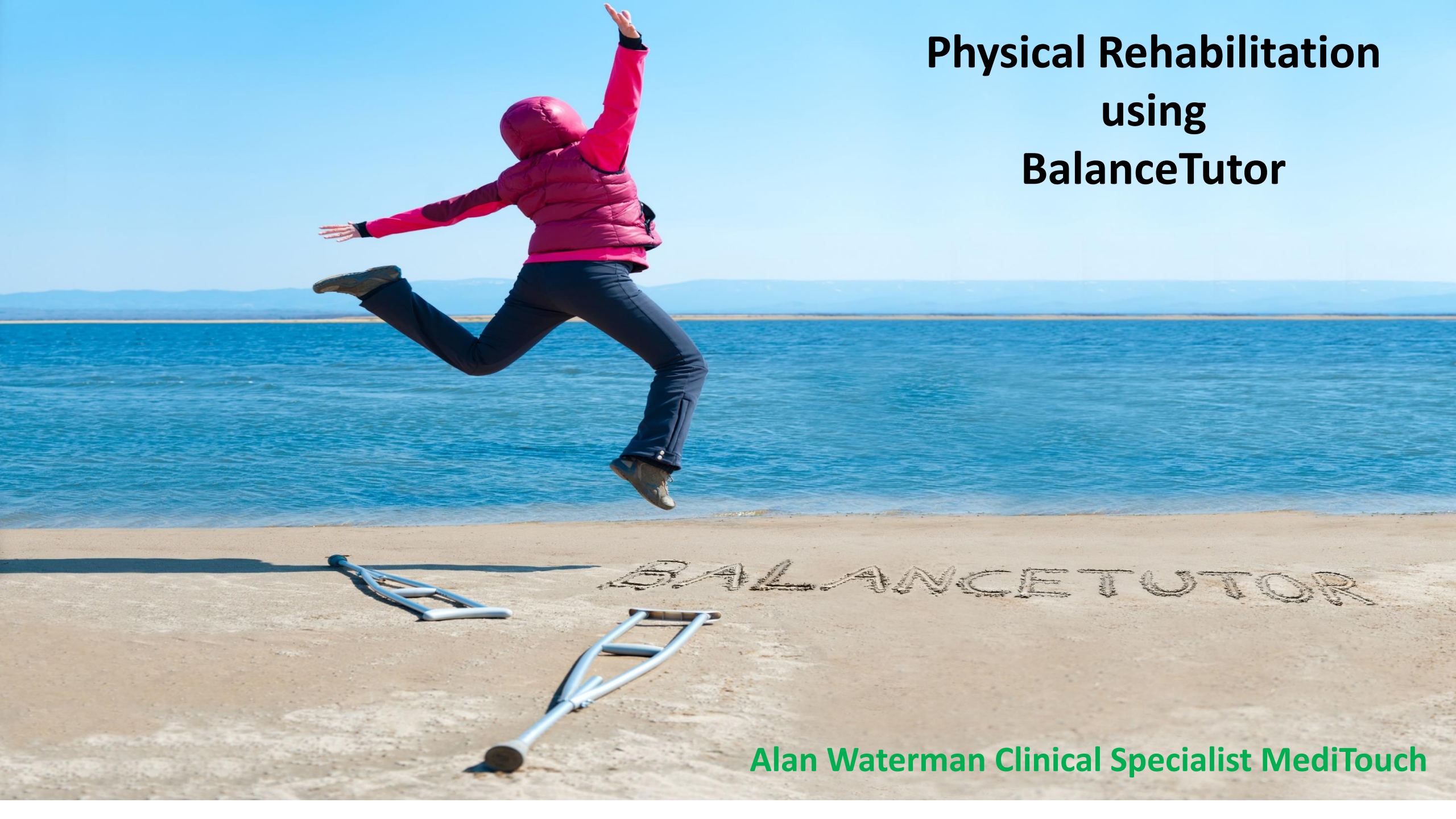


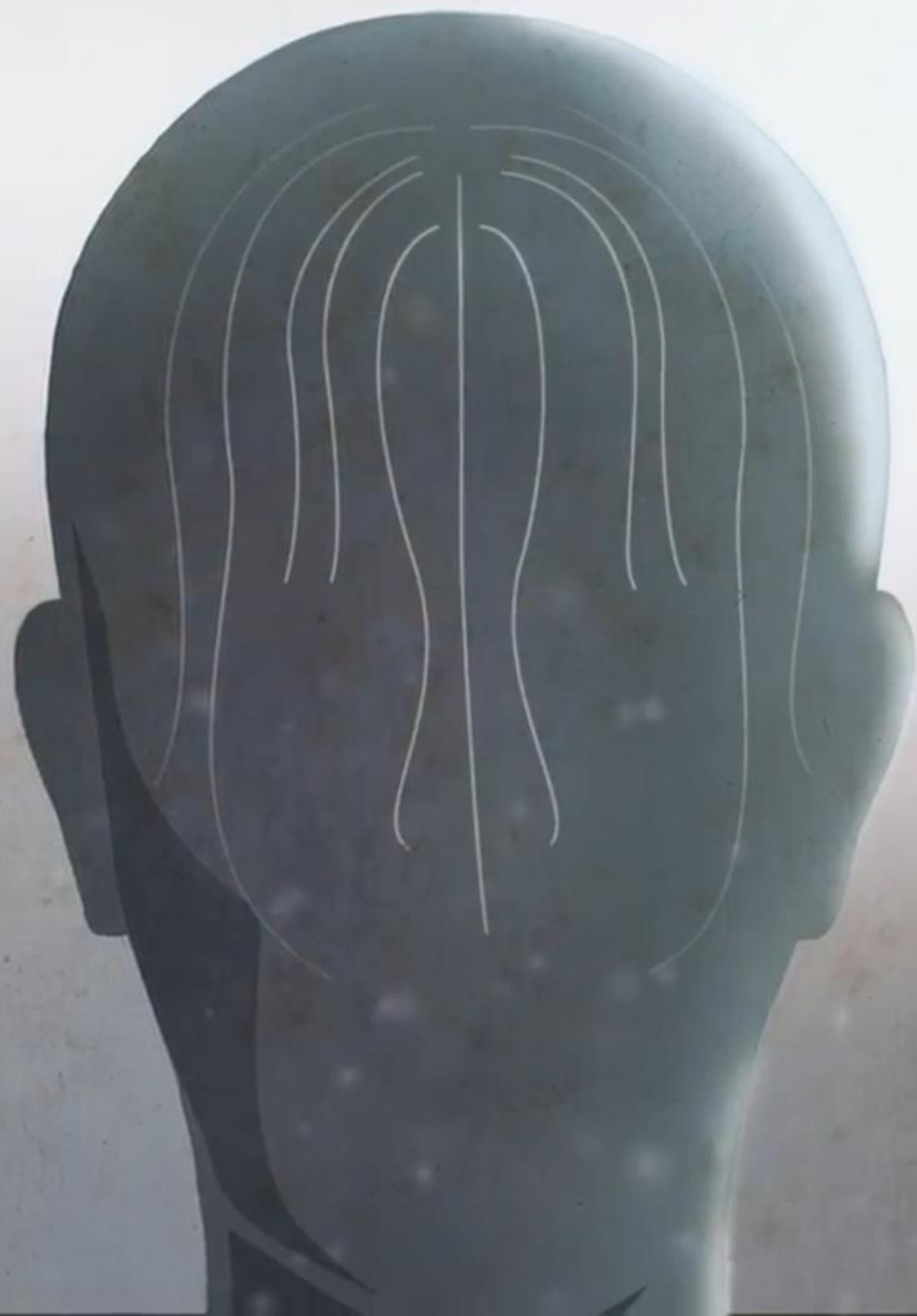
# Physical Rehabilitation using BalanceTutor



