Parkinson Society British Columbia

The Research-Based Benefits of Exercise for Parkinson's

Dr. Matthew Sacheli, Research Program Manager,
BC Brain Wellness Program, UBC

MOVING FORWARD

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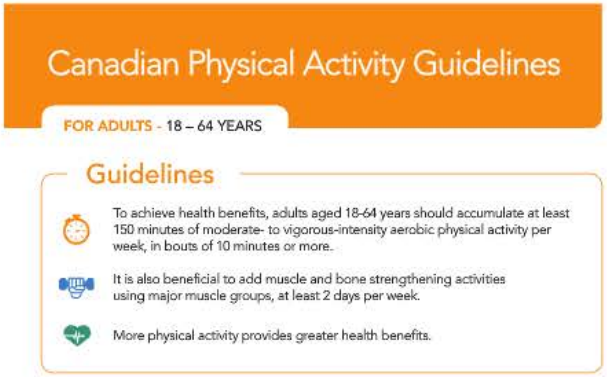
MOVING FORWARD *together*

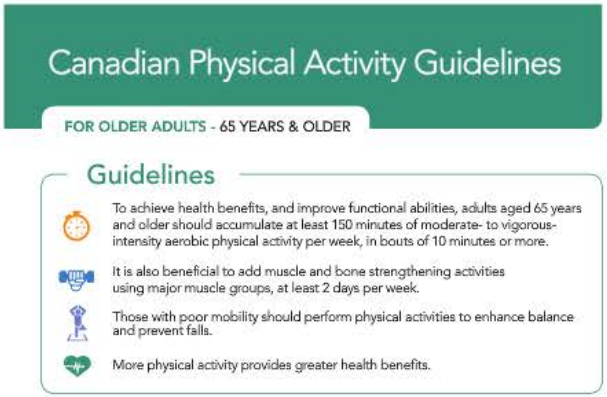
University of British Columbia

Djavad Mowafaghian
CENTRE FOR BRAIN HEALTH

PACIFIC PARKINSON'S
Research Centre

Exercise = better health





Reduced risk of:

- Heart disease
- Stroke
- High blood pressure
- Certain types of Cancer
- Type 2 diabetes
- Osteoporosis
- Overweight and obesity

Benefits include:

- Fitness
- Strength
- Mental health (morale and self–esteem)

And also help to:

- Maintain functional independence
- Maintain mobility
- Improve fitness
- Improve or maintain body weight
- Maintain bone health

Exercise and Parkinson's Disease







Motor complications

- Tremor
- Rigidity
- Balance
- Posture
- Gait (walking)
- Muscle weakness
- Aerobic capacity (fitness)

Non-motor complication

- Cognition
- Mood/depression
- Sleep
- Autonomic function

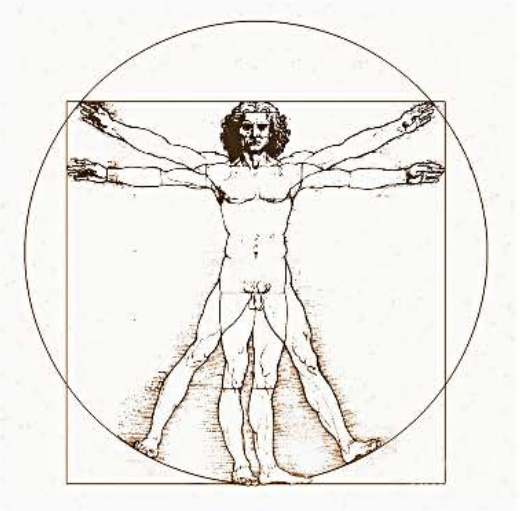
Activities of Daily living

- Getting out of a chair
- Getting dressed
- Preventing falls
- Maintaining independence
- etc...

Neuroprotection?

- Neuroprotection
  - Prevent further death of neurons
- Neurorestoration
  - Formation of new neurons

Motor complications



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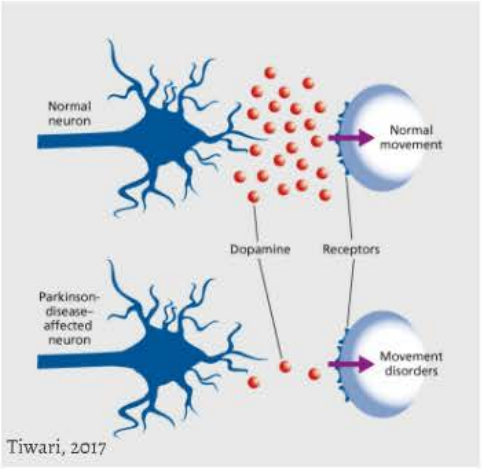
Why is exercise beneficial for Parkinson's disease?

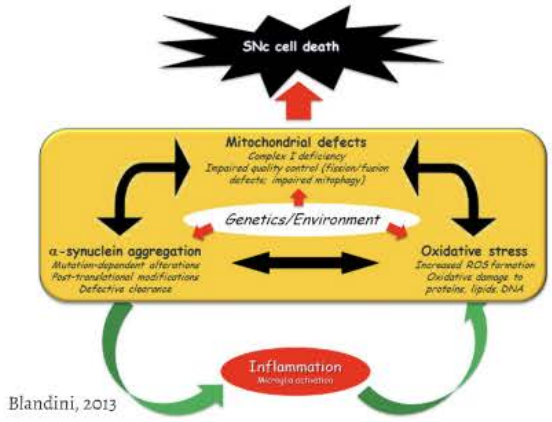


Tiwari, 2017

In animal models, exercise:

- Increases dopamine receptors (Petzinger et al., 2007; Vuckovic et al., 2010)
- Increases growth of brain cells (Toy et al., 2014)
- Protects against neurotoxic agents and to promote recovery (Tillerson, Caudle, Reveron, & Miller, 2003).
- Decreases toxin-induced neuroinflammation (Real et al., 2017)

How does exercise change the brain in someone with Parkinson's disease?



Blandini, 2013

Hypotheses

- Exercise has a beneficial effect on brain plasticity as evidenced by enhanced dopaminergic responsiveness
- Exercise may confirm long term benefits via modulation of abnormal neuroinflammation

Exercisers vs. Non-exercisers: PET and fMRI study

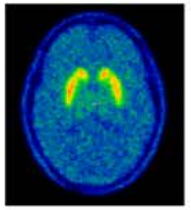
VS.

Habitual exercisers n=9

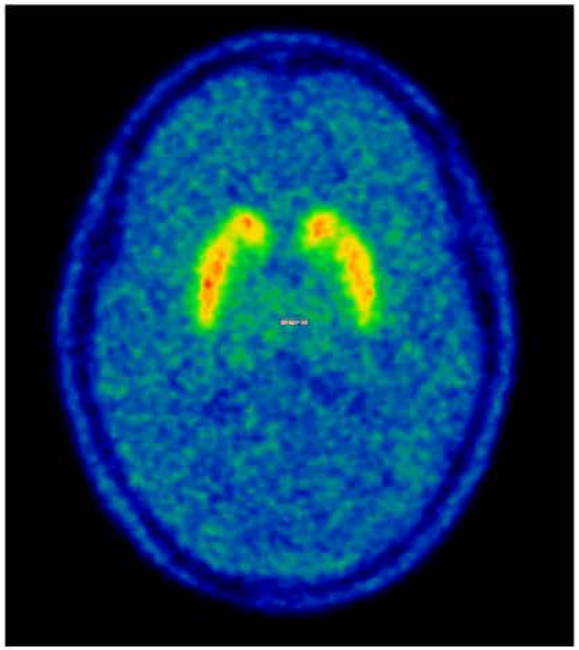
Sedentary n=8

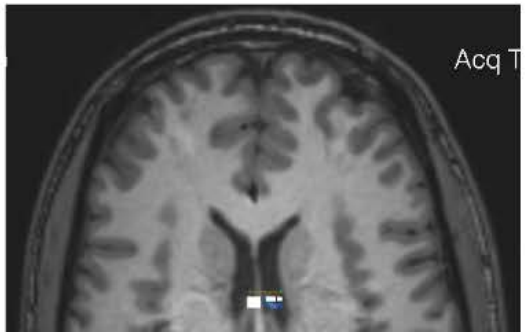
Evaluating people with PD who exercise compared to people who do not exercise

- Dopamine release in response to exercise using PET
- Brain activity in response to reward using fMRI
- Motor function
- Mood/depression/apathy
- Cognition

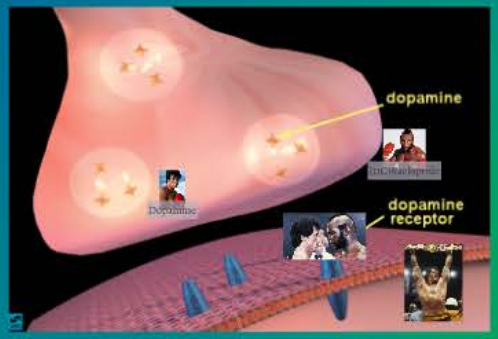


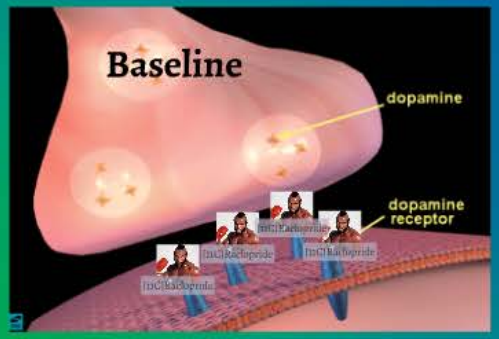
edentary n=8





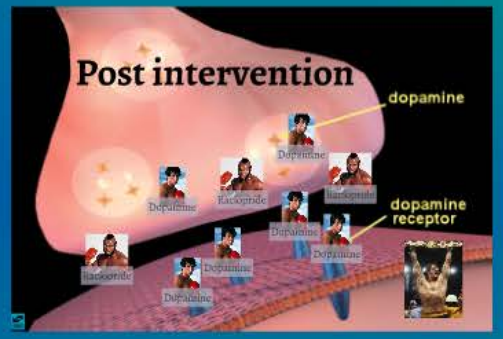
Measuring DA release with PET: [11C] Raclopride

