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March 14, 2023

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Impact of Motor and Non-Motor Symptoms on Exercise

Working With Your Parkinson's Symptoms to Optimize Your Fitness Plan



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What is Parkinson's Disease?

A chronic **neurodegenerative** disorder that affects how a person...

Symptoms develop **gradually** and get worse over time

Each person experiences Parkinson's disease **differently**



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MOVES

People with Parkinson's disease experience motor symptoms

THINKS

Parkinson's disease can impact a person's cognition

FEELS

Parkinson's disease can impact a person's emotions and motivation



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Key Motor and Non-Motor Symptoms

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Parkinson's is more than just its cardinal signs

CARDINAL SIGNS	 BRADYKINESIA	 RIGIDITY	 TREMOR	 POSTURAL INSTABILITY		
OTHER MOTOR SYMPTOMS	 AMBULATION	 INCOORDINATION	 POSTURE	 BALANCE	 FINE MOTOR	 SPEECH SWALLOW
NON-MOTOR SYMPTOMS	 COGNITION	 SENSORY	 MOOD MOTIVATION	 AUTONOMIC REGULATION	 PAIN	 SLEEP FATIGUE



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Exercise Helps Parkinson's Symptoms

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In addition to medical management like medications, surgery, physical therapy, etc.

Research protocol variability!!!



Different types

- Classic ↔ Contemporary



Different PD stages

- Early ↔ Late



Different frequency, intensity, timing



Motor Function

Exercise improves walking function, balance, and strength in people with PD



Cardiovascular Fitness

Exercise improves heart and pulmonary function in people with PD



Non-Motor Symptoms

Exercise improves non-motor symptoms like cognitive changes, mood dysregulation, and sleep problems in people with PD



What "active ingredients" should all Parkinson's-specific exercise programs include in order to be safe and effective?

Wongpakdeekul H 2022; Hsieh S 2022; Sivanandhi P 2022; Ben M 2021; Olsson BR 2021; Dawson VL 2021; Emig H 2021; Fontana C 2021; Kivimäki A 2021; Rafferty MP 2021; Olanow JA 2021; Salazar-Casasola J 2021; Armstrong MJ 2020; Chang HC 2020; Cooley CF 2020; Fernandez B 2020; Rajput RH 2020; Kiehl PE 2020; Roelke DL 2020; San Martin Valenzuela C 2020; van de Werling van Dongen VK 2020; additional references available on request



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PD Exercise Program Active Ingredients

The 4 core “active ingredients” to every Parkinson’s-specific exercise plan

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Key Motor and Non-Motor Symptoms

Parkinson's is more than just its cardinal signs

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CARDINAL SIGNS	 BRADYKINESIA	 RIGIDITY	B R A D Y K I N E S I A	R I G I D I T Y
	 AMBULATION	 INCOORDINATION		
OTHER MOTOR SYMPTOMS			S E Q U E N T I A L	I N F L E X I B I L E P R O G R A M S E L E C T I O N
NON- MOTOR SYMPTOMS	 COGNITION	 SENSORY	C O G N I T I O N	S E N S O R Y

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B.R.A.I.N.S. Framework™

Parkinson's-Specific Exercise Scaling "Active Ingredients"

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A / Hypo / Bradykinesia

- Kinesia = movement
 - A-kinesia = no movement
 - Brady**-kinesia = slow movement
 - Hypo**-kinesia = smaller movement

(Bloem BR 2021, Osborne JA 2021, Armstrong MJ 2020, Bologna M 2020, Vieira de Moraes Filho A 2020, Fernandez L 2018, Opata J 2017, Schilder JCM 2017, David FJ 2016, Ni M 2016, Panigrahi B 2016, Baraduc P 2015, Earhart GM 2013, Mazzoni P 2012, Turner RS 2010, Espay AJ 2009, Mazzoni P 2007, Forkey BG 2006)

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A Speed-Amplitude Dysregulation

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Big, accurate movements come out slower. Fast movements come out smaller and imprecise.

