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Are we walking in the right direction?

Julie Jones

What we are going to get through..

- Gait – what's behind the walk
- Look at the evidence base, explore what we know and what we do not know about:
    - Exercise therapy
    - Cueing
    - Tai Chi
    - Aerobic exercise
- My research interests

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Who am I?

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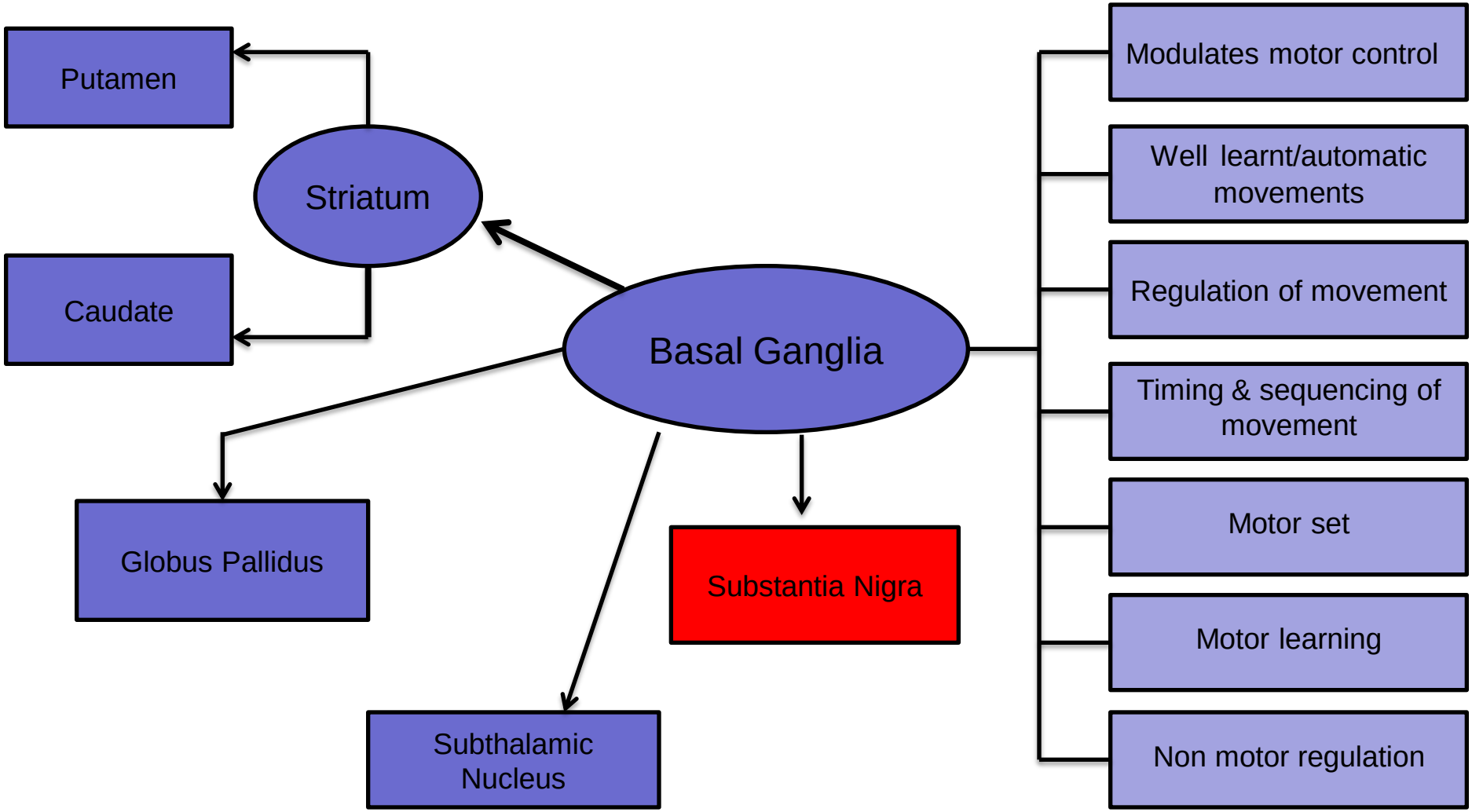
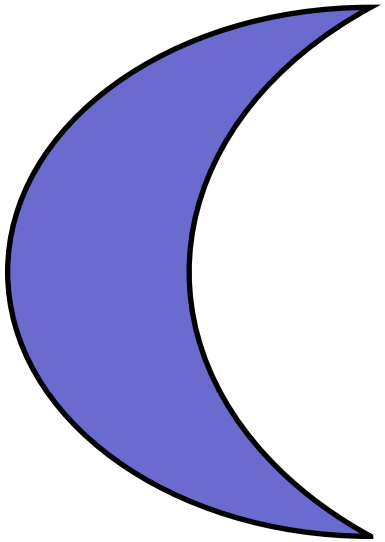
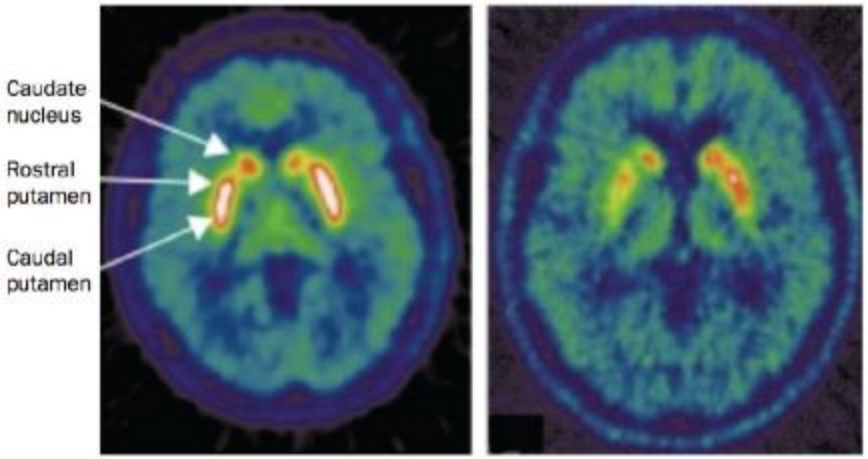
Gait is a major determinant to quality of life but why is it a problem in PD?

