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Postural Instability in Parkinson's Introduction

Presented by Dr Melissa McConaghy
Specialist Neurological Physiotherapist

Module 1 - Live 4th June

Pathophysiology of Postural Instability in Parkinson's disease, with Dr Melissa McConaghy
60 minutes

Module 2

Research to Clinical Practice: The Link Between Cognition and Mobility, with Dr. Rosie Morris
60 minutes

Module 3

Vestibular Theory
60 minutes

Module 4 - Live 18th June

Finding Balance - Vestibular Treatment Strategies for Postural Instability in Parkinson's, With Kumbelin Levin
60 minutes

Module 5

Theory of External Perturbation & Proprioception in Parkinson's, with Dr. Paulo Pelicioni
60 mins

Module 6

Practical Applications: External Perturbation & Proprioception
60 minutes

Module 7 - Live 16th July

Part 1: Freezing of Gait Theory, with Prof. Moran Gilat
60 minutes

Module 8 - Live 16th July

Part 2: Freezing of Gait Practical Applications , with Prof. Moran Gilat
60 minutes

Course Objectives

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- Master the underpinning knowledge
- Build your confidence
- Strengthen your clinical reasoning skills
- Learn practical, real-world strategies
- Be guided by experienced clinicians
- Learn to enhance patient outcomes and support functional independence in your Parkinson's clients

What Is Parkinson's disease?

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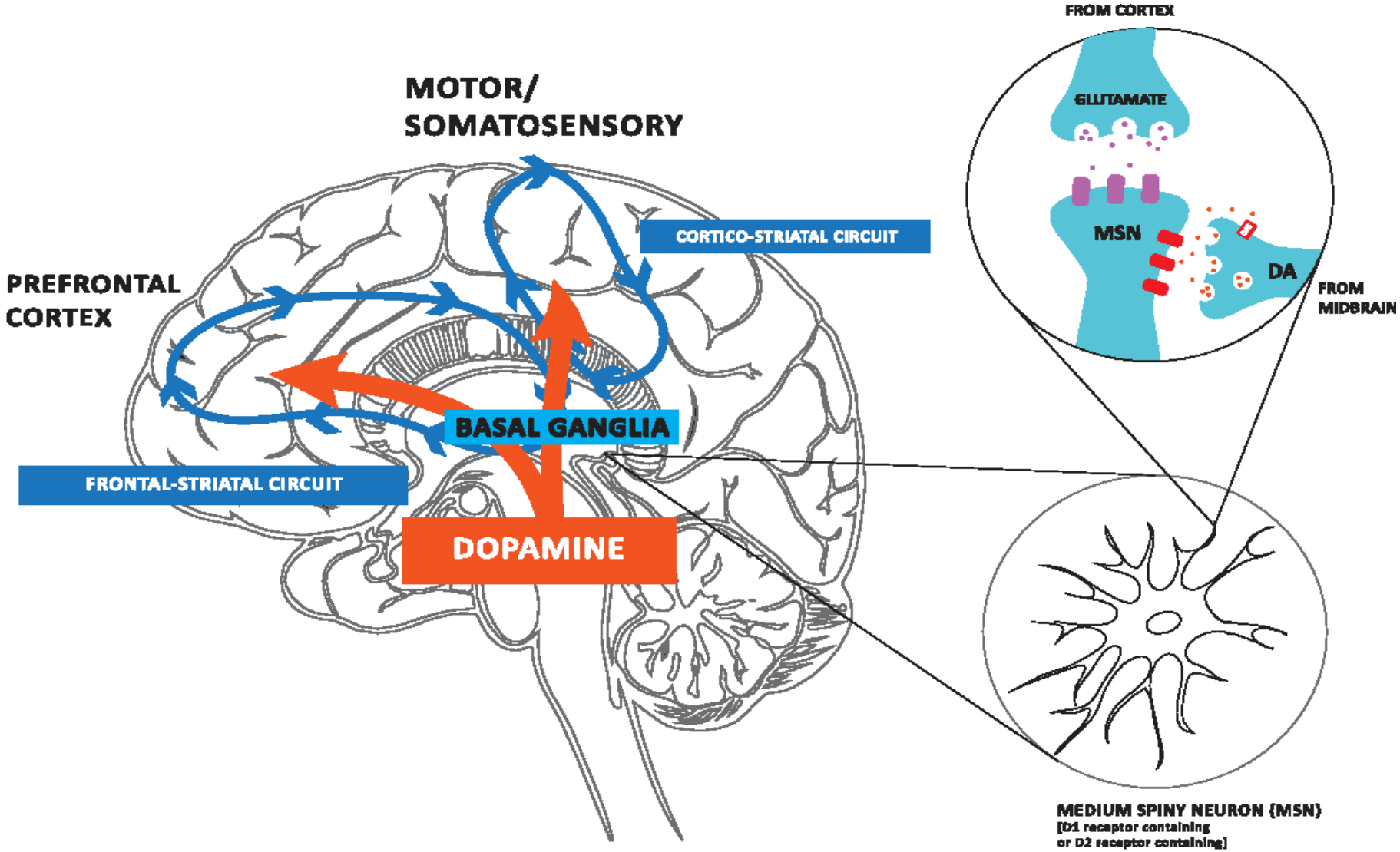
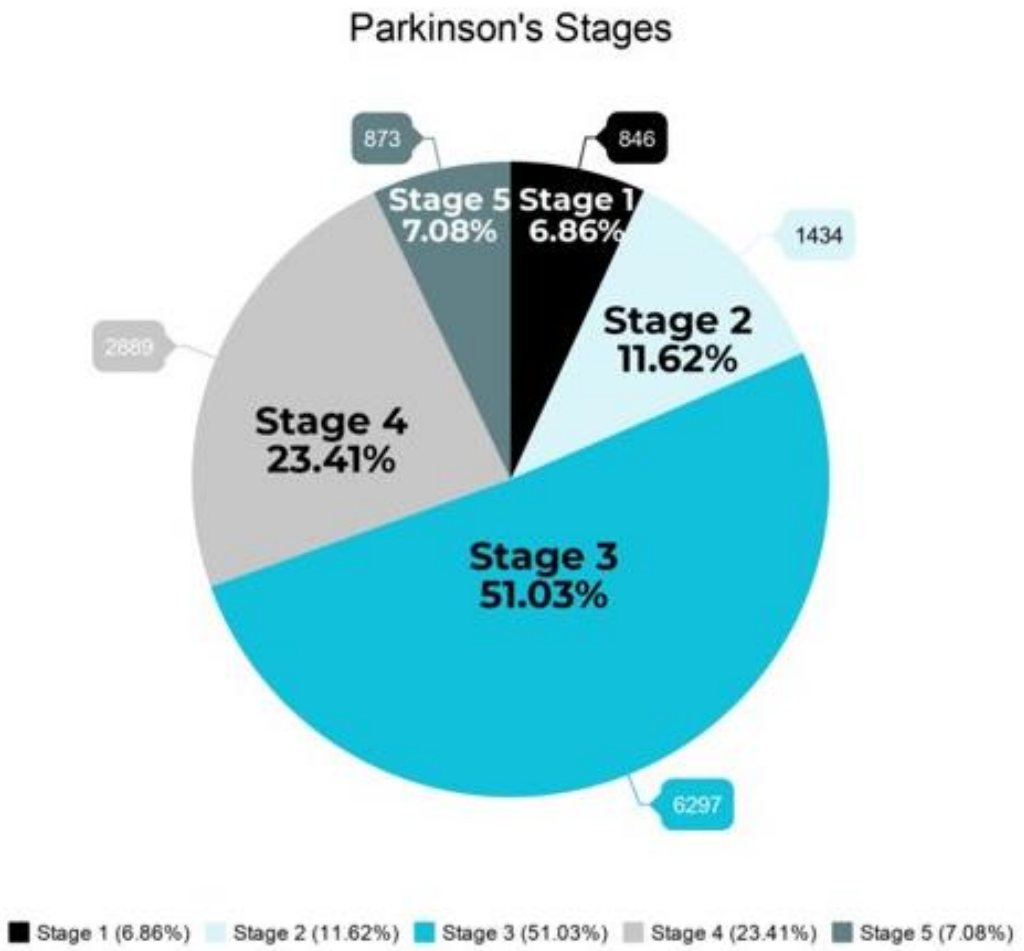