Alan Waterman Clinical Specialist MediTouch







# Postural Control Strategies

APAs: Anticipatory Postural Adjustment

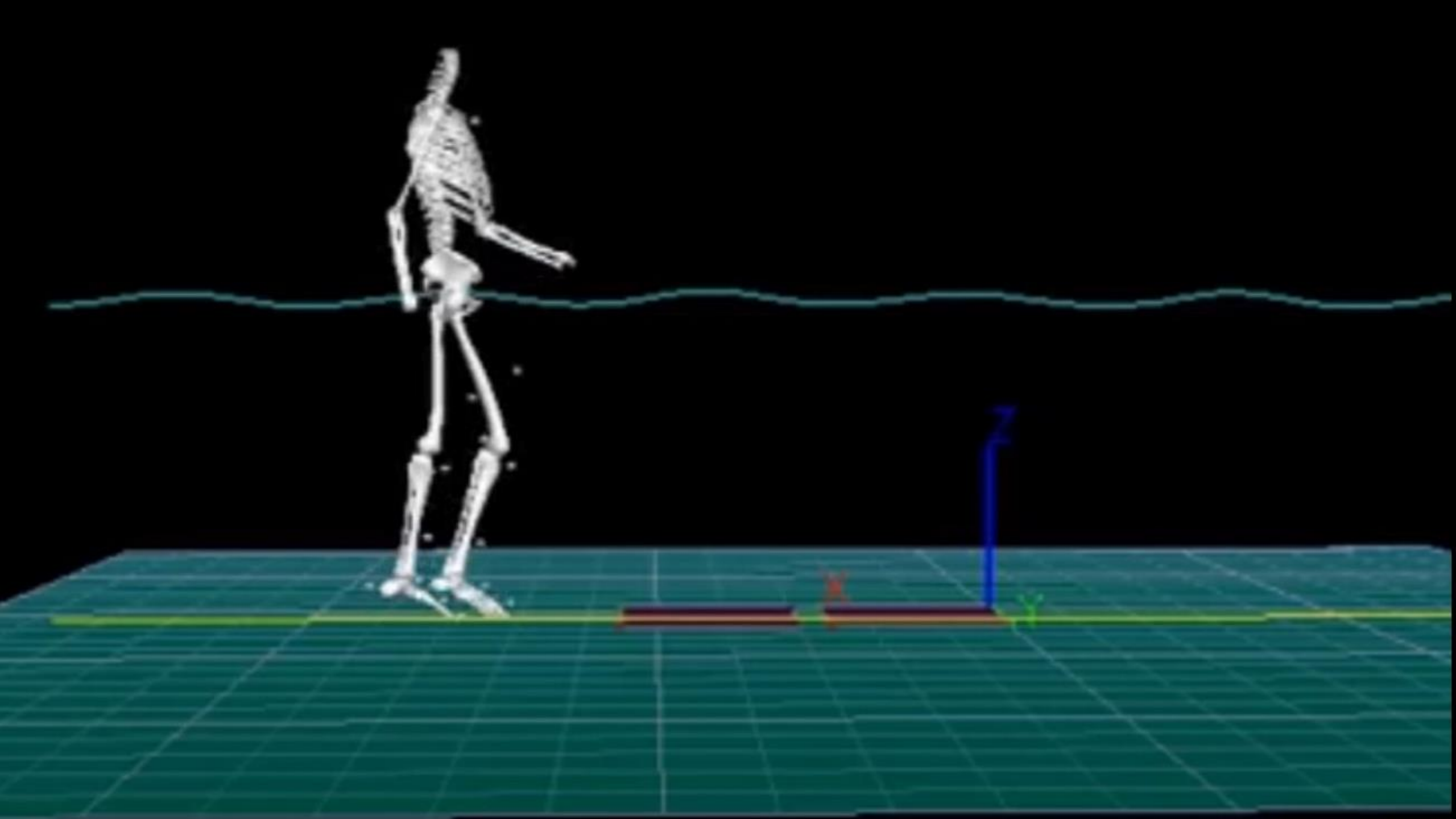


CPAs: Compensatory Postural Adjustment



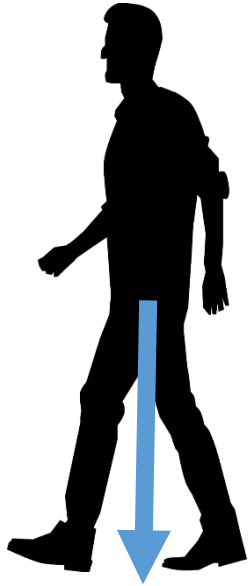
Latash ML, 1998







1



**Anticipatory postural adjustments (APAs)** control the position of the center of mass (COM) of the body by activating the trunk and leg muscles **prior** to a forthcoming body perturbation, thus minimizing the danger of losing equilibrium.

Massion J, 1992



2



**Compensatory postural adjustments (CPAs)** are initiated by the sensory feedback signals and serve as a mechanism of restoration of the position of the COM after a perturbation has already occurred.