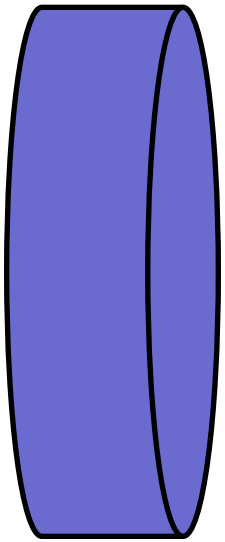
The Basal Ganglia



Caudate and Putamen



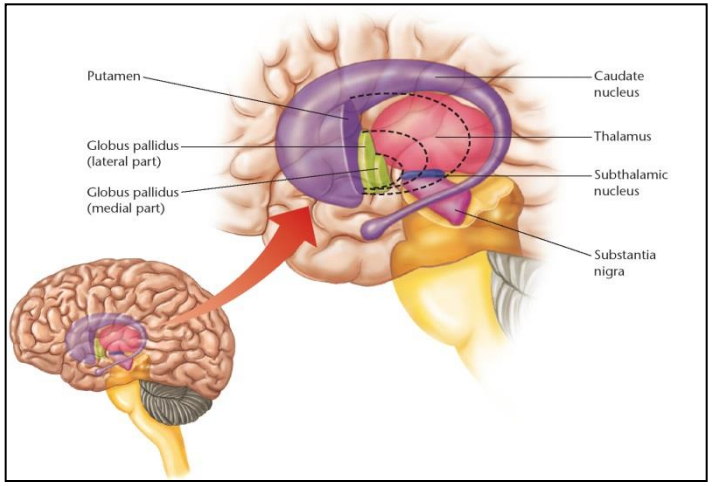




Speed & accuracy

Body & limb position/posture

Linked with sleep & social behaviour

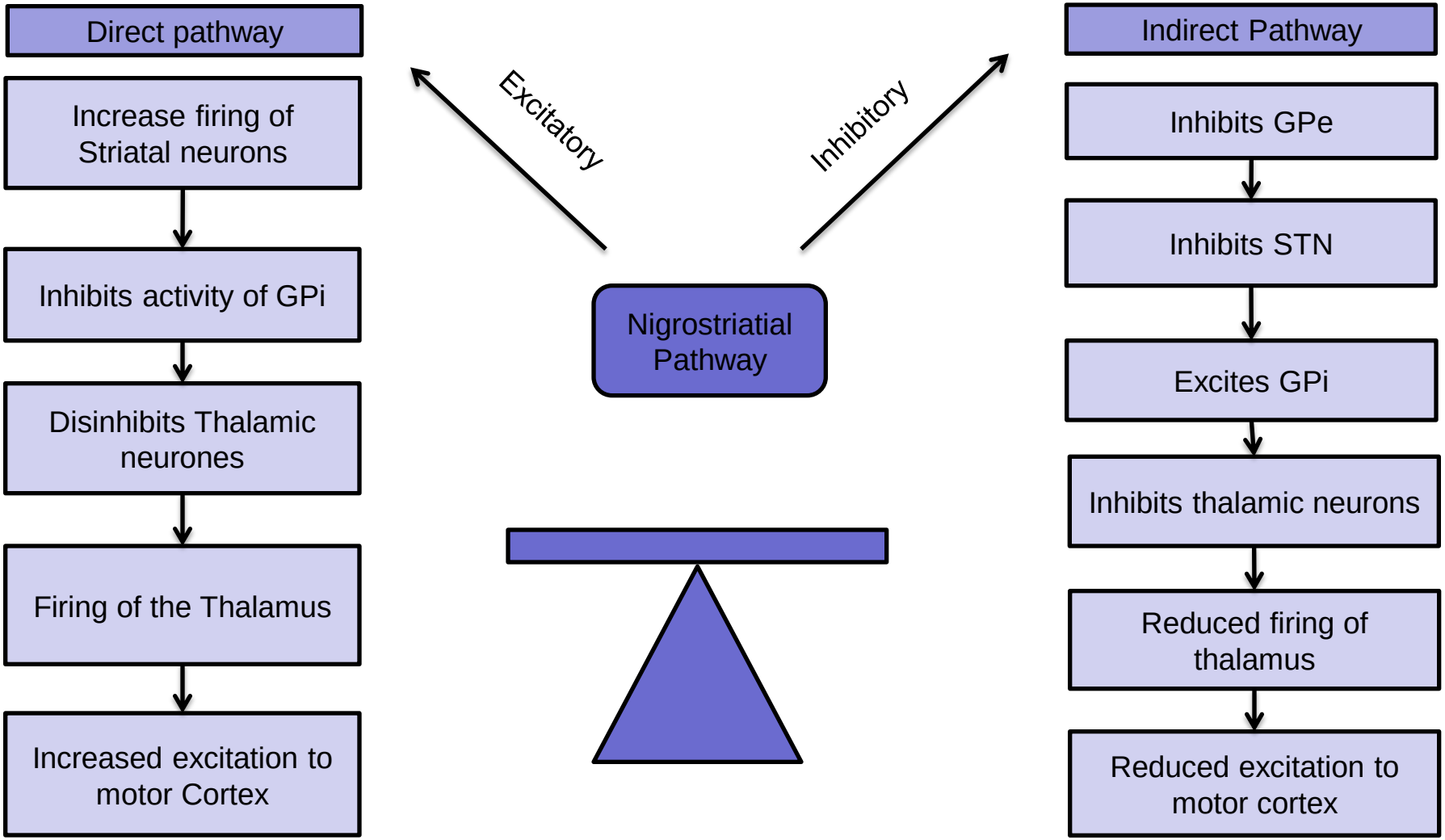


Motor preparation