(Bloem BR 2021, Osborne JA 2021, Armstrong MJ 2020, Bologna M 2020, Vieira de Moraes Filho A 2020, Fernandez L 2018, Opata J 2017, Schilder JCM 2017, David FJ 2016, Ni M 2016, Panigrahi B 2016, Baraduc P 2015, Earhart GM 2013, Mazzoni P 2012, Turner RS 2010, Espay AJ 2009, Mazzoni P 2007, Forkey BG 2006)

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Parkinson's-Specific Exercise Scaling "Active Ingredients"

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Bradykinesia

- Speed-amplitude dysregulation
 - Big accurate movements come out slower
 - Fast movements come out smaller and imprecise

Progression/ Regression Ideas

- Progression examples:
 - Bigger movements while keeping the same speed
 - Drive extensor motor output – high effort, powerful, whole body movements
- Regression examples:
 - Add visual cues/targets for mvt size
 - Slow down pace to focus on big mvts

Blom BR 2021, Emig M 2021, Osborne JA 2021, Armstrong MJ 2020, Bologna M 2020, Fritzsche M 2020, Peterson DS 2020, Tinaz S 2020, Vieira de Moraes Filho A 2020, Calabró RS 2019, Raza C 2019, Fernandez L 2018, Hagura N 2017, Opazo J 2017, Schilder JCM 2017, Avanzino L 2016, David FJ 2016, Ni M 2016, Pangrazi B 2015, Leow LA 2014, additional references on reference list

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B.R.A.I.N.S. Framework™

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Sequential Incoordination + Inflexible Program Selection

- Coordinating, timing, and synchronizing body parts
- Stringing together complex movement sequences
- Delay or inability to adapt or refine the motor plan to the situation

Eligioni C, ed. 2022, Kindlinger A 2021, Macedo-Lima M 2021, McCusker MC 2021, Bologna M 2020, Fritzsche M 2020, King LA 2020, Rose D 2020, Vroly JA 2020, Behroozmand R 2019, Calabró RS 2019, Lee YV 2018, Marsolino ALA 2018, Mok MY 2018, Cochran De Cock V 2018, Fennell D 2018, Giordano N 2018, Gull A 2017, Marinelli L 2017, additional references on reference list

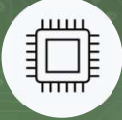
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Motor Control/Learning


A crash course!

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MOTOR PROGRAM

A group of instructions encoded in your neural pathways that tell you how to perform a movement.



(SET) (SET SHIFTING) (TASK SWITCHING)

FLEXIBLE PROGRAM SELECTION

The process when your brain adapts or changes the neural circuits for the motor program because of:

- Change in context
- Past experience
- Assumption

(Yaffe JA 2020, Shumway-Cook A 2017, Chong RKY 2000, Chong RK 1999, Robertson C 1990)

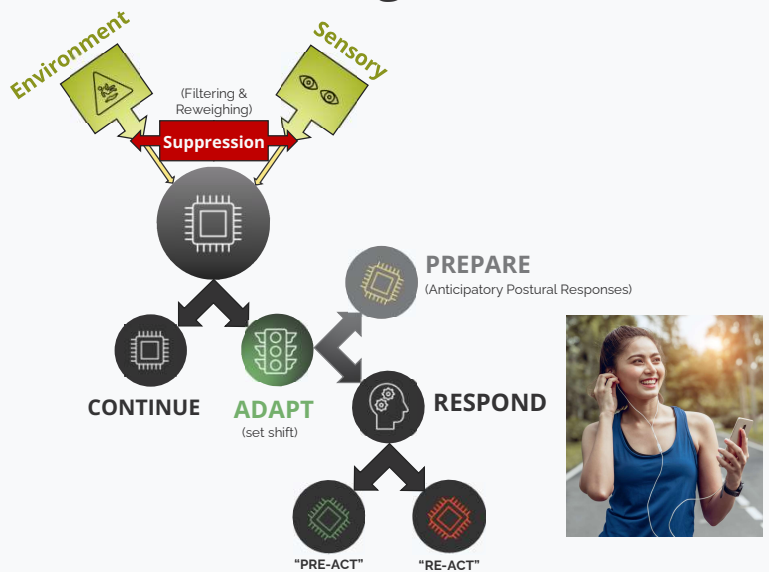
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Motor Control/Learning

A crash course!