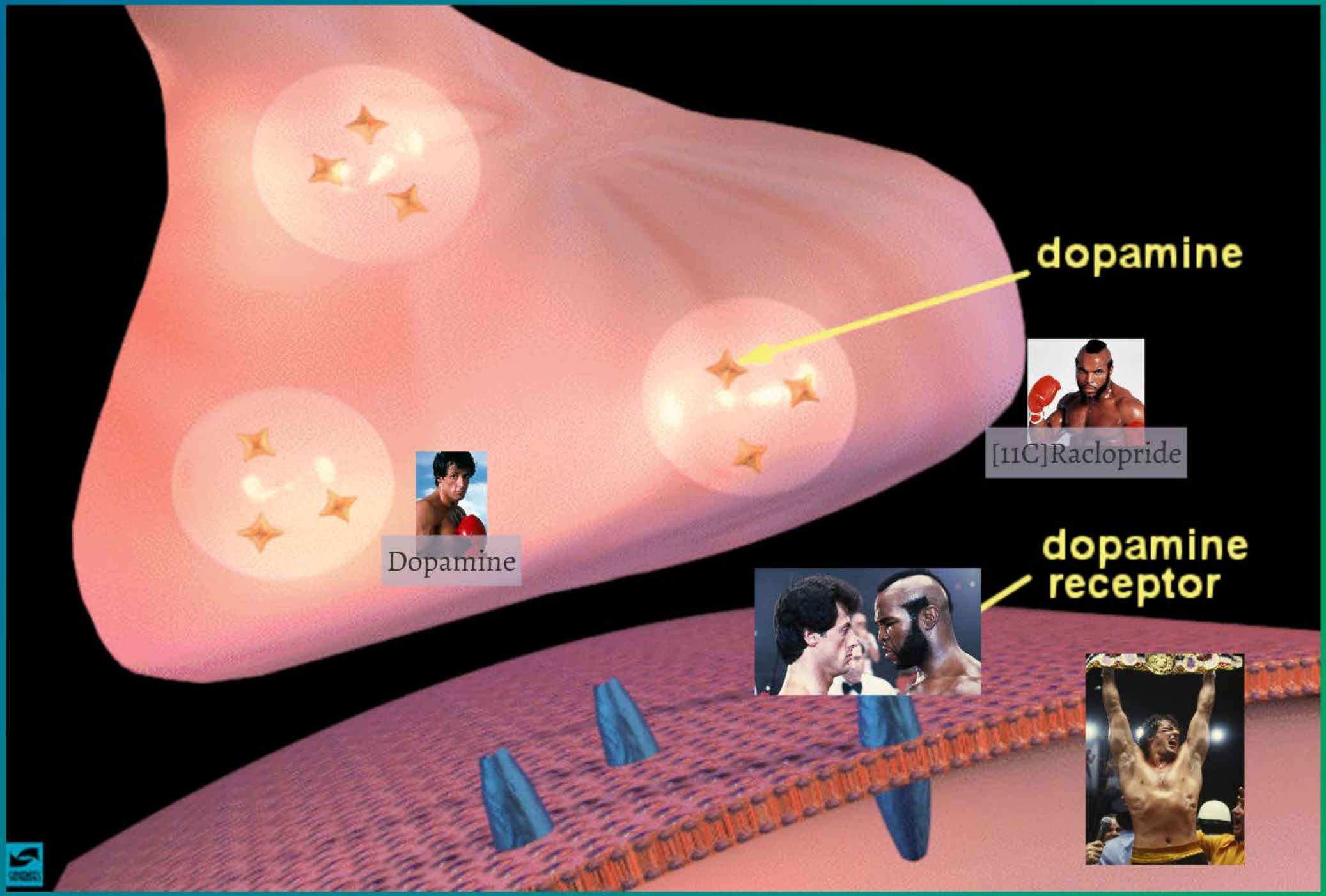


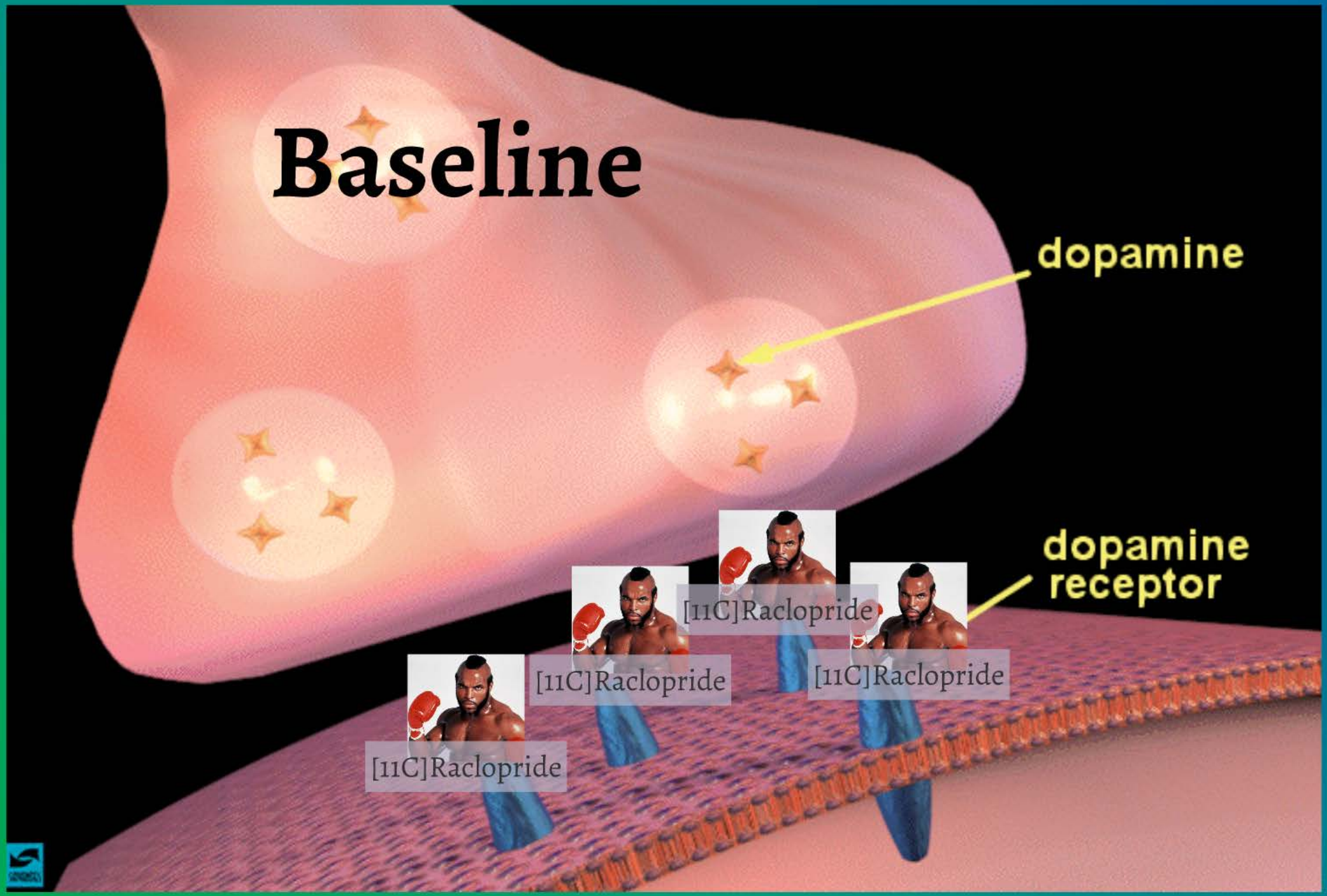


Intervention

Neuroplasticity




dopamine
[11C]Raclopride
Dopamine
dopamine receptor


Baseline
dopamine
dopamine receptor
[11C]Raclopride
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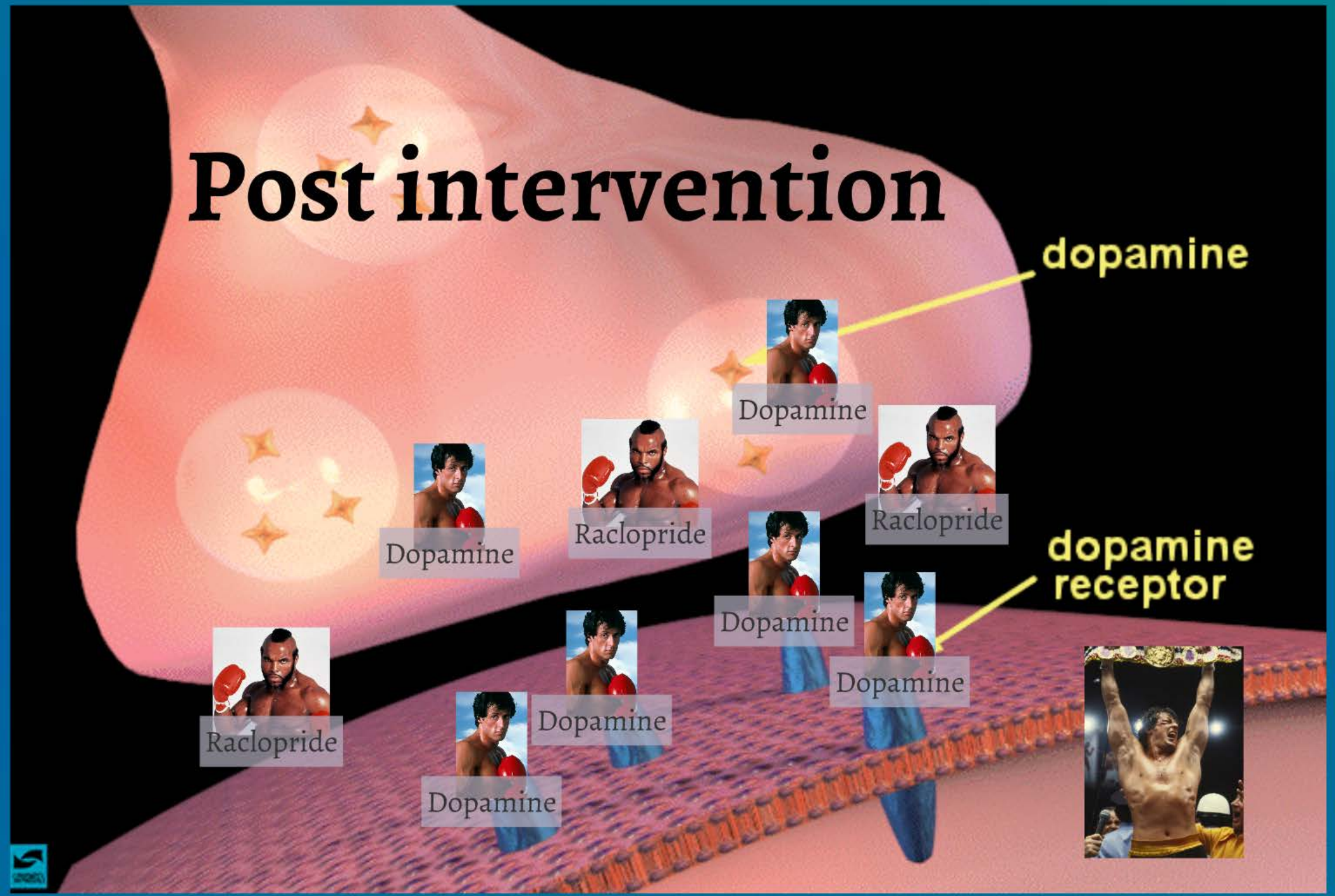
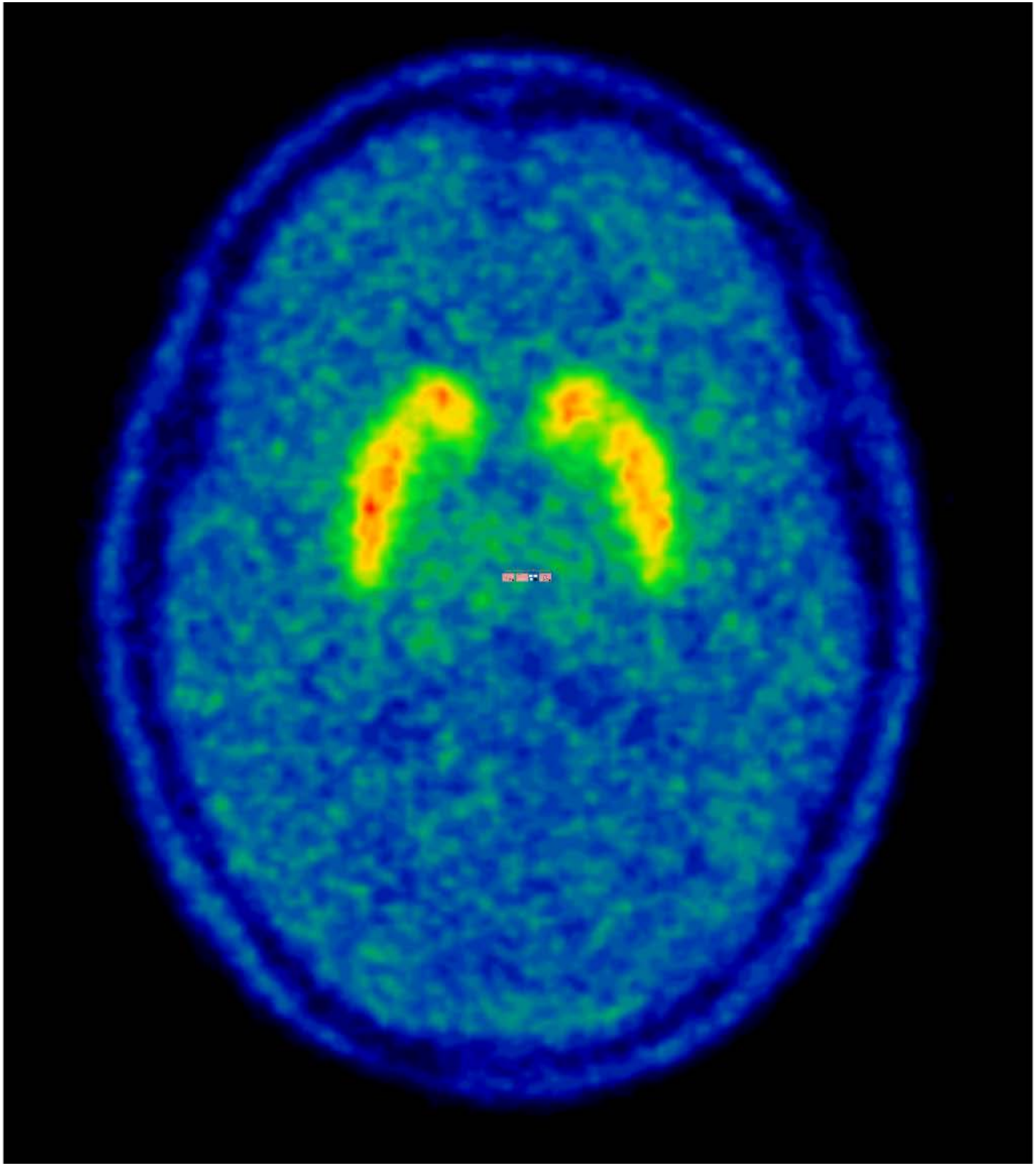
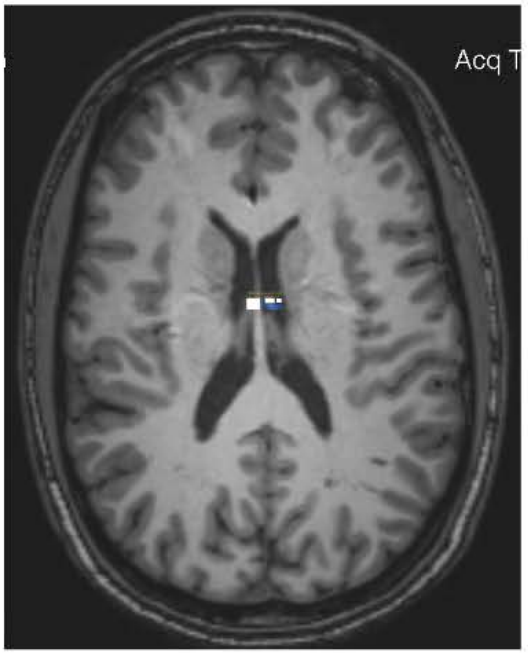
Intervention