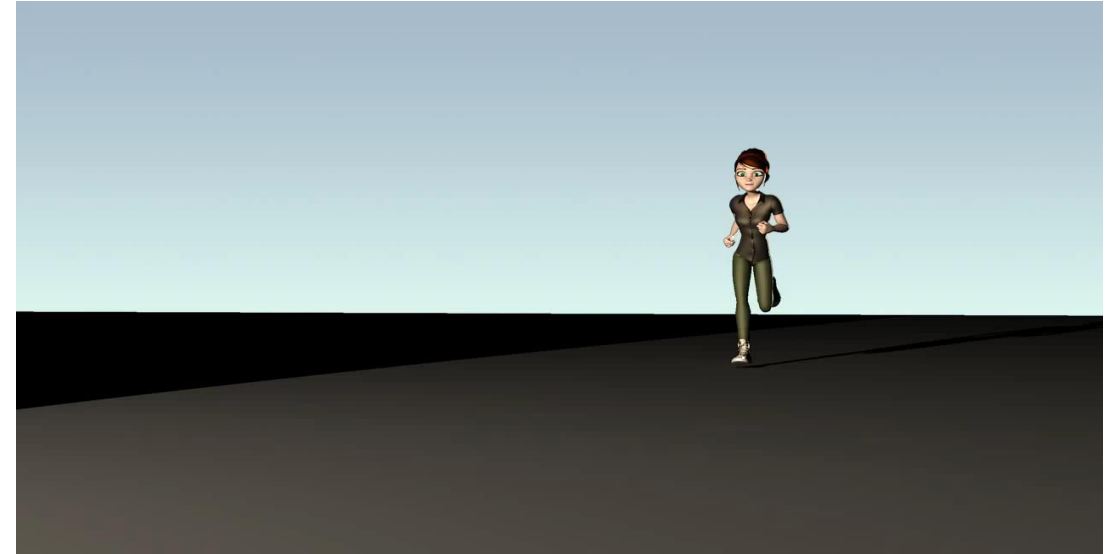
Alexandrov AV, 2005



# Proactive Response

## Anticipatory Postural Adjustment

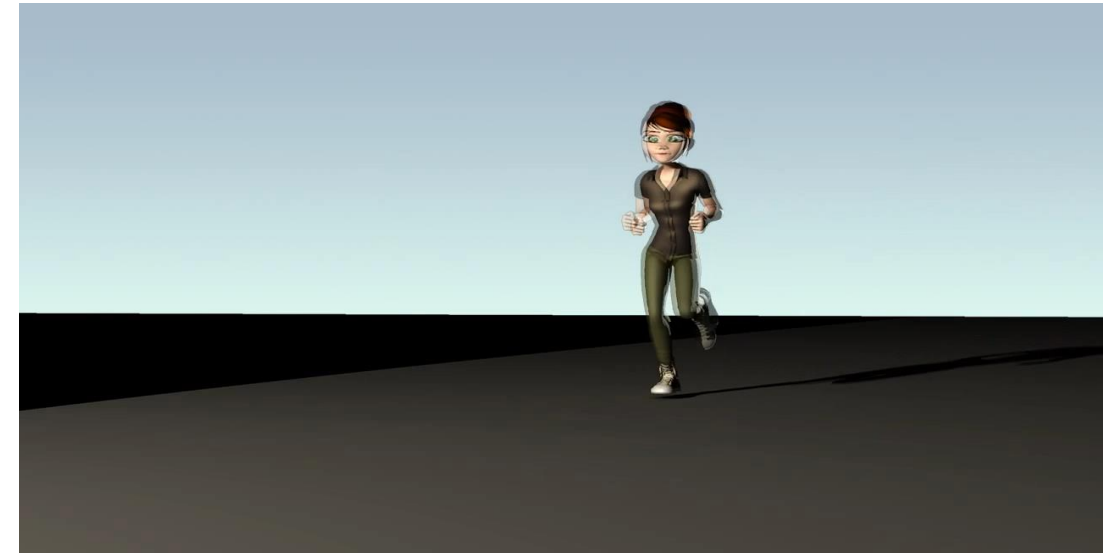
**Postural** muscles activation in a **feedforward** manner to stabilize postural balance, **before** a voluntary movement begins.



# Reactive Response

## Compensatory Postural Adjustment

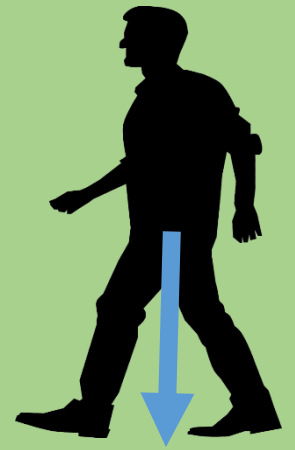
**Postural** muscles activation in a **feedback** manner **after** an unexpected postural perturbation.



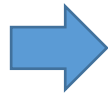


# APAs: Anticipatory Postural Adjustment

## Proactive response



Task planning



Sensory information



Choose strategic



Task performance



Anticipatory Postural Adjustment

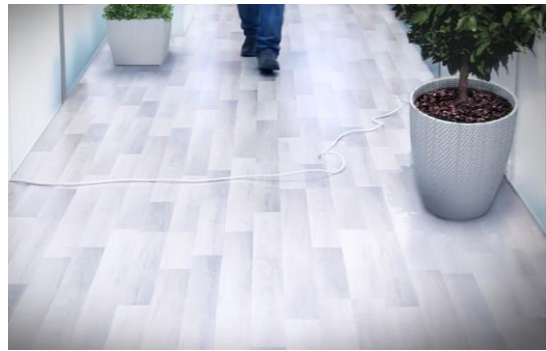




# CPAs: Compensatory Postural Adjustment Reactive Response



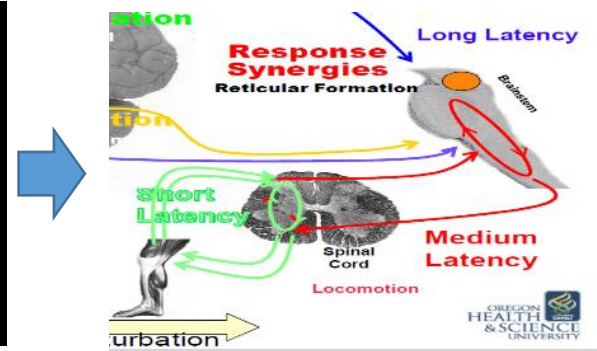
Unexpected perturbation



Sensory information



Reflex-like processing (CNS)

