



# Freezing or Sweating Falls When Walking with Parkinson's Disease

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Dr. Horak has significant financial interest in ADPM, a company that may have a commercial interest in the results of this research and technology. This conflict has been reviewed and managed by OHSU.

## 1. Understand how the brain controls walking and balance

- Balance and gait should be automatic
- The basal ganglia works with the frontal cortex and brainstem

## 2. Discover what types of balance impairments result in freezing and falls

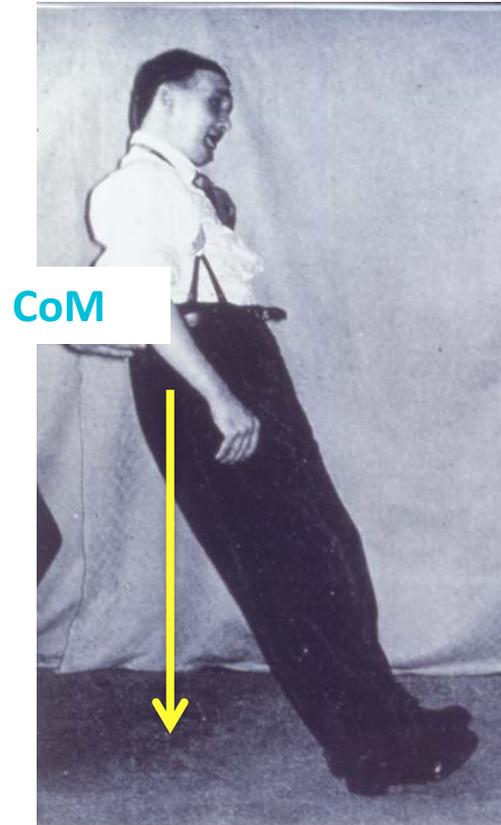
- Small stepping responses (multiple weight shifts)
- Lack of automaticity (dual-tasks)
- Inability to stop inhibition (cognitive deficit)

## 3. Explore what can be done to minimize freezing and falls

- Biofeedback and Cueing
- Exercise: Dance, Tai Chi, Agility, Cognitive

# What Is Balance?

An active brain process that controls the body center of mass over its base of support

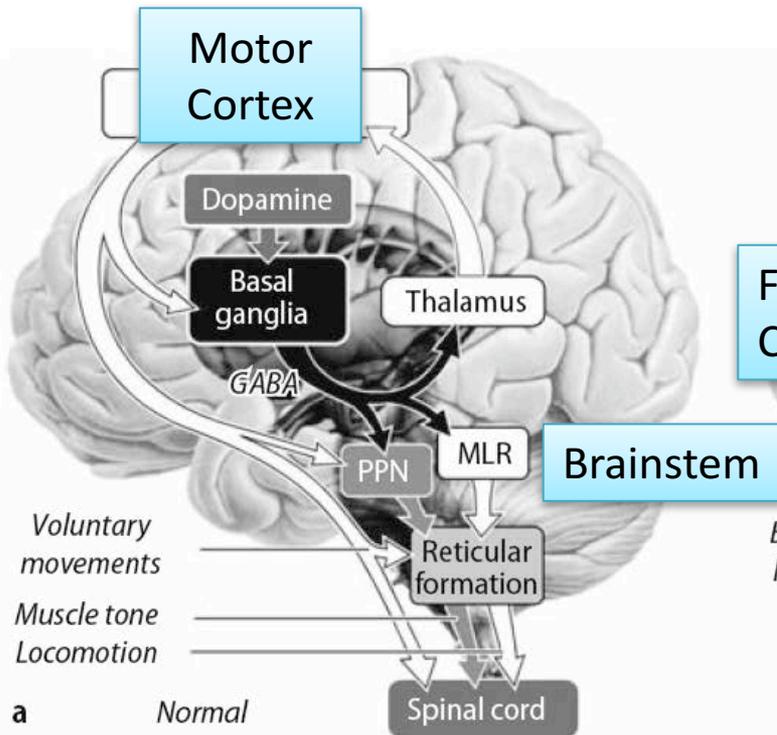


Walking is falling and catching yourself

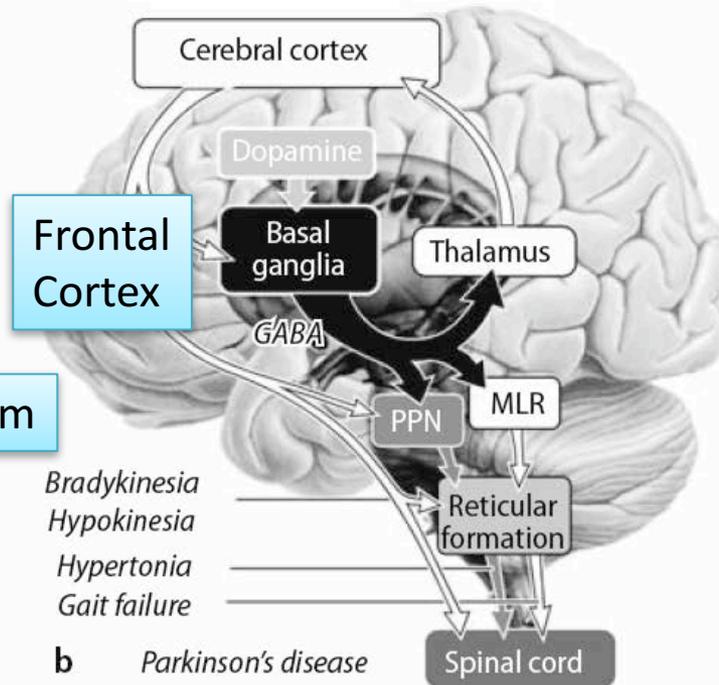


# Brain Control of Balance and Walking: What Goes Wrong in PD?

## Control



## Parkinson



PD: too much BG inhibition of Motor Cortex and Brainstem....

So rely more on Frontal (cognitive) cortex.

# What Is Freezing of Gait (FoG)?



*FoG:*

*“a brief, episodic absence or marked reduction of forward progression of the feet despite the intention to walk. A feeling the feet are glued to the floor...”*

*Usually associated with rapid trembling of the knees (weight shifting) as try to start walking.*

*Tricks can help overcome FoG.*

*Nutt, et al, Movement Disorders*

# Turning 360 Degrees is Best Way to Freeze

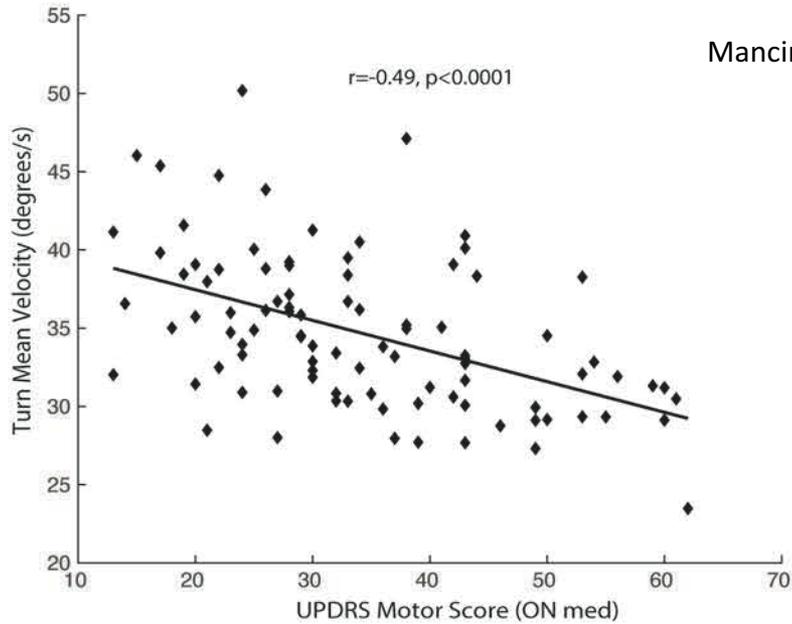
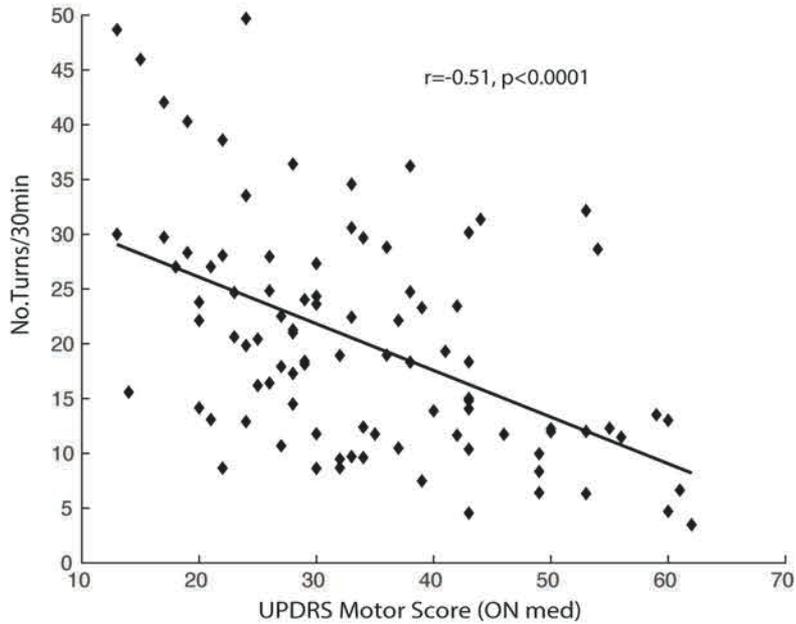
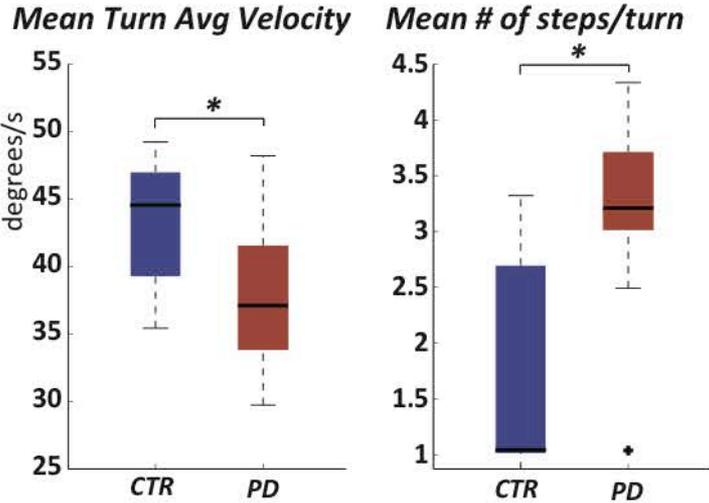


Falls while turning are common and dangerous-  
Lead to fractured hips!