Neuroplasticity

Post intervention

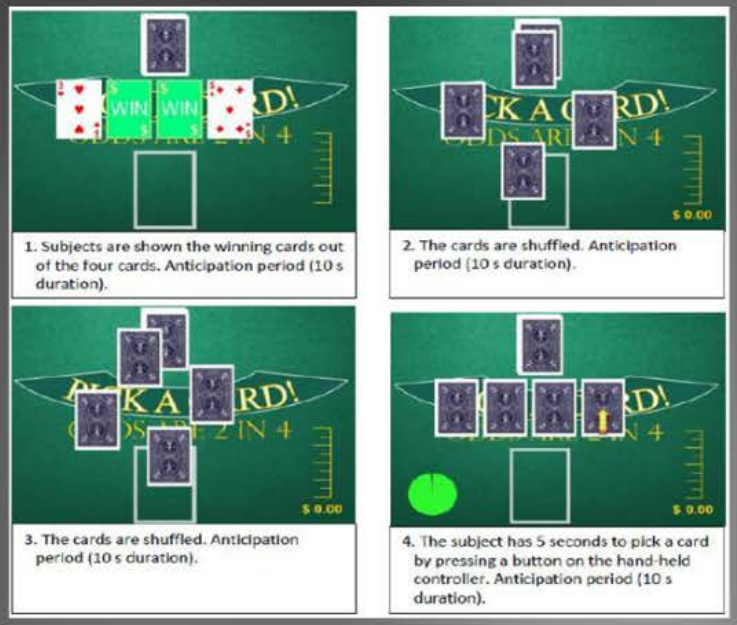





Acq T

$ fMRI monetary reward task $

Anticipation - 10 seconds



1. Subjects are shown the winning cards out of the four cards. Anticipation period (10 s duration).

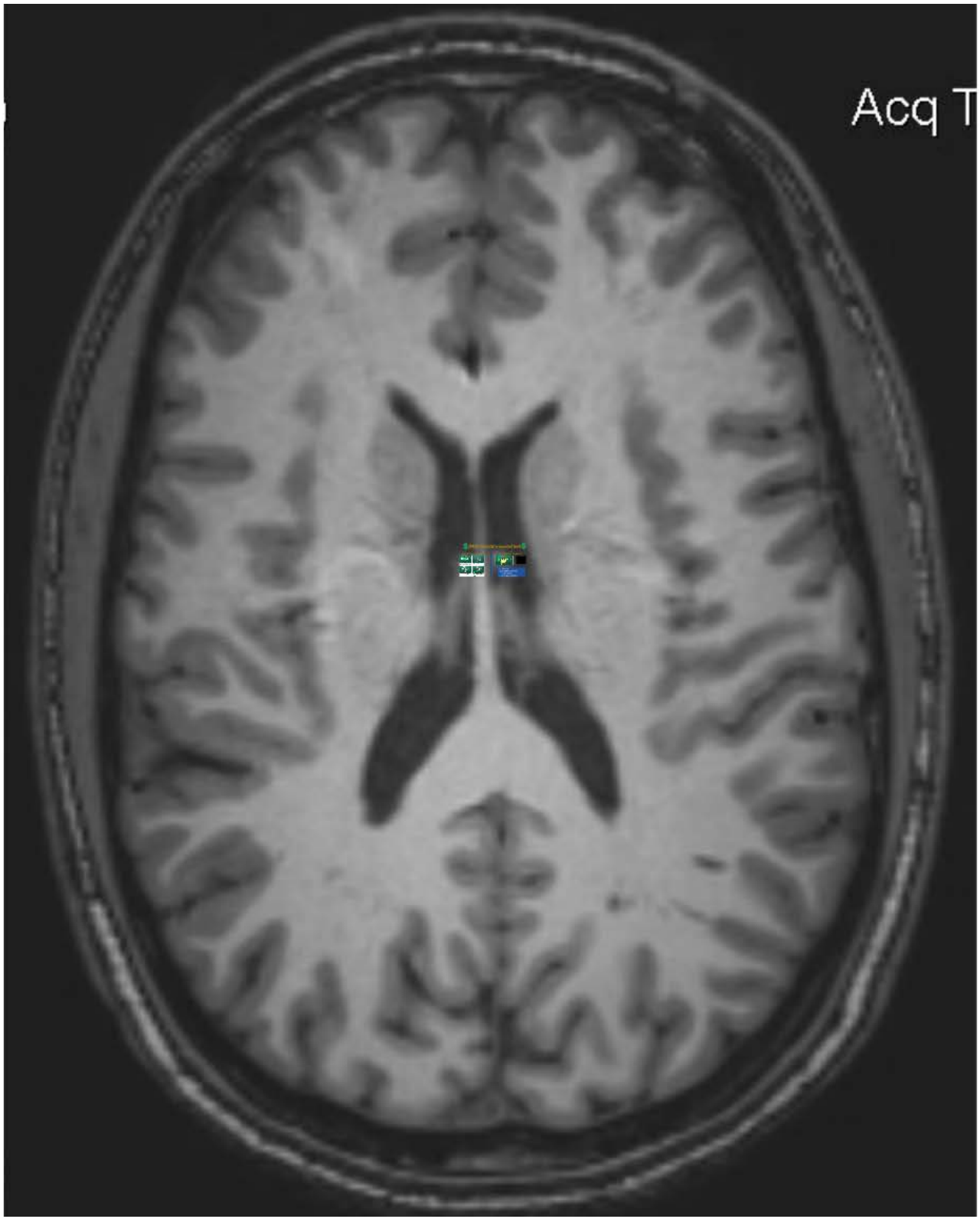
2. The cards are shuffled. Anticipation period (10 s duration).

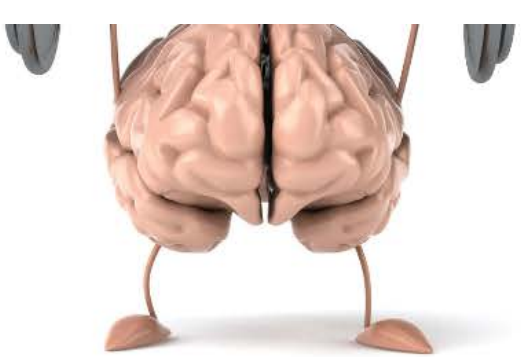
3. The cards are shuffled. Anticipation period (10 s duration).

4. The subject has 5 seconds to pick a card by pressing a button on the hand-held controller. Anticipation period (10 s duration).

Reward - 10 seconds

- $0.50/ trials
- 4 probabilities of winning
  - 0, 50, 75, 100%
- 20 trials per probability


Acq T



VS.