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graph TD
    Environment[Environment] -- "(Filtering & Reweighing)" --> Brain[Brain]
    Sensory[Sensory] -- "(Filtering & Reweighing)" --> Brain
    Brain -- "Suppression" --> Brain
    Brain --> CONTINUE[CONTINUE]
    Brain --> ADAPT[ADAPT  
(set shift)]
    ADAPT --> PREPARE[PREPARE  
(Anticipatory Postural Responses)]
    ADAPT --> RESPOND[RESPOND]
    PREPARE --> "PRE-ACT"[PRE-ACT]
    RESPOND --> "RE-ACT"[RE-ACT]
  
```

The diagram illustrates the motor control and learning process. It starts with 'Environment' and 'Sensory' inputs, which are processed by the brain through 'Filtering & Reweighing'. The brain then performs 'Suppression' and branches into 'CONTINUE' and 'ADAPT (set shift)'. 'ADAPT' leads to 'PREPARE (Anticipatory Postural Responses)' and 'RESPOND'. 'PREPARE' leads to 'PRE-ACT', and 'RESPOND' leads to 'RE-ACT'. A photograph of a woman running is included on the right side of the diagram.

(Yaffe JA 2020, Shumway-Cook A 2017, Park JH 2015, Ruitenberg MFL 2015, Cameron KJM 2010, King L 2009, Chong RKY 2000, Chong RK 1999, Robertson C 1990)

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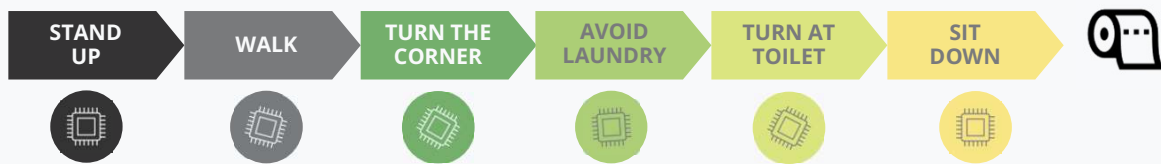
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Motor Control/Learning

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Program 1 + Program 2 + Program 3 = MOTOR PLAN → MOTOR GOAL



(Shumway-Cook A 2017, Robertson C 1990)



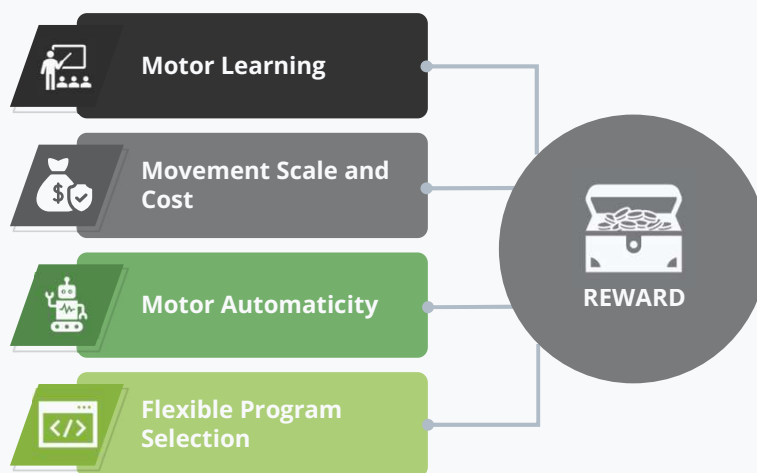
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Motor Control/Learning

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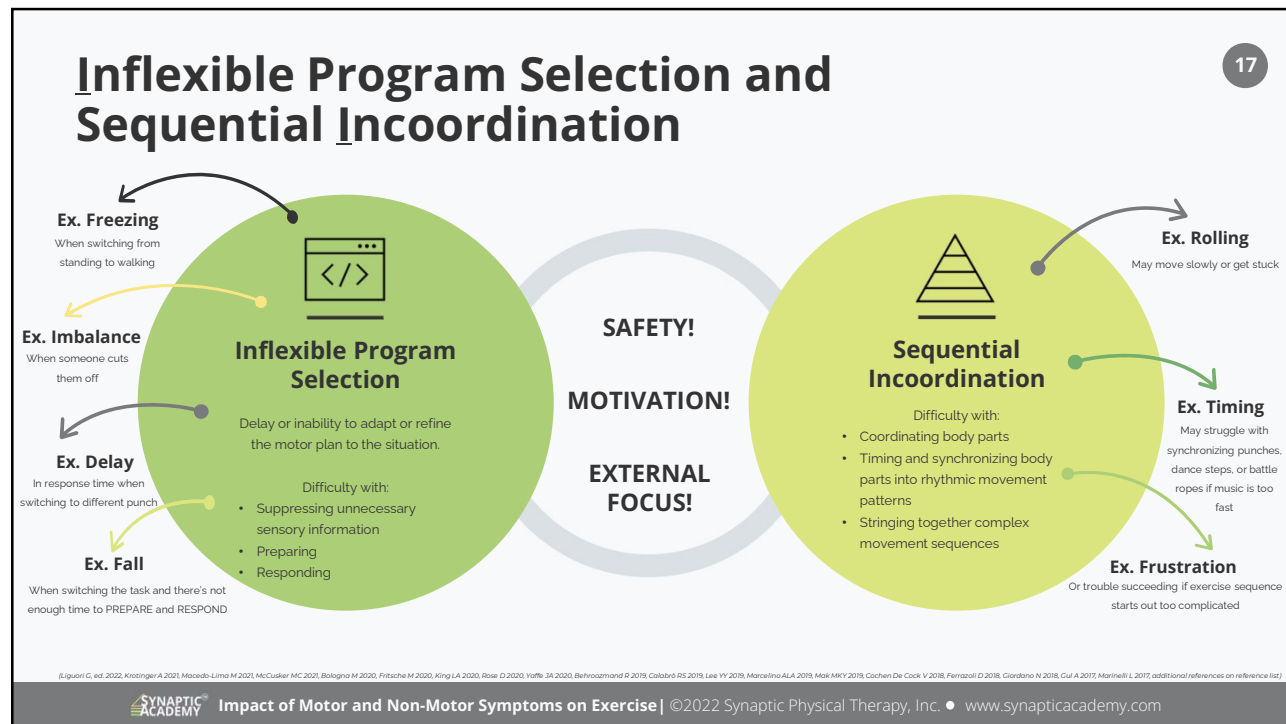


(Macedo-Lima M 2021, Wolfe JA 2020, Marcelino ALA 2018, Ferrazoli D 2018, Giordano N 2018, Montali L 2017, Shumway-Cook A 2017, Panigrahi B 2015, Wu T 2015, Baraduc P 2013, Petzinger GM 2013, Turner RS 2010, Mazzoni P 2007, Chong SKY 2005, Chong SK 1999, Robertson C 1990)