# We Turn 1,000 Times a Day!



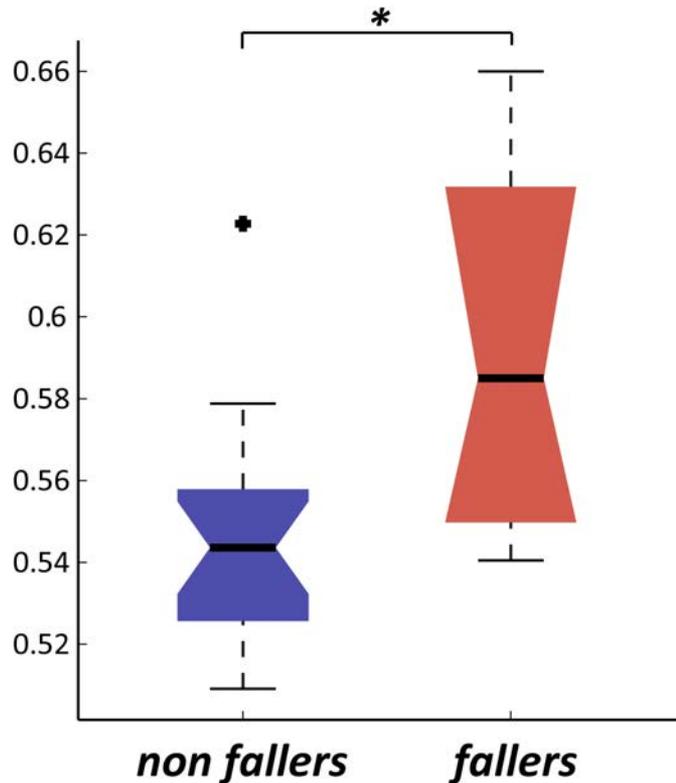
# Turning at Home Is Related to Severity PD



Mancini, et al, 2017

# Turning Variability at Home Predicts Falls

*CoV of mean # of steps/turn*

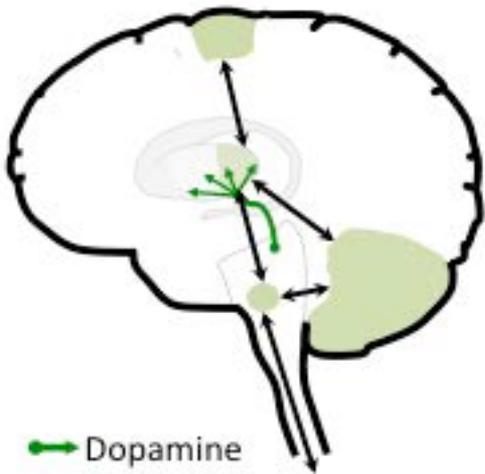


More variable turns may reflect less automatic turns.

Mancini et al,  
2016

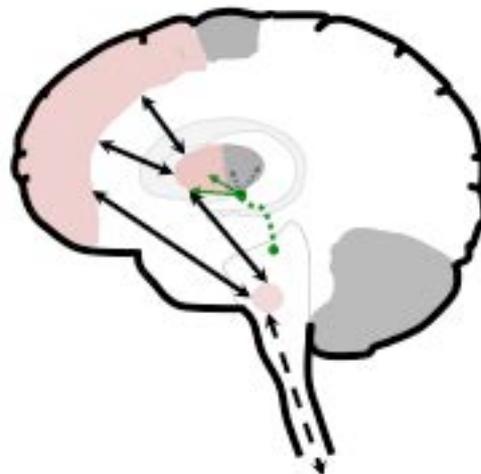
# Why are Balance and Walking Less Automatic in PD (especially with FoG)?

Healthy Subjects



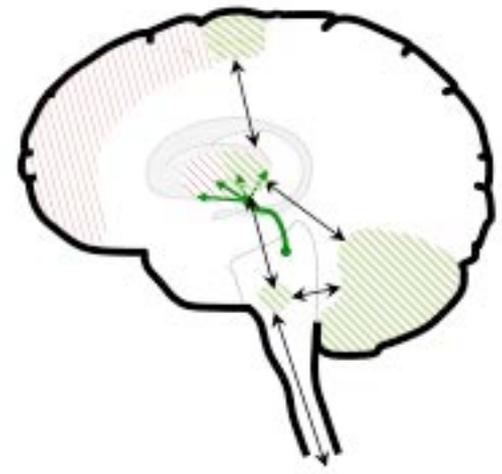
Automatic control

Parkinson's disease "off" with FoG



Frontal (cognitive) control

Parkinson's disease "on"



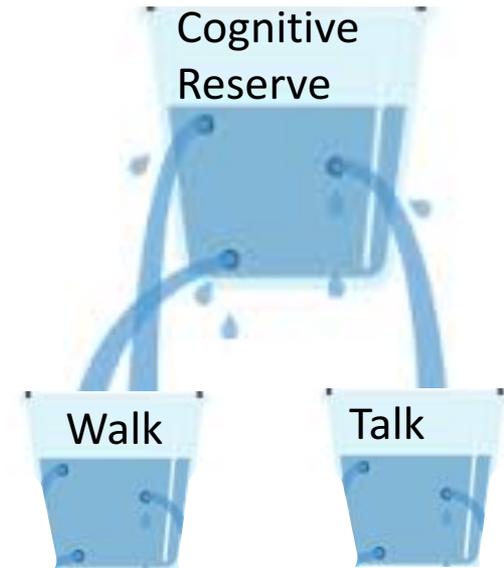
More automatic

Gilat et al. 2017

# Balance and Walking Need Attention

## More Attention in PD, esp. with FoG!

**Walking slows when talking**  
**Thinking slows when walking**



# More Difficult the Balance Task, the More Attention is Needed

But practice can make walking and turning more and more automatic



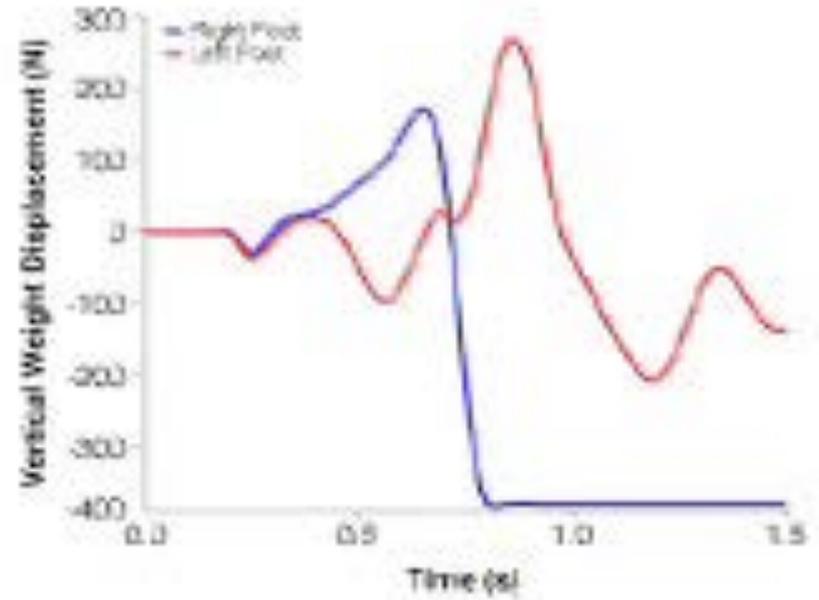
# Balance Stepping Response is Impaired by Dual Tasking