What is Parkinson's disease

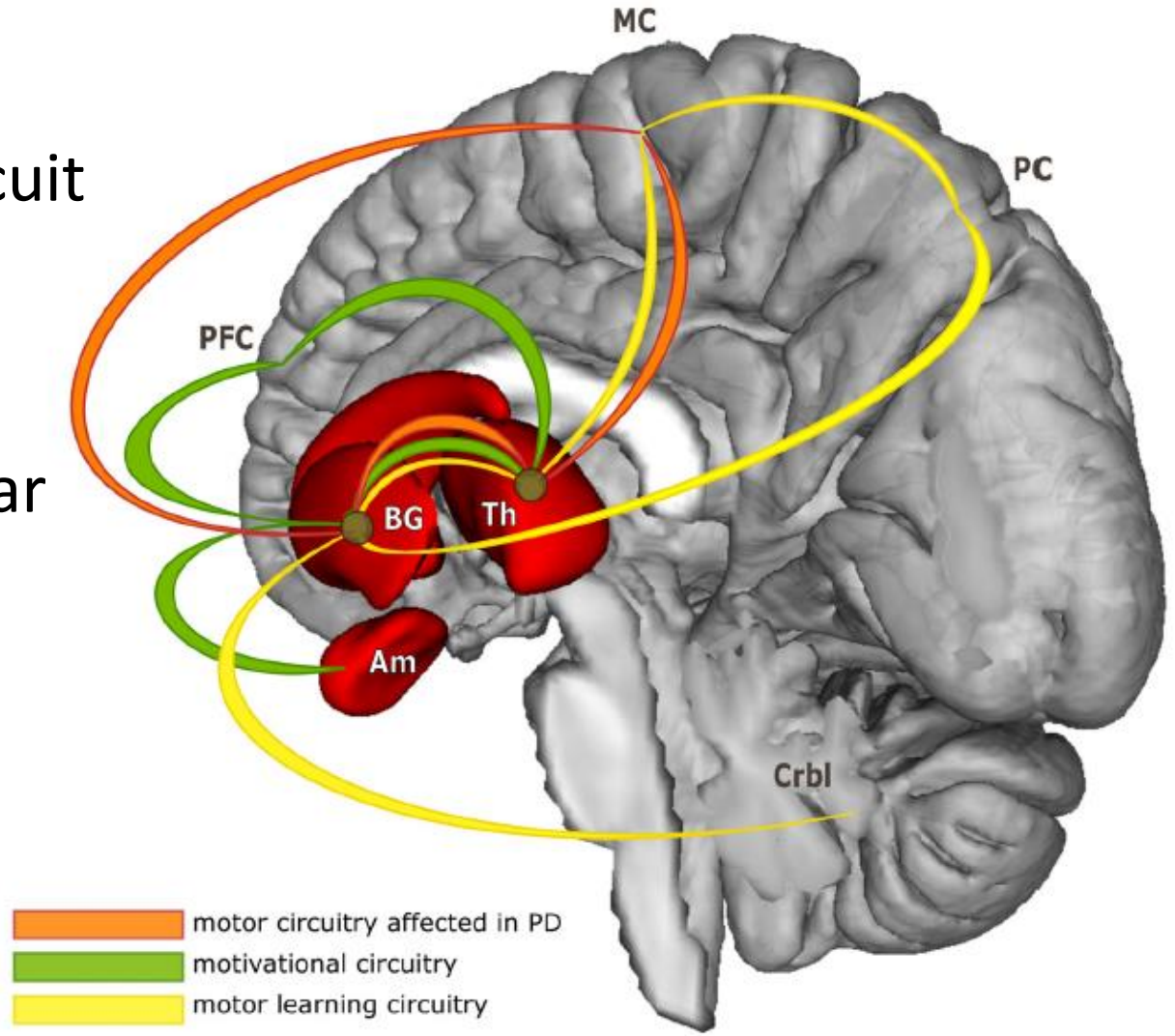
- Men are 1.5 times more likely to have Parkinson's than women
- 200,000+ in the total Australian population
- 10% of people diagnosed with Parkinson's are under the age of 45
- 18% of people with Parkinson's are of working age i.e under 65 (including YOPD)
- Parkinson's is increasing by 4%+ per year



Parkinson's Australia 2025, Deloitte Access Economics 2015, Parkinson's Foundation 2009-2018x

Brain Circuit Interference

- Cortico-striato-thalamo-cortical circuit
- Cerebello-thalamo-cortical circuit
- Meso-cortico-limbic circuit
- Cortico-striato and cortico-cerebellar



Zemankova et al 2016

At which stage of Hoen & Yahr does postural instability first appear?

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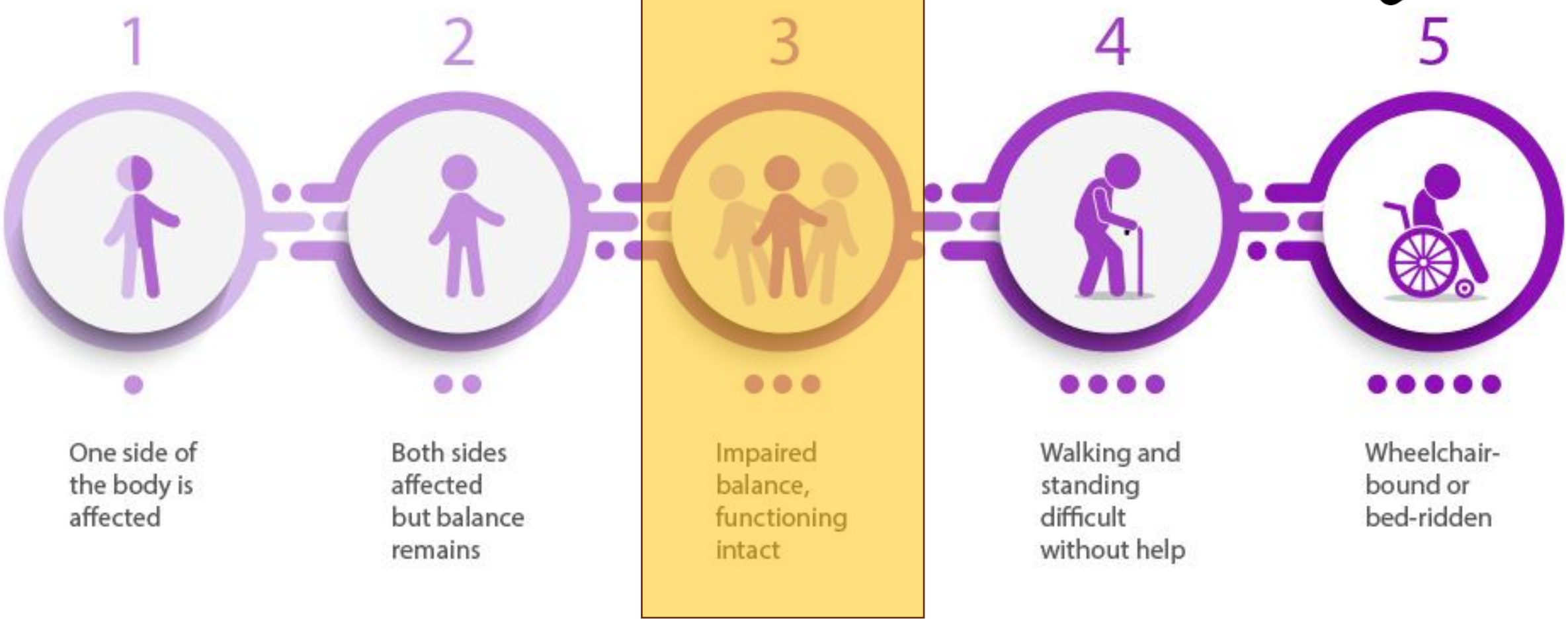

Which of the following best characterises postural instability in Parkinson's?