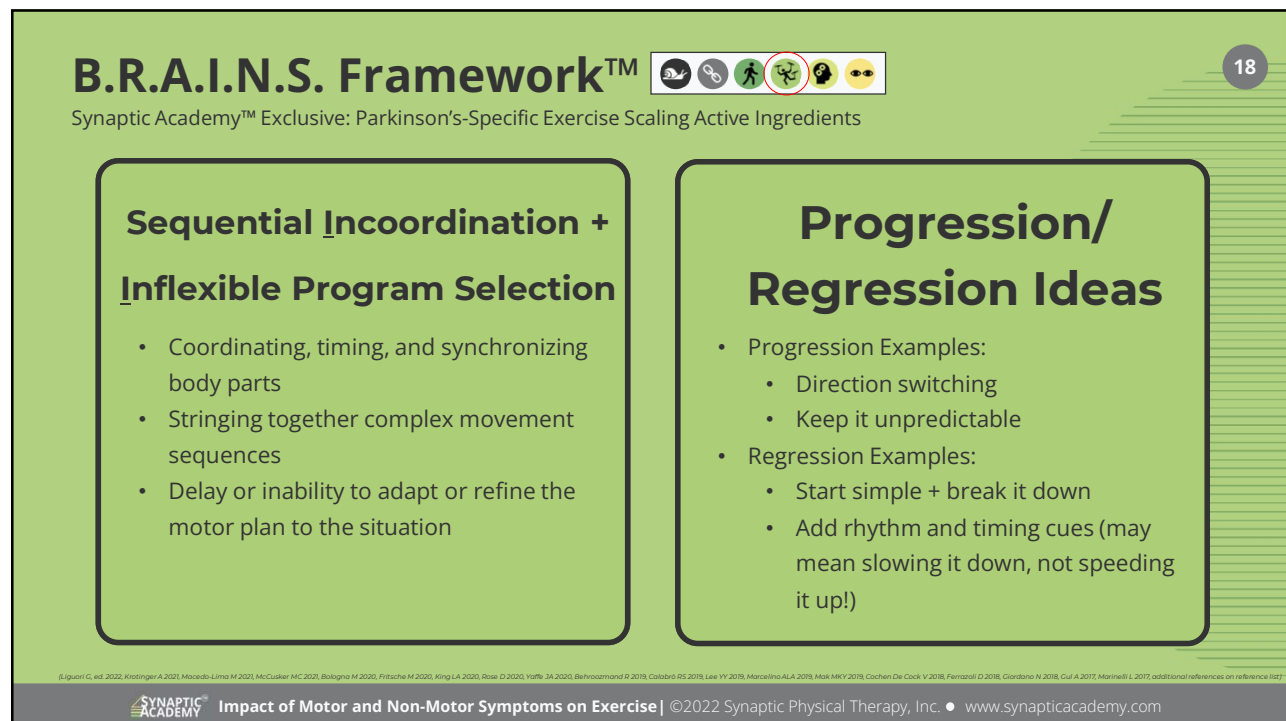


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B.R.A.I.N.S. Framework™

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CogNition

- Changes in all cognitive domains but has biggest impact on these four:
 - Perceptual-motor function
 - Learning & memory
 - Complex attention
 - Executive function**

(Huang CY 2022, Liguori C, ed. 2022, Pouley L 2022, Ritchey LN 2022, Aarland D 2021, Arriaga A 2021, Beadick O 2021, Cardona JF 2021, Chung YC 2021, Dana A 2021, Dauwan M 2021, Emig M 2021, Hanna-Pladdy B 2021, Kinstinger A 2021, Loftus AM 2021, Osborne JA 2021, Pilgrim MD 2021, Ramos AA 2021, Tagini S 2021, Biddiscombe KJ 2021, additional references on reference list)


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Cognition: Executive Function


Anything to do with reasoning, problem-solving, and planning for the future.

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Planning & Decision Making

The ability to organize, prioritize, and anticipate in order to make reasoned choices.




Working Memory

The ability to temporarily and consciously hold information in your mind so that you can use it for reasoning, problem-solving, and making decisions.



Error Correction


The ability to know when you've made a mistake as well as to react and adapt to avoid future errors.



Inhibition

The ability to stop automatic or impulsive responses.

- Organizing, prioritizing, anticipating, planning (including workouts!)
- Manipulate information in real time to use for reasoning, problem-solving, decisions
- Detecting and correcting a motor mistake and adapting to avoid it in future