No Cognitive Task

With Cognitive Task



# Stepping to Recover Balance Requires Weight Shifts

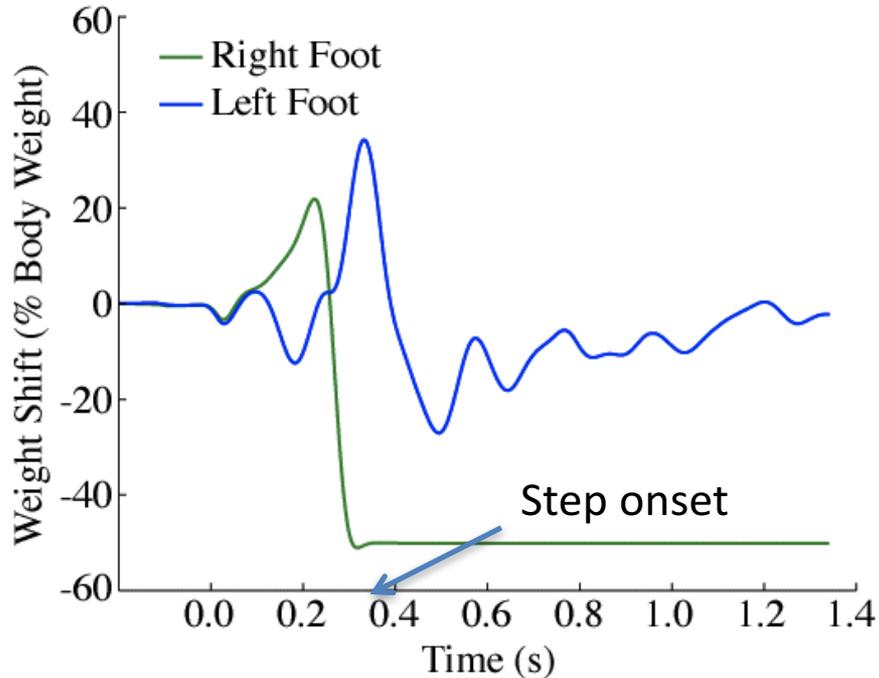


CTR

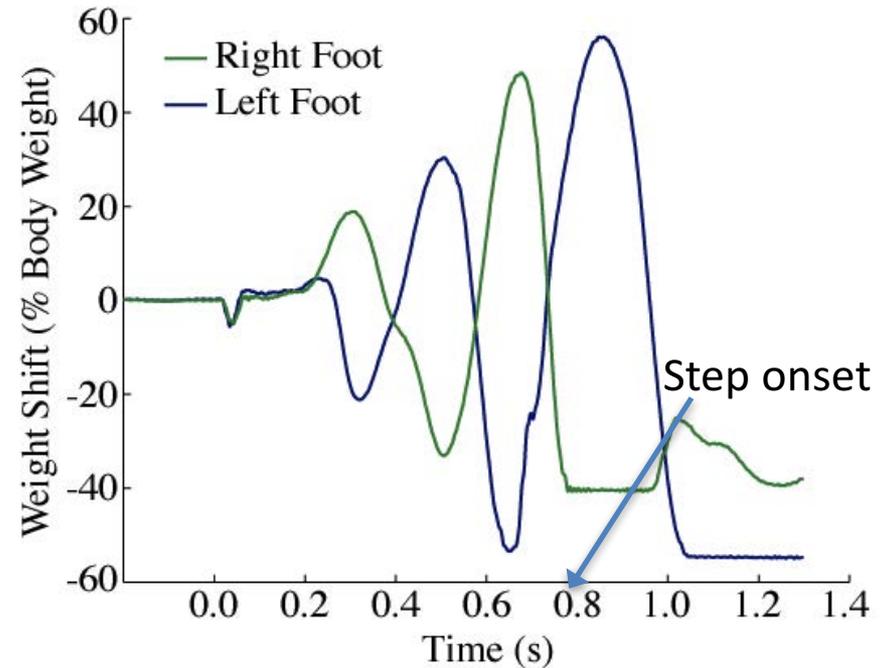
# Freezing is Associated with Multiple Postural Weight Shifts: As if Can't Inhibit Balance to Start Walking

Jacobs et al, *Exp Neurology* 2009

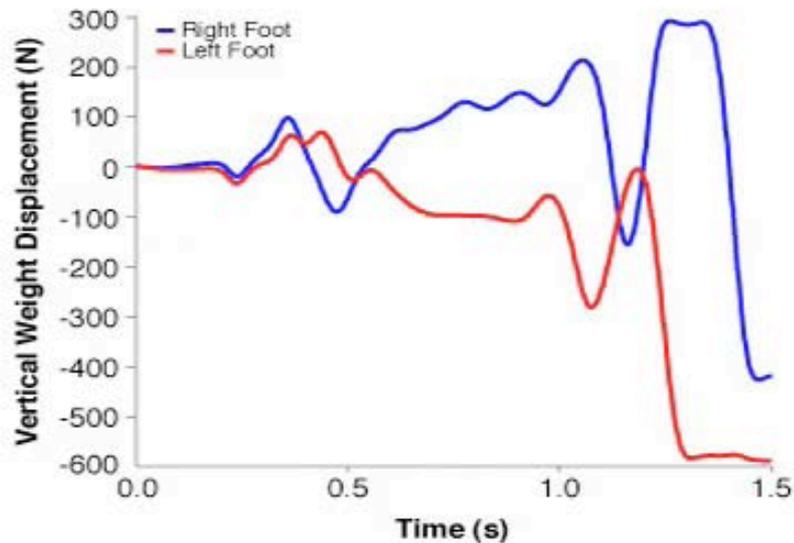
## Control Subject



## PD Subject

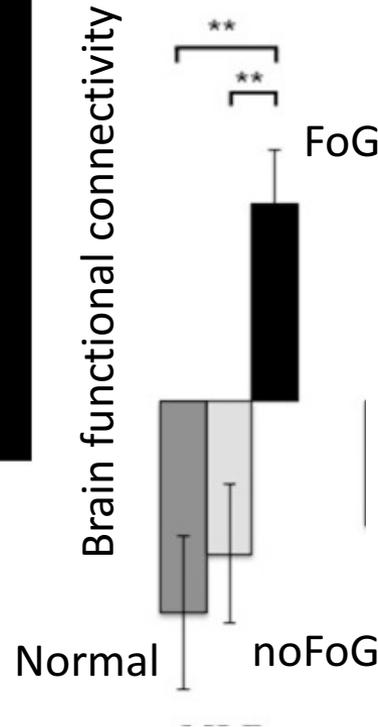
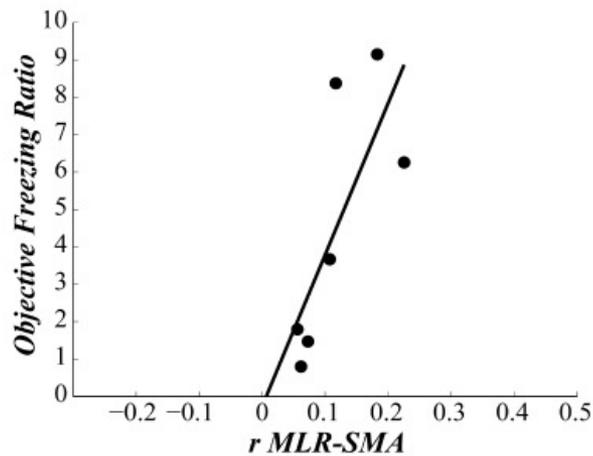
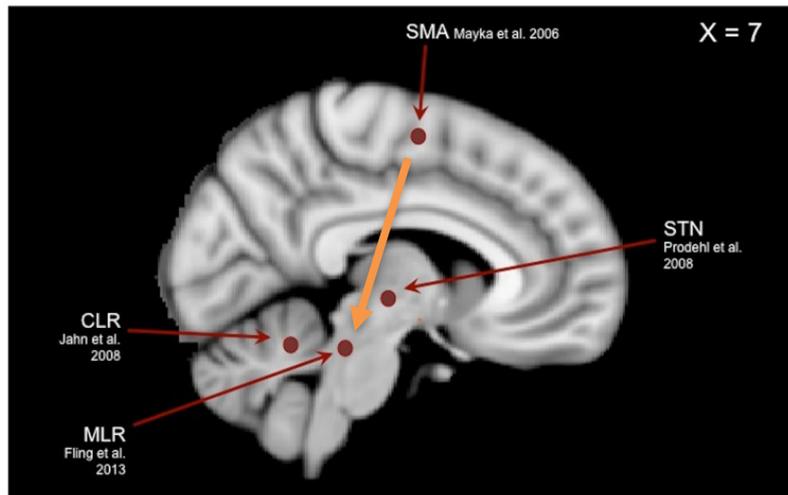