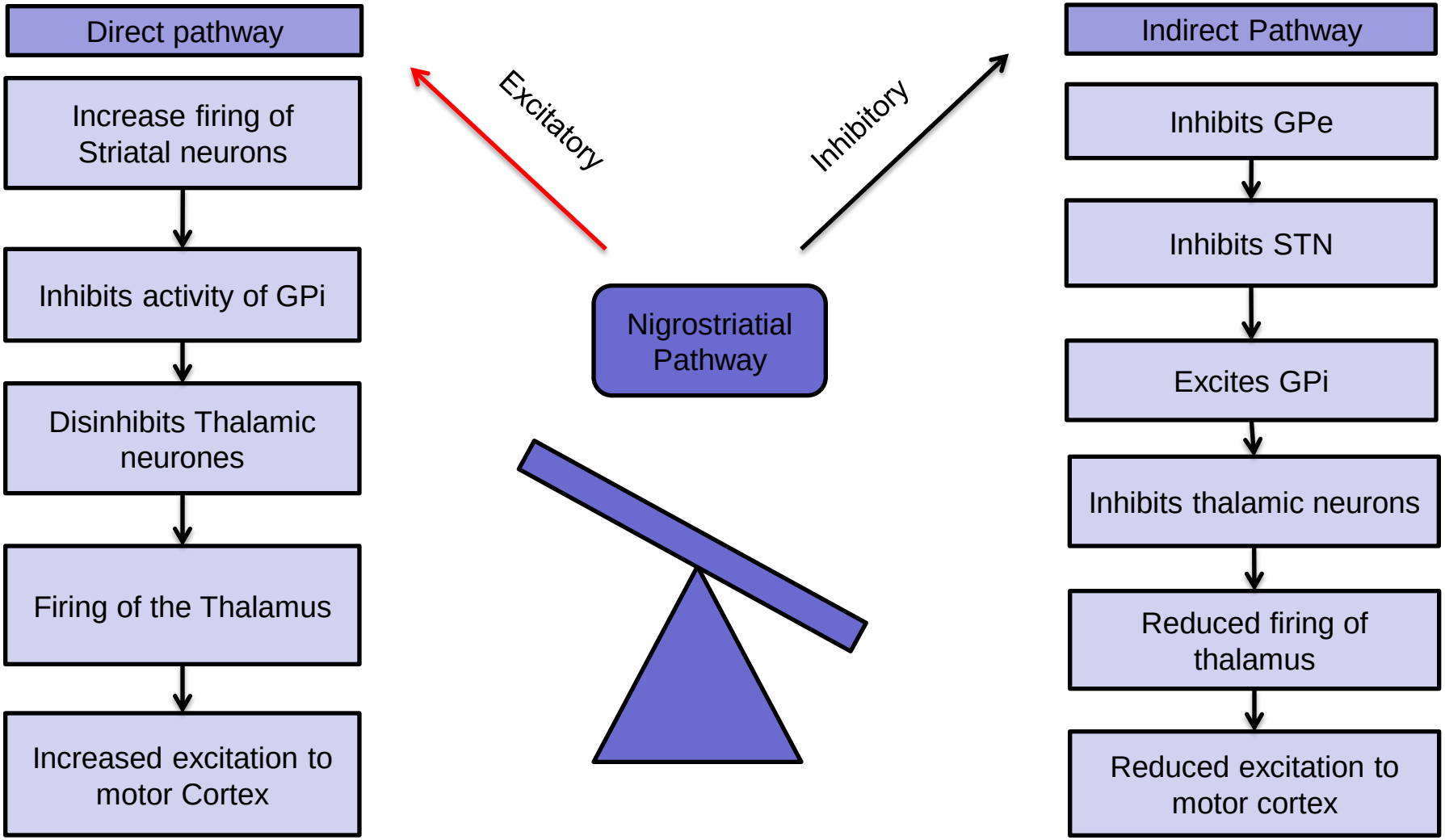
Sequencing, & amplitude

Learning

Direct and Indirect Pathway



What happens in PD



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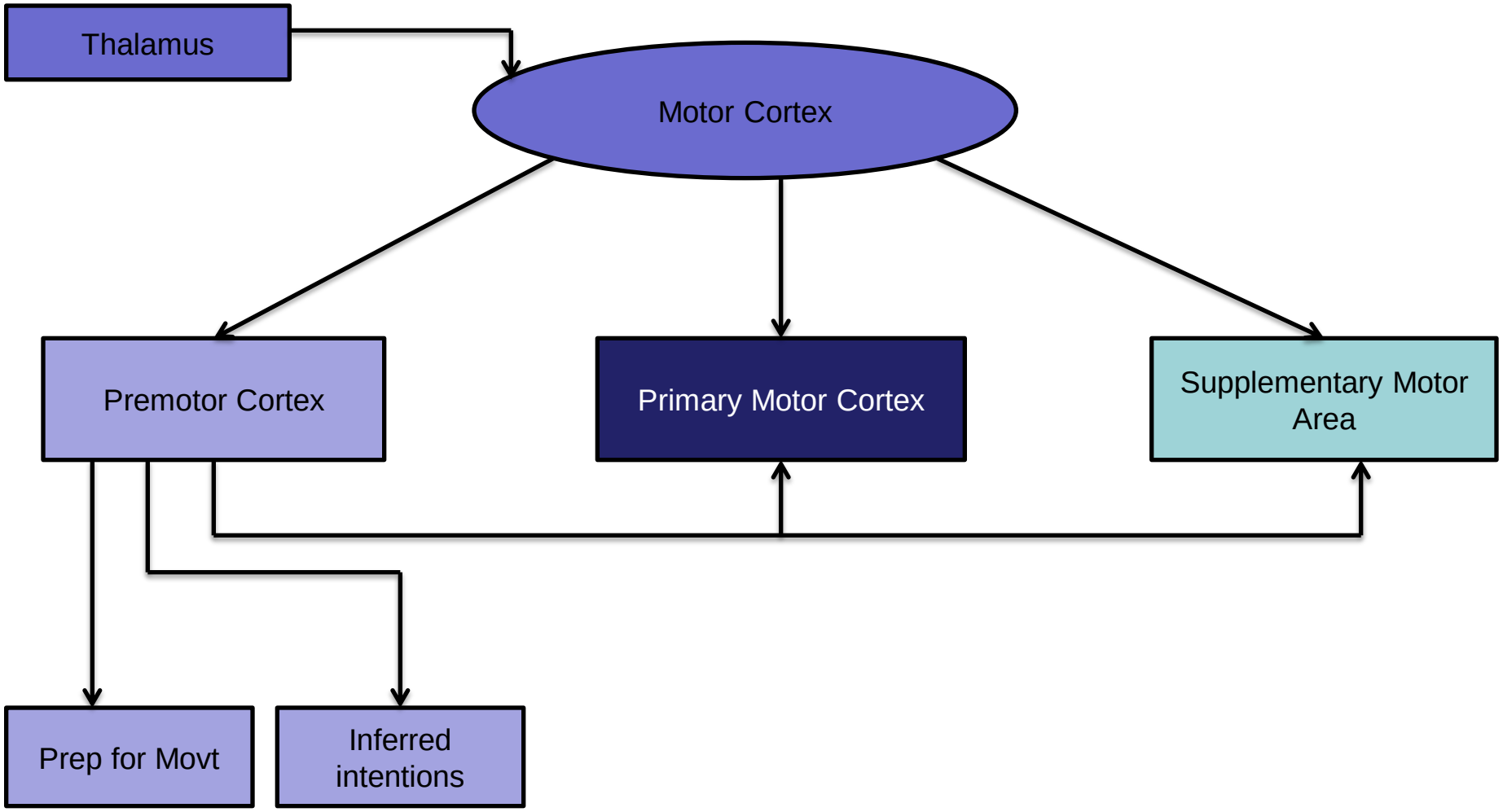
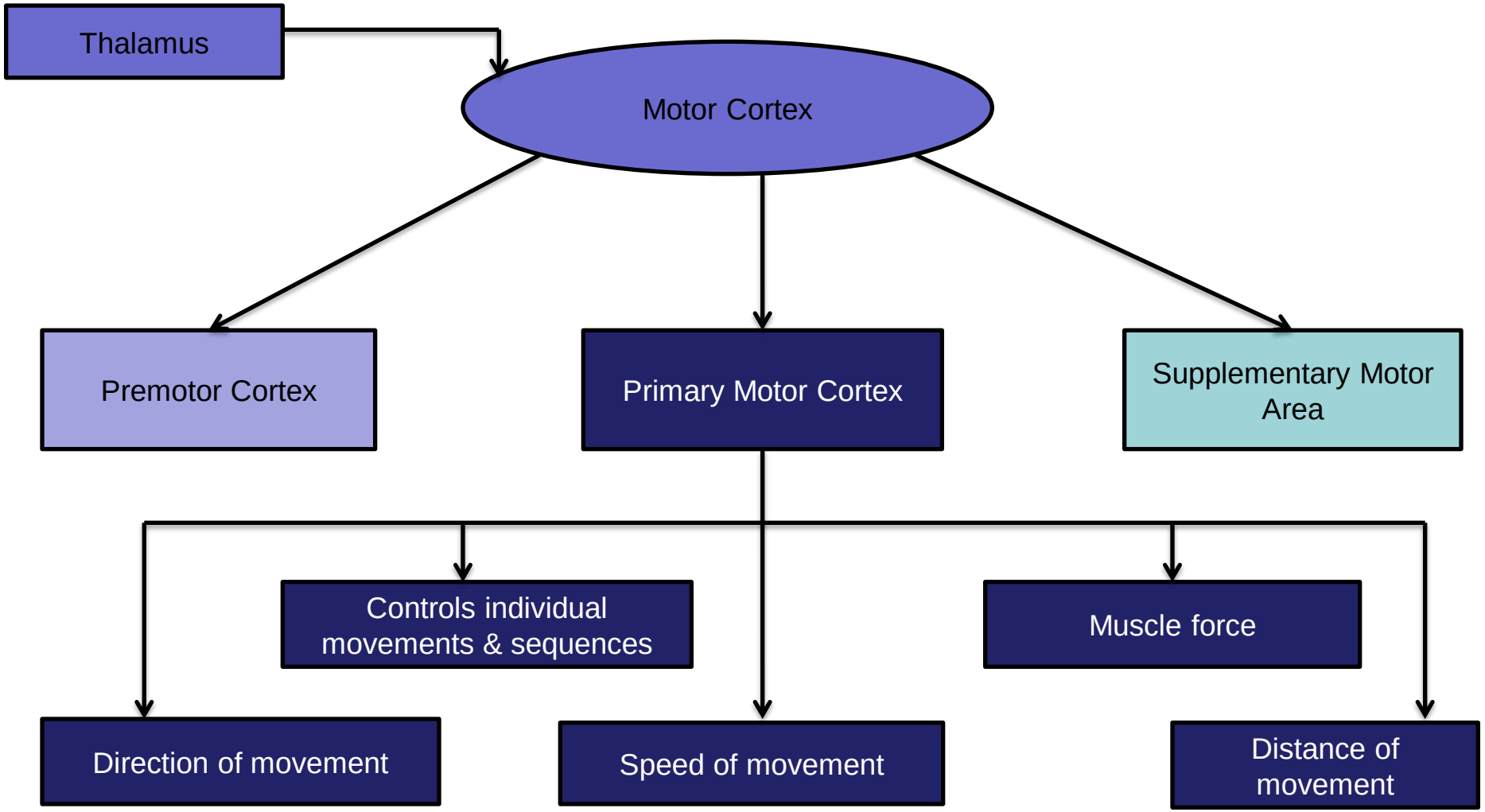
But how does this impact upon gait?

