Freezing or Sweating Falls When Walking with Parkinson’s Disease

Fay B. Horak, Ph.D, PT
Professor of Neurology
Oregon Health & Science University
Parkinson’s Foundation Center of Excellence

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Disclosure

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.
Objectives

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

Motor Cortex

Motor Cortex

Brainstem

Parkinson

Cerebral cortex

Bradykinesia

Hypokinesia

Hypertonia

Gait failure

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

So rely more on Frontal (cognitive) cortex.

Voluntary movements

Muscle tone

Locomotion

a Normal

Spinal cord

b Parkinson’s disease

Spinal cord

Dopamine

Basal ganglia

GABA

Thalamus

PPN

MLR

Reticular formation

Forward tilt of trunk

Reduced arm swinging

Rigidity and trembling of extremities

Shuffling gait with short steps

Forward tilt of trunk

Reduced arm swinging

Rigidity and trembling of extremities

Shuffling gait with short steps
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

More variable turns may reflect less automatic turns.

Mancini et al, 2016
Why are Balance and Walking Less Automatic in PD (especially with FoG)?

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

Freezing of postural stepping.

Jacobs, Exp Neurology 2009

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

- BLUE
- GREEN
- YELLOW
- PINK
- RED
- ORANGE
- GREY
- BLACK
- PURPLE
- TAN
- WHITE
- BROWN

Rho = .84

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

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.

Bienvenida Gait and Posture, 2017
Can PD Balance be Improved? YES!

But take your levodopa for learning!

Improved backward stepping doesn’t transfer to lateral steps
Improved Balance Responses with Practice: Especially When ON Levodopa
Biofeedback to Reduce Freezing of Gait

Mancini and Horak, 2015
Tactile Biofeedback During Stance Phase Reduces FoG

Vibrotactile Biofeedback Can Reduce FoG

Frontal Brain Activity Increases Before FoG
Biofeedback Can Reduce this Hyperactivity

![Graph showing frontal brain activity increases before FoG and how biofeedback can reduce this hyperactivity.](image-url)
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!

Gait speed (m/sec)

- Pre training
- Post training
- Retention

4 weeks
30 days

Killane, 2015
Tango Can Improve Balance in PD

Earhart, G, et al
Boxing Can Improve Balance

Before practice

After 4 weeks practice
FoG When Challenging and Stressful
FoG Improves with Practice
Exercise Can Improve Dual Task Cost

**DT cost on Gait Speed**

- **% Slowing from Single-task**
  - Baseline
  - Midpoint
  - Final

**DT cost on Gait speed**

- **Education**
- **Exercise**

Exercise Can Improve Brain 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
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

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

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

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
Educational Resources

Order Materials
Information about Parkinson’s symptoms, medications, resources and more.
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

National Helpline
Available at 1-800-4PD-INFO or 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