# Freezer Using Multiple Weight Shifts with Small Steps for Stepping Response.



**PD**

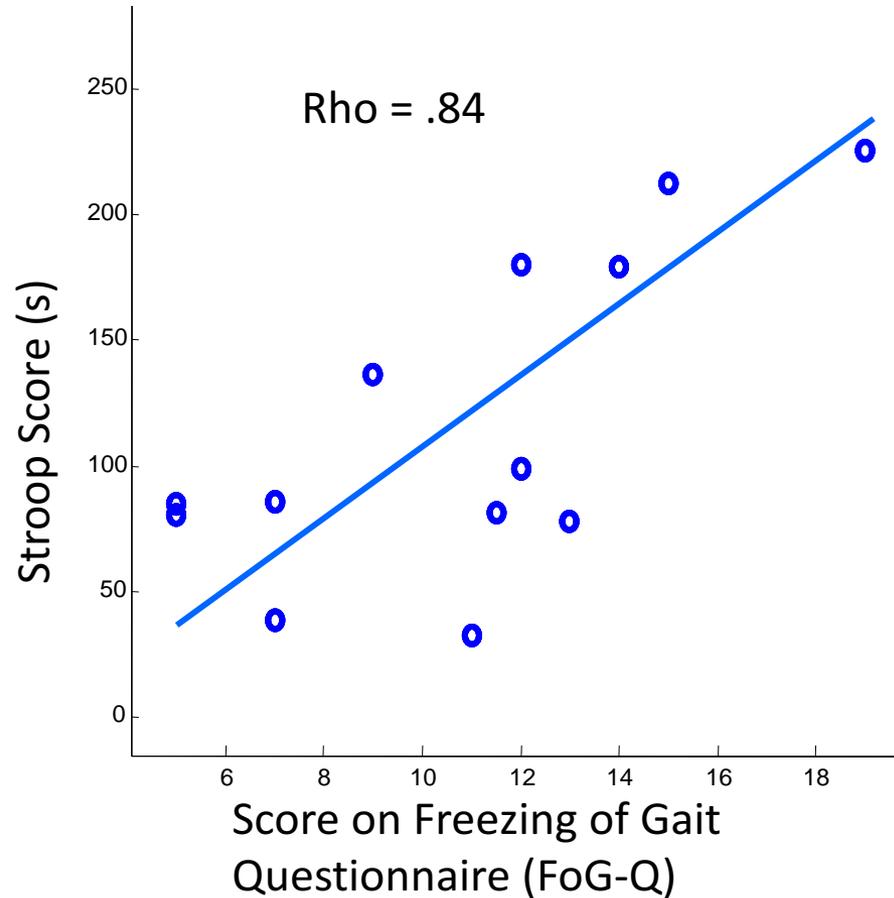
# FoG is Associated with Too Much Frontal Cortex Control of Brainstem



*FoG involves too much cognitive control of balance/gait so less automatic.*

Fling, et al, 2015

# Freezers Have Difficulty Releasing Inhibition So Can “Go”

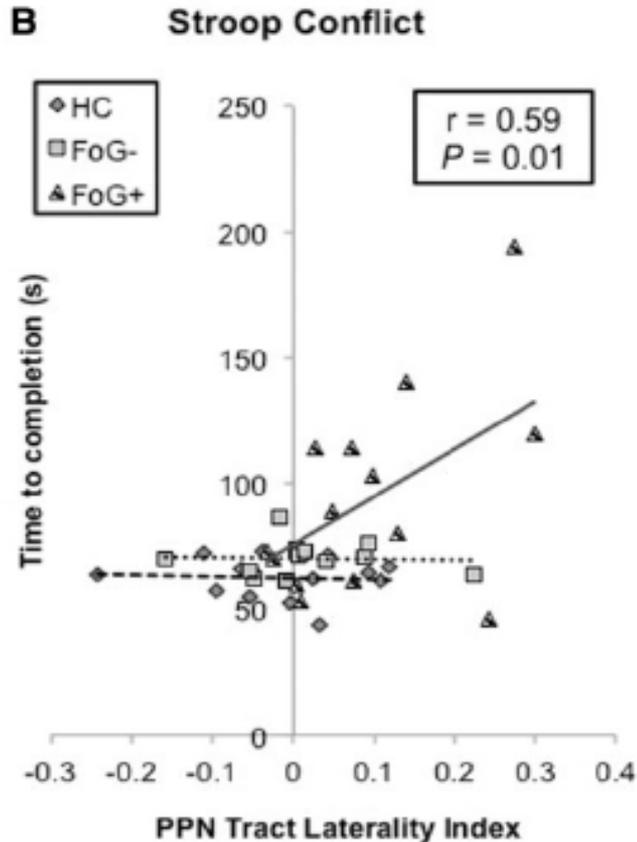


## Stroop Inhibition Test

<b>BLUE</b>	<b>GREEN</b>	<b>YELLOW</b>
<b>PINK</b>	<b>RED</b>	<b>ORANGE</b>
<b>GREY</b>	<b>BLACK</b>	<b>PURPLE</b>
<b>TAN</b>	<b>WHITE</b>	<b>BROWN</b>

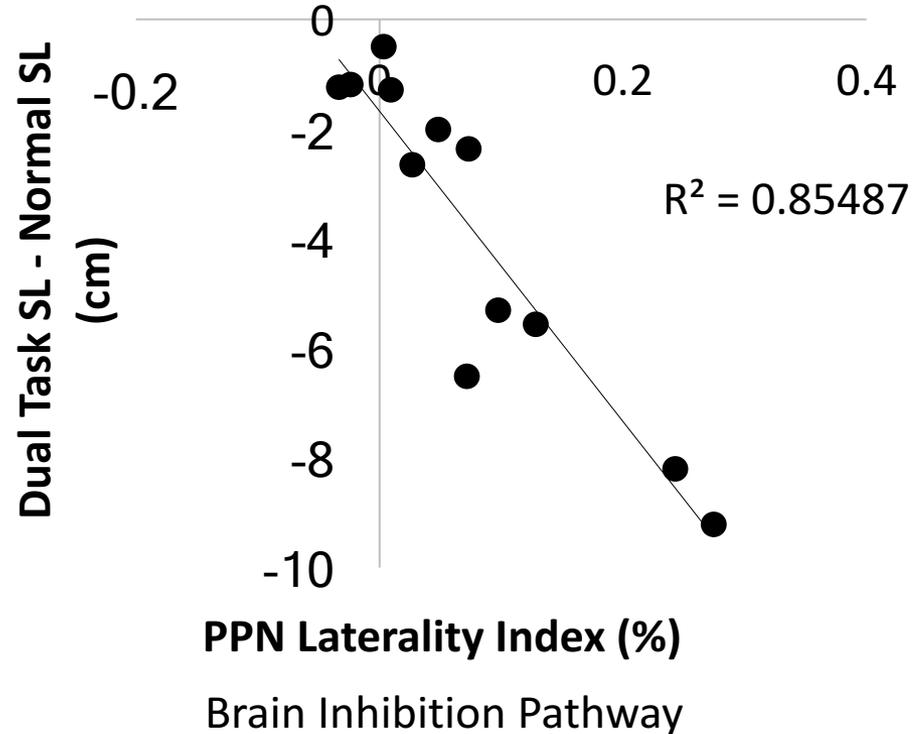
Cohen et al, 2014  
Park and Related Disorders

# Stroop Cognitive Task and Dual Task Cost on Gait are Both Related to Brain Inhibition Pathway from Frontal Cortex to Brainstem.



Brain Inhibition Pathway

Fling et al. *Brain* 2013



Brain Inhibition Pathway

Peterson et al. 2017

# Why Is it Hard to Walk and Chew Gum?

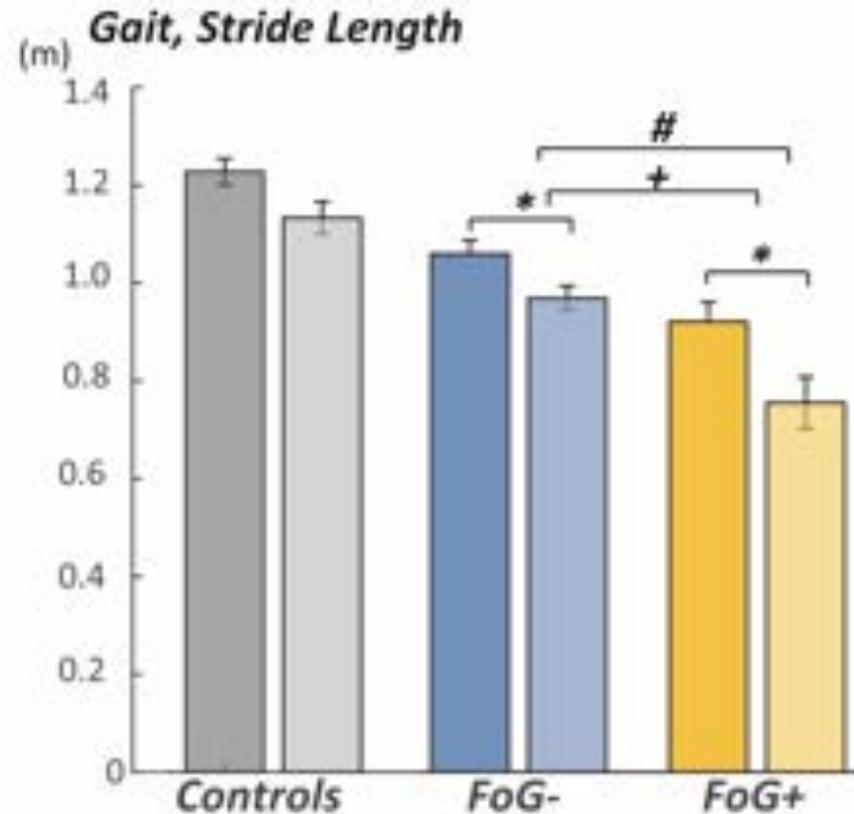
## Attention is required for balance!

- It is difficult for the brain to control balance and thinking at the same time
- Poor balance requires more attention
- Attention can be reduced by aging and PD
- As skilled tasks become more AUTOMATIC, they require less attention



# Freezers Require More Attention for Balance and Walking

Dual Task Cost is larger in Freezers than Nonfreezers for balance and walking.