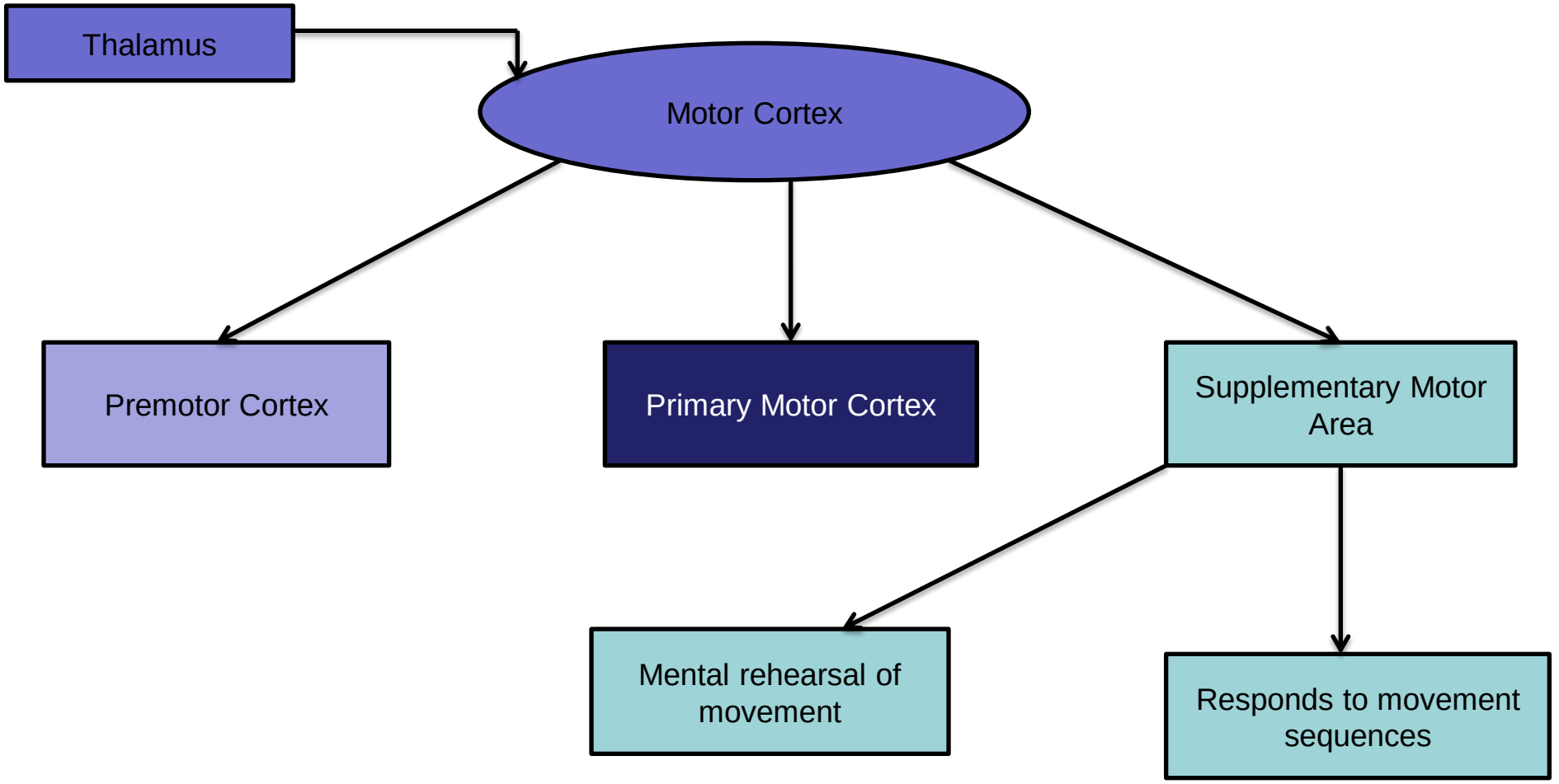
Pre-Motor Cortex



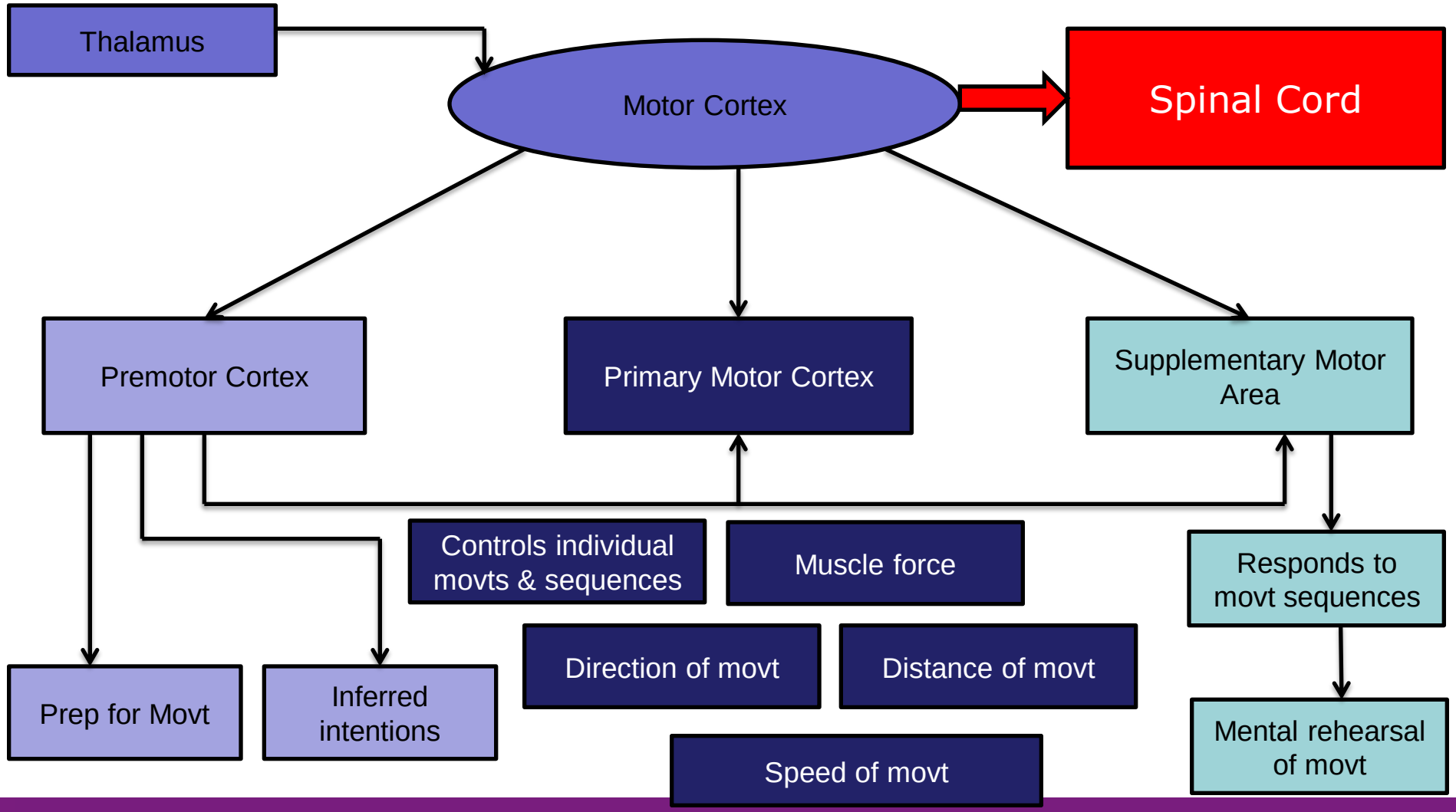
Primary Motor Cortex



Supplementary Motor Area



Motor Cortex



Net effect in the CNS

- Alteration in selectivity, and force generation
- Reduction in control of individual muscles
- Reduction in speed, and amplitude of movement
- Alteration in sequencing of movement
- Reduction in background preparation of movement
- Behavioural context of movement
- Alteration in sequencing of movement

Therefore……

- Reduction in motor neuron activity in Spinal cord
- Reduction or alteration of muscle tone and proprioception
- Reduction in generation of muscle force

Net effect in the periphery

- Reduction in muscle strength and power
- Reduction in co-ordination of muscle activity
- Reduced stability and balance
- Reduced sensitivity of proprioceptors

Value of exercise in PD (Fox et al 2006)

- Intensive activity maximises synaptic plasticity
- Complex activities promote greater structural adaptation
- Rewarding activities increase dopamine levels 7 promote learning
- Dopaminergic neurones are highly responsive to exercise and inactivity
- Early initiation of exercise and slow down progression

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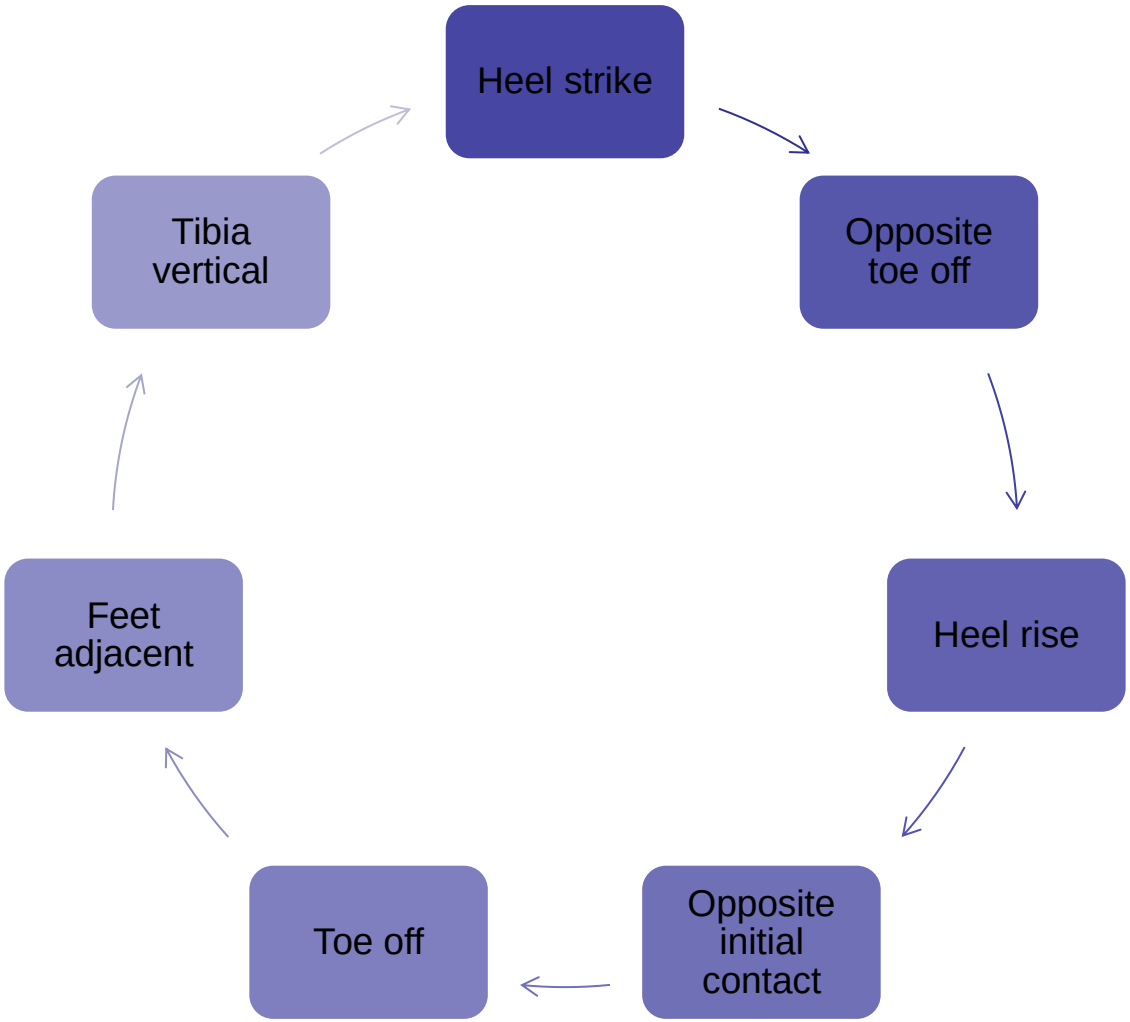
Relationship with gait?

Gait.

- Gait – is the manner or style of walking
- Walking is more akin to the process
- Kinetics: study of forces, moments, masses and accelerations
- Kinematics: to do with motion

Gait Cycle


Heel strike
Opposite toe off
Heel rise
Opposite initial contact
Toe off
Feet adjacent
Tibia vertical

Gait Cycle.