A. Enhanced proprioceptive feedback and rapid postural reflexes during balance challenges

B. Difficulty with anticipatory postural adjustments, increased sway with eyes closed, and possible falls

C. Upright posture with brisk, coordinated postural responses and minimal freezing of gait

D. Improved balance on unstable surfaces and reduced risk of falls due to compensatory mechanisms

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What is postural Instability?

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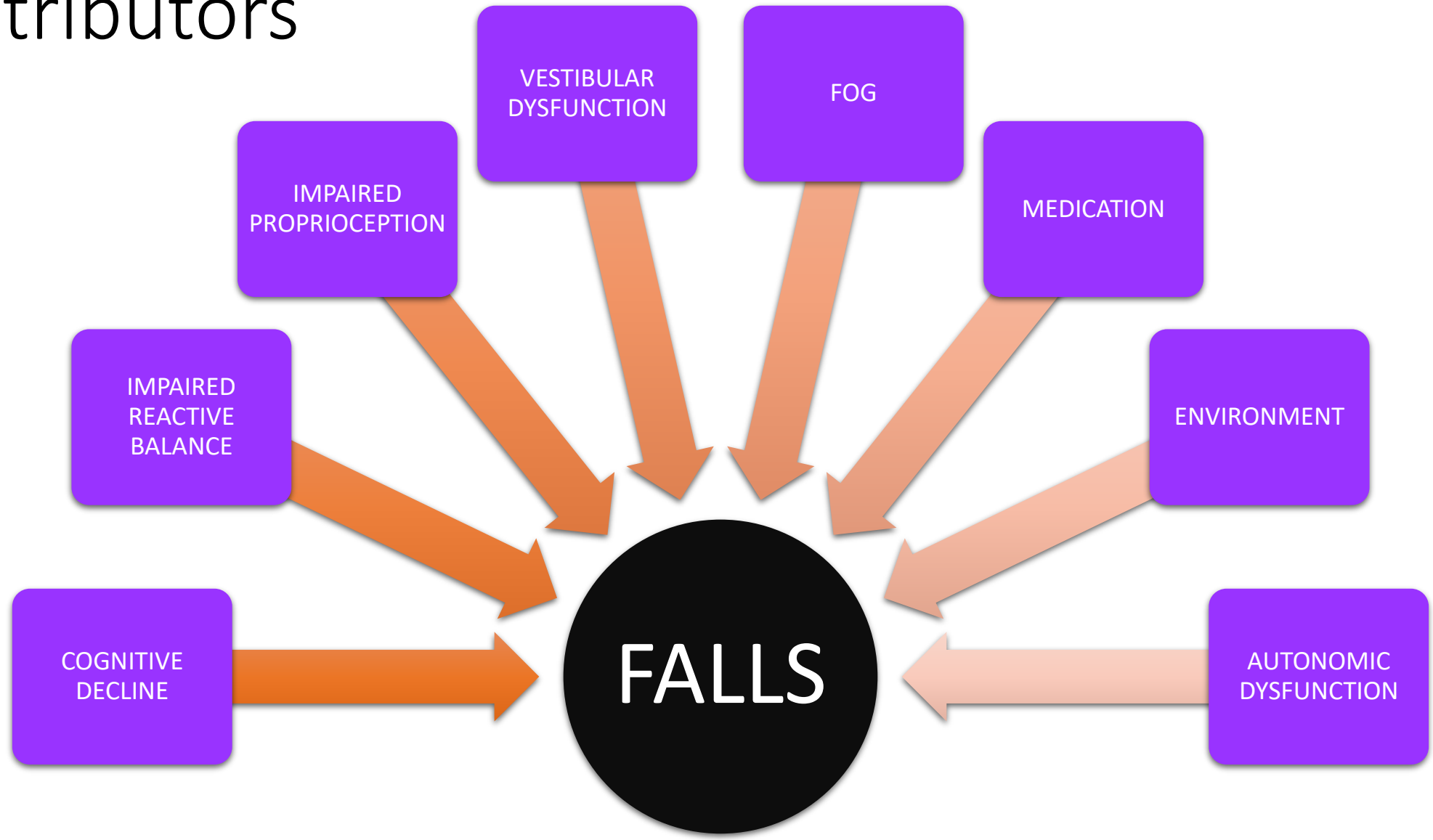
- Impaired reactive balance and proprioception
- Difficulty with anticipatory adjustments
- Stooped posture, slow and stiff postural responses
- Increased sway or instability when standing, particularly with eyes closed or on unstable surfaces
- Freezing of gait (FOG)
- Falls or near-falls, *loss of confidence*

Mancini and Horak 2016, Bloem et al 2001

Contributors



Allen et al 2022, Pelicioni et al 2019

How does cognitive decline contribute to postural instability?

A. It enhances automatic motor control, reducing the need for compensatory strategies during balance tasks.

B. It improves dual-task performance and facilitates better adaptability during complex motor tasks.

C. It impairs dual-tasking, planning, and task-switching, reducing the effectiveness of compensatory strategies for postural control.

D. It has minimal impact on postural stability, as balance is primarily regulated by subcortical motor circuits.

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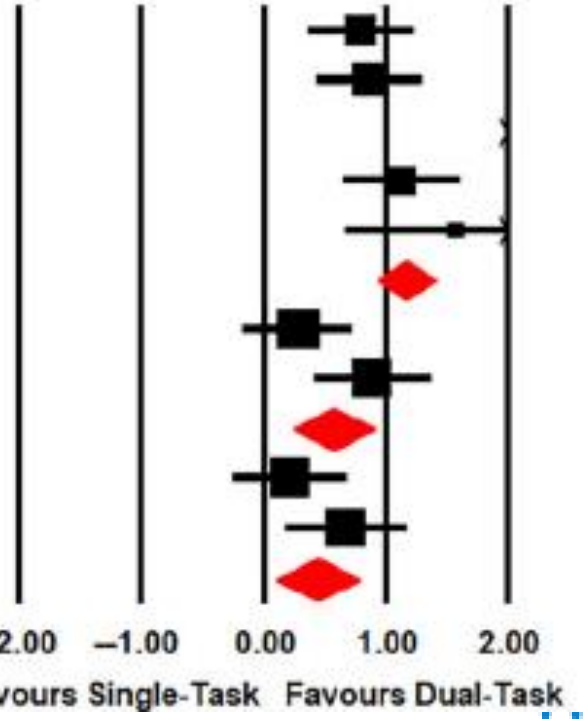
Role of Cognition

- Dual-tasking and divided attention
- Planning and sequencing movements
- Task-switching and adaptability
- Compensatory strategies for loss of automaticity

