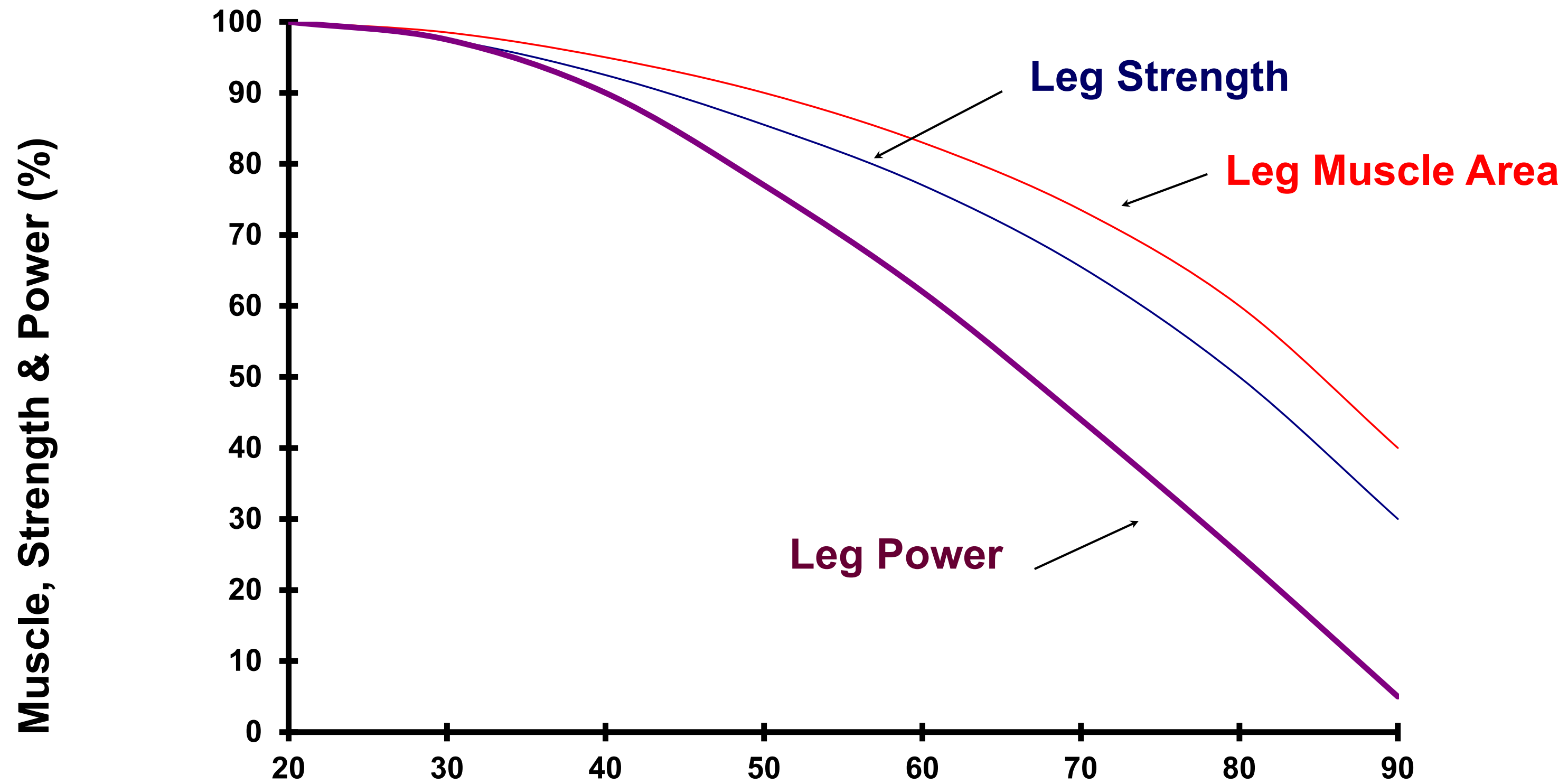


## Power Comparisons

	<u>Force</u>	<u>Power</u>
Shot (7.25 Kg 18.19 m)	513 N	5075 W
Snatch (150 Kg)	2000 N	3163 W