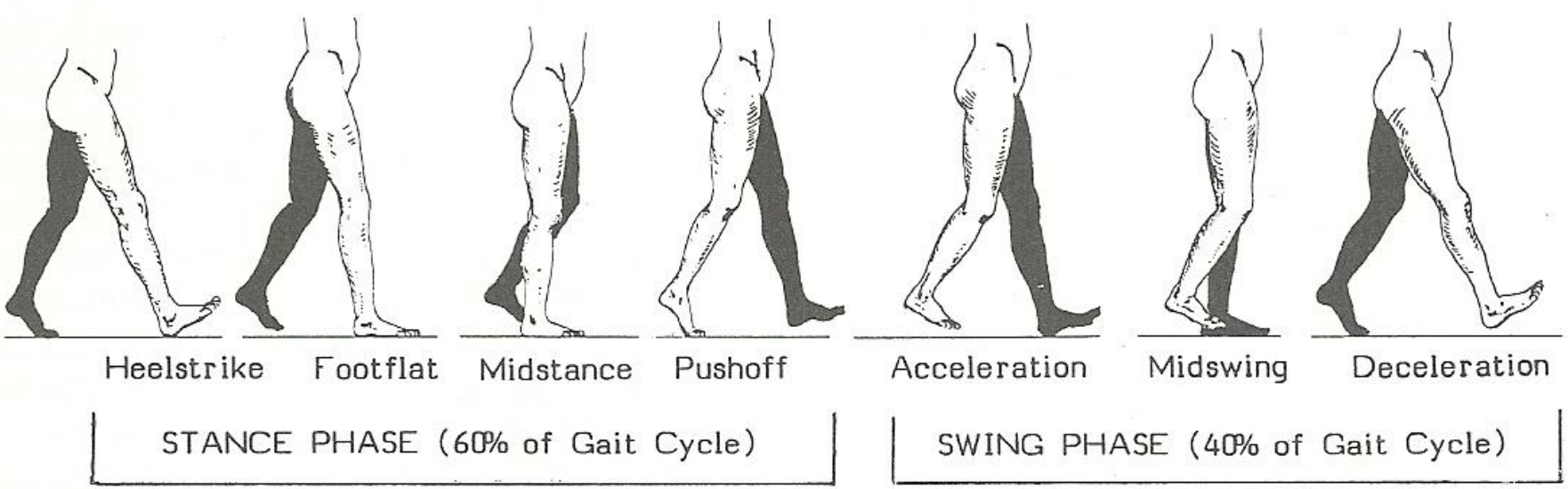


Figure 4.19. The complete gait cycle: stance and swing. Walking is a purposeful disturbance in body equilibrium during which alternating leg displacement sustains body weight.

Components of gait training

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So what is the evidence?

Effectiveness of LL resistive exercise

- Systematic review conducted
- Inclusion criteria:
    - Mixed gender
    - Stage I-III
    - any types of resistive exercise
    - studies which utilised gait related outcome measures
    - minimum quality score of 5

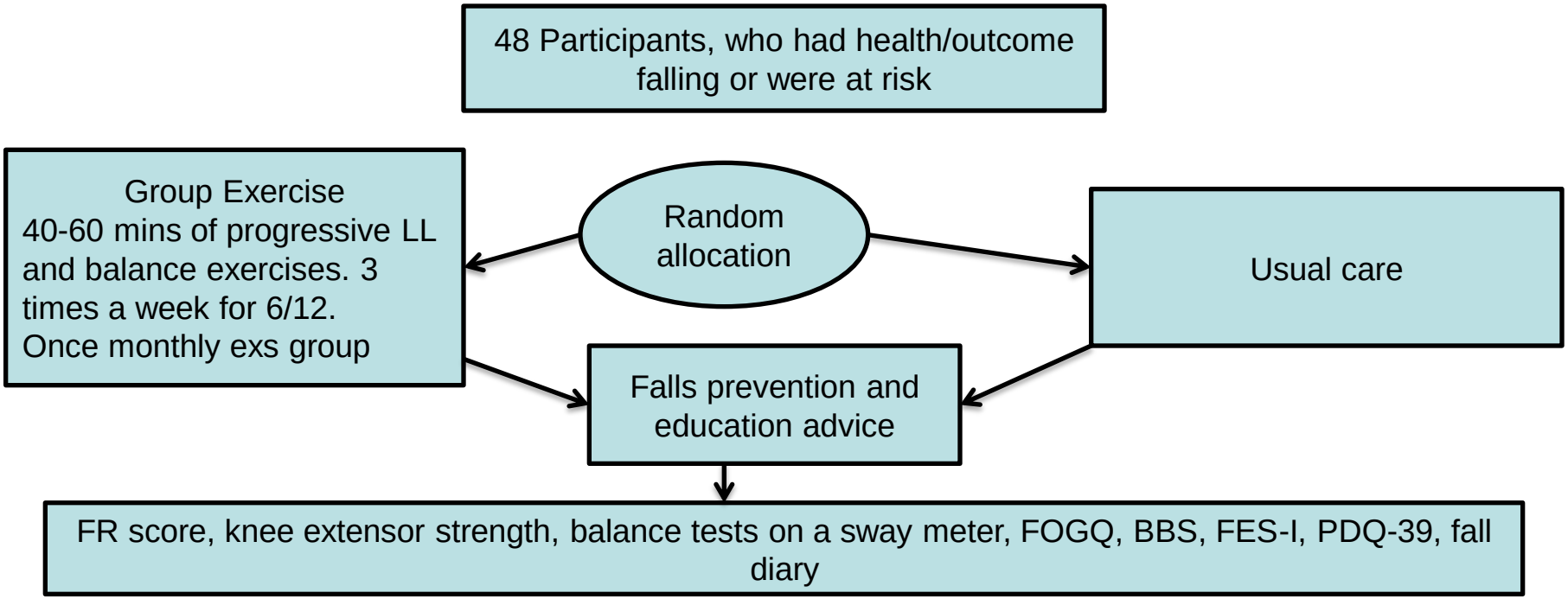
Results

Author and Year	Title
Allen et al 2010	The effects of an exercise program on fall risk factors in people with Parkinson's disease
Combs et al 2013	Community-based group exercise for persons with Parkinson's disease: A randomized controlled trial
Hass et al 2012	Progressive resistance training improves gait initiation in individuals with Parkinson's disease
Paul et al 2014	Leg muscle power is enhanced by training in people with Parkinson's disease: a randomized controlled trial
Schilling et al 2010	Effects of moderate-volume, high-load lower body resistance training on strength and function in persons with Parkinson's disease: a pilot study
Shen & Mak 2012	Repetitive step training with preparatory signals improves stability limits in patients with Parkinson's disease
Shulman et al 2013	Randomized clinical trial of 3 types of physical exercise for patients with Parkinson's disease

Outcome measures included

Author & Year	TUG	6 MWT	10 MWT	2.5/5m walking velocity	Stride Length	Initial Stride Velocity	Cadence	FOG Question Yes/No	FOG Question-naire
Allen et al 2010				✓				✓	✓✓
Combs et al 2013	✓✓	✓		✓✓					
Hass et al 2012					✓✓	✓✓			
Paul et al 2014	✓		✓						
Schilling et al 2010	✓	✓✓							
Shen & Mak 2012				✓✓	✓		✓✓		
Shulman et al 2013		✓✓	✓						

Effects of exercise on falls risk & gait (Allen et al 2010)



Longer duration, and functional based exercises

Attended just over half the exs classes
Completed a mean of 70% of the prescribed exs session
Exs group 7% reduction in falls risk (P = 0.26)
Knee extension strength increased but NS
Improved sit to stand time p = 0.03
Significant improvement in FOGQ p= 0.03
Significant improvement in GI

Community based exercise: RCT (Combs et al 2013)

To compare boxing training with traditional exercise

Boxing Training
24-36 sessions lasting 90 minutes over 12 weeks. Stretching, boxing (e.g. lateral foot work, punching bags), resistance exercises, and aerobic training.

Random allocation

Traditional exercise
24-36 sessions lasting 90 minutes over 12 weeks Stretching, resistance exercises, aerobic training, and balance activities

TUG, 6MWT balance confidence, mobility, gait velocity, gait endurance, and quality of life

Functional based exercises
Speed and motor planning components
No specifically look at gait in training

The traditional exercise group demonstrated significantly greater gains in balance confidence $P < 0.025$
Boxing group demonstrated significant improvements in gait velocity & endurance
Both groups demonstrated significant improvements with the balance, mobility, and QoL

PRE and gait initiation (Hass et al 2012)

N = 18

GRF, stride length, gait speed, muscle strength

PRE exs
GI focus with velocity Group. Seated Leg press, knee ext, flex, abd curls, back ext, calf raised and ankle exs, 18 sessions over 10 weeks