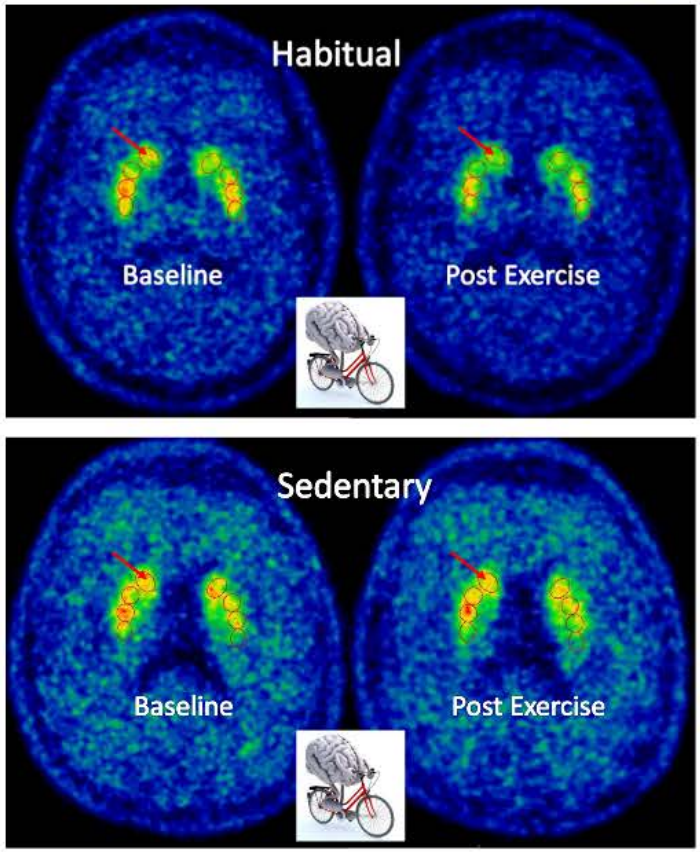
Habitual exercisers n=9

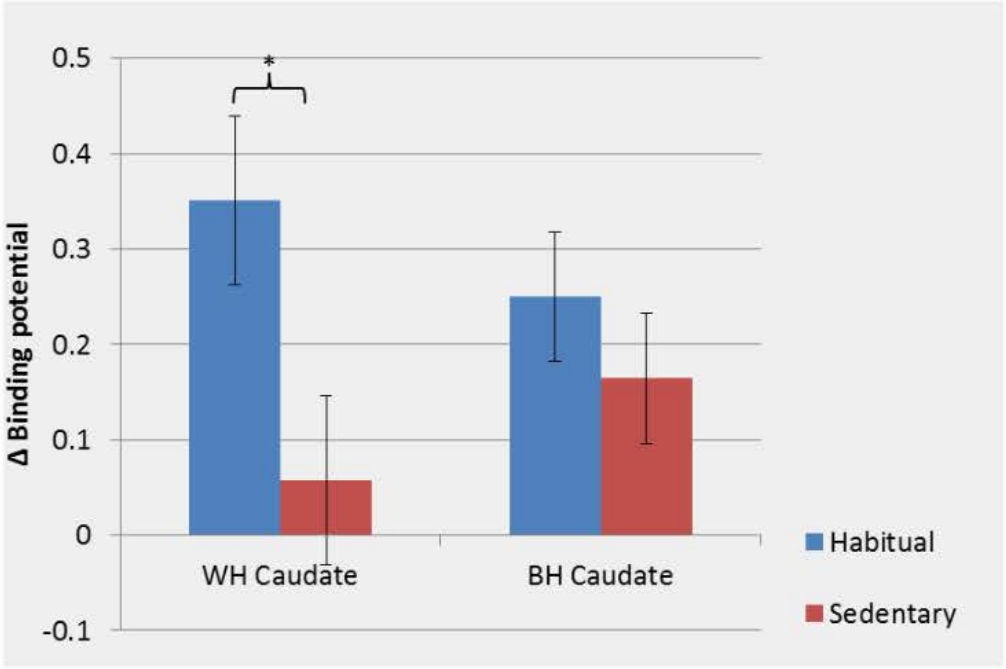
Sede

Evaluating people with PD who exercise compared to people who do not exercise

- Dopamine release in response to exercise using PET
- Brain activity in response to reward using fMRI
- Motor function
- Mood/depression/apathy
- Cognition

Exercise induced dopamine release is higher in PD habitual exercisers





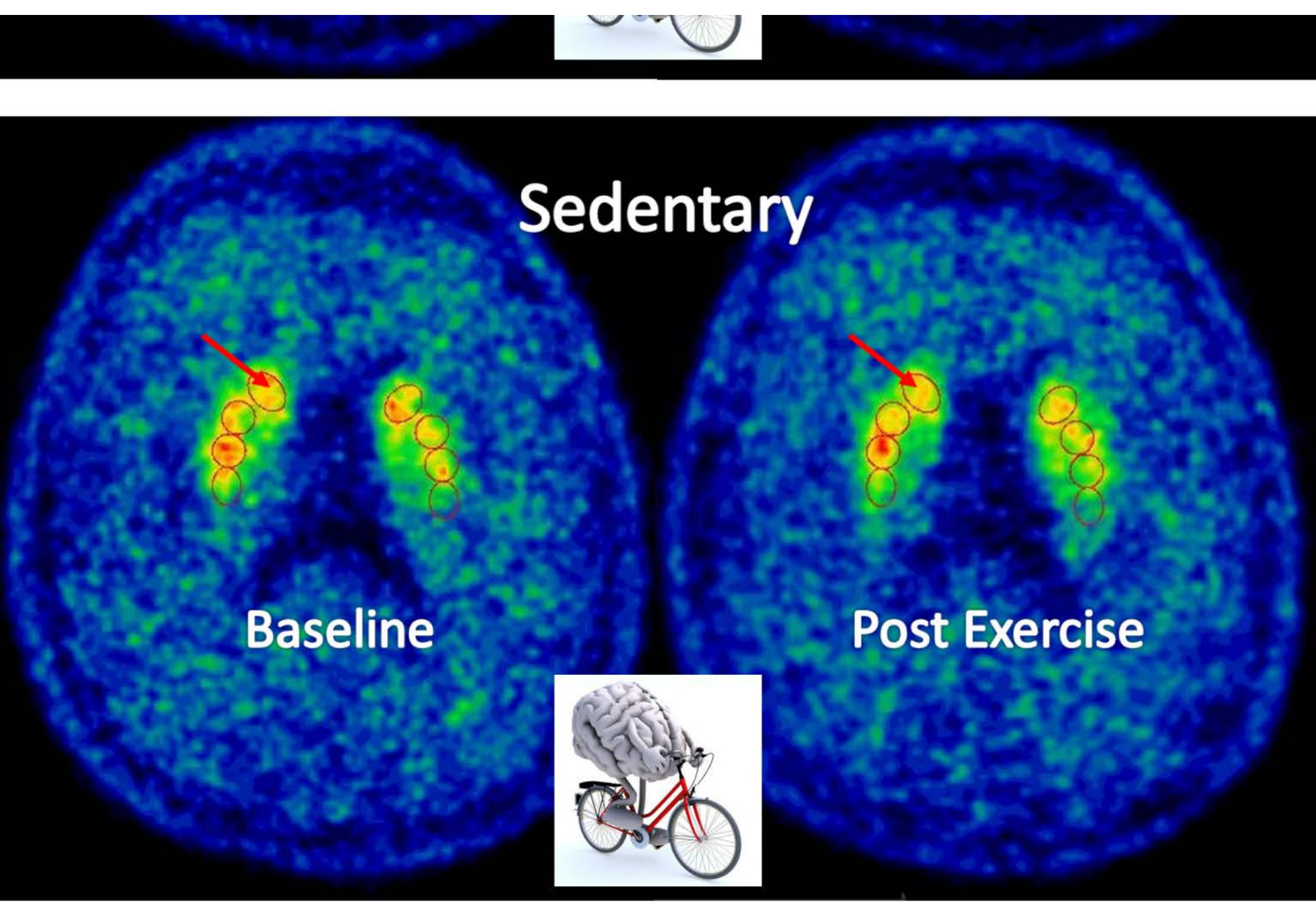
Habitual exercisers have more dopamine release in the caudate, especially in the more affected hemisphere