# Muscle Power Declines Quickly with Age



# Power Training for Older Adults

## **Exercises**

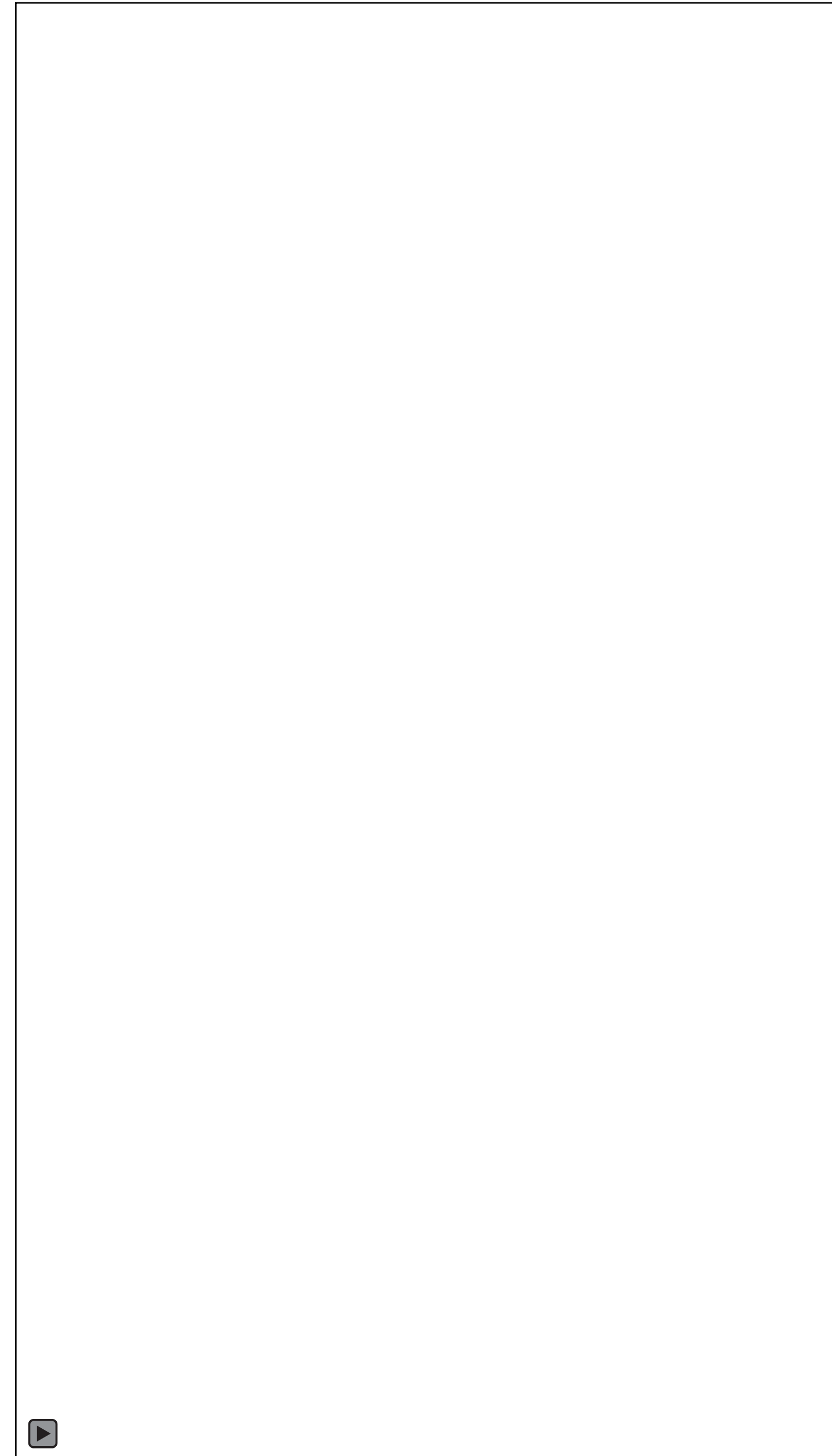
- Power chair stands
- Thrusters
- Wall Balls
- Forward ball push
- Hops
- Box jumps

## **Considerations**

- With speed comes inaccuracy
- Likelihood that someone loses their balance increases
- Monitor closely
- Use open space free of objects
- Teach landing technique on jumps
- Load should be light (or no load)