Amboni et al 2013, Yogev-Seligmann et al 2008, Morris et al 2008

Dual Task Training

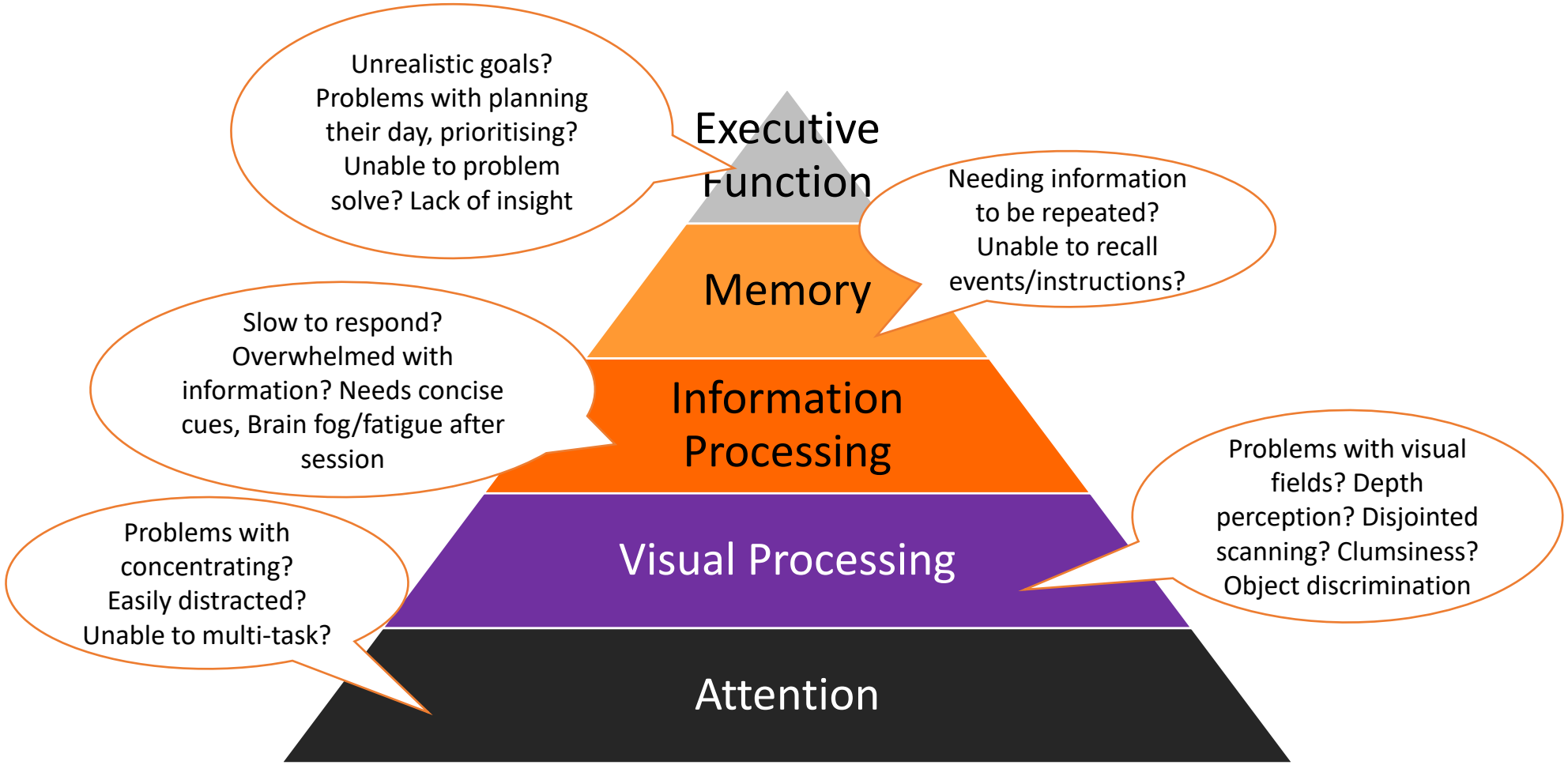
Group by Time Point	Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit	*Z*-Value	*p*-Value
Immediate effect	Benka-Wallén, M et al 2018 (1)	0.790	0.218	0.047	0.363	1.216	3.626	0.000
Immediate effect	Conradsson, D et al 2015	0.861	0.219	0.048	0.431	1.291	3.928	0.000
Immediate effect	Duncan, RP et al 2012	3.900	0.472	0.223	2.974	4.826	8.256	0.000
Immediate effect	Wong-Yu, ISK et al 2015 (1)	1.130	0.241	0.058	0.658	1.602	4.692	0.000
Immediate effect	Zanardi da Silva, A et al 2019	1.571	0.460	0.212	0.669	2.473	3.415	0.001
Immediate effect		1.155	0.121	0.015	0.918	1.392	9.550	0.000
6 months	Benka-Wallén, M et al 2018 (2)	0.279	0.225	0.051	−0.162	0.719	1.240	0.215
6 months	Wong-Yu, ISK et al 2015 (2)	0.887	0.244	0.060	0.409	1.365	3.636	0.000
6 months		0.558	0.165	0.027	0.234	0.882	3.376	0.001
12 months	Benka-Wallén, M et al 2018 (3)	0.214	0.234	0.055	−0.243	0.672	0.917	0.359
12 months	Wong-Yu, ISK et al 2015 (3)	0.670	0.249	0.062	0.183	1.158	2.696	0.007
12 months		0.428	0.170	0.029	0.094	0.762	2.514	0.012



C Forest Plot of functional balance

Garcia-Lopez et al 2023

Cognitive Changes



Malia and Brannigan 2012

What is the primary impact of proprioceptive deficits on postural instability?

A. Enhanced postural reflexes and reduced reliance on visual input during gait

B. Impaired sensorimotor integration leading to increased visual dependence and gait disturbances

C. Improved adaptability during complex walking tasks due to heightened tactile sensitivity

D. Reduced risk of freezing of gait and falls due to compensatory vestibular mechanisms

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Proprioceptive Deficits

- Impaired postural reflexes
- Increased visual dependence
- Gait disturbances
- May contribute to Freezing of Gait (FOG) and falls during complex walking tasks.
- Impaired sensorimotor integration

Alashram et al 2023, Jacobs et al 2009, Konczac et al 2009

Proprioceptive Training

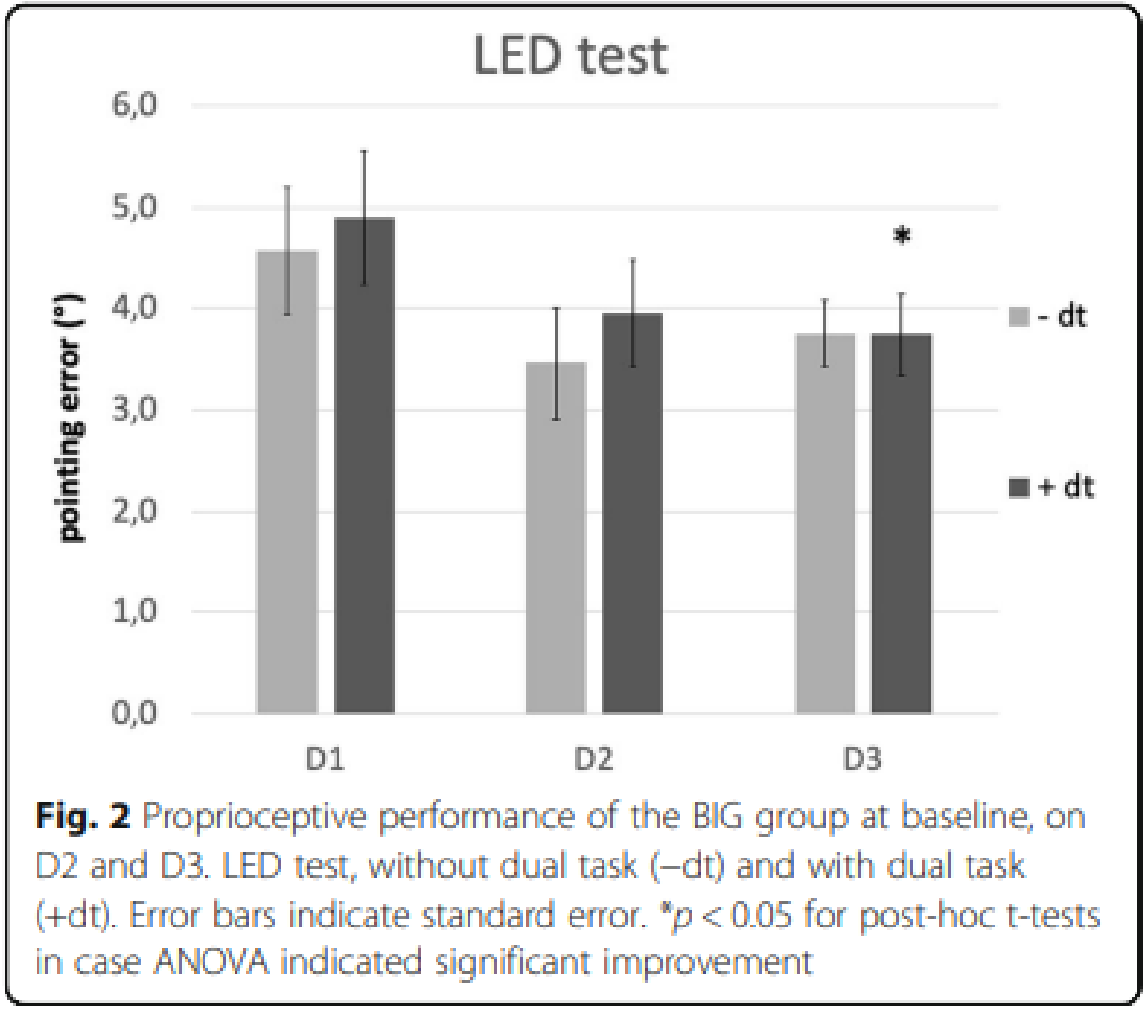

Fig. 2 Proprioceptive performance of the BIG group at baseline, on D2 and D3. LED test, without dual task (–dt) and with dual task (+dt). Error bars indicate standard error. *$p < 0.05$ for post-hoc t-tests in case ANOVA indicated significant improvement