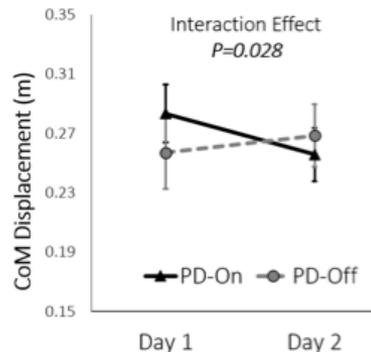
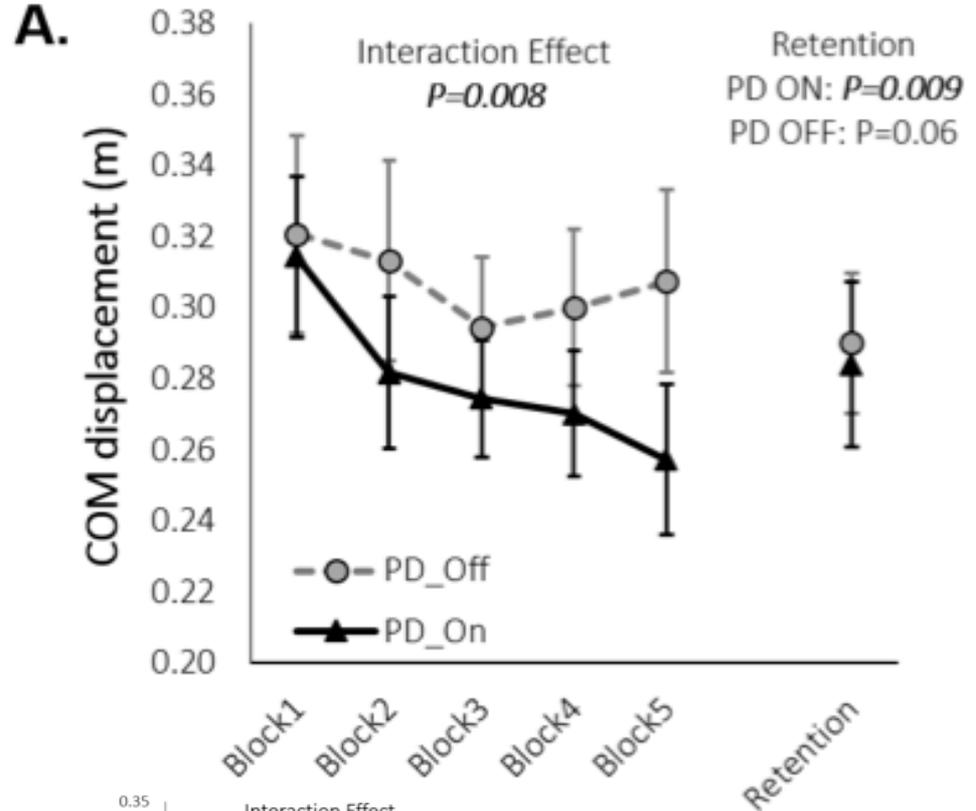
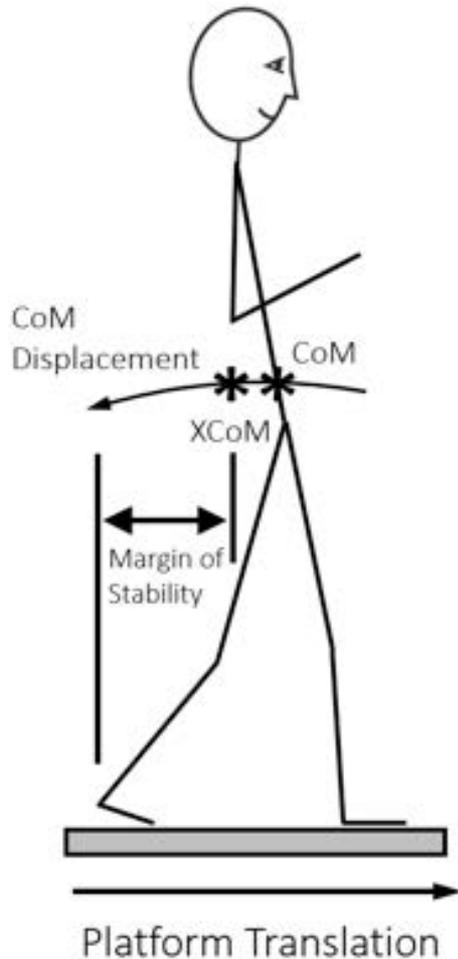


Bienvénida *Gait and Posture*, 2017

# Can PD Balance be Improved? YES!

But take your levodopa for learning!

“Backward Perturbation”



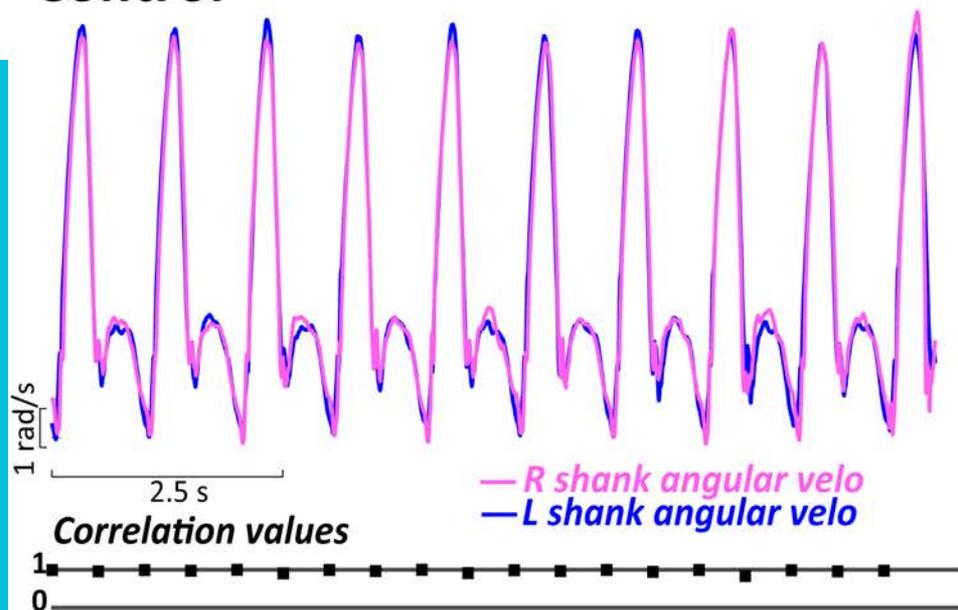
Improved backward stepping doesn't transfer to lateral steps