Habitual exercisers have greater activation in the

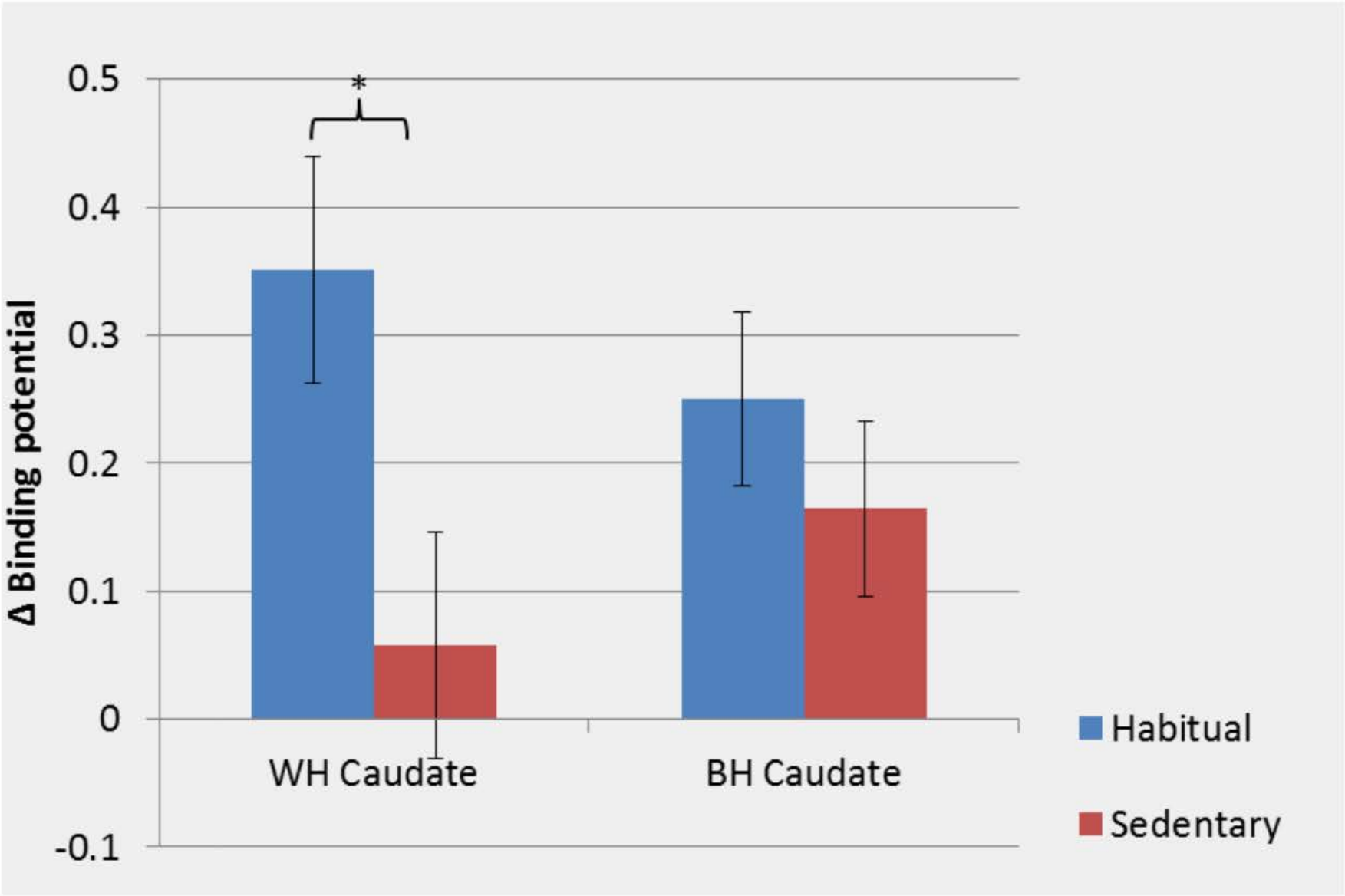
Habitual

Baseline

Post Exercise

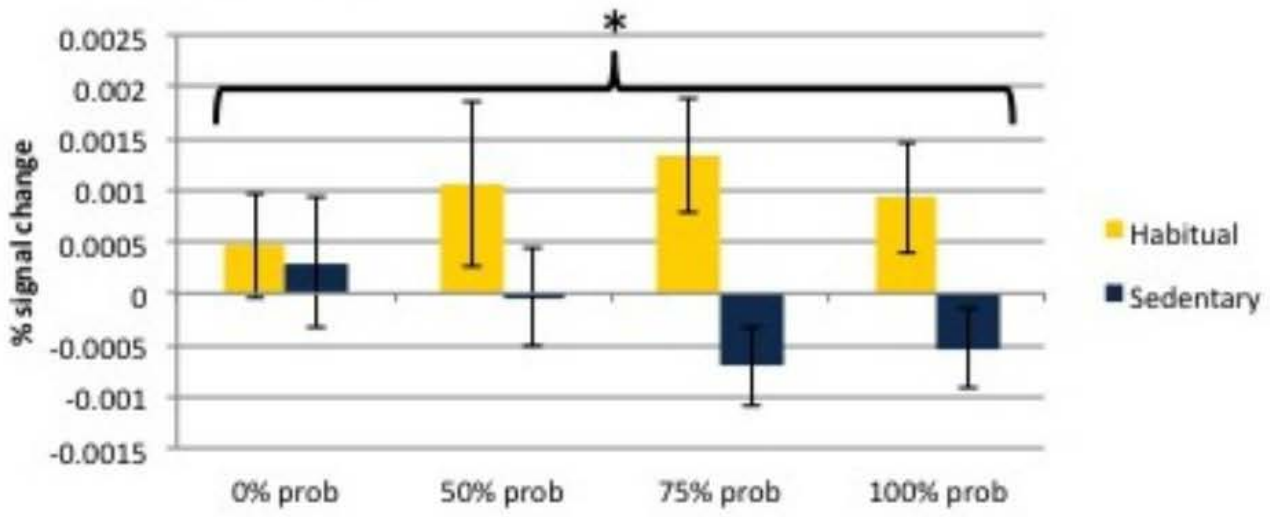

Sedentary
Baseline
Post Exercise

Habitual exercisers



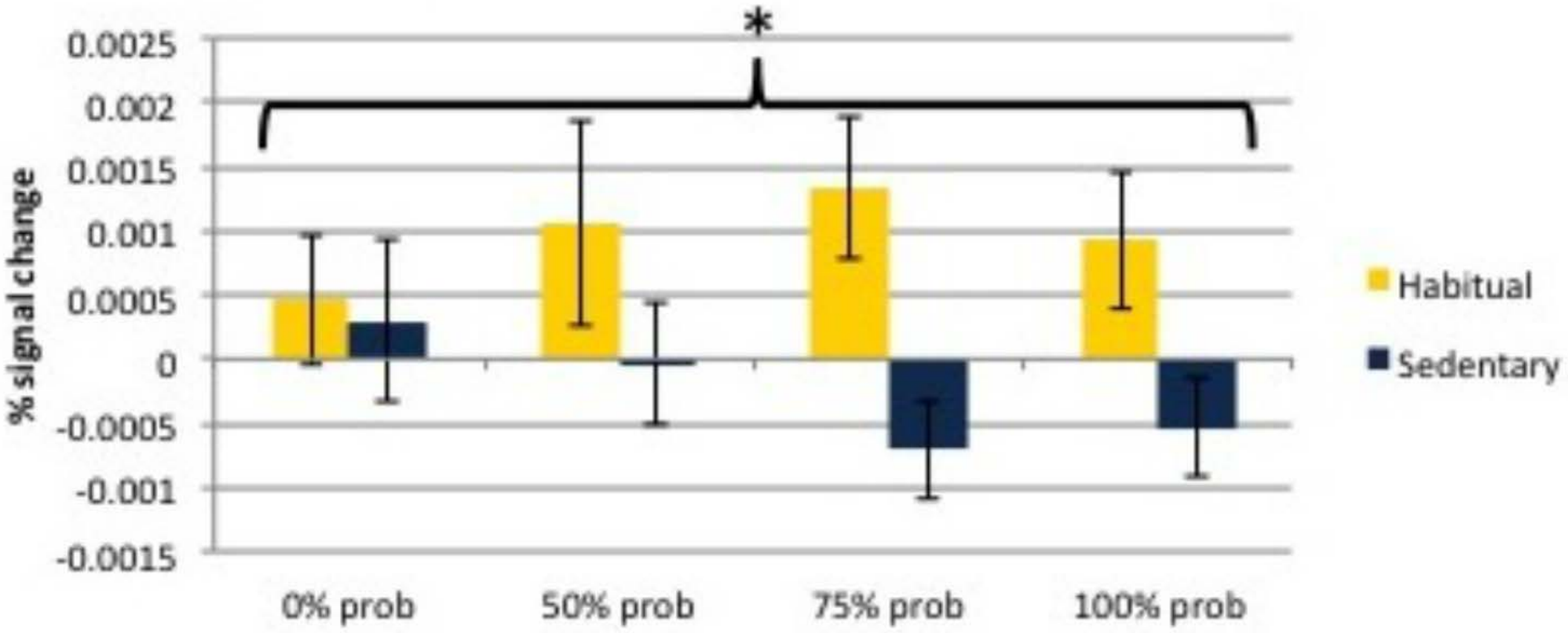
Habitual exercisers have more dopamine release in the caudate, especially in the more affected hemisphere

Habitual exercisers have greater activation in the 'reward' circuit



- *Habitual exercisers have increased response to monetary reward at 75% probability*
- *Exercise may change reward connectivity*
- *Could explain why exercise makes you feel good.*

Habitual exercisers have greater activation in 'reward' circuit



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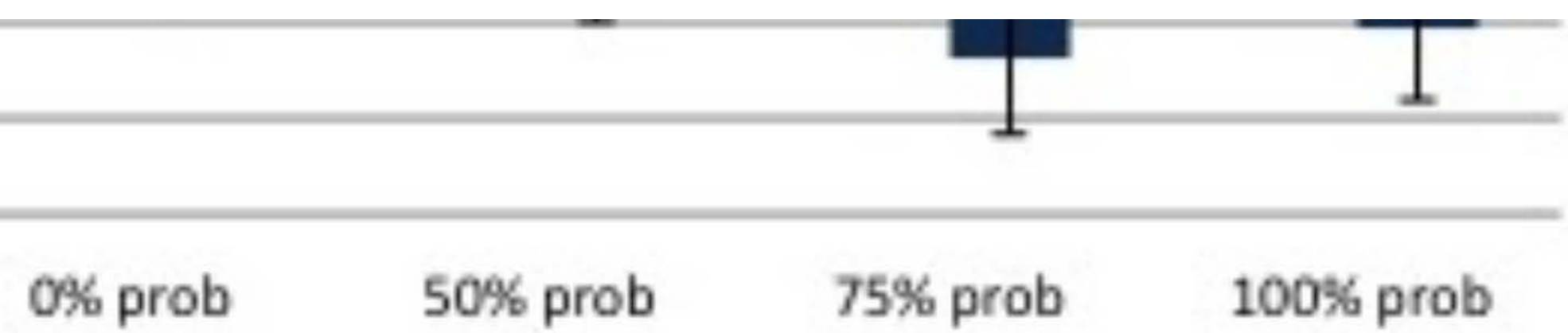

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Exercisers vs. Non-exercisers: PET and fMRI study

VS.

Summary

- Habitual exercisers showed greater dopamine release in the caudate
- Habitual exercisers showed greater activity in the ventral striatum
- *Habitual exercise = greater dopamine function...?*

Limitations

- Retrospective cohort study
- Do people have better dopamine function because they exercise or,
- Do people exercise because they have better dopamine function?

Prospective cohort study is needed

Summary

- Habitual exercisers showed greater dopamine release in the caudate
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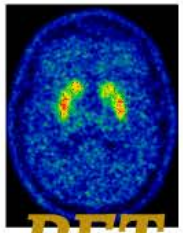
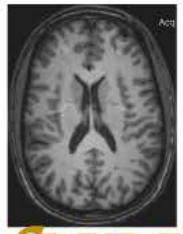
Can exercise change the brain?



Neuroplasticity

PET



fMRI

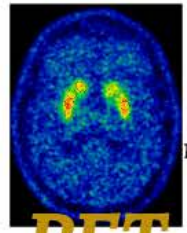
3 months of exercise

- 3x/ week
- 36 sessions
- 45-60 minutes/ session

Cycling n=20

vs.

Stretching/yoga n=15



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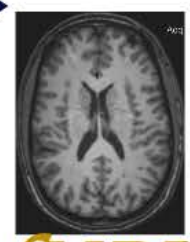
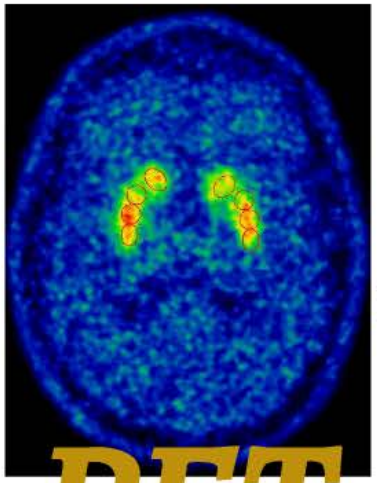


fMRI

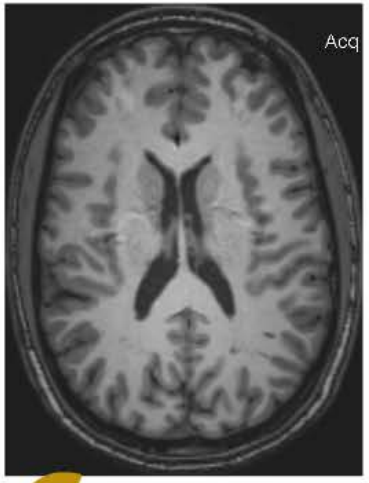
Determine the effects of exercise on:

- **Dopamine release (motor symptoms)**
- **Active of the ventral striatum (reward/pleasure)**
- **Neuroinflammation (sub-set of the subjects)**



PET

Neuroplasticity



fMRI

Cyc

Det

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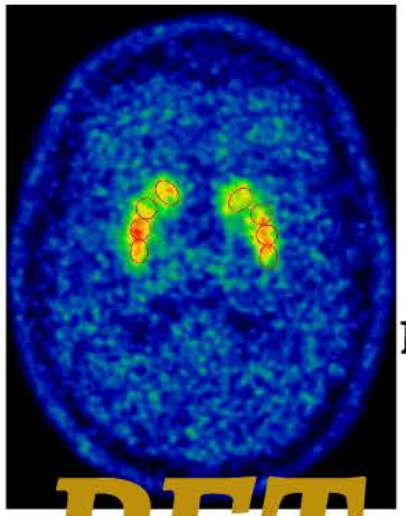
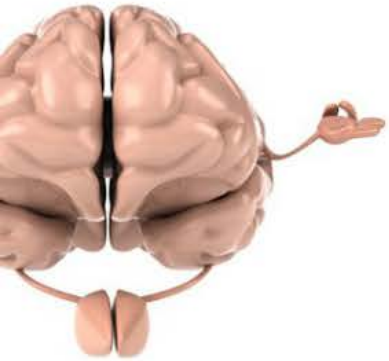
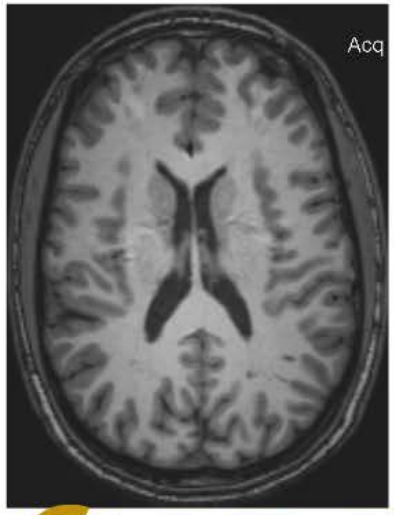


Neuroplasticity

PET



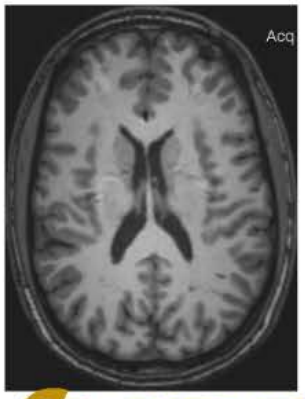


ing/yoga n=15

fMRI

ercise on:

VS.