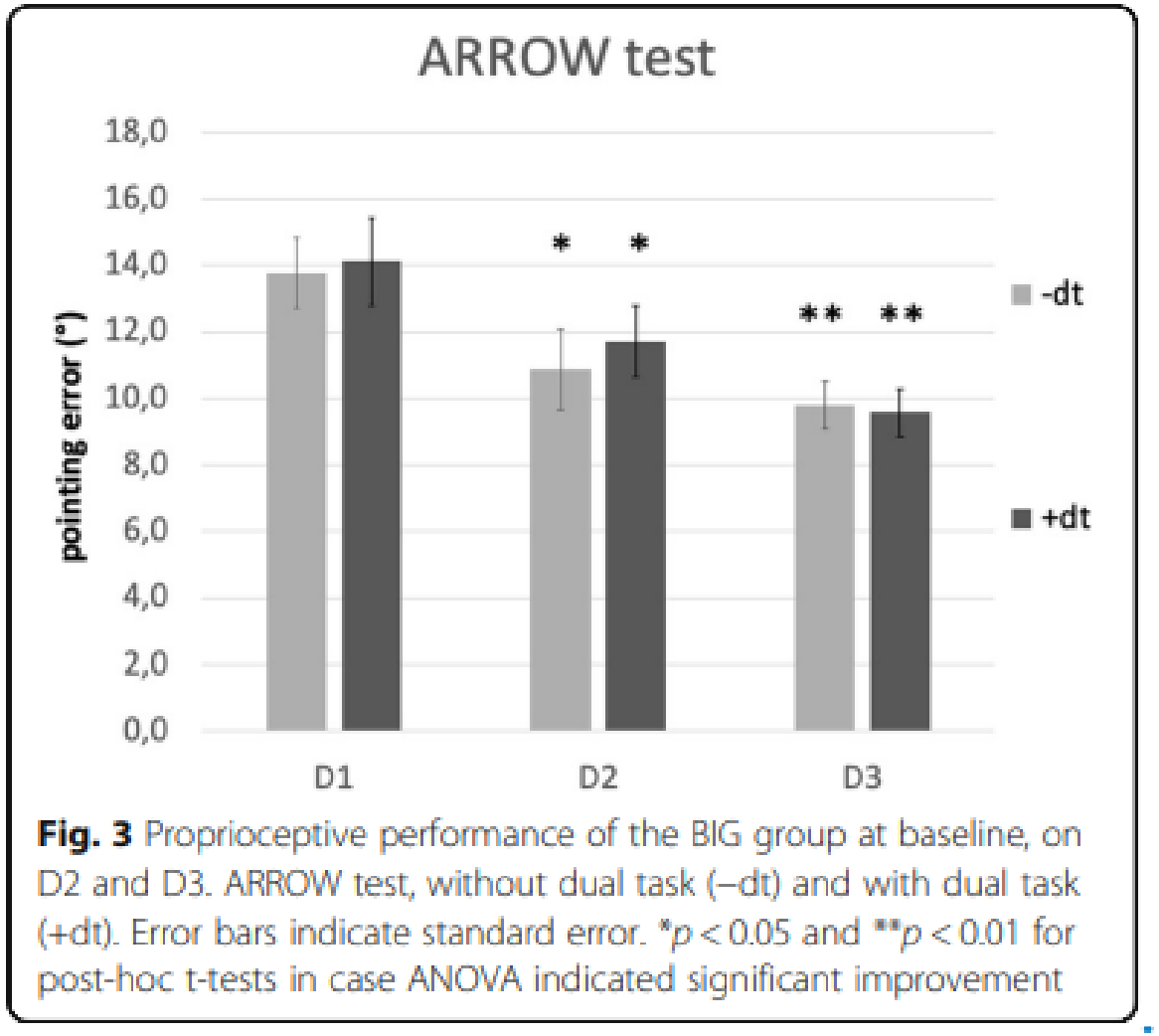

Fig. 3 Proprioceptive performance of the BIG group at baseline, on D2 and D3. ARROW test, without dual task (–dt) and with dual task (+dt). Error bars indicate standard error. *$p < 0.05$ and **$p < 0.01$ for post-hoc t-tests in case ANOVA indicated significant improvement

Peterka et al 2020

How does impaired reactive balance contribute to postural instability

A. It leads to slower postural responses, reduced corrective movement amplitude, and abnormal muscle activation patterns.

B. It enhances the speed and strength of corrective movements, reducing fall risk during perturbations.

C. It improves coordination of muscle activation, allowing for more efficient balance recovery.

D. It has minimal impact on postural control, as reactive balance is preserved in early Parkinson's disease.

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Reactive Balance

- Slower postural response times
- Reduced amplitude or strength of balance-correcting movements
- Abnormal muscle activation patterns (e.g., co-contraction or reversed sequencing)
- Freezing or delayed initiation of corrective steps

de Souza et al 2023, Allen et al 2011, Horak et al 2005

Falls Prevention

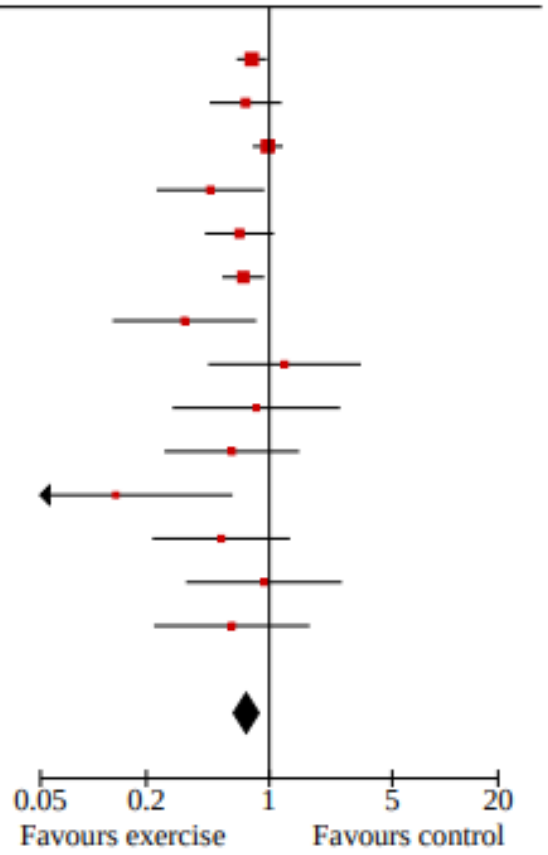
Analysis 1.1. Comparison 1: Exercise vs control (rate of falls), Outcome 1: Rate of falls

Study or Subgroup	log[Rate Ratio]	SE	Exercise Total	Control Total	Weight	Rate Ratio IV, Random, 95% CI
Ashburn 2007 (1)	-0.23	0.1	64	62	21.3%	0.79 [0.65 , 0.97]
Canning 2015a (2)	-0.31	0.24	115	116	8.6%	0.73 [0.46 , 1.17]
Chivers Seymour 2019 (3)	-0.02	0.1	231	230	21.3%	0.98 [0.81 , 1.19]
Gao 2014 (4)	-0.77	0.36	37	39	4.5%	0.46 [0.23 , 0.94]
Goodwin 2011 (5)	-0.39	0.23	61	64	9.1%	0.68 [0.43 , 1.06]
Li 2012 (6)	-0.34	0.14	65	33	16.4%	0.71 [0.54 , 0.94]
Li 2012 (4)	-1.11	0.48	65	33	2.7%	0.33 [0.13 , 0.84]
Martin 2015 (7)	0.2	0.51	9	9	2.4%	1.22 [0.45 , 3.32]
Paul 2014 (8)	-0.17	0.56	19	19	2.0%	0.84 [0.28 , 2.53]
Protas 2005 (9)	-0.49	0.45	9	9	3.0%	0.61 [0.25 , 1.48]
Sedaghati 2016 (10)	-2.01	0.78	15	8	1.1%	0.13 [0.03 , 0.62]
Sedaghati 2016 (11)	-0.63	0.46	14	8	2.9%	0.53 [0.22 , 1.31]
Song 2018 (12)	-0.07	0.52	29	25	2.3%	0.93 [0.34 , 2.58]
Wong-Yu 2015 (5)	-0.49	0.52	32	36	2.3%	0.61 [0.22 , 1.70]
Total (95% CI)			**765**	**691**	**100.0%**	**0.74 [0.63 , 0.87]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 18.59$, df = 13 (P = 0.14); $I^2 = 30\%$

Test for overall effect: Z = 3.66 (P = 0.0003)

Test for subgroup differences: Not applicable



Allen et al 2022

How does vestibular dysfunction contribute to postural instability?