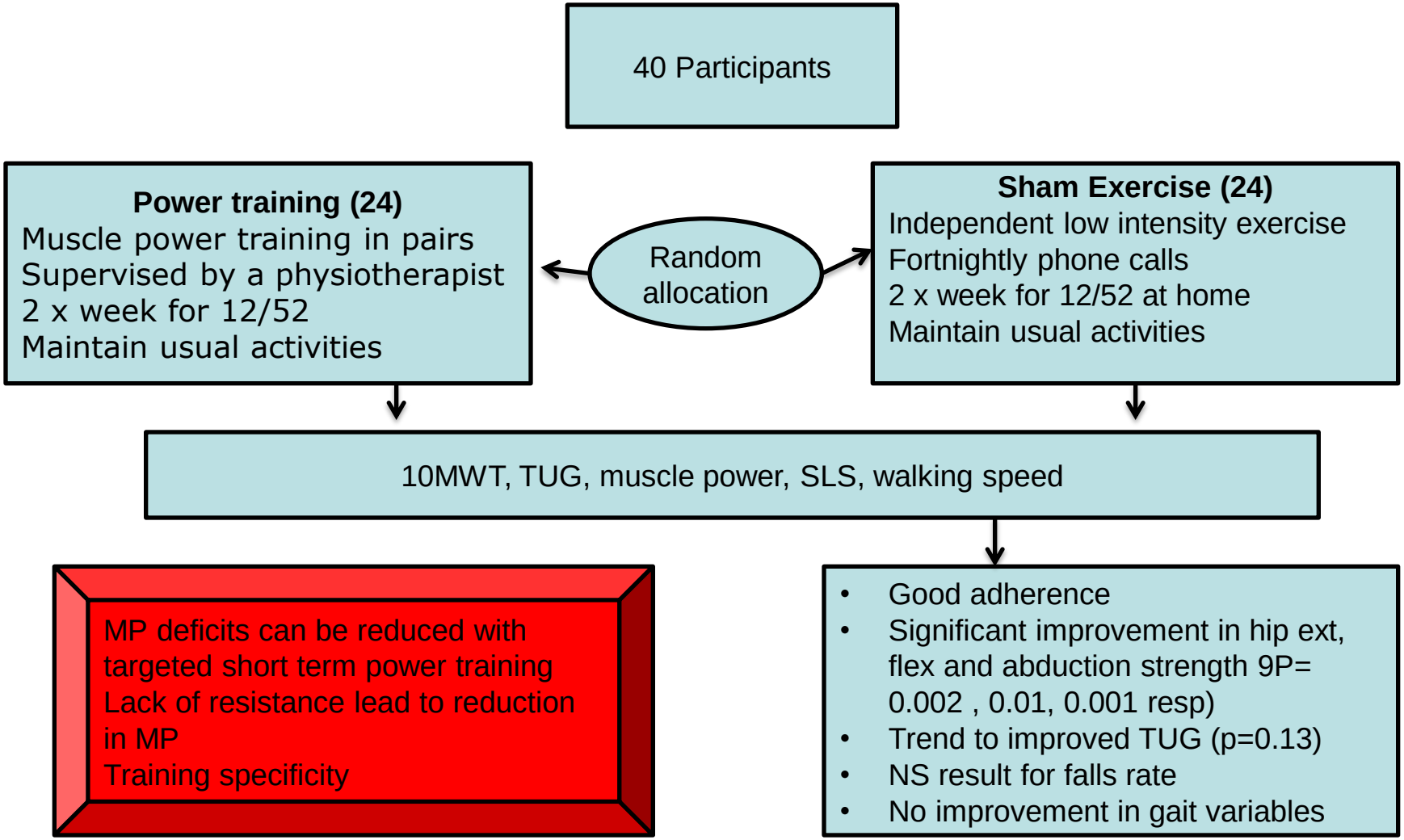
Randomly allocated

Control

- PRT group significantly improved initial stride length, gait initiation and gait velocity
- Improvements noted in FOG
- No improvements within the control

PRT group – considerably long disease duration but comparable age
Machine based

Lower Leg Muscle Power (Paul et al 2014)



Effect of moderate, high load resistance training (Schilling et al 2010)

Effects of moderate volume, high load 8 week resistance training on lower body strength and functional mobility

Training group
3 sets of 5-8 reps for the leg press, seated curl, calf press, twice weekly, n = 9

Random allocation

Control group
Usual care
n = 9

1RM, Activities specific balance confidence scale, TUG, 6MT

Significant increase in the leg press (p = 0.001)
Absolute strength increased by 25%
No change in control, remain stable
No change to TUG, 6MWT, or balance

No functional improvements
Machine based
In a gym
Suggestive of no higher level skill acquisition

Balance and gait training (Shen and Mak 2014)

To explore whether balance and gait training with augmented feedback enhances balance confidence

Balance Group:
Balance and gait training with feedback for 12 weeks

4 weeks in lab supervised 3 session per week
4 weeks at home unsupervised 5 times a week
4 weeks in lab

Control group:
LL strength training for 12 weeks

Activities specific balance scale, SLS, limit of stability test, GaitRite

- 6% increase in ABC score p = 0.025 and again at 3 (10%) and 12 (7%) months
- Both groups improved stability but only balance group maintained this at 3 months
- Both groups improved gait velocity Balance gp by 7% & Con gp by 9% and maintained at 3 and 12 months
- Only balance gp improved SL, which was maintained at 3 & 12 months

Impact of feedback
Targeted many of features of PD
Intense
Good compliance
Combined approach

3 different types of exercise (Shulman et al 2013)

To compare the efficacy of treadmill exercises, and stretches and resistance exercises in improving gait speed, strength and fitness

High intensity TT (23)
30 mins 70-80% HR reserve
3x per week for 3 months

Lower intensity TT (22)
30 mins 40-50% HR reserve
3x per week for 3 months

Stretching& resistance exs 2 set of 10 reps incidence, leg press, leg extension and curl
3x per week for 3 months

6MWT, VO2 max, and muscle strength (1RM)

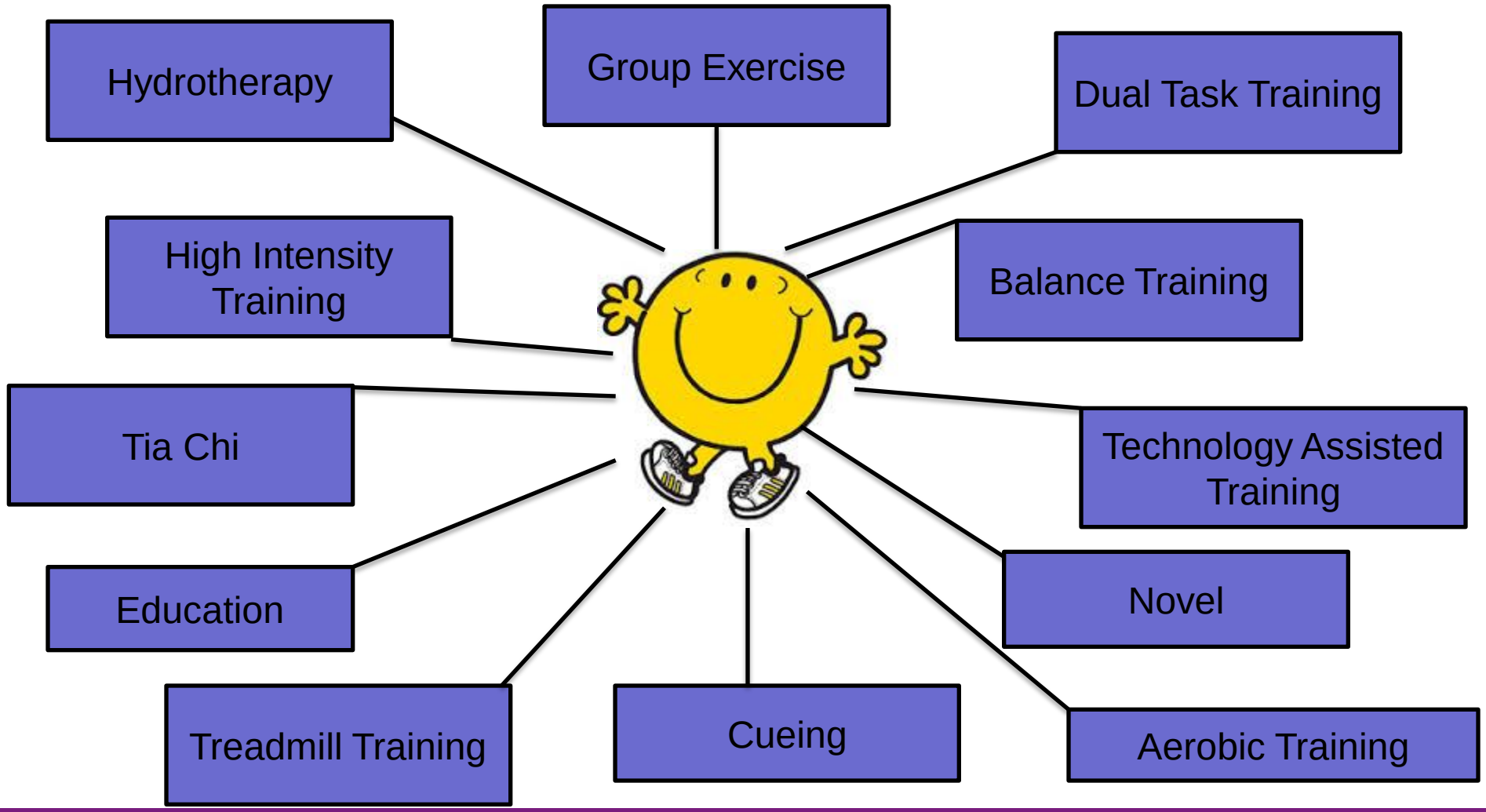
- All 3 groups improved 6MWT, although only low Tt (12%) and exs group (9%) were significant
- Both TT Improved Cv fitness
- Exs group statistically significant imp in strength
- No change in the UPDRS
- No imp in depression, fatigue or QoL

Exercise can improve gait speed, strength and fitness in PD
Combined approach may be better