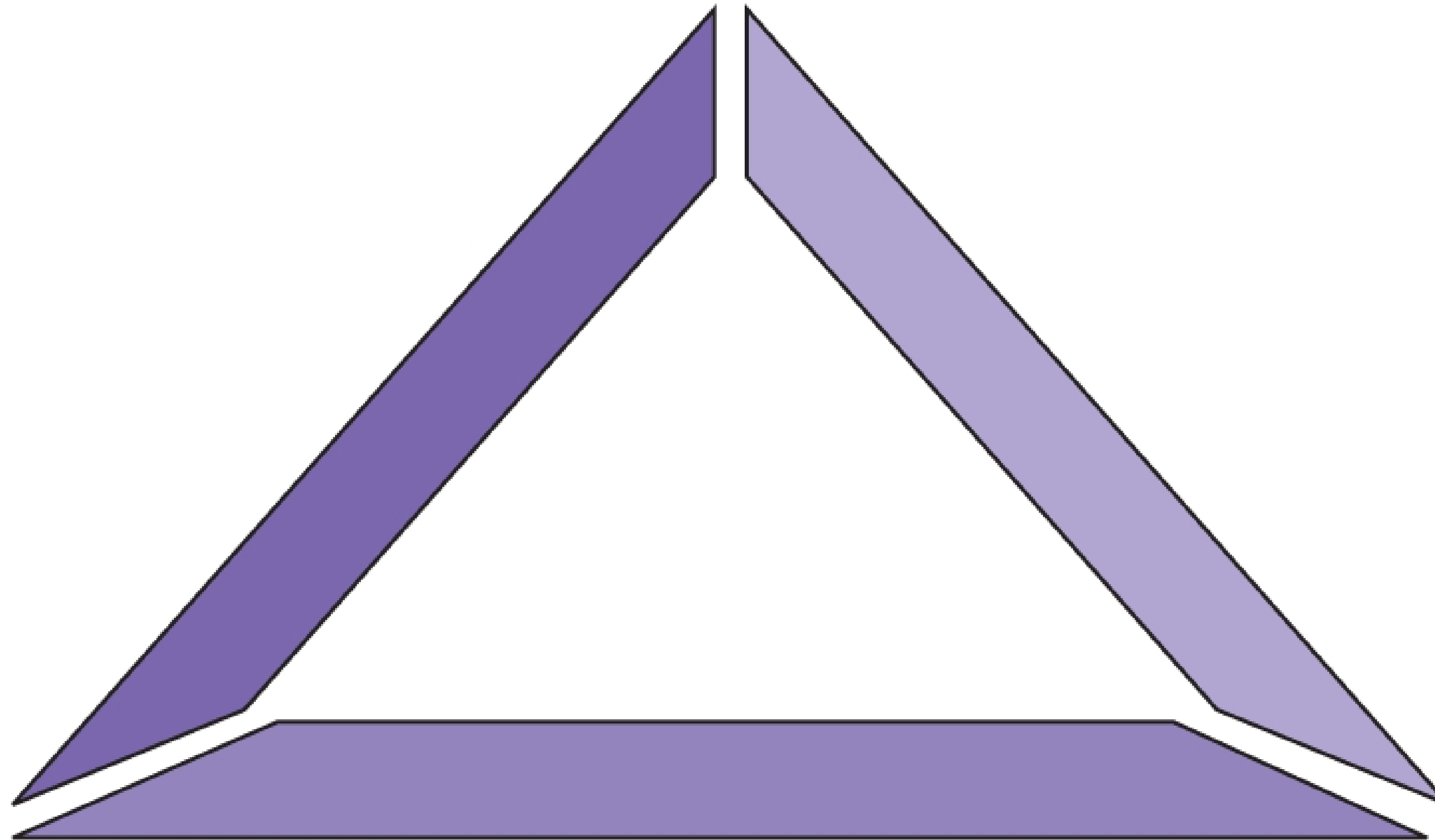


81 year old  
30" Box Jumps



# Multi-Sensory Training

Visual



Somatosensory

Vestibular

# Somatosensory Inputs

1. The cutaneous and pressure sensations from body segments in contact with support surfaces (\*particularly important in standing)
  - Standing: the feet
  - Sitting: buttocks, thighs, and feet on the floor
2. Muscle and joint proprioception throughout the body
3. Provides information about the relative orientation and movements of the body in relation to the support surface

*Short Foot is a way to enhance somatosensory input*



# Visual Input

Visual proprioception: the ability to use our visual system to perceive our movements and detect the relative orientation of the body parts and the body as a whole in space

Vision is critical in planning movements and reacting to our environment

Vision tends to dominate our sensory input yet many people use their vision poorly and many older adults lose visual acuity