A. Enhanced vestibulo-ocular and vestibulo-spinal reflexes that improve postural control

B. Central vestibular processing deficits and VOR abnormalities leading to increased sway and limited response to dopaminergic therapy

C. Improved balance through compensatory visual and proprioceptive mechanisms

D. Reduced postural sway due to heightened sensitivity of the vestibular system

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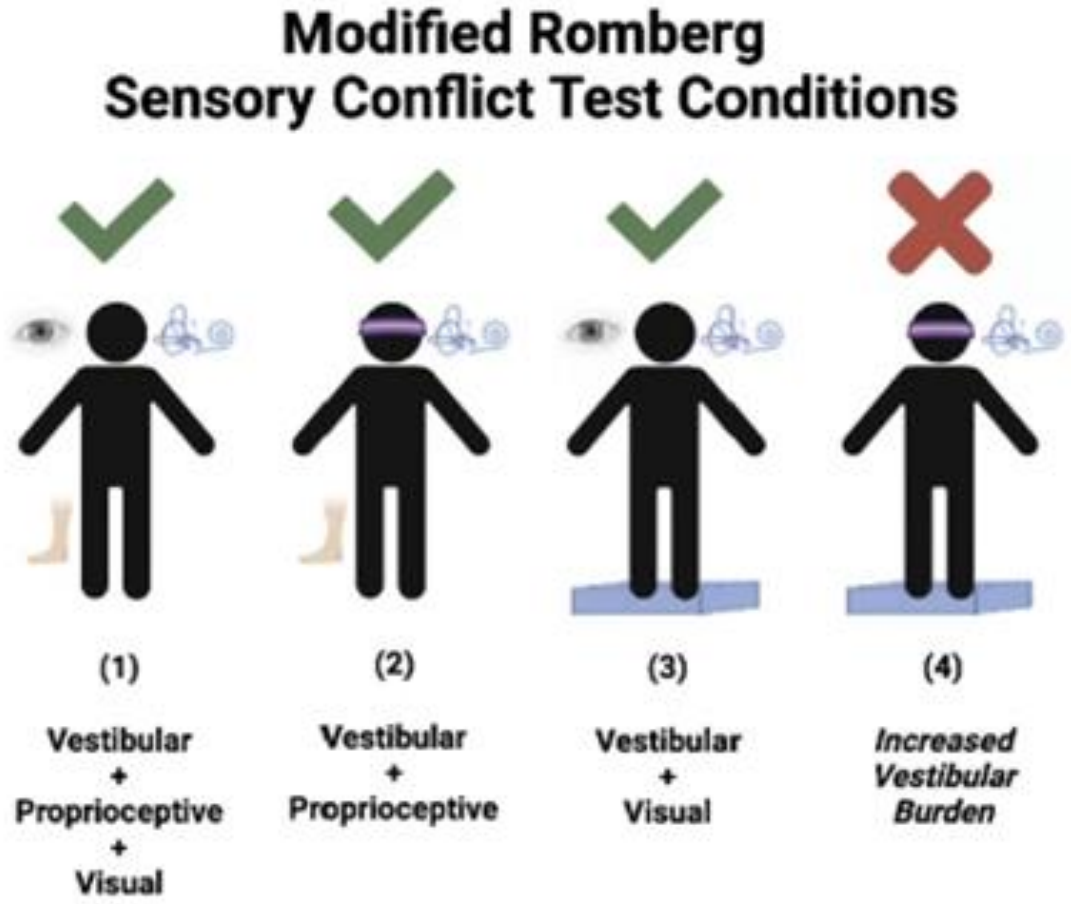
Vestibular Dysfunction

- Central vestibular processing deficit
- Vestibulo-Ocular Reflex (VOR) abnormalities
- Vestibulo-Spinal Reflex dysfunction
- Increased postural sway and instability
- Limited response to dopaminergic therapy



Bohnen et al 2022, Gui et al 2024, Smith 2018

How does freezing of gait (FOG) contribute to postural instability?