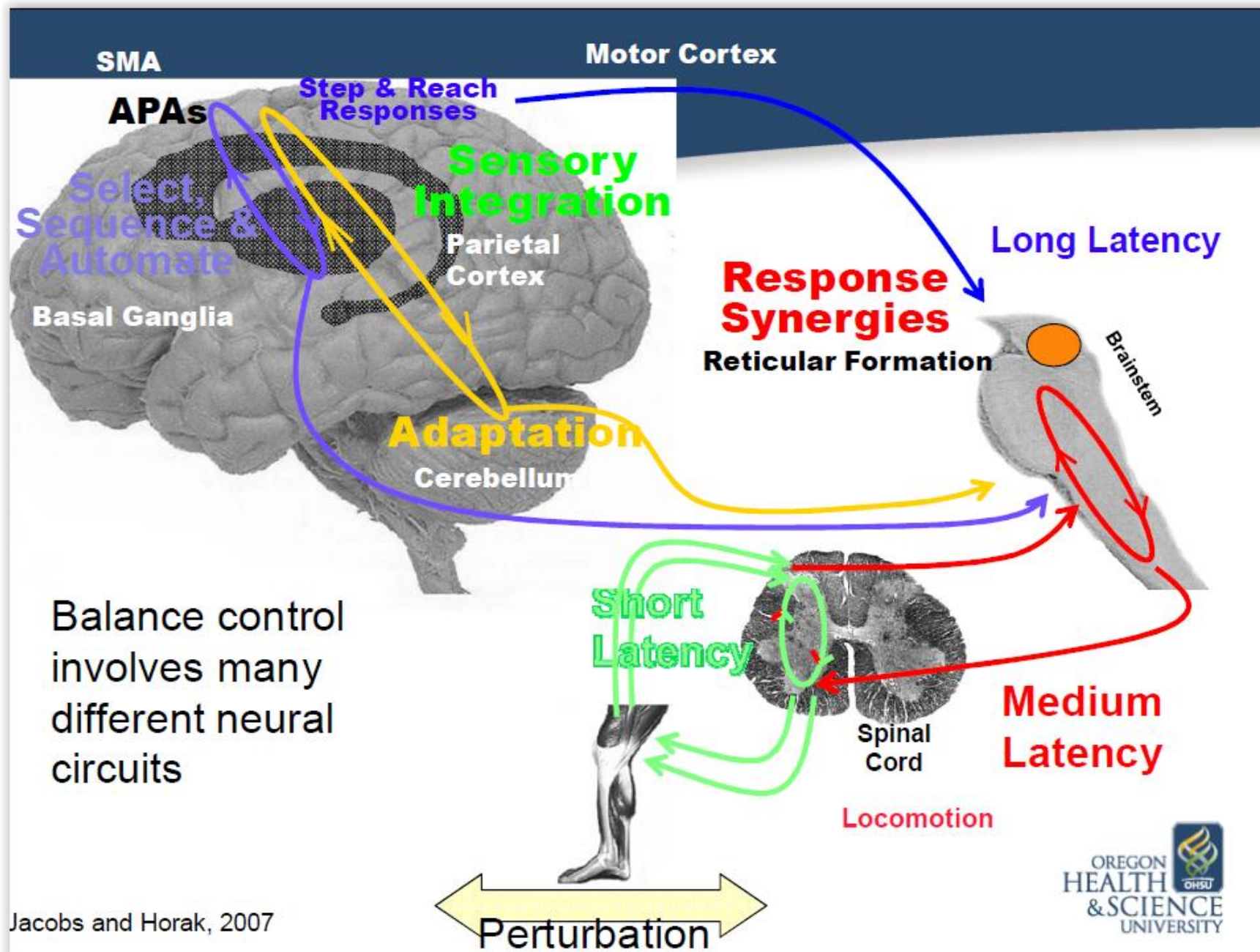


Compensatory Response





# Postural responses



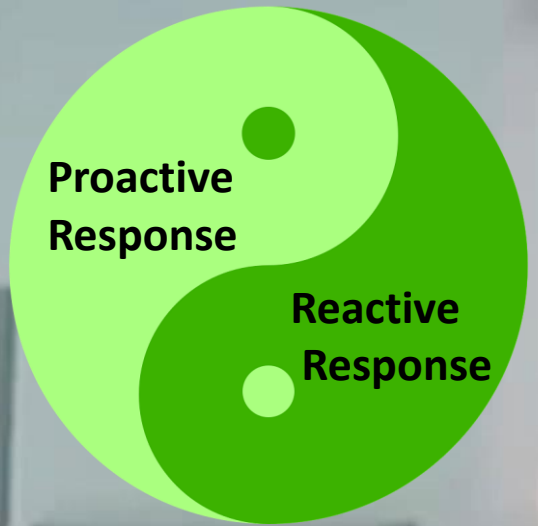


**Compensatory postural adjustment (CPAs)**



**Anticipatory postural adjustment (APAs)**





**Proactive  
Response**

**Reactive  
Response**



Reactive stepping response can improved by unexpected perturbation training.

Mansfield et al., 2017

Balance recovery strategies should be trained in unexpected situations and not through voluntary exercises.