# Improved Balance Responses with Practice: Especially When ON Levodopa

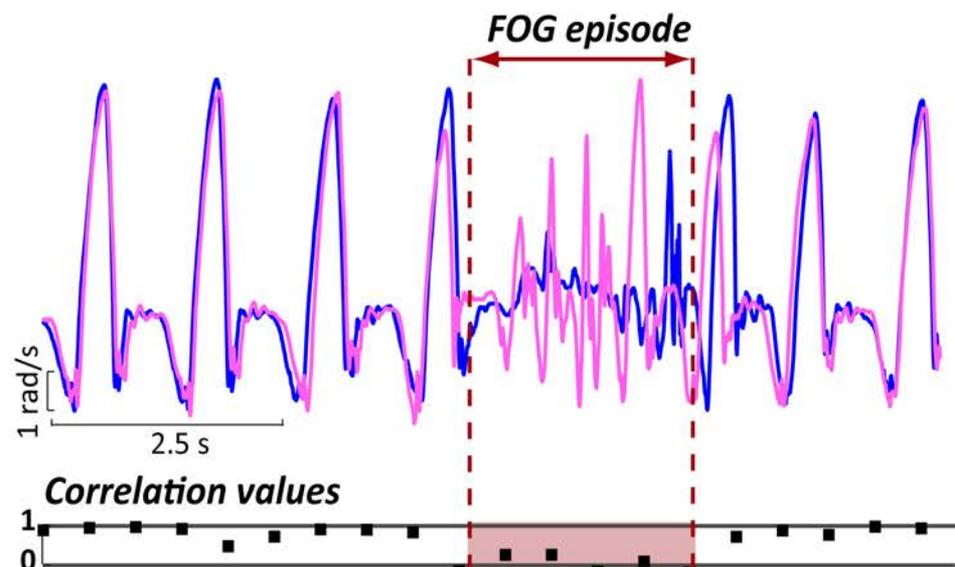


# Biofeedback to Reduce Freezing of Gait

## Control

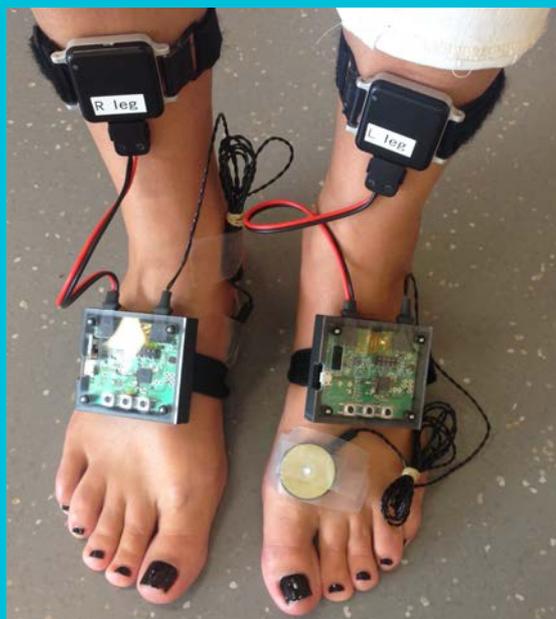


## PD FOG+

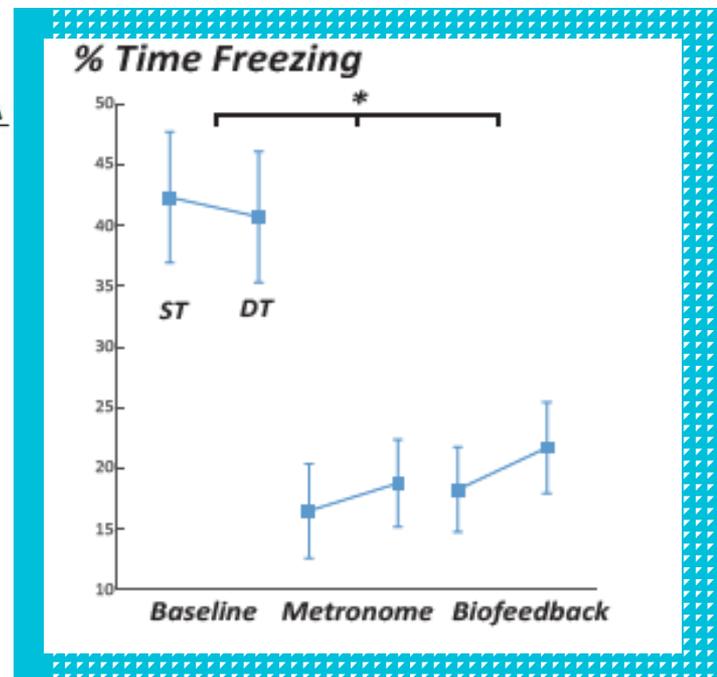
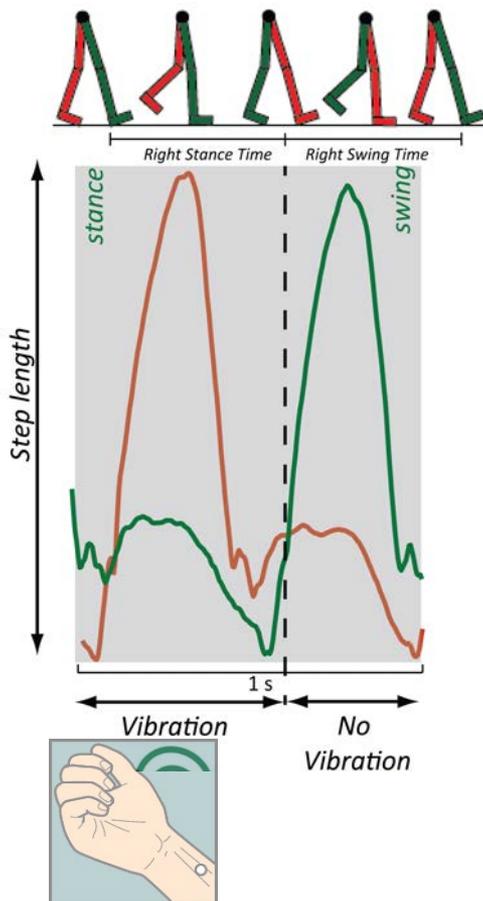


**Better Lives. Together.**

# Tactile Biofeedback During Stance Phase Reduces FoG



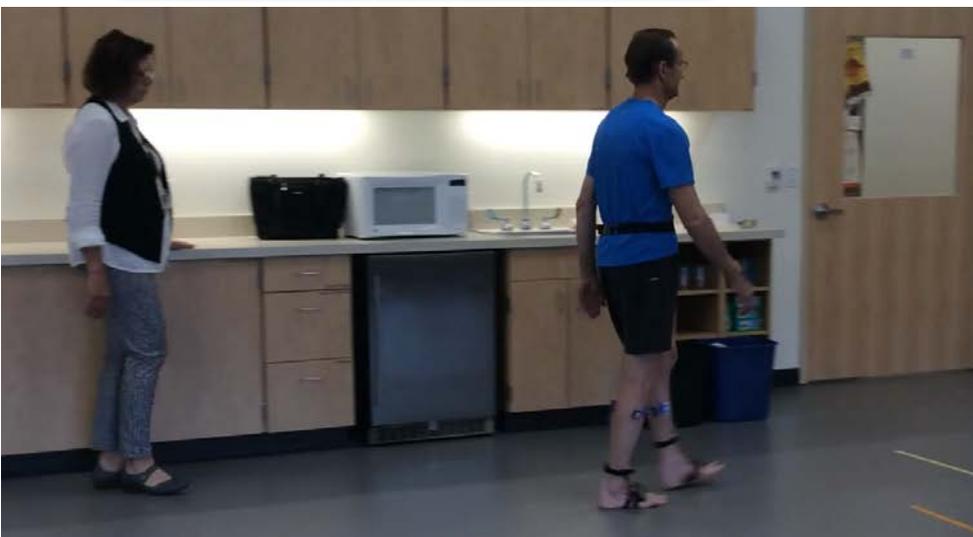
Mancini, et al, MDS, 2016



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# Vibrotactile Biofeedback Can Reduce FoG

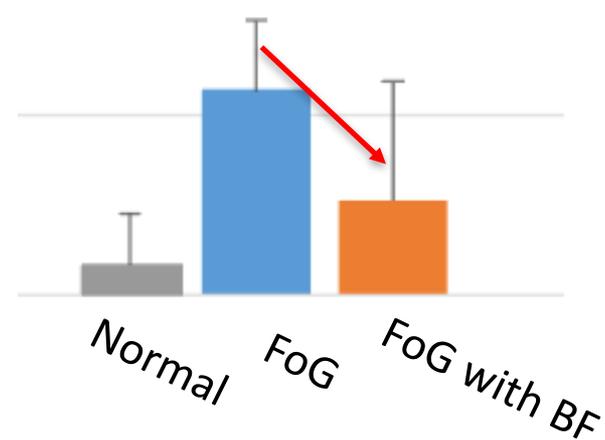
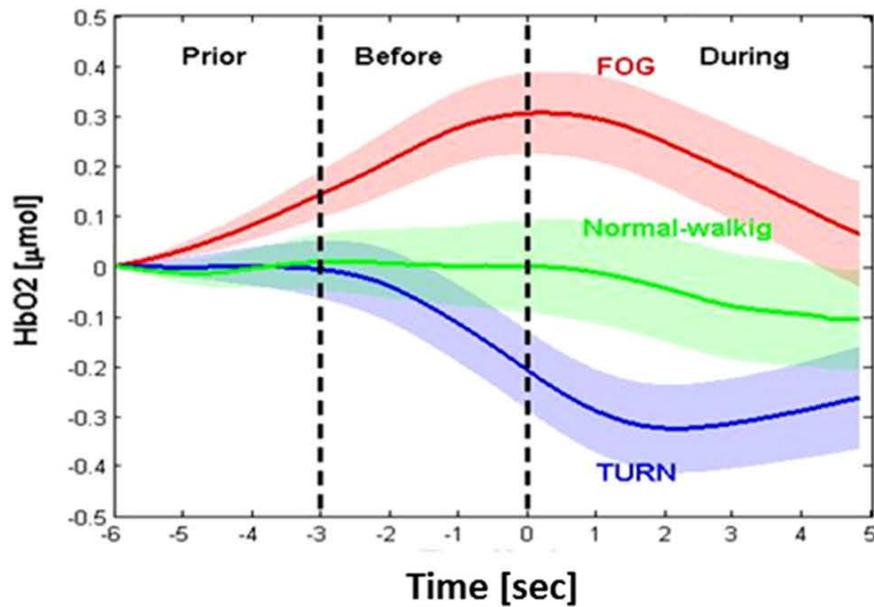
Baseline Freezing during Turns



Less Freezing with Vibrotactile Biofeedback



# Frontal Brain Activity Increases Before FoG Biofeedback Can Reduce this Hyperactivity



# Exercise

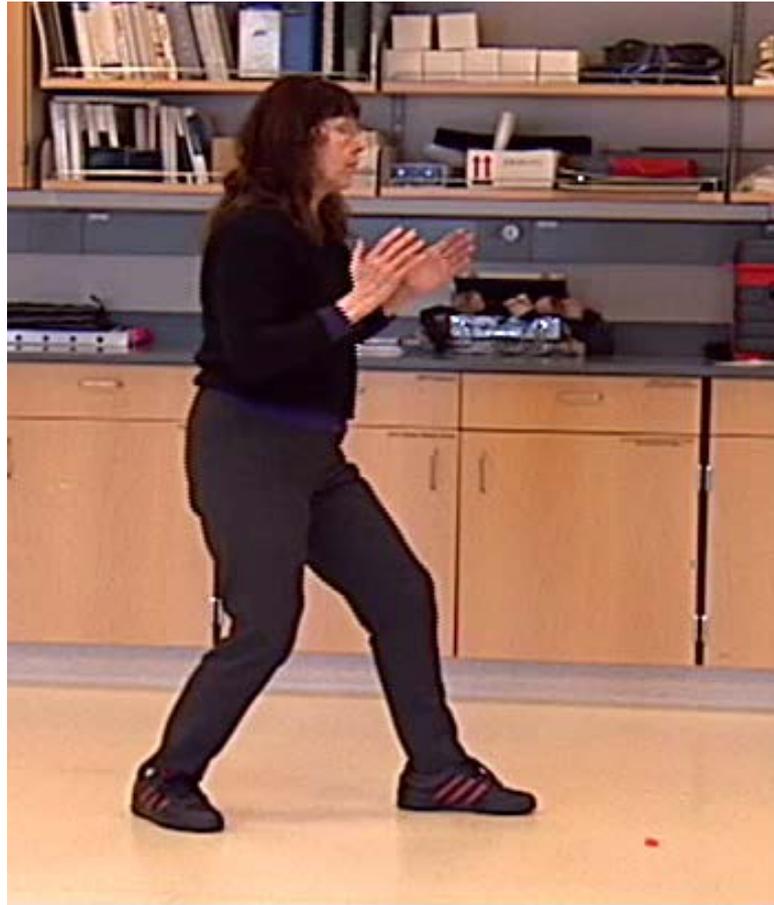


- The only intervention that significantly reduces risk of falling!