A. It enhances anticipatory postural adjustments and reduces fall risk during complex tasks

B. It has minimal impact on postural stability and is primarily a cognitive phenomenon unrelated to motor control

C. It improves balance by limiting movement and reducing the need for postural corrections

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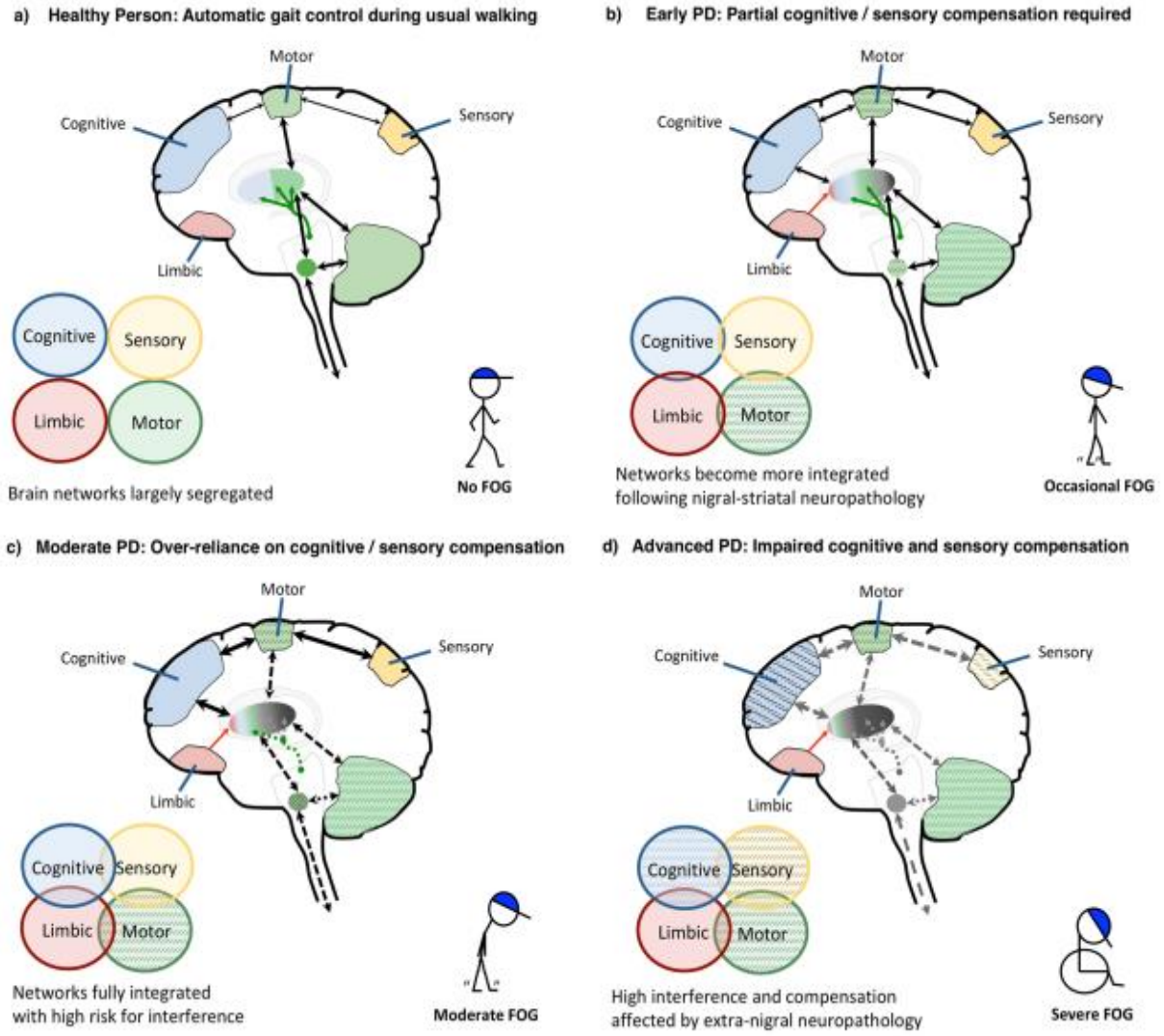
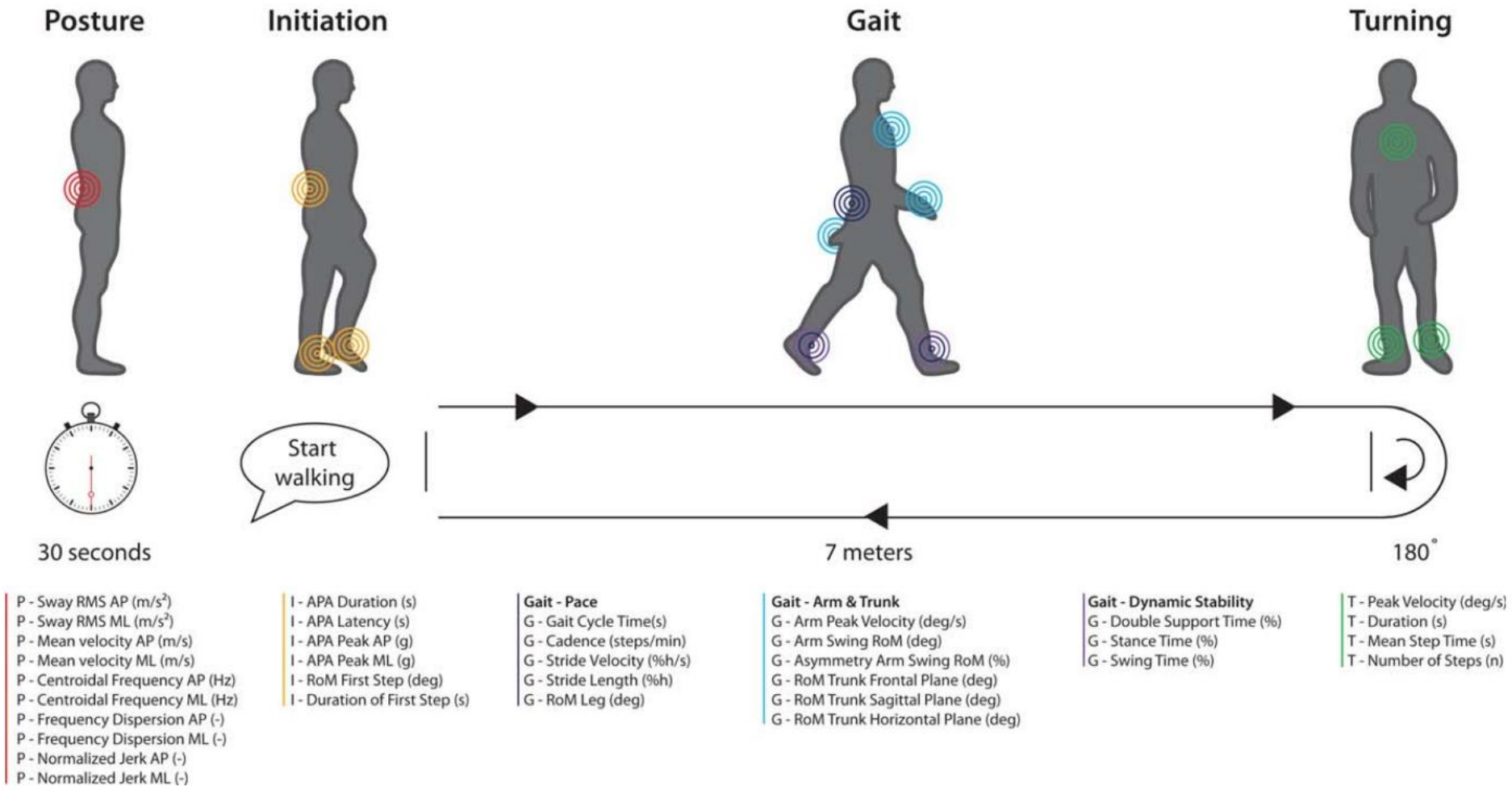
Freezing of gait

- Sudden loss of dynamic postural control
- Impaired Anticipatory Postural Adjustments (APA)
- Increased falls risk
- Compensatory strategies may fail
- Psychological and cognitive load