Melzer and Oddsson, 2010, 2013







✓ Patient safety

✓ Treatment customization

✓ Fast treatment set up time

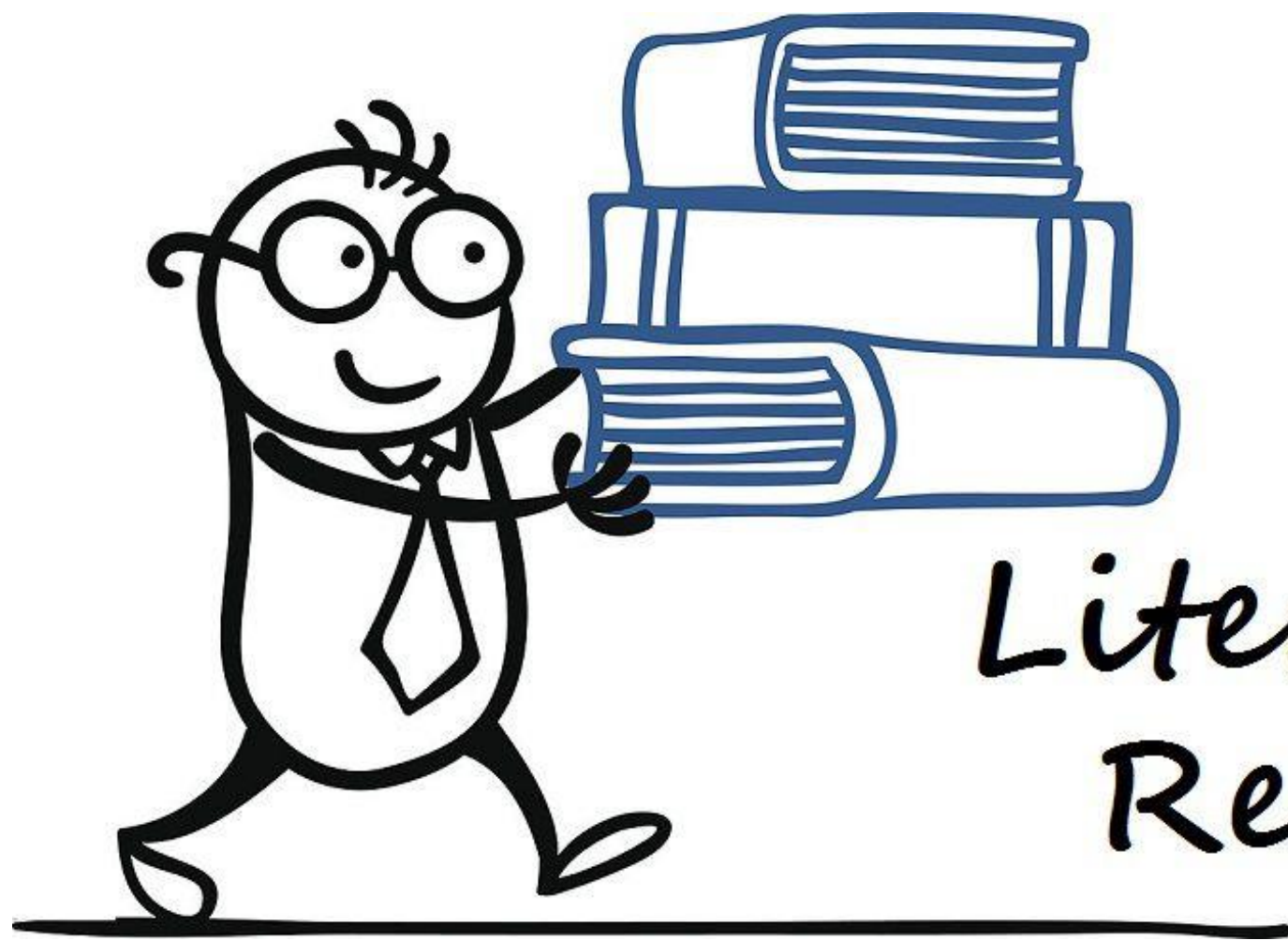
✓ Reasonable price tag

✓ Repeatability of the perturbation

✓ Using proper acceleration / displacement to COM

✓ Perturbation in standing /during the gait

✓ Objective documentation and follow up



Literature  
Review



unexpected postural perturbation

X Search

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[User Guide](#)

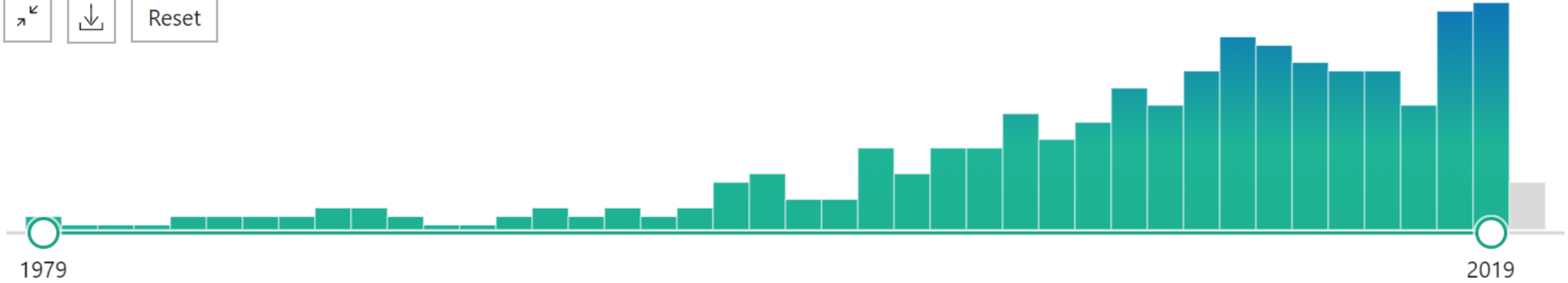
Save Email Send to

Sorted by: Best match Display options

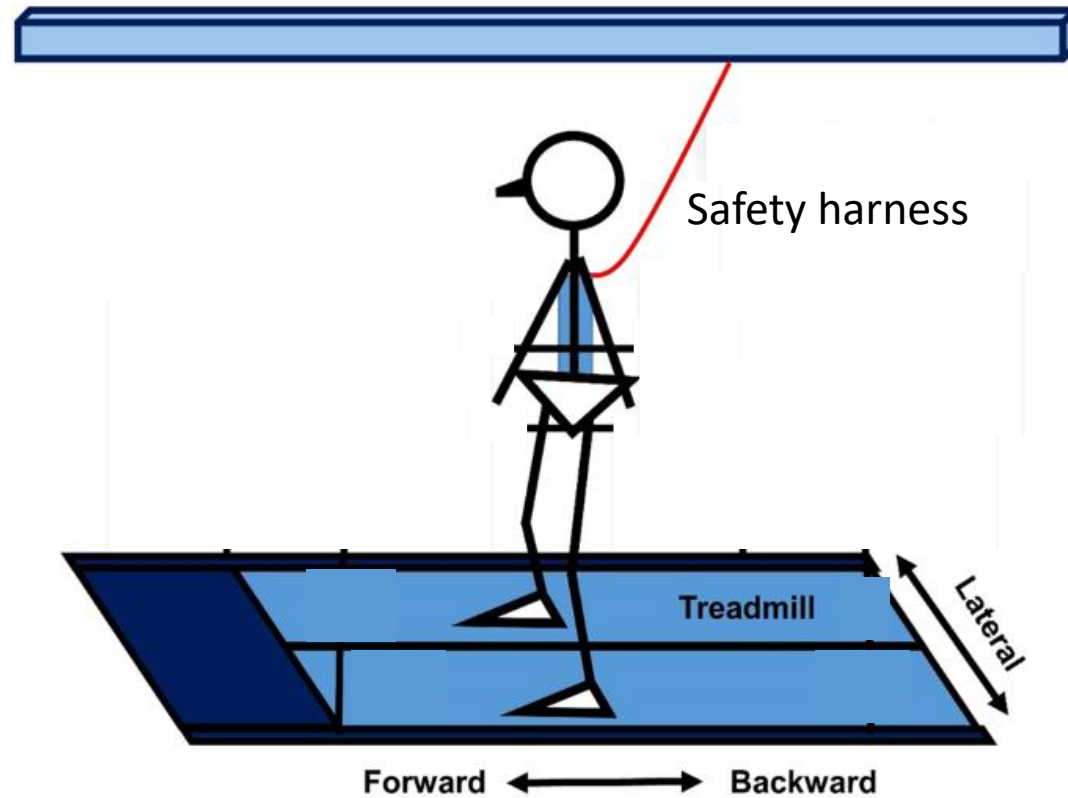
RESULTS BY YEAR

268 results

↶ ↷ Reset







**Perturbation-based balance training (PBBT)** is a task specific intervention aiming to improve reactive balance control after the loss of balance in a safe and controlled environment.