Conclusions

- Heterogeneity of the studies
- Strength gains can be achieved
- Functional closed-chain progressive bodyweight exercises may be most effective
- A frequency of 2-3 times per week using 2x(8-10) repetitions for at least 12 weeks
- Further work

Physiotherapy



EU, NICE, and Dutch guidelines 2014, 2006, 2004 resp

Cueing

Auditory

- Bypass the internal rhythm deficit in the BG, providing this rhythm of a voluntary basis

Visual

- Utilising the visual cerebellar pathways bypassing the BG

Sensory

- Utilises the dorsolateral Pre motor control areas so bypassing the automatic pathways which go the via the SMA

External Cueing (Rocha et al 2014)

- Undertook a Meta analysis which reviewed all studies which have studies the effectiveness of cueing, n =10
- Cueing results in improvements in Stride length, step length, speed, and cadence
- Visual provide better improvement in cadence

External Cueing (Rocha et al 2014)

- Sensory cues decrease cadence, but increase speed and stride length

- Combined cueing with auditory and visual also show improvements in the UPDRS and freezing

Little literature into functional benefit, or impact on QoL

Tai Chi , Yang et al (2014)

- Evaluated the evidence of the efficacy of PD, in particular motor function, balance and gait.
- N = 8
- Improvements in motor function as measured by UPDRS III
- But does not support or refute it in comparison to other therapies

Tai chi, Yang et al (2014)

- Effect at improving balance.
- Better improvements with the BBS compared to other therapies
- Not effective in gait parameters
- Improvements in functional mobility

Little benefit on walking, aerobic capacity, and muscle strength

Aerobic exercise (Shu et al 2014)

- Systematic review incorporating 18 studies totalling 901 PwPD
- Age 67+/-303 years
- PD Duration 6.4 +/-2.7
- Only 2 studies looking at stages I-IV

Aerobic exercise (Shu et al 2014)

- Improvements in UPDRS III
- Some effect on balance
- Superior effects at improving gait
    - all spatiotemporal gait parameters
    - 6MWT
- No difference when compared with other therapies for QoL

So where does this leave us?

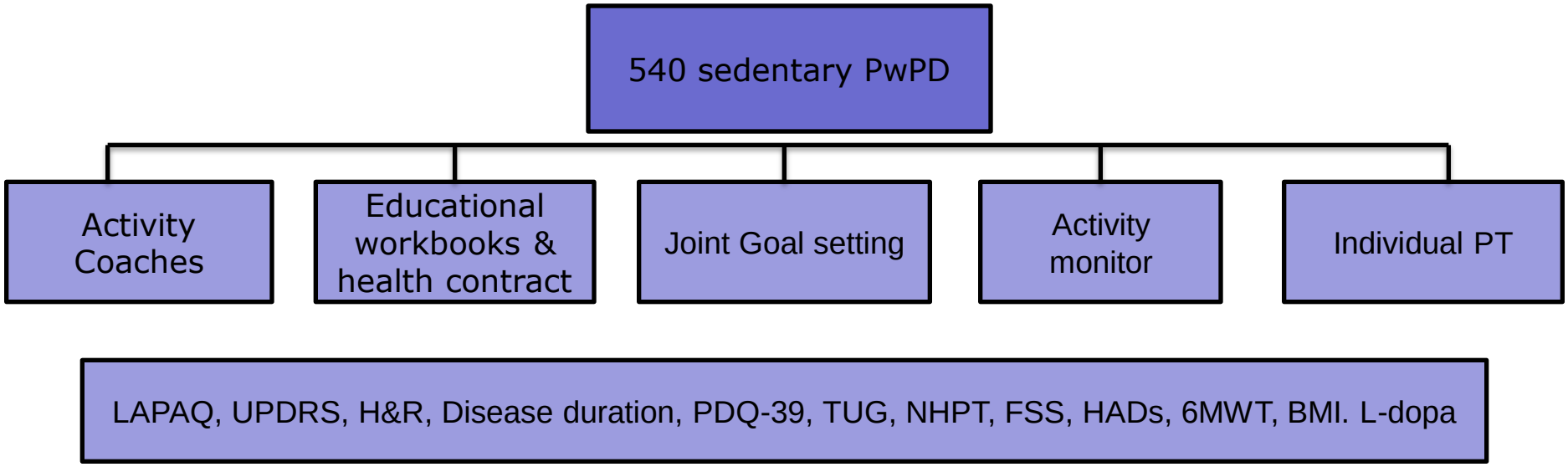
We know that improvements can be made in:

- Strength
- Power
- Flexibility
- Balance
- Gait

What we don't know:

- Which type of exercise would be best?
- Combined approach would seem best but which forms of exercise?
- At what prescription?
- How long will it last?

ParkFit (Speelman et al 2014)



63% Physical Limitations

Effective:

- Sedentary people
- Women
- Higher disease severity
- Shorter disease duration
- Older

ParkFit 34% more active than controls

Behavioural change

PRE (Prodoehl et al 2015)

48 PwPD

UPDRS, MPPT, sit-stand, FR, TUG, BBS, walking speed

1:1 training twice weekly for 6 months, once weekly thereafter. Second session independent. Sessions last 60-90 mins

Randomly allocated

PRE Programme
- 11 Ul & LL strengthening exs
- 30-40% IRM for UL
- 50-60%1RM LL

Fitness Counts programme
- Stretching
- Non progressive strengthening
- Balance & breathing

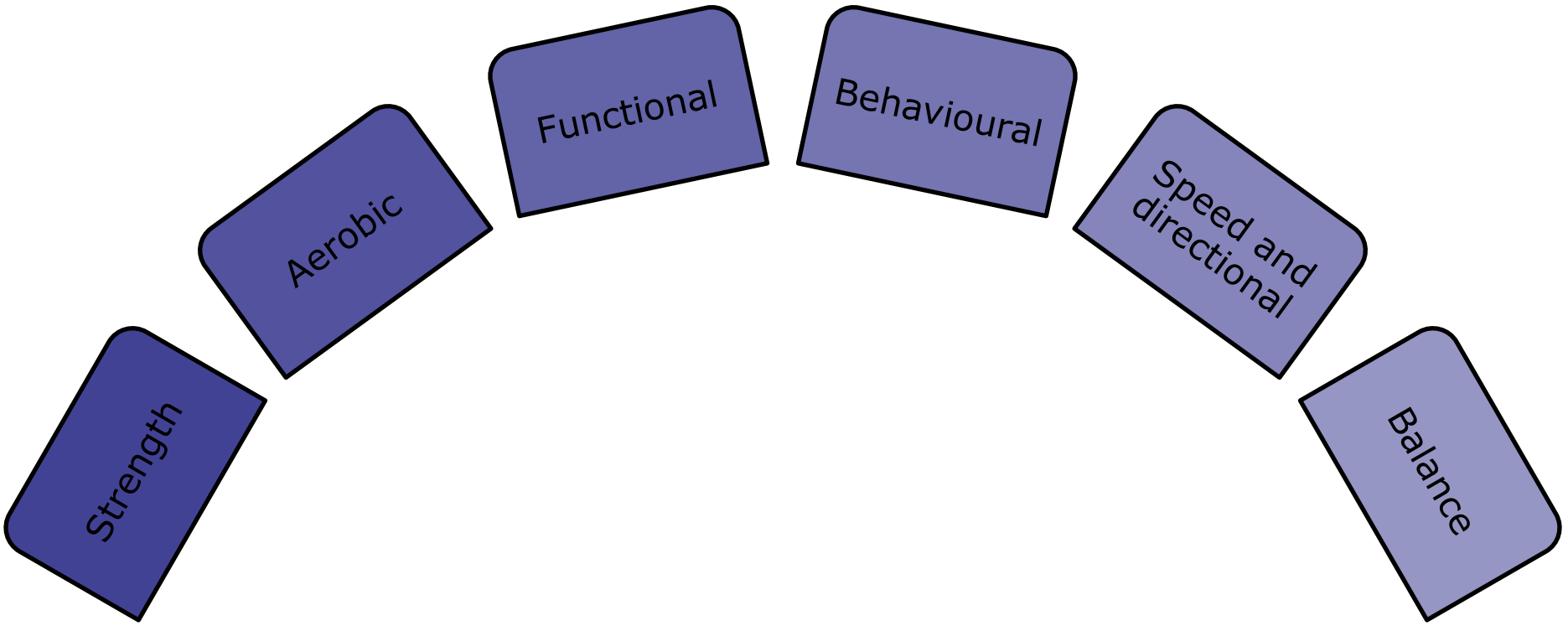
Data collected at baseline, 6, 12, 18 and 24 Months

Statistically significant improvements in all Physical measures except 6MWT

No difference between groups

Varied approach to exercise prescription targeting multiple muscles, including motor and non motor components

Ideal world


Strength
Aerobic
Functional
Behavioural
Speed and directional
Balance

How can we do it

- Well designed research methodologies
- Larger sample sizes
- Research function
- More research trials

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My research

- Referral and access to Physiotherapy
- Physical activity
- Measurement of function
- Perceptions of physiotherapy
- Service provision

Aims

- To determine
  - Level of access to specialist PD physiotherapy
  - Proportion of patients referred
  - Timing of referral
  - Perceived role of physiotherapy
  - Factors which influence referral