- Doing an unsafe exercise even though cautioned not to
- Suddenly stopping one motor program to switch to another
- Responding to one set of instructions while ignoring another



(Beadick O 2021, Loftus AM 2021, Ramos AA 2021, Harvey PD 2018, Ferrazoli D 2018, Picalli A 2016, Duchesne C 2015, Obeso JA 2014, Dimpfanger C 2013, Nogueira JP 2011)

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B.R.A.I.N.S. Framework™

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CogNition

- Changes in all cognitive domains but has biggest impact on these four:
 - Perceptual-motor function
 - Learning & memory
 - Complex attention
 - **Executive function**

Progression/ Regression Ideas

- Progression Examples:
 - Add a math challenge
 - Add go/no-go to an exercise
- Regression Examples:
 - Reduce distractions
 - Give more time for exercises that involve anticipating and planning

(Huang CY 2022, Liguori C, ed. 2022, Pouley L 2022, Richey LN 2022, Aarland D 2021, Arriaga A 2021, Beadick D 2021, Cardona JF 2021, Chung YC 2021, Dana A 2021, Dauwan M 2021, Enrig M 2021, Hanna-Pladdy B 2021, Kinstinger A 2021, Loftus AM 2021, Osborne JA 2021, Pilgrim MD 2021, Ramos AA 2021, Tagini S 2021, Biddiscombe KJ 2020, additional references on reference list)


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Final Take-Aways


Integrating the Fab4Fitness Framework™ and B.R.A.I.N.S. Framework™




Try to include cardiovascular, strength, flexibility, and balance into your fitness program.



When in doubt, slow things down a bit and focus on big, vigorous movements.



Bradykinesia = Big, accurate movements come out slower. Fast movements come out smaller and imprecise.



Work with a physical therapist and a personal trainer who specializes in helping people with PD.

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