Cycling n=20

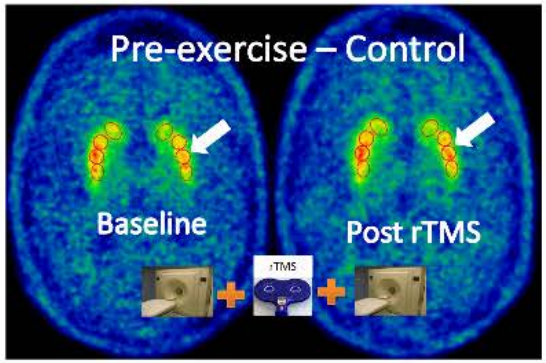
Stretching/yoga n=15

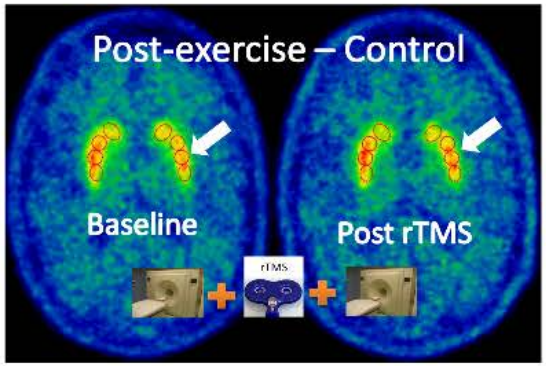
fMRI

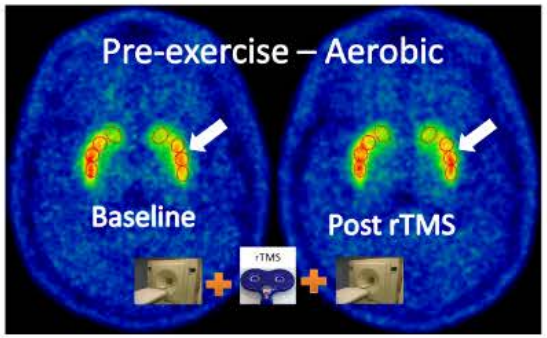
Determine the effects of exercise on:

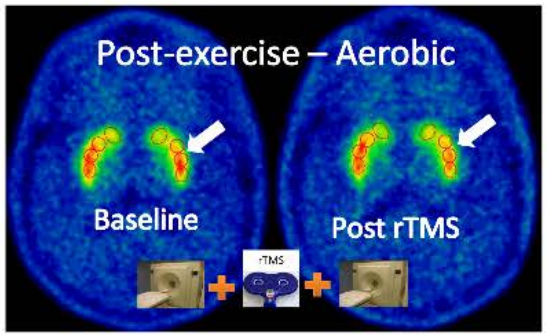
- **Dopamine release (motor symptoms)**
- **Active of the ventral striatum (reward/pleasure)**
- **Neuroinflammation (sub-set of the subjects)**

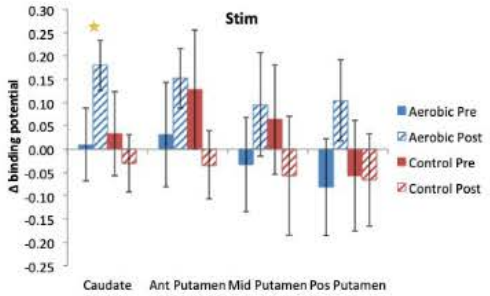
Dopamine release increases after aerobic exercise











Conclusions:

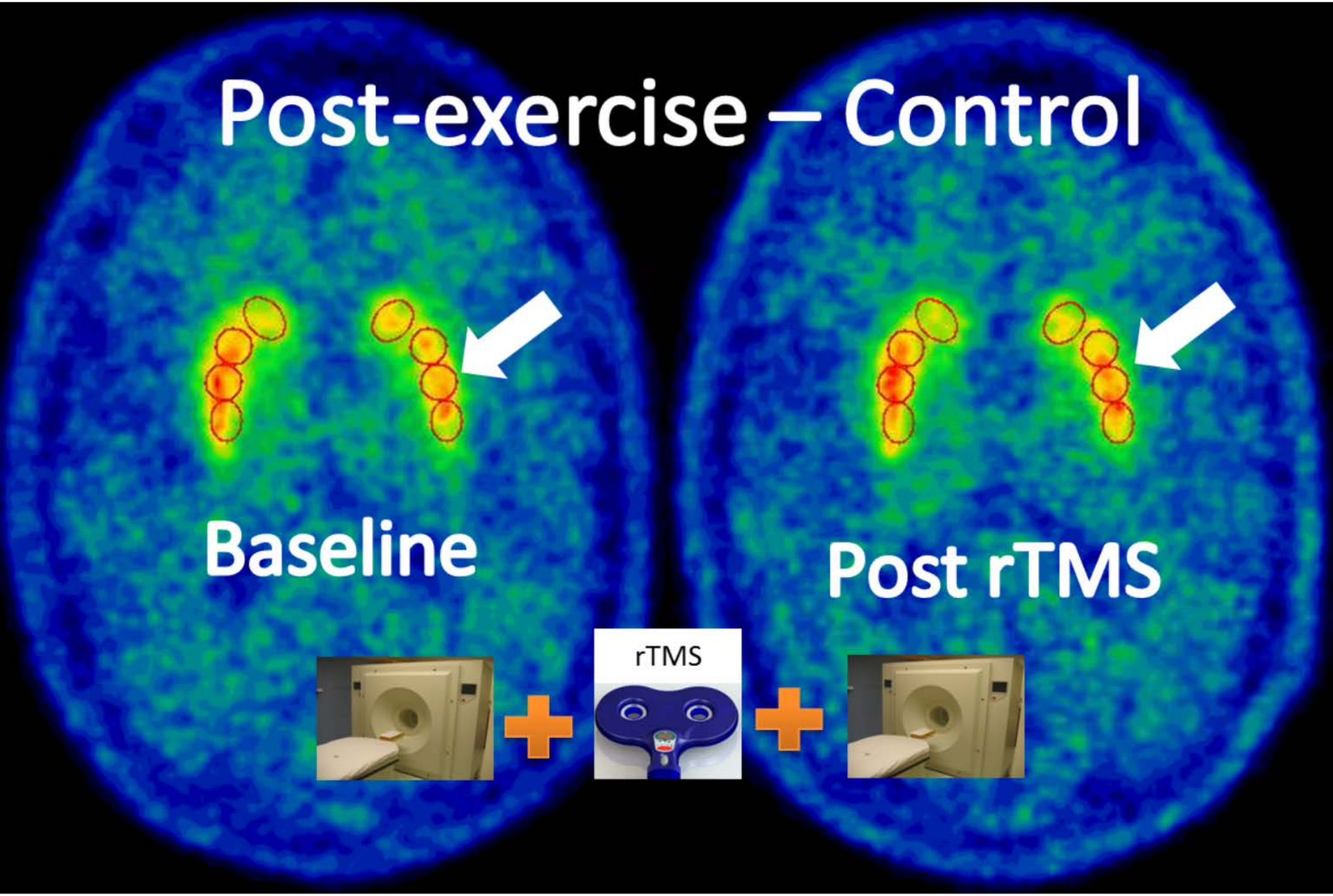
- *Increased dopamine release in the caudate after aerobic exercise*
  - *Caudate is related to cognitive function, which may explain why many exercise programs show improvement to cognitive function*