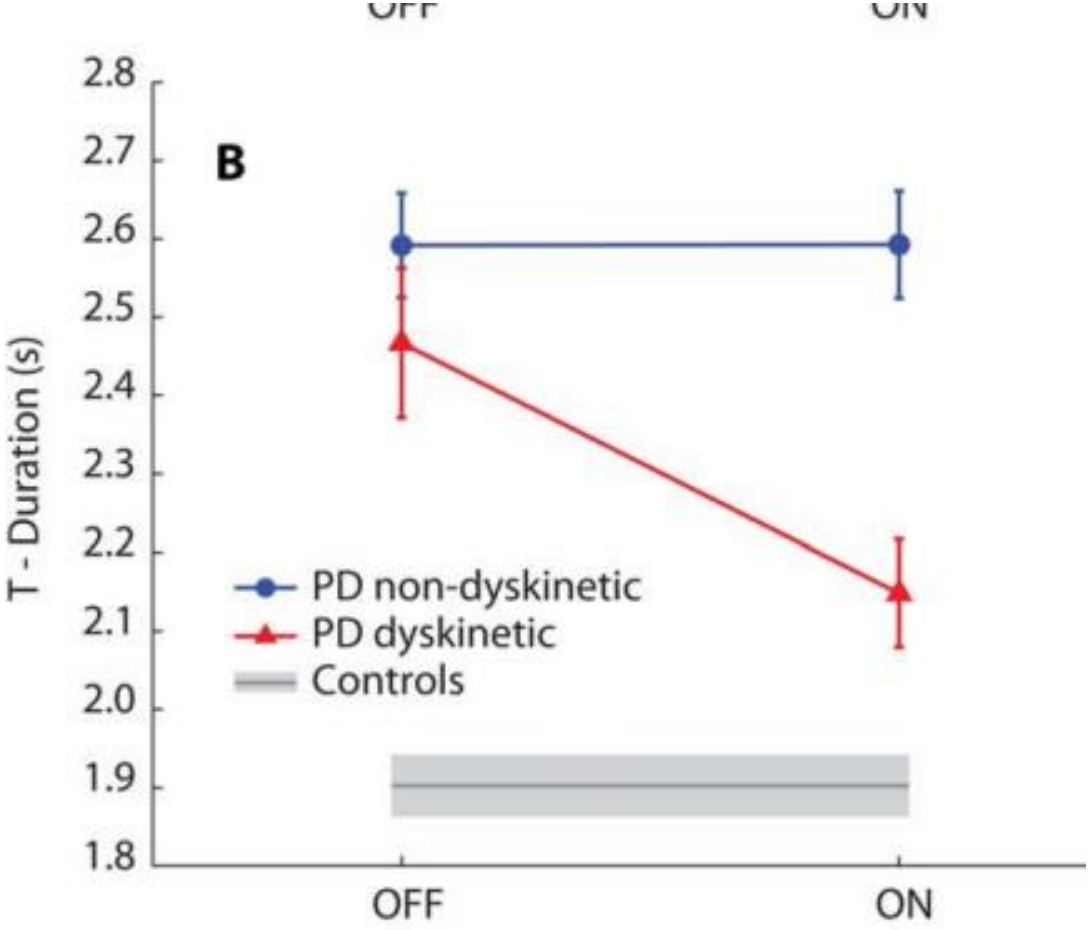
Gilat et al 2021

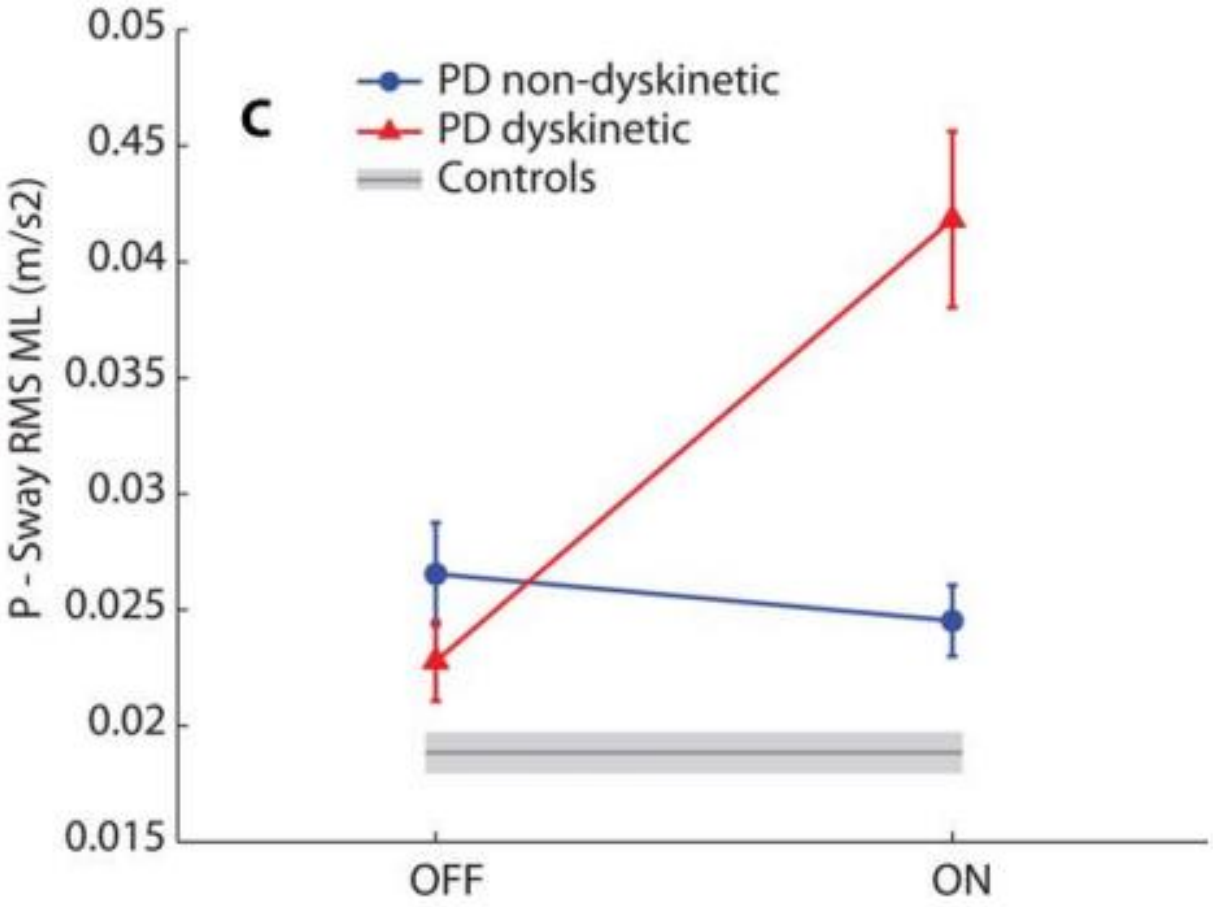
Levadopa – the double edged sword



Aderonmu et al 2024

The Effect of Dyskinesia





Curtze et al 2015

Physical Activity Levels

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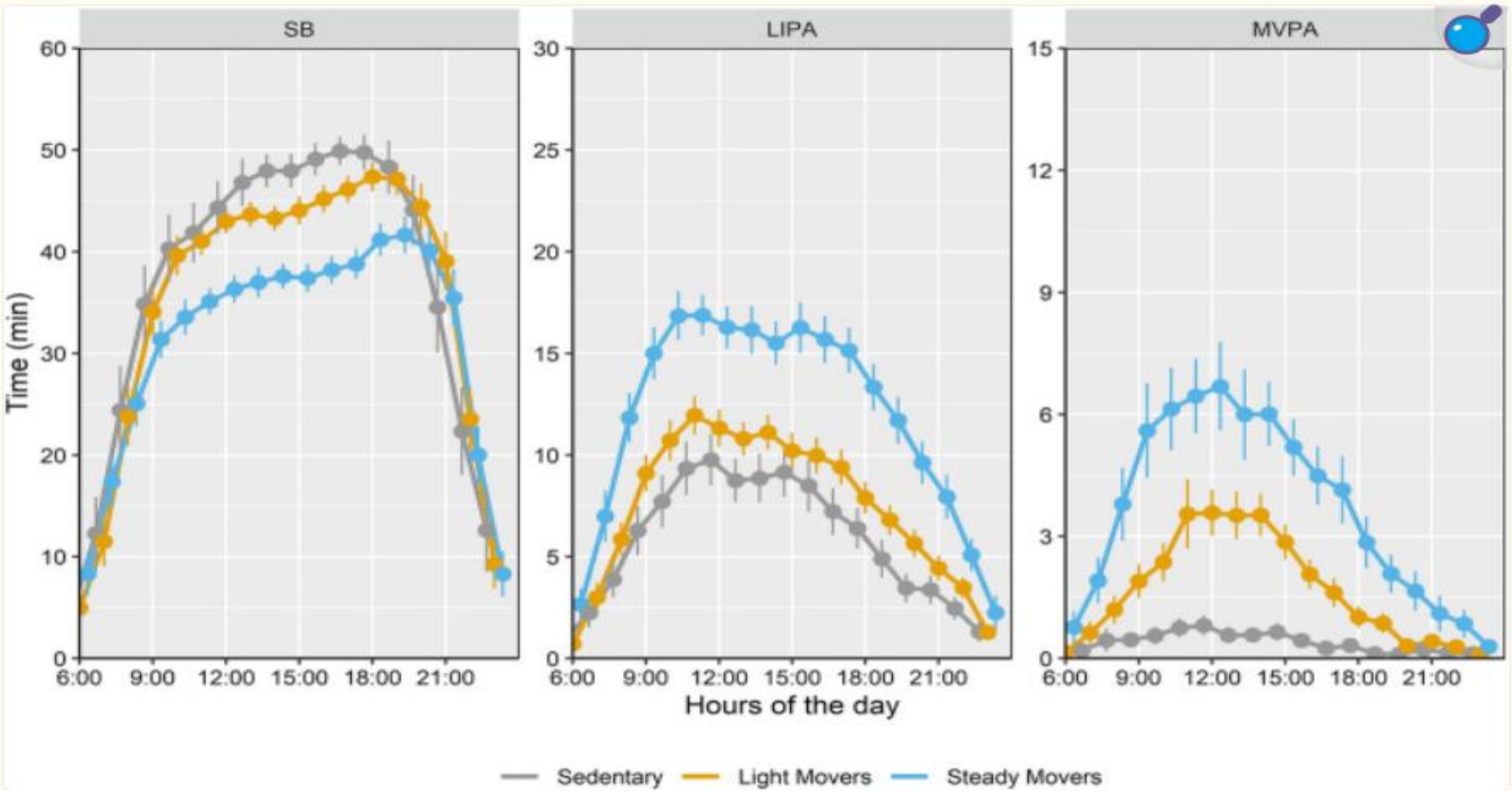

Von Rosen et al 2021

Summary

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- Pathophysiology of Parkinson's
- Defined postural instability and its clinical relevance in Parkinson's.
- Set the scene for multifactorial contributors to postural instability.

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THANK YOU

Want to get in touch?

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Presented by:

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