Gerards MHG, McCrum C, Mansfield A, Meijer K., 2017





## SECTION 2

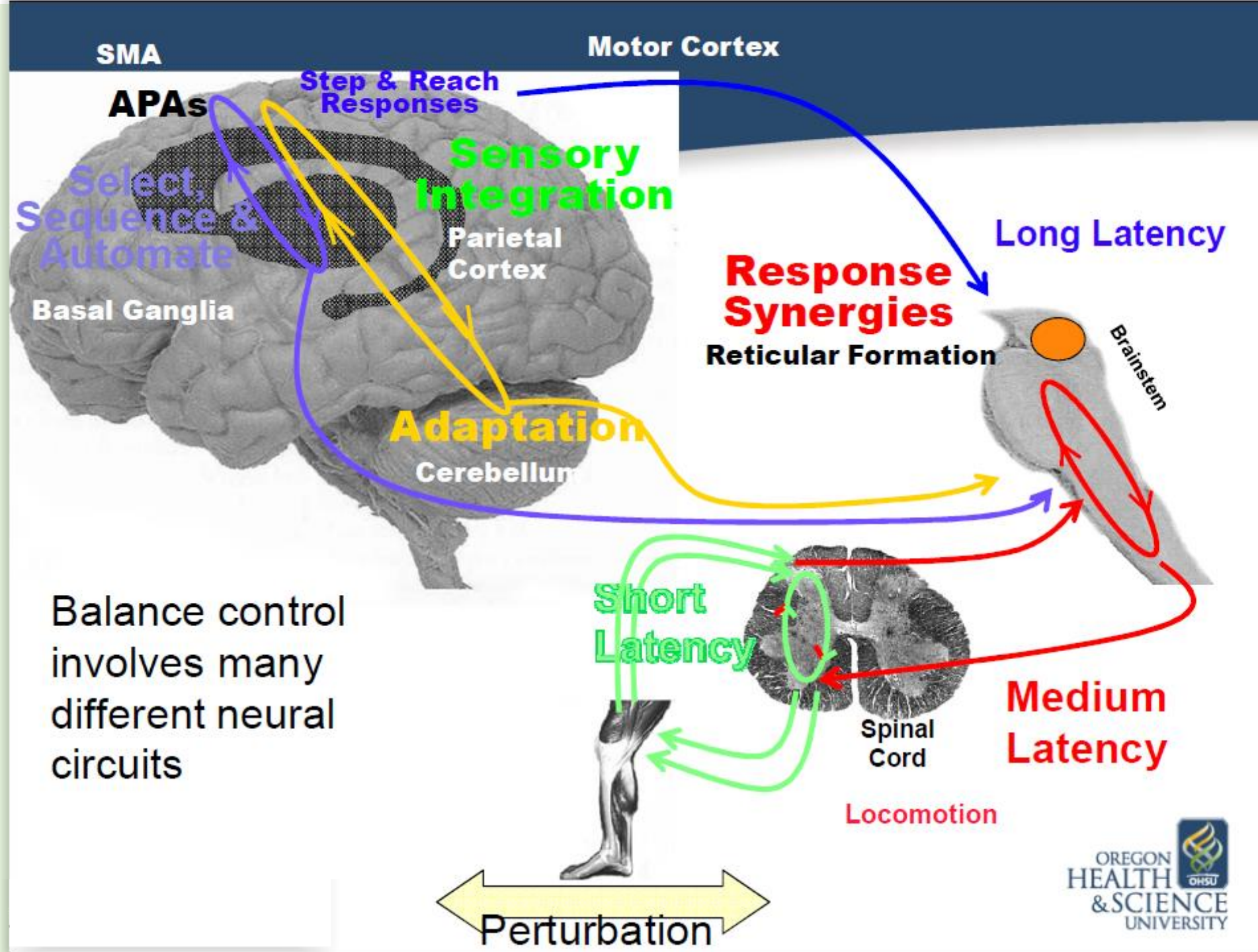




## Neural networks

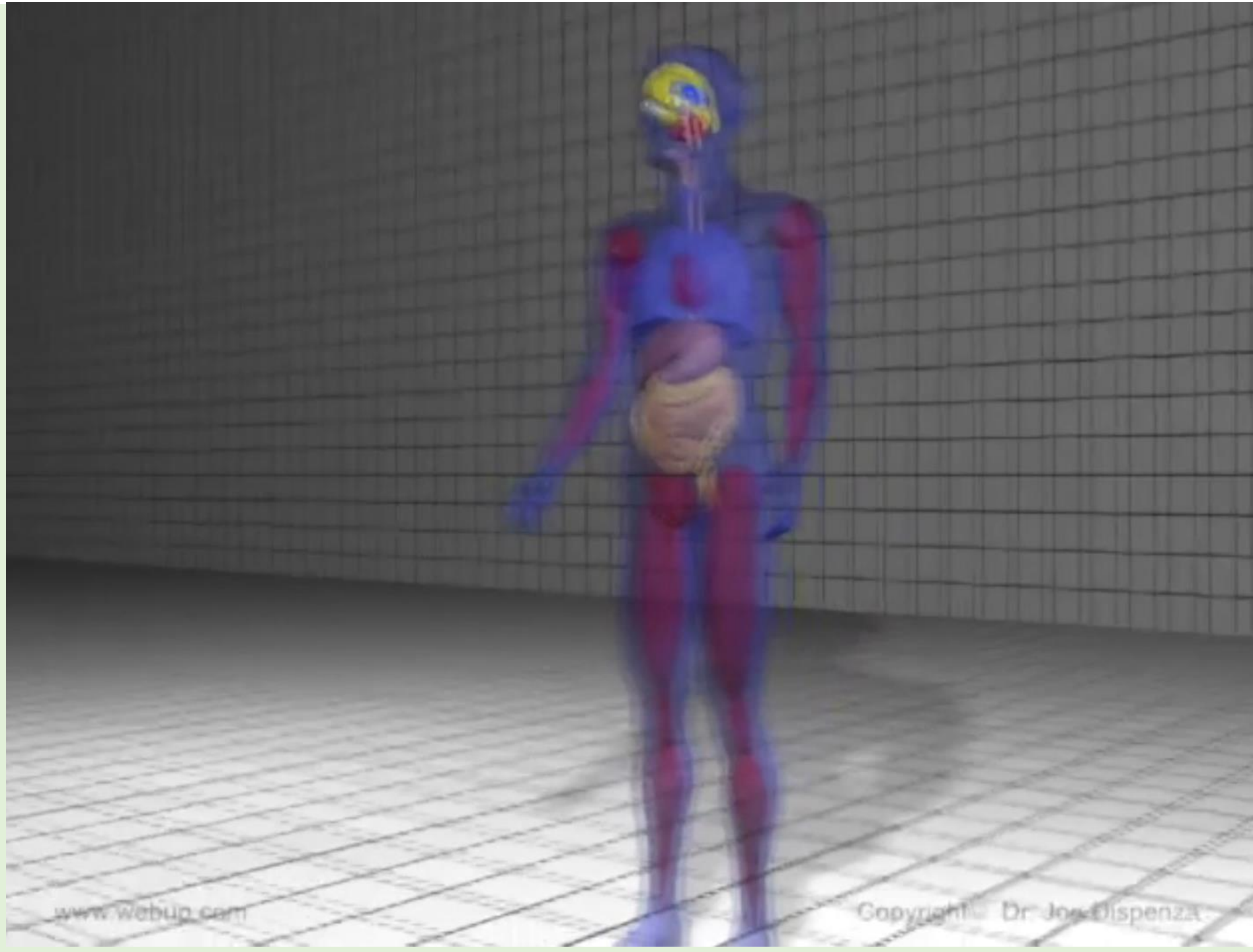
In **APAs** the Cerebral cortex is mainly activated for task planning

In **CPAs** the subcortical brain is mainly activated for reactive balance responses