*Excellent visual input is a characteristic of top-level athletes*

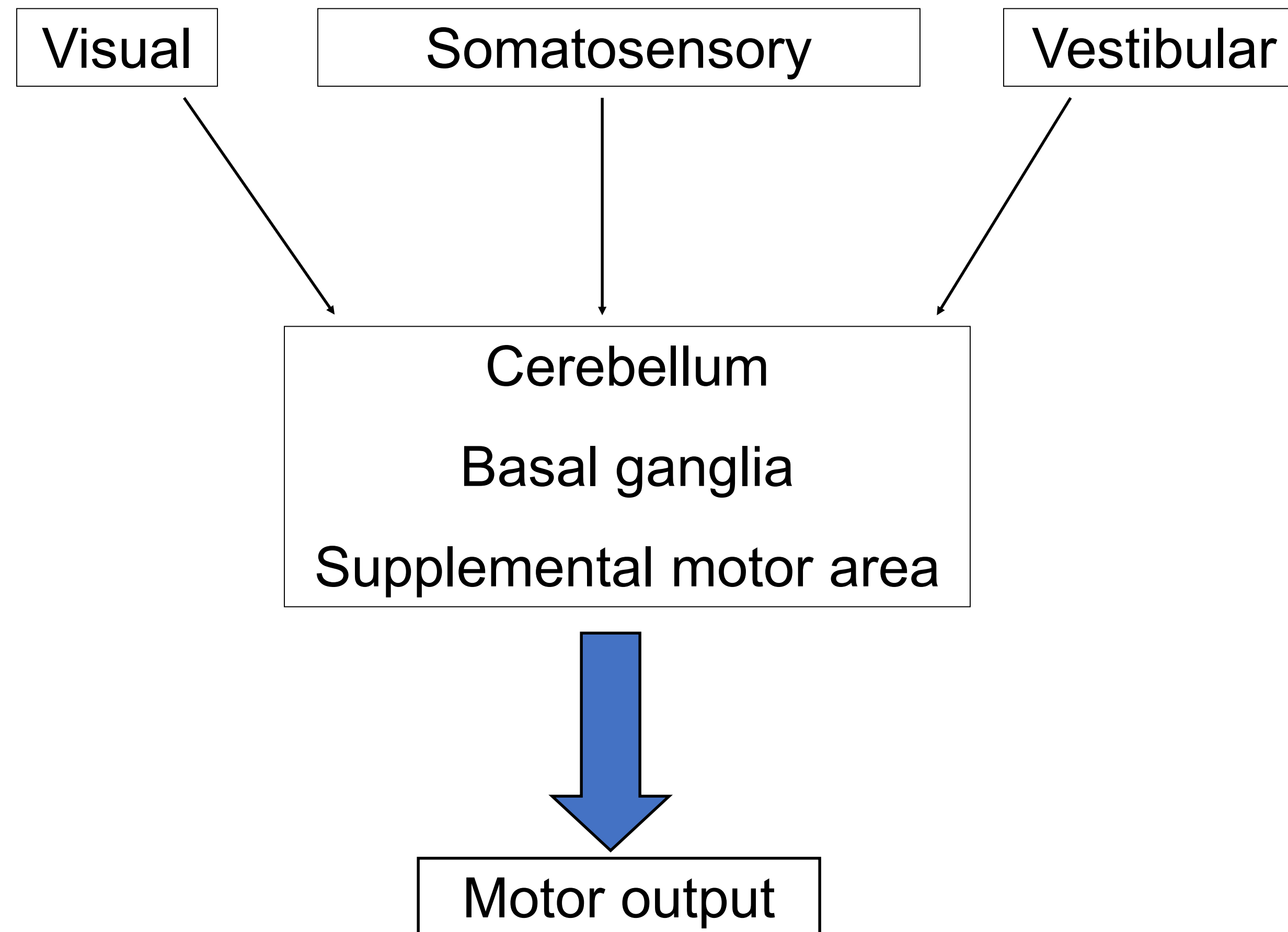
# Vestibular Input

1. Adjusts muscle activity in neck, trunk, and proximal extremities to generate appropriate postural reflexes and to maintain balance.
2. Coordinates eye and head movements
  - Vestibulo-ocular reflex provides clear vision during head motion like a vision stabilizer on a camera
3. Detects linear and angular accelerations of head.
4. Detects static head position (esp when visual and somatosensory systems are absent/limited)
5. Provides information about body orientation in space.

Vestibular System works in an integrated manner with somatosensory and visual input to determine appropriate postural strategies.

Approximately 70% of all adults over the age of 70 have vestibular hypofunction  
The effects of a concussion on visual and vestibular function can last a long time

# Processing Sensory Information





# Multisensory Training – Promote One System

## Somatosensory

- Remove/limit/distract vision and use a hard surface
  - Raise awareness of touch, pressure
  - Reduce visual dependence
- Must reduce or remove visual input and keep somatosensory input

## Visual

- Full use of vision on either a compliant or solid surface
- Improve gaze stability (fixed and visual tracking)
- Cue visual targeting

## Vestibular

- Either perform movements on a compliant surface AND reduced/engaged/absent vision OR move head around quickly
- Vision: Low light, sunglasses, eyes closed
- Surface: mat/foam pad
- Force inner ear to tell brain where head is positioned/moving