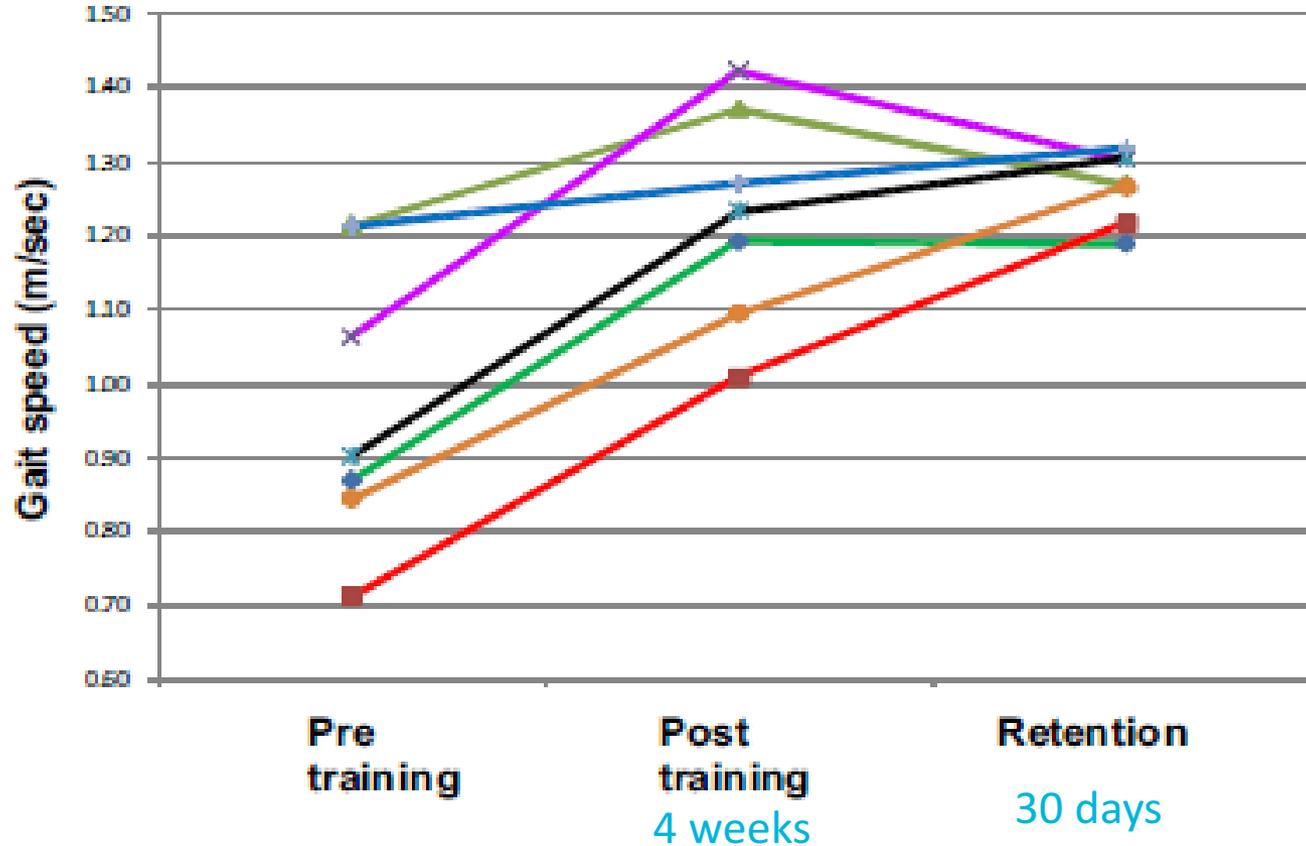
(Gillespie et al, Cochrane Review, 2009)

- People receiving Balance Exercises were 20% less likely to fall.