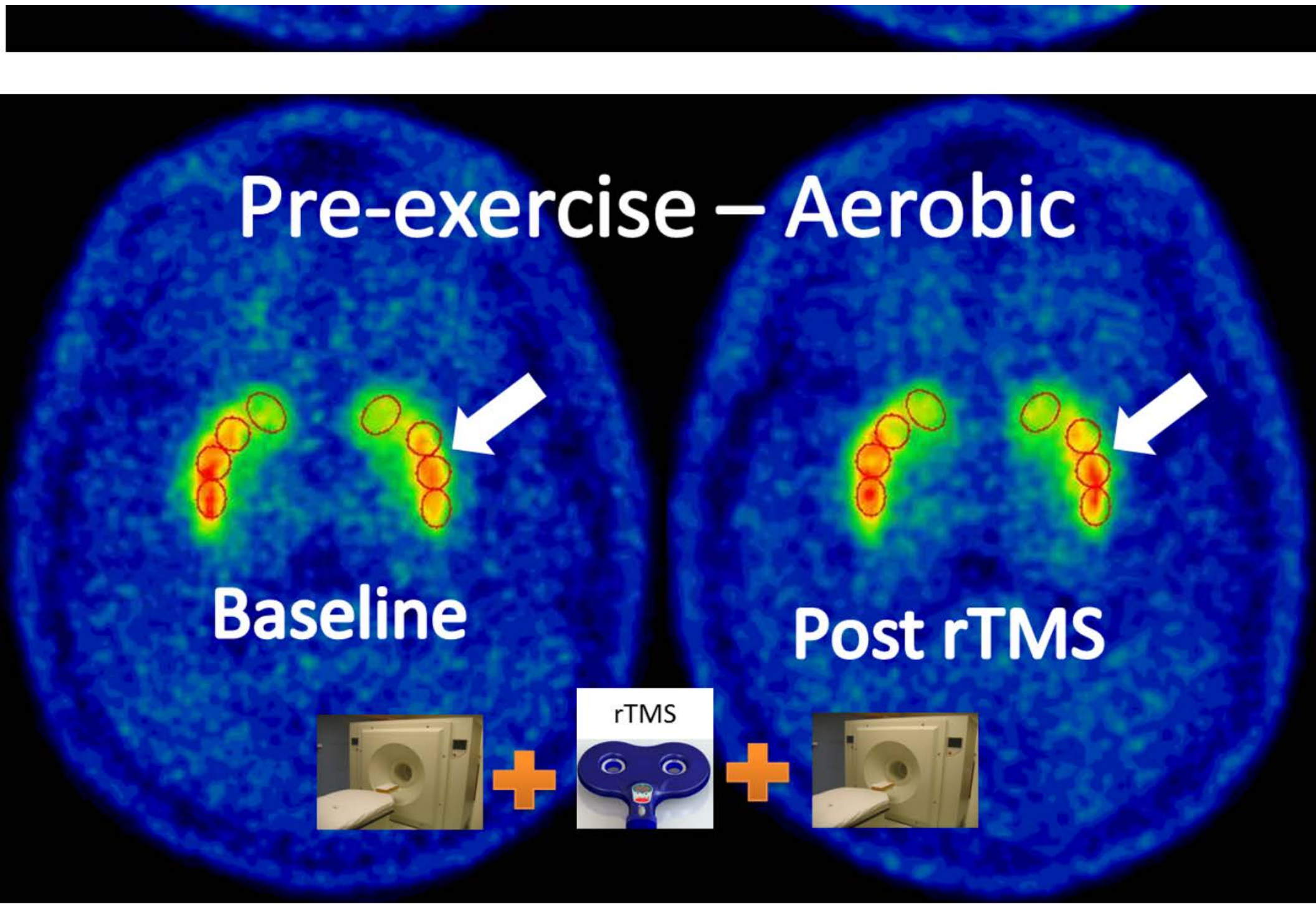
Exercise is beneficial for PD

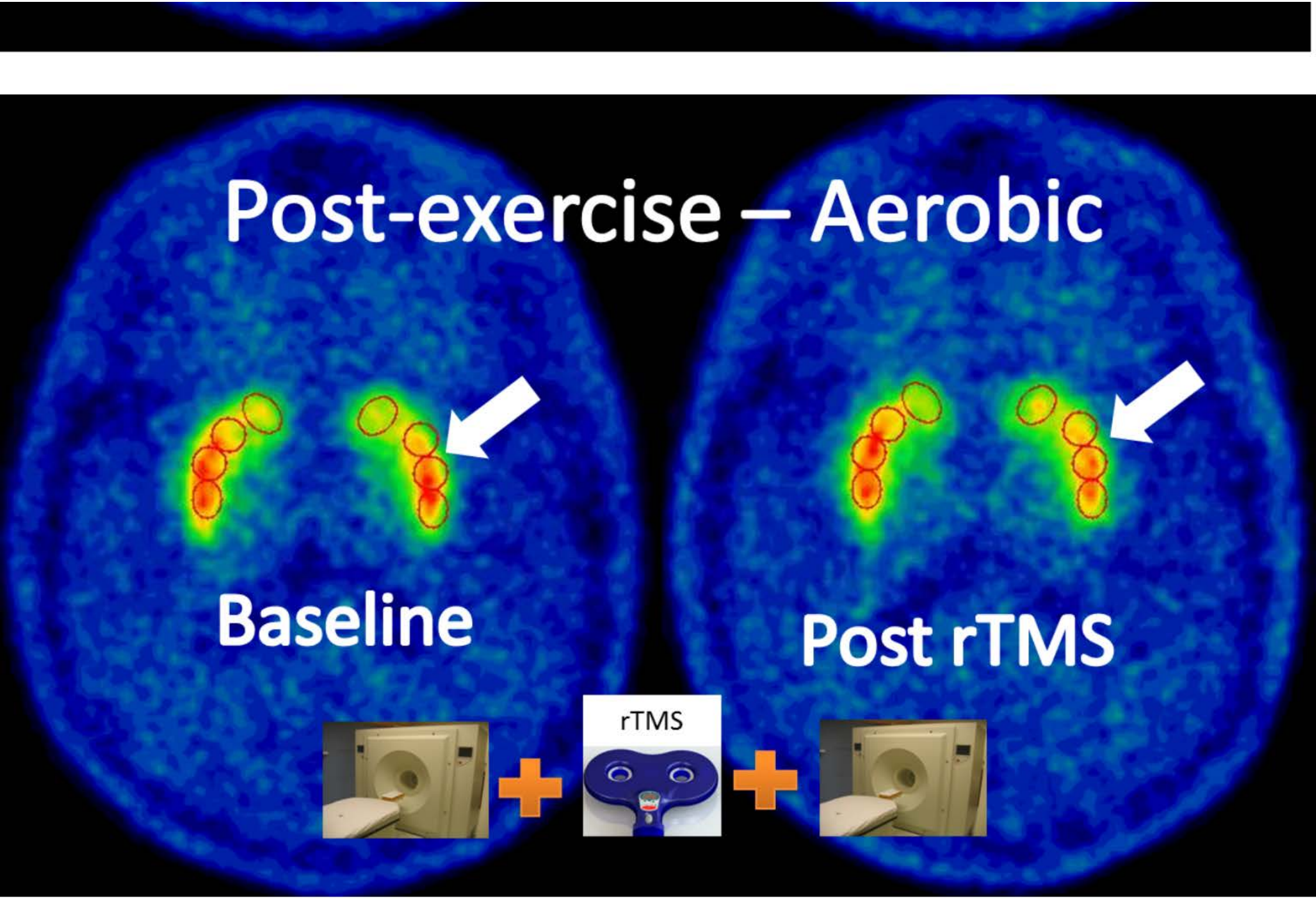
Pre-exercise – Control

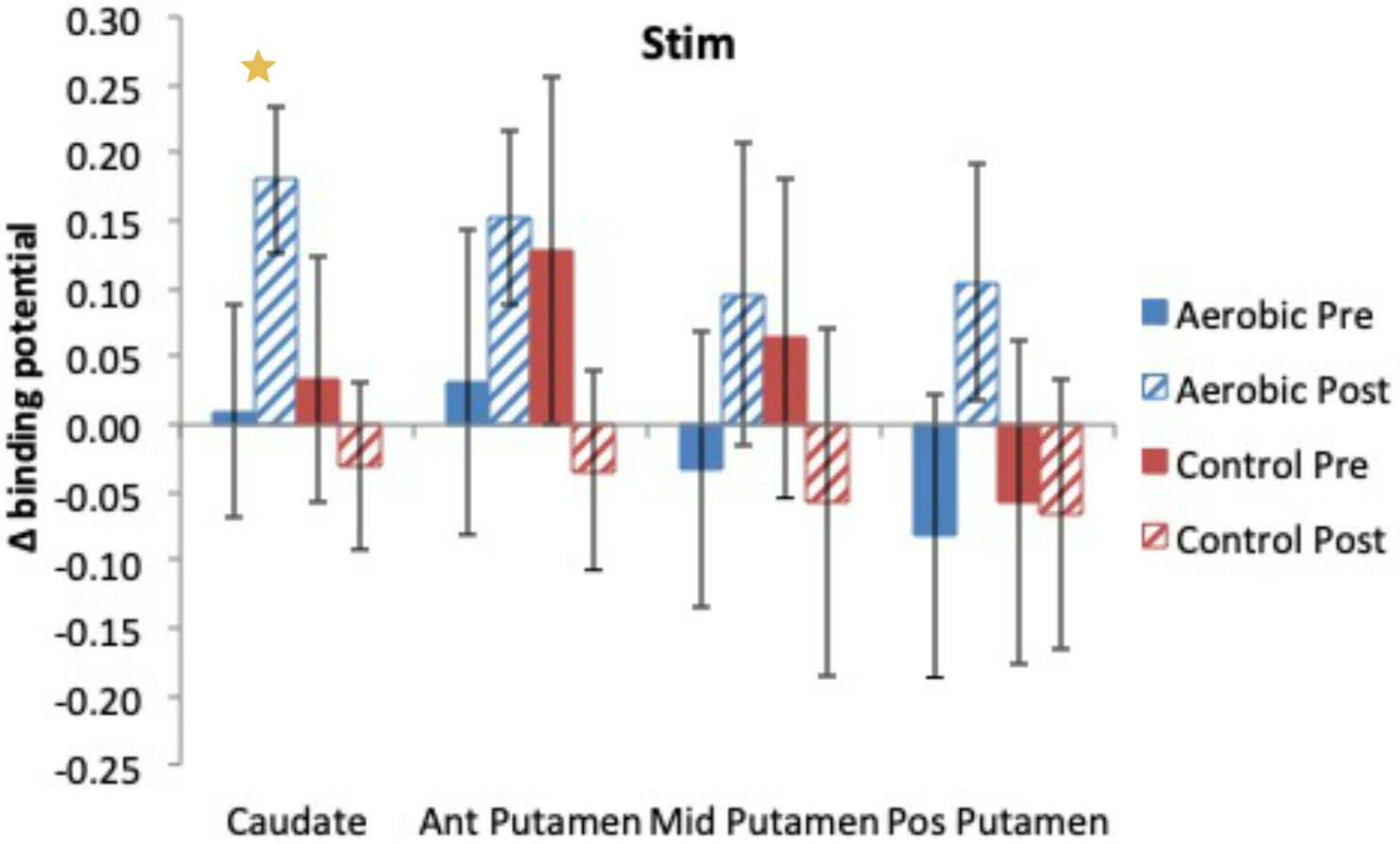
Baseline

Post rTMS


Post-exercise – Control
Baseline
Post rTMS
rTMS


Pre-exercise – Aerobic
Baseline
Post rTMS
rTMS


Post-exercise – Aerobic
Baseline
Post rTMS
rTMS


Stim
Δ binding potential
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
Caudate
Ant Putamen
Mid Putamen
Pos Putamen
Aerobic Pre
Aerobic Post
Control Pre
Control Post

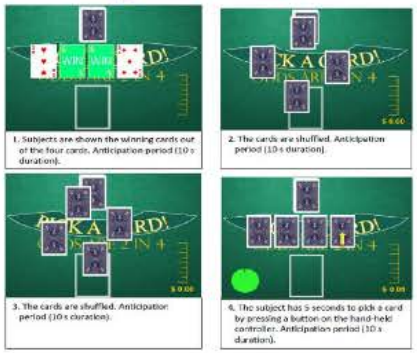
Conclusions:

- *Increased dopamine release in the caudate after aerobic exercise*
  - *Caudate is related to cognitive function, which may explain why many exercise programs show improvement to cognitive function*

Exercise is beneficial for PD

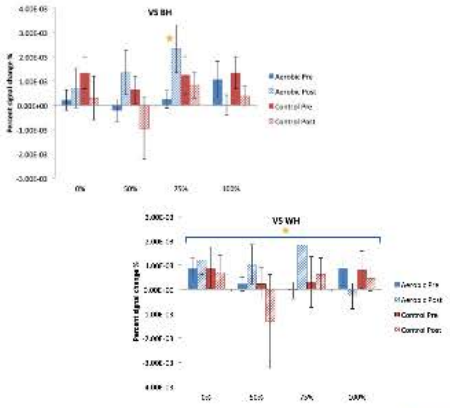
Activation of reward pathway increases after aerobic exercise

Anticipation - 10 seconds



Reward - 10 seconds

- $0.50/ trials
- 4 probabilities of winning
  - 0%
  - 50%
  - 75%
  - 100%



- *Increased activity in the ventral striatum after aerobic exercise*
- *No change in the control group*
- *Exercise changes the area of the brain related to reward, which is associated with dopamine release*
  - *Good feelings after exercise*