# Somatosensory Training

## Exercises

- Key #1: Use hard surface
- Key #2: Manipulate vision
  - Distract vision: busy surface pattern moved quickly through the visual field; read
  - Reduce vision: sunglasses
  - Remove vision: close eyes; turn off lights
- Key #3: Cue sensory awareness (see below)

## Sensory Awareness Cues

- Imagine there is a string connected to the top of your head that is being pulled toward the ceiling
- Sense that your ears are directly above your shoulders
- Sense that your shoulders are directly above your hips
- Feel equal weight on both sides of your buttocks
- Sense the angle of your knees relative to your hips and ankles
- Feel your feet in contact with the floor
- Feel that the pressure is distributed evenly under both feet

These can be done seated or standing

# Visual Training

## Exercise Strategies

- Visual Targeting (focus on a target for 10-30 sec)
  - Sit, stand or walk on a compliant surface
    - Focus on a stationary target at eye level
  - Hold pen in front of you and move it towards your nose
  - Hold pen in front and slowly move to side until you can't see it (keep looking forward)
- Visual Tracking
  - Level 1: Eye movements with stationary head while seated
    - Smooth pursuits
    - Quick (saccadic) eye movements
  - Level 2: Combination head and eye movements seated
  - Level 3: Head and eye movements while shifting weight in a seated position
    - Turn body, head and eyes to find objects or follow objects
  - Level 4: Head and eye movements while walking
    - Tick Tock Walks



# Visual Training – Advanced Exercises

## Color Vision

- Toss different colored balls rapidly at client but they only catch a specific color or colors
- Toss a three or four pronged “star” where each prong is a different color; call out the color they have to grab while it is in the air
  - Do color tosses with one eye covered
  - Quickly switch between covering each eye during the task

Peripheral Vision - From behind place items in client’s peripheral vision and have them react quickly if it is the correct item or color

Depth Perception - Hold a straw at arm’s length and try to drop a BB into it

*For more difficulty do any of these while on one leg or standing on an unstable surface*

# Vestibular Training

## Compliant Surface with Vision Manipulation

- Seated (on ball and foam pad) or standing (on foam pad)
- Static and dynamic movements
- Exercises
  - Stand on foam pads with eyes closed for 30 seconds
  - Stand on foam pads and reach for objects
  - Sit on ball with feet on foam pads and lean in different directions
  - Walk across a foam surface with sunglasses on

## Head Movements (start on stable surface)

- 2 cycles per second for 10-30 seconds
- +/- 30 degrees each way
- Nod “no” – side to side (horizontal plane)
- Nod “yes” – up and down (vertical plane)
- Swing, turn, spin, roll...

# FAS Assessments

5x Sit to Stand

Timed Up and Go

Senior Fitness Test 8' Up and Go\*

Senior Fitness Test 30 Second Chair Stand

Berg Balance Scale\*

Fullerton Advanced Balance Scale\*

Modified Clinical Test of Sensory Interaction in Balance (mCTSIB)\*

Short Physical Performance Battery\*

PARQ+

Single Leg Stance\*

Handgrip Strength

Functional Movement Screen

Cognitive Screens

Dynamic Gait Index

Senior Athlete Fitness Exam

Senior Fitness Test Battery

Functional Reach Test\*

Sarcopenia Questionnaire (SARC-F)

\* = balance-specific test

# Programming

- Balance needs to be trained regularly and consistently in older adults with balance impairments or previous falls
  - Try to achieve 2-3x/wk for 8+ weeks (30-60min each session)
- Utilize exercises that challenge the different systems but focus on specific areas of deficit
  - Incorporate balance exercises into circuit programs for higher functioning
  - Perform balance training sessions for high-risk or fallers
- Scale the exercises to be challenging (RPE 13+) but still allows the person some level of success
  - Spotting and safety is critical
- Utilize props and aids whenever necessary
- Work on self-efficacy and building balance confidence



# Otago Exercise Program

Backwards Walking

Walking and Turning Around

Sideways Walking

Tandem Stance

Tandem Walk

One-Leg Stand

Heel Talking

Toe Walking

Heel Toe Walking Backwards

Sit to Stand

Evidence-Based program with four stages of progression intended for lower-functioning older adults with balance impairments or who have fallen previously

# Summary

Effective balance training must be performed at least 2-3 times per week consistently for 8+ weeks in order to be effective

Balance is affected by many different systems and those systems all need to be trained

Corrective exercises should be used to address deficiencies that can impair balance

ALL adults, older adults and athletes should be performing balance training regularly

# Thank You

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