# Autonomic system

The sympathetic nervous system is more activated during a reactive postural response compared to a proactive postural response



## Autonomic system

Triggering of autonomic system allows for greater muscle facilitation



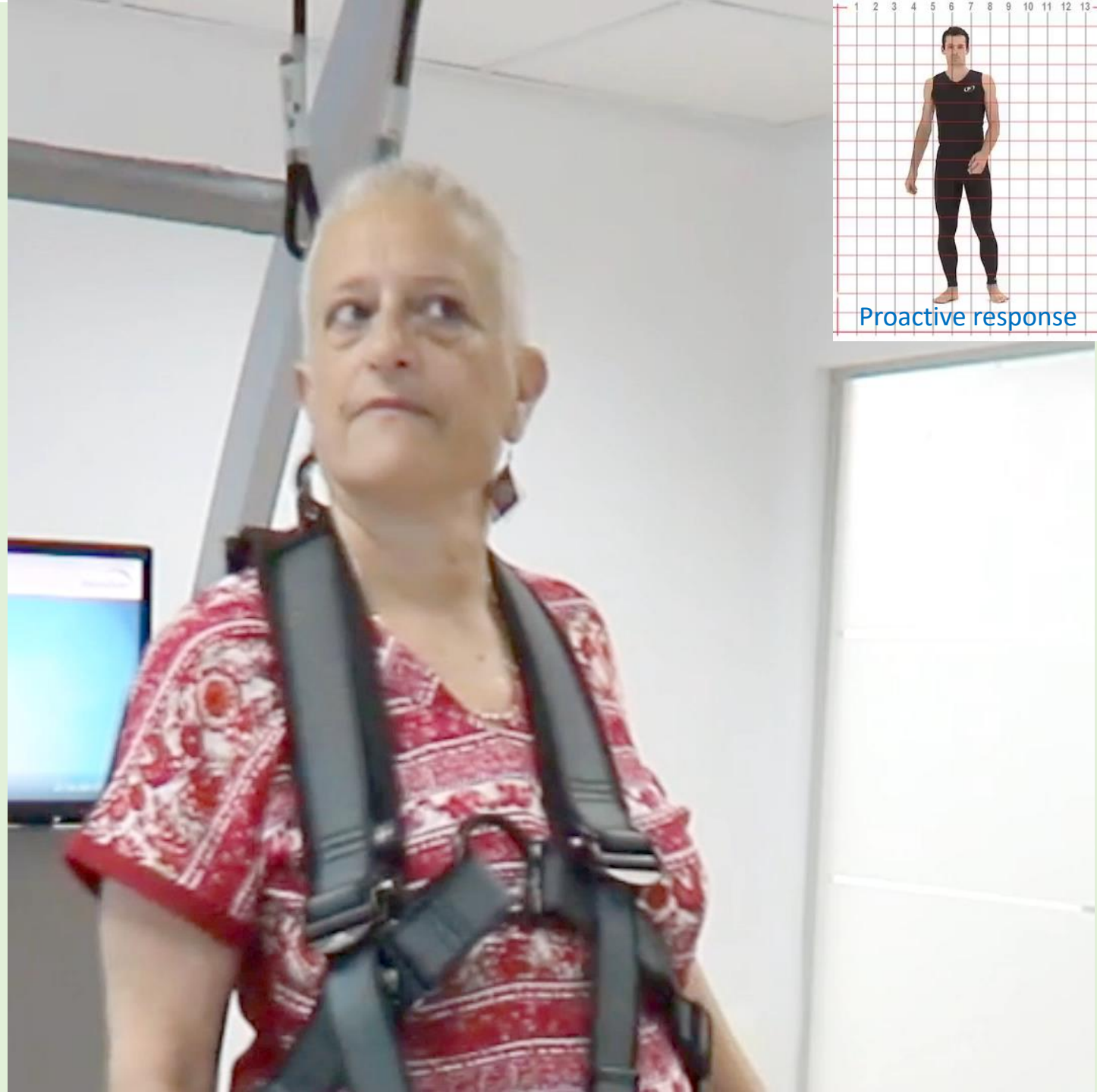


# Vestibular Rehabilitation

Neural firing in the vestibular nerve is proportional to head velocity over the range of frequencies in which the head commonly moves (0.5 to 7 Hz).

Timothy C. et al., 2020

Reactive response result in higher head velocity and greater Range of Motion compared to proactive head response



# Intra spatio- temporal muscle coordination



**Type I**, slow twitch, or "red" muscle, contract for long time & with low loads.



**Type II**, fast twitch muscle, contract quickly & with high loads.

Muscle types fiber coordination within a single muscle.





Aging



Diseases/ Injuries

# Use it

The type II (fast-twitch) muscle fibers are decreased due to aging and reduced physical activities

J Lexell. 1997

Physical and functional losses due to aging and diseases decrease human mobility and postural balance that can be improved by appropriate physical training

Martin G et al., 2019



## (or lose it)

## Maintaining Your Mobility

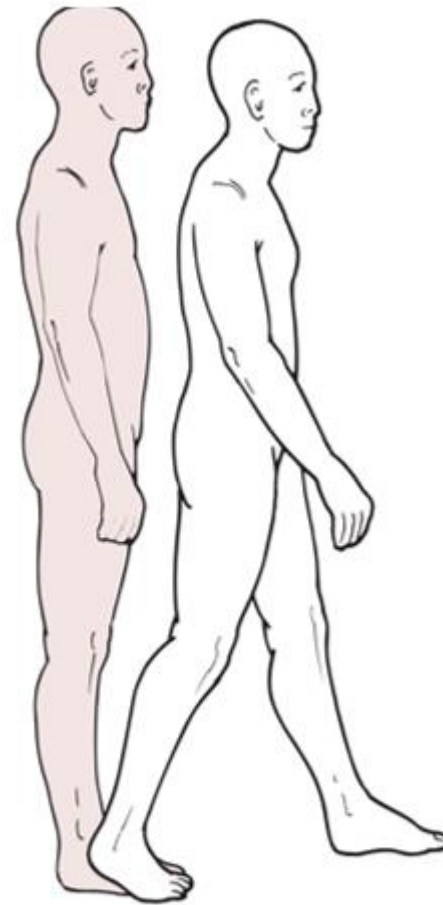




Ankle strategy



Hip strategy



Stepping strategy



# Medial/ Lateral perturbation in standing position



Shifting of body weight-bearing in opposite direction to perturbation.

Crossover step to opposite side of perturbation direction.

Increased sensory integration as mainly force and tension applied in the lower limb to opposite direction.

Increased reversal activation of GM muscle (mainly type II) of the limb in opposite side to perturbation direction.

Increased activation of lateral canal of vestibular system.

Activation of an Inter spatiotemporal distal to proximal coordination pattern.

# Medial/ Lateral perturbation during the gait



Execution of a compensatory step by the swing leg to the opposite side of the perturbation direction.

Dynamic stabilization of the lower limb joint in single stance phase

Increased sensory integration ability.



# Anterior / Posterior perturbation in standing position



Balance strategy practicing ( Ankle, Hip and compensatory step) in sagittal plan.

Step initiation practicing ( mostly the less loaded limb initiates the stepping).

Increased vestibular system activation mainly posterior canal.

# Anterior / Posterior perturbation during the gait



A compensatory step execution by the swing leg in the opposite side to the perturbation direction.

Dynamic stabilization of the lower limb joint in single stance phase

Increased sensory integration ability.

Inter spatiotemporal coordination pattern of muscles of the trunk and lower limb.



## Medial/ Lateral perturbation in standing

- Encouraging body weight-bearing
- Improvement of crossover step
- Greater sensory integration





## Medial/ Lateral perturbation during the gait

- Execution of a compensatory step
- Stabilization of the stance leg
- Greater sensory integration













Before treatment



**Before treatment**









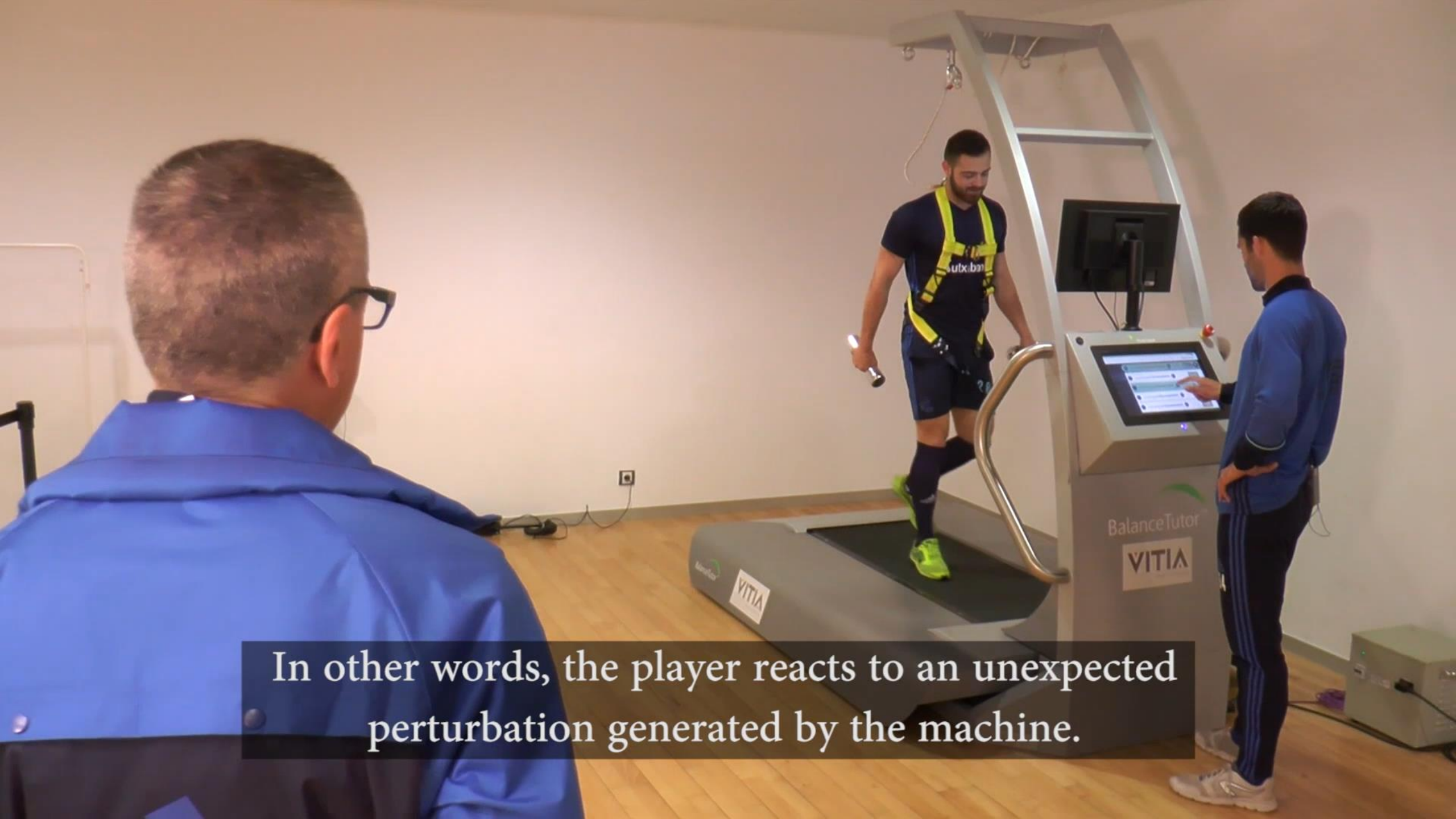
A person is standing in a laboratory, wearing a black safety harness that is attached to a metal frame on the right. They are wearing dark grey athletic pants and black sneakers with white soles. They are standing on a large blue exercise ball. The floor is light-colored wood. In the background, there is a white brick wall and a window with vertical blinds. To the right of the person, there is a piece of equipment with a black control box and a grey power supply unit. The text "Unexpected perturbation during standing" is overlaid at the bottom of the image.

Unexpected perturbation during standing









In other words, the player reacts to an unexpected perturbation generated by the machine.











# Gait analysis



Confidential/Private

Date: 2019-09-25 12:52

Printed By: admin

Page: 1/1

## Gait Analysis Report

First Name: test

Last Name: test

ID No.: 1

Measure	Value	Normal
Speed (m/s)	1.38	1.1-1.3
Cadence (step/min)	116	110-130

Measure	Left		Right		Normal
2019-09-23 13:50:48	Mean	COV	Mean	COV	Range
Step Length (cm)	71±2	3%	71±2	2%	65-75
Step Width (cm)	14±1	10%	13±1	10%	5-15
Stride Length (cm)	142±2	2%	142±2	2%	140-160
Single Support (% of gait cycle)	40±1	3%	40±1	3%	40-50
Double Support (% of gait cycle)	10±1	8%	10±1	8%	10-25
Stance (% of gait cycle)	60±1	2%	60±1	2%	55-65
Swing (% of gait cycle)	40±1	3%	40±1	3%	35-45

Comments:



## BalanceTutor publications

*Original Research Article*



# **Effects of Perturbation-Based Balance Training in Subacute Persons With Stroke: A Randomized Controlled Trial**

Neurorehabilitation and  
Neural Repair  
1–12

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Nachum Soroker, MD<sup>2,3</sup>, Guy Shani, PhD<sup>1</sup>, and Itshak Melzer, PhD<sup>1</sup>**



# Other Clinical Indications



# Certifications

**FDA 510K EXEMPT & CE CLASS 1 MEDICAL DEVICES**



**ISO9001:2008 & ISO13485:2003**





Thanks for Your Time