# Exercises to Improve Balance

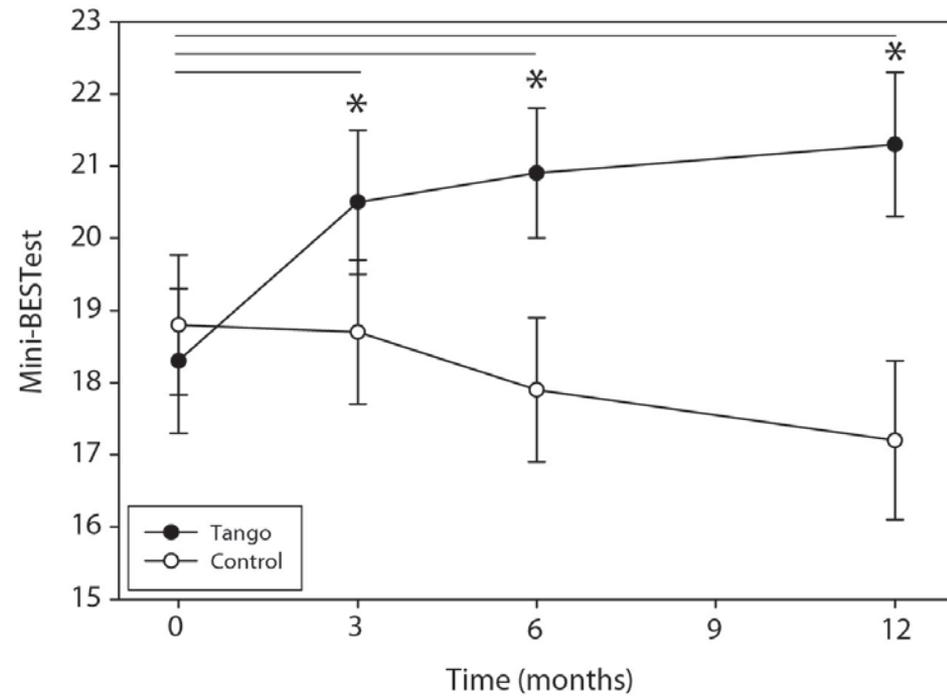


# Dual Task Walking in People with PD Can Improve with Training!



Killane, 2015

# Tango Can Improve Balance in PD



Earhart, G, et al

# Boxing Can Improve Balance

## Before practice



## After 4 weeks practice



# Agility Boot Camp



walking



PWR moves®



lunges



agility course



boxing



tai chi



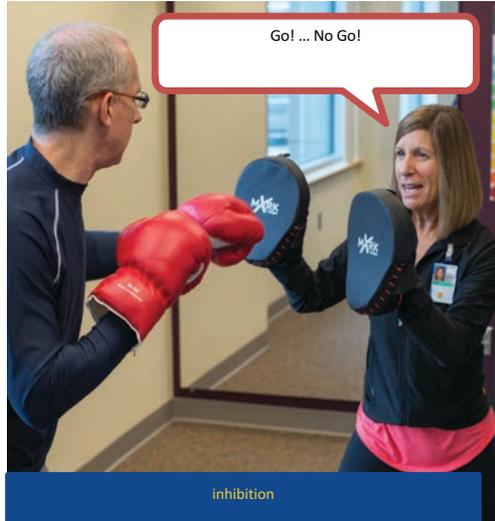
dual tasking



prioritization



set shifting



inhibition

# FoG When Challenging and Stressful

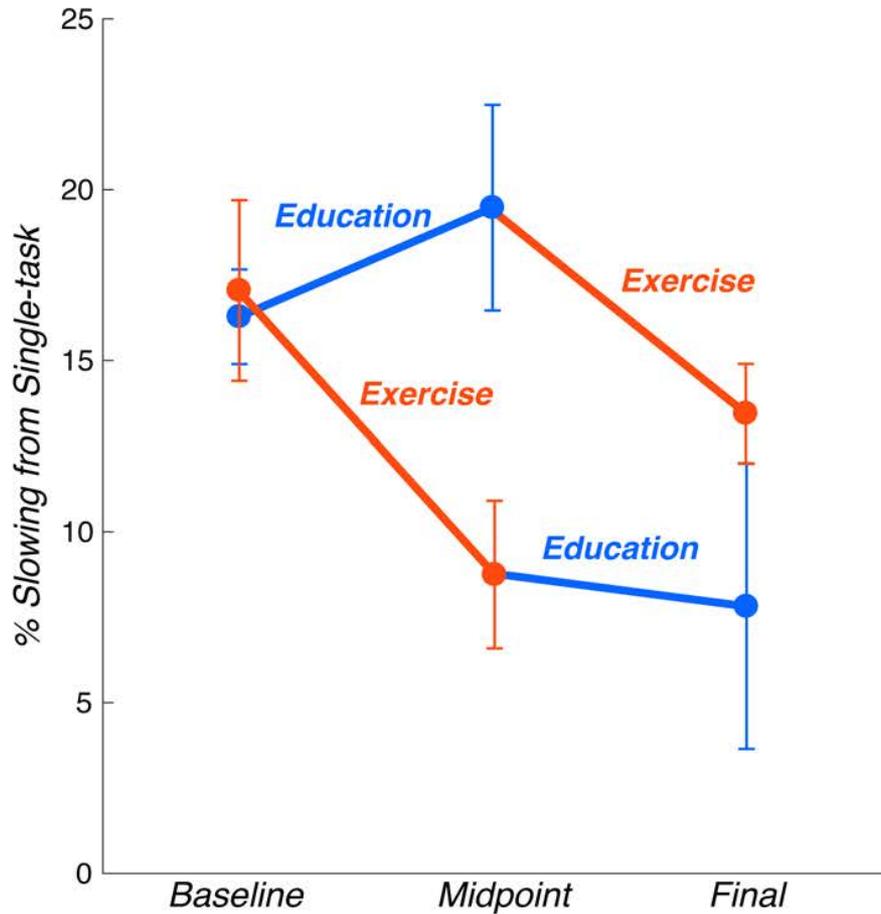


# FoG Improves with Practice

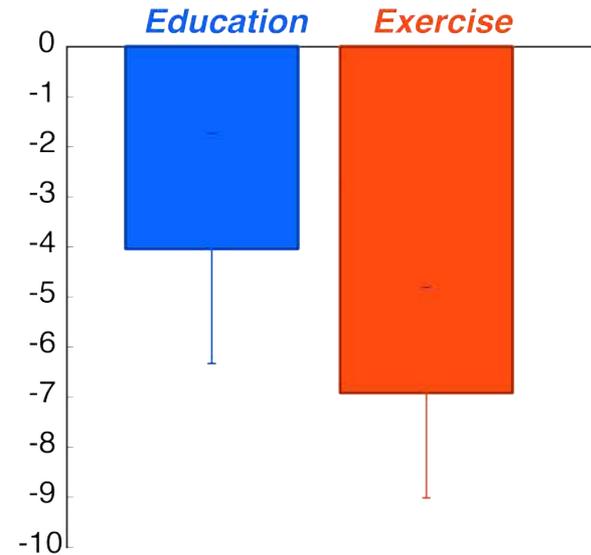


# Exercise Can Improve Dual Task Cost

*DT cost on Gait Speed*

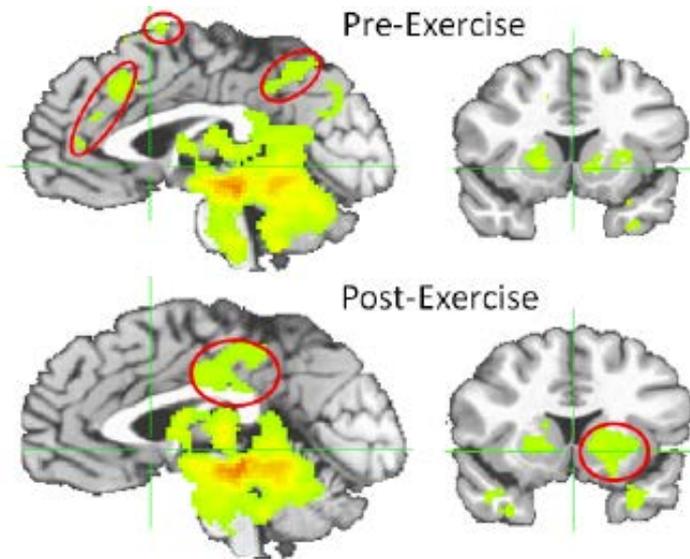
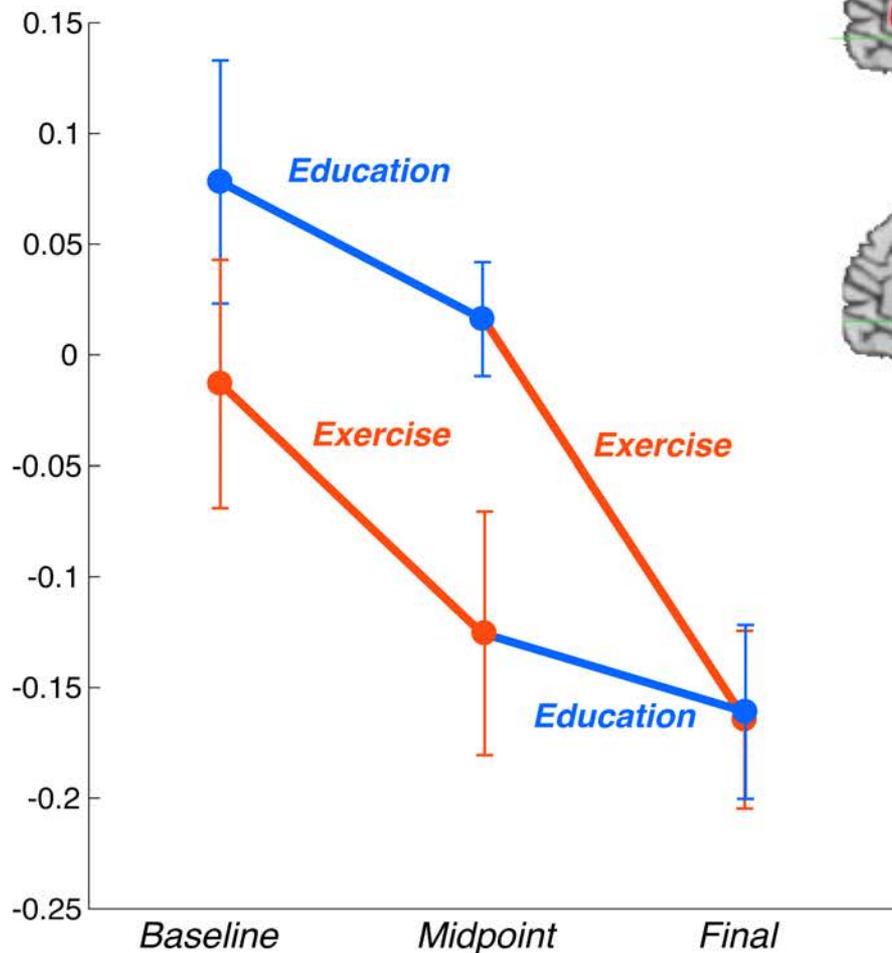


*DT cost on Gait speed*

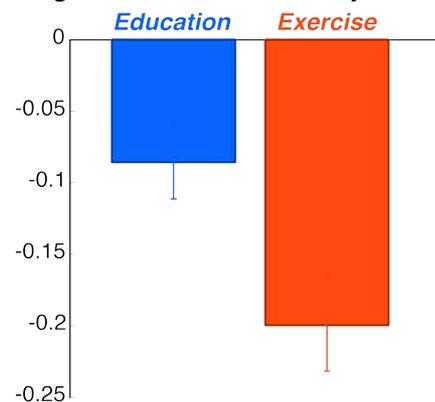


# Exercise Can Improve Brain Connectivity

### Right SMA-PPN Connectivity



### Right SMA-PPN Connectivity



# Good Exercises for PD

- Make you sweat (>80% HR)!
- At least 3x/week
- At least 30 minutes
- Get harder as you get better!
- Join others to stick with it!
- Variety is the spice of life!



# Main Summary Points



- Balance and gait should be automatic.
- PD and FoG results in less automatic control of balance/gait.
- Freezing and falls in PD:
  - Small stepping responses
  - Lack of automaticity (dual-tasks)
  - Inability to stop inhibition (cognitive deficit)
- Exercise can reduce falls

# OHSU Balance Disorders Laboratory



## Sponsors:

- The NIH-National Institute on Aging
- The Kinetics Foundation
- The NIH-National Institute of Neurologic Disorders and Stroke
- NIH- National Center of Medical Rehab Research
- Oregon Health and Science University
- Department of Veterans Affairs

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# Upcoming Educational Programs

## Allied Team Training for Parkinson's Disease™ (ATTP)

ATTP is a three-day course designed to increase knowledge of PD and build capacity for comprehensive inter-professional care in the treatment of Parkinson's disease.

*Vancouver, BC Canada from April 4-6, 2018*

[Parkinson.org/attp](http://Parkinson.org/attp)

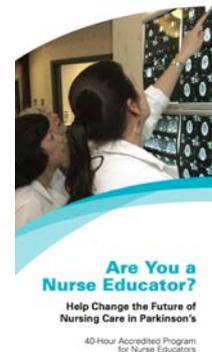


## Nurse Faculty Program

Apply to the Edmond J. Safra Visiting Nurse Faculty Program to help us prepare the next generation of nurses to care for the growing population of people with PD.

[Parkinson.org/edmondjsafranursing](http://Parkinson.org/edmondjsafranursing)

THE EDMOND J. SAFRA  
VISITING NURSE FACULTY PROGRAM  
at Parkinson's Foundation



## Physical Therapy Faculty Program

Learn from internationally recognized PT experts in an intimate classroom setting and help change the future of physical therapy care in Parkinson's.

[Parkinson.org/ptfaculty](http://Parkinson.org/ptfaculty)



**Physical Therapy**  
FACULTY PROGRAM  
Parkinson's Foundation



## Order Materials

Information about Parkinson's symptoms, medications, resources and more.

[Parkinson.org/books](https://parkinson.org/books)

## Aware in Care Kit

Includes tools and information for people with PD to share with hospital staff during a planned or emergency hospital stay.

[Parkinson.org/awareincare](https://parkinson.org/awareincare)



## National Helpline

Available at 1-800-4PD-INFO or [helpline@parkinson.org](mailto:helpline@parkinson.org) Monday through Friday 9:00 AM – 5:00 PM ET.

## Podcast: Substantial Matters

New episodes every other Tuesday featuring Parkinson's experts highlighting treatments, techniques and research.

[Parkinson.org/podcast](https://parkinson.org/podcast)