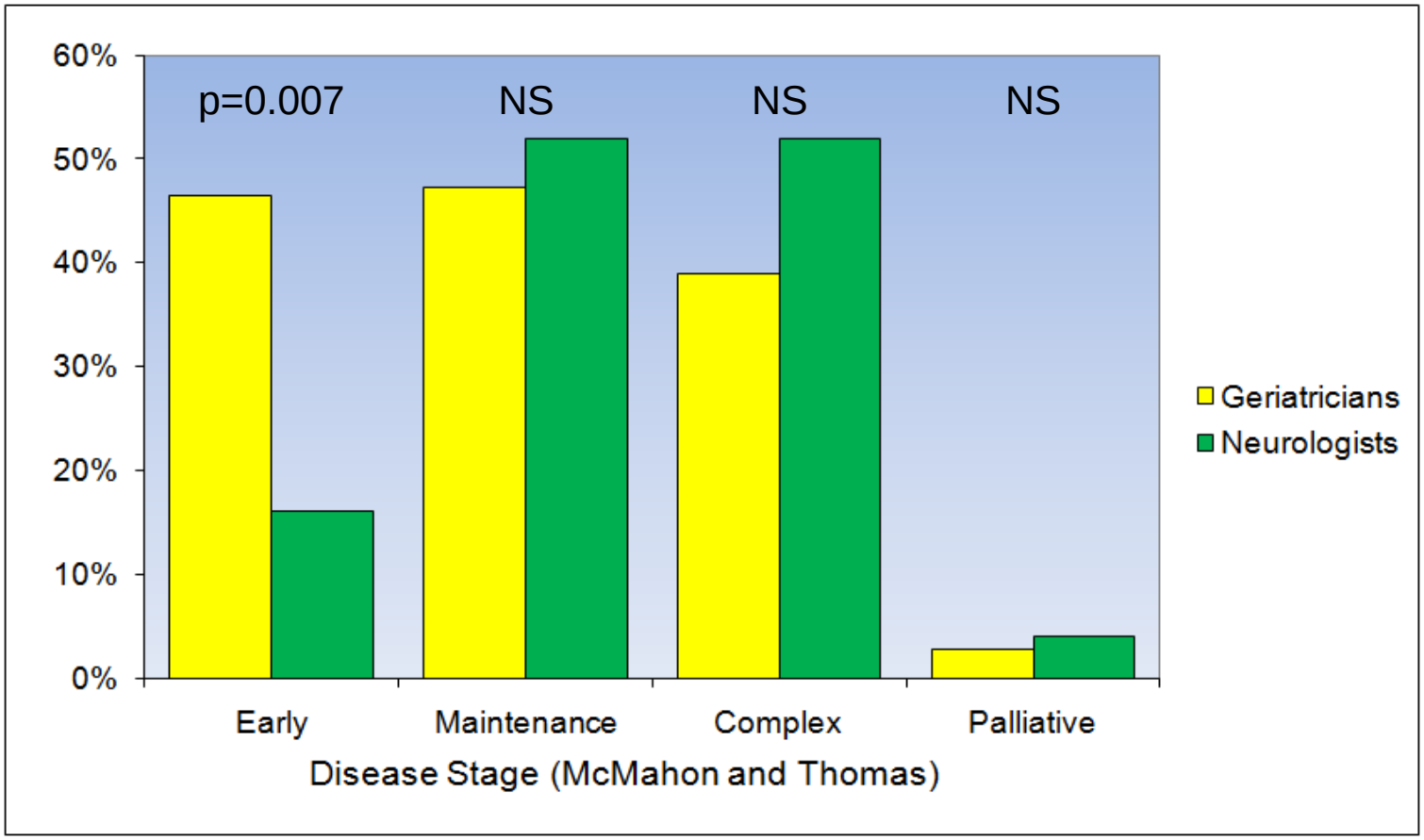
Results

- Access to specialist services
  - Physiotherapy 33%
  - PDNS 79%

- Access and referral to physiotherapy

	Geriatrician	Neurologists	Chi²
Access	39%	23%	p=0.13
Refer (>50%)	69%	4%	p<0.001

Referrals by Stage

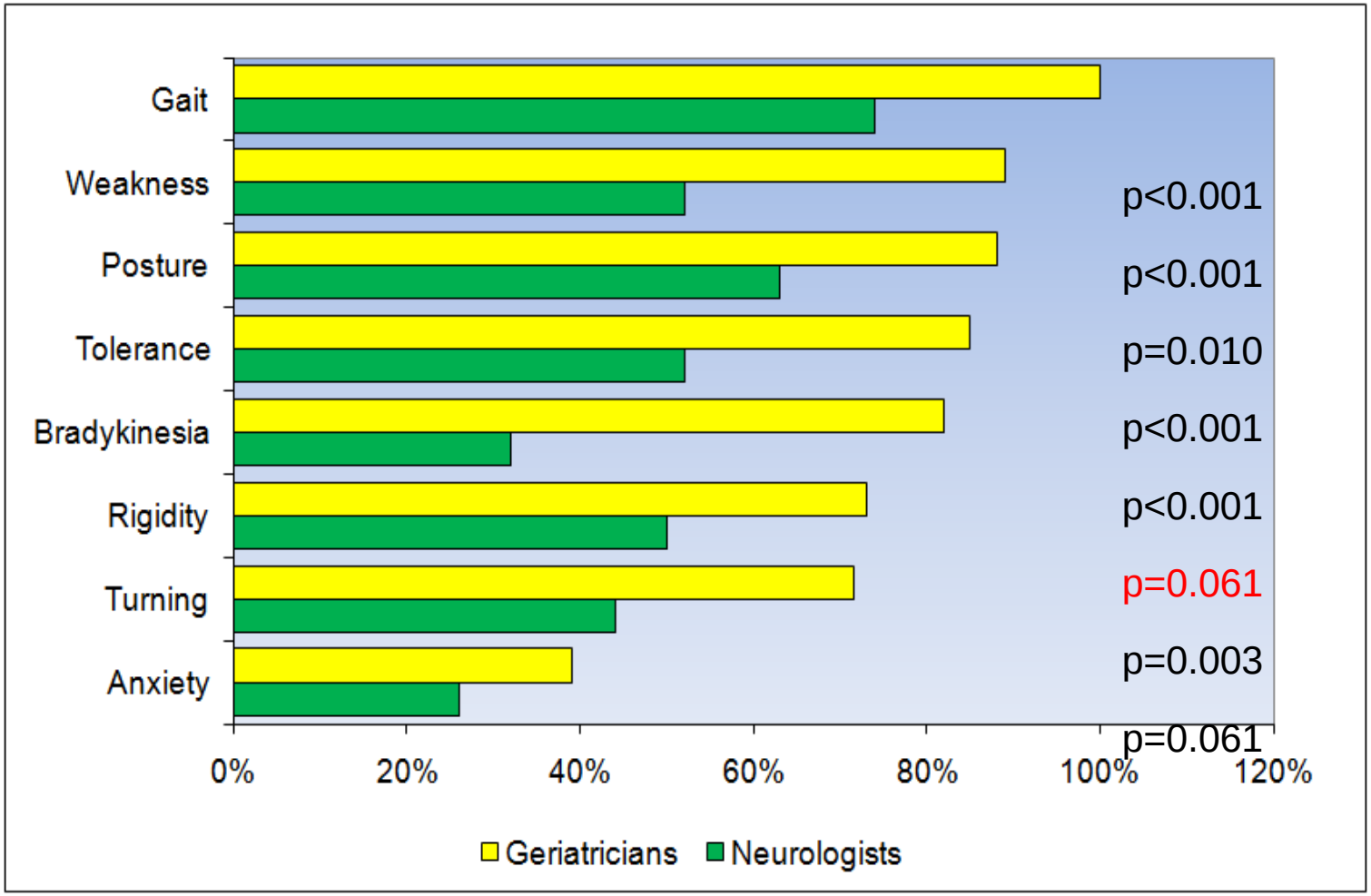


Factors Influencing Referral

	AGREE	UNCERTAIN	DISAGREE
Difficulty turning in bed	☐	☐	☐
Rigidity	☐	☐	☐
Gait Hypokinesia	☐	☐	☐
Bradykinesia	☐	☐	☐
Muscle Weakness	☐	☐	☐
Poor Exercise Tolerance	☐	☐	☐
Anxiety	☐	☐	☐
Poor Posture	☐	☐	☐

Other Please state _____

Factors Influencing Referral



	Geriatricians	Neurologists
Improve physical function	100	86
Falls prevention	99	78
Gait re-education	97	87
Postural re-education	97	83
Provision of walking aids	97	75
Prescribe exercise	96	78
Maintain independence	93	83
Improve exercise tolerance	93	48
Provide education	88	65
Prevention of secondary complications	59	23
Monitor drug efficacy	45	0
Carer support	42	41
Psychological and social support	30	41
Educate on drug regime	7	0

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Summary

- One-third of consultants have access to specialist physiotherapy
  - Geriatricians more likely to refer

- Referrals
  - High in maintenance and complex stages
  - Low in palliative stage
  - Low neurologist referral in early stage

Summary

- Variation in perceived role of physiotherapy
  - Perceived role in education
  - But not drug education

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Physical Activity