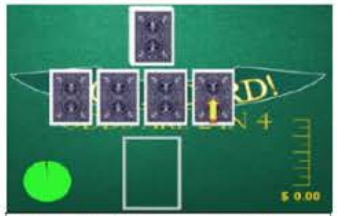
aerobic exercise

Anticipation - 10 seconds

1. Subjects are shown the winning cards out of the four cards. Anticipation period (10 s duration).

2. The cards are shuffled. Anticipation period (10 s duration).

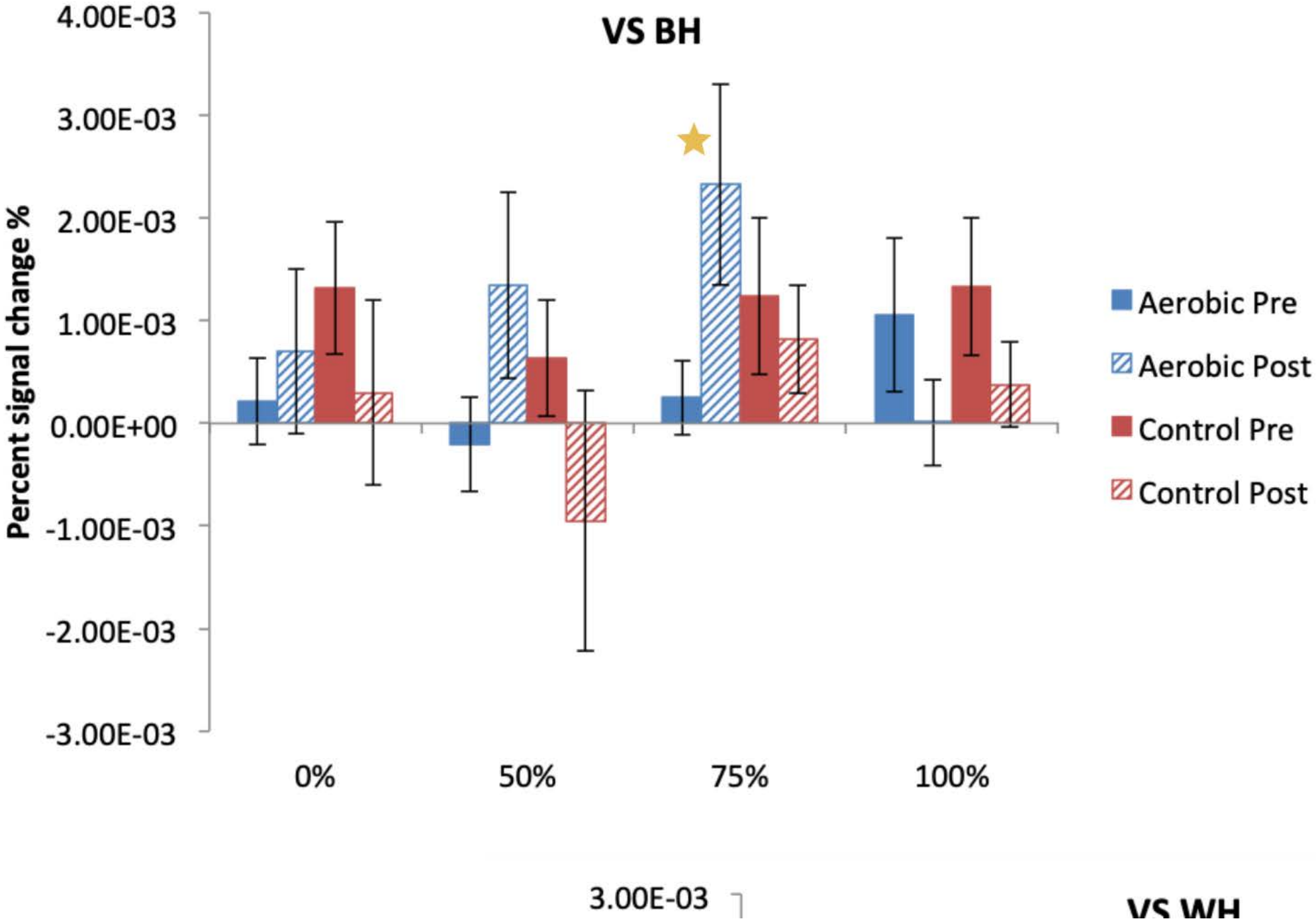
3. The cards are shuffled. Anticipation period (10 s duration).



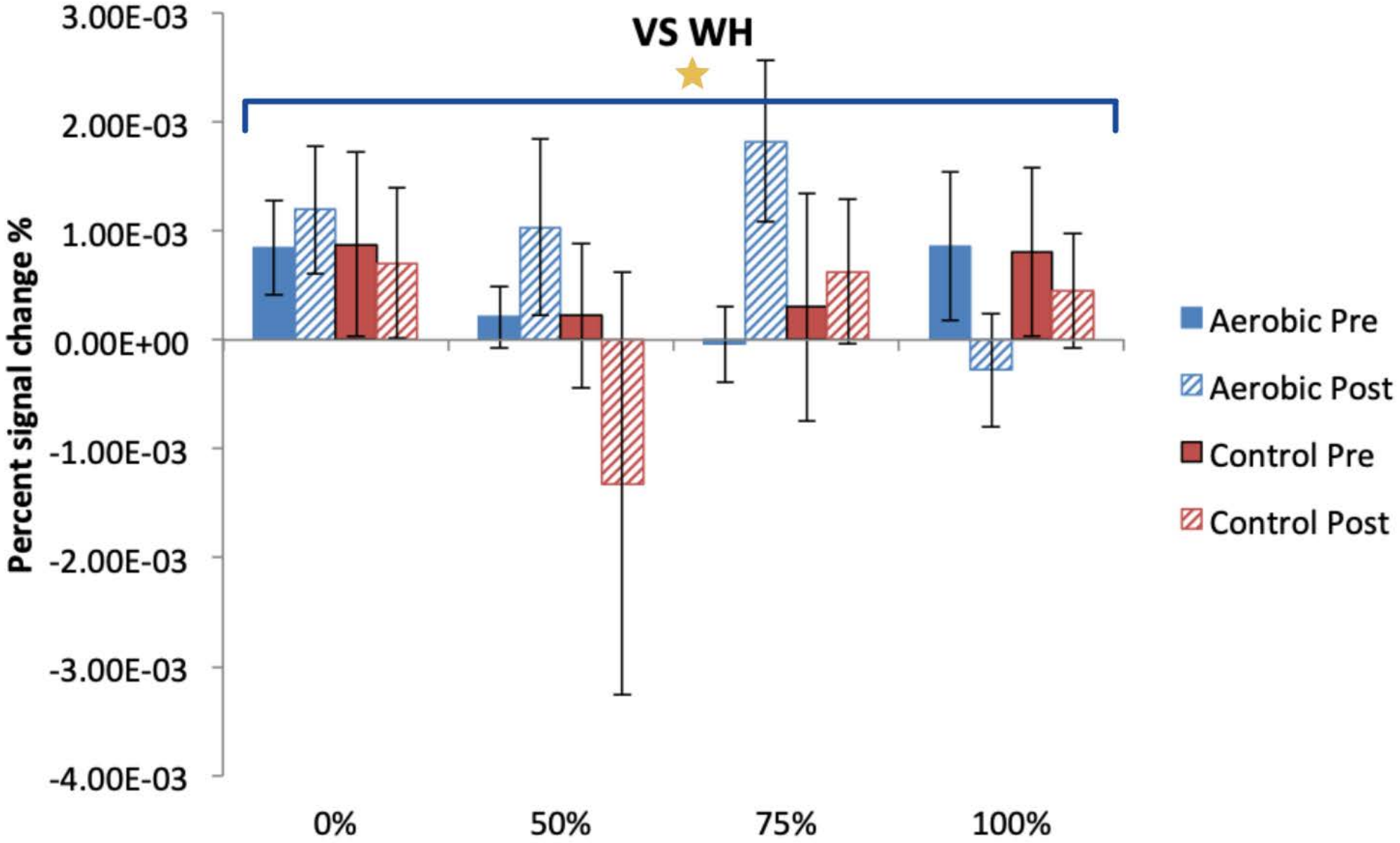
4. The subject has 5 seconds to pick a card by pressing a button on the hand-held controller. Anticipation period (10 s duration).

Reward - 10 seconds

- $0.50/ trials
- 4 probabilities of winning
  - 0%
  - 50%
  - 75%
  - 100%


VS BH
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
-1.00E-03
-2.00E-03
-3.00E-03
Percent signal change %
0%
50%
75%
100%
Aerobic Pre
Aerobic Post
Control Pre
Control Post
3.00E-03

50% 75% 100%


VS WH
3.00E-03
2.00E-03
1.00E-03
0.00E+00
-1.00E-03
-2.00E-03
-3.00E-03
-4.00E-03
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Aerobic Post
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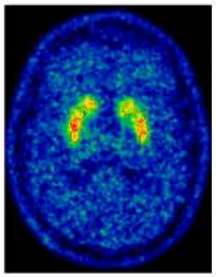
Effect of exercise on neuroinflammation in Parkinson's disease

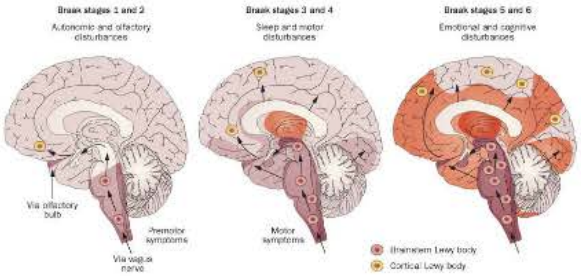
Scanned 10 subjects with [11C]PBR 28 - a measure of neuroinflammation -



Conducted 2 different analyses

1) SUV analysis

- Increase in binding of [11C]PBR 28 after the control intervention in the:
  - Putamen
  - OFC
  - PPN
- Reduction of binding after the aerobic intervention in the:
  - Thalamus
  - Globus pallidus
  - Cerebellum.



2) SUVr analysis – Cerebellum reference

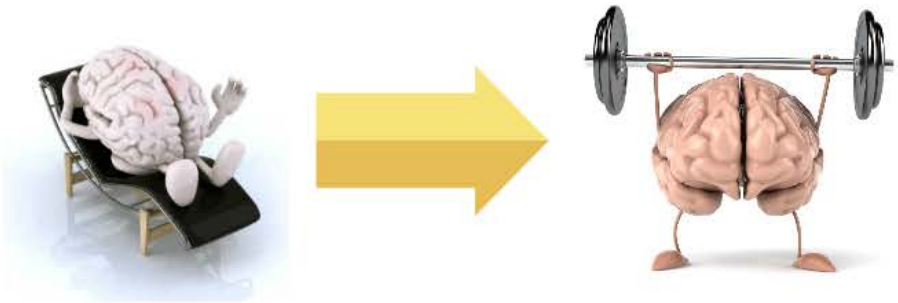
- The disease relevant pattern of decreased neuroinflammation observed after aerobic exercise disappeared.
- The only brain area that showed a significant result was the PPN

There is no conclusive evidence that aerobic exercise decreases neuroinflammation in subjects with PD

Summary

Habitual exerciser:

- **Greater dopamine release in the caudate compared to non-exercisers**
- **Greater activation of the ventral striatum at 75% probability**



Aerobic exercise increased:

- **Dopamine release in the caudate**
- **Activation in the ventral striatum at 75% probability**

Why is exercise good for PD? - DOPAMINE!

- Increases dopamine release
  - Motor improvements
  - Non-motor improvements
- Increases activity of the ventral striatum
  - Motivation to exercise
  - Positive feelings after exercise

The benefits of exercise in PD are the result of neurological changes to the dopaminergic system

striatum at 75% probability

Why is exercise good for PD? - DOPAMINE!

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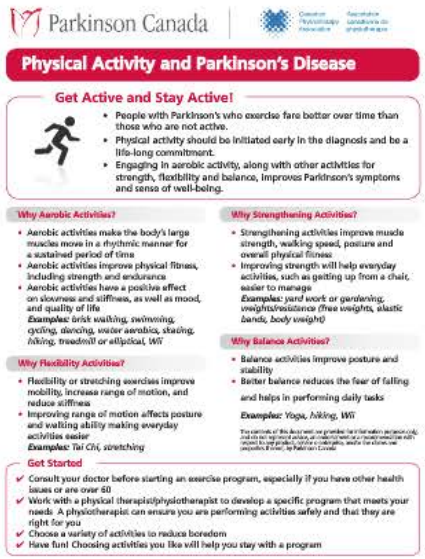
The benefits of exercise in PD are the result of neurological changes to the dopaminergic system

Take home messages

Exercise is even more important for people with PD

- Recommendations
  - Speak with your doctor
  - Do what you enjoy
    - Find a group
  - Do what you can tolerate
  - Switch it up
    - Aerobic
    - Resistance training
    - Balance training
- Need ideas?



Parkinson Canada

Physical Activity and Parkinson's Disease

Get Active and Stay Active!

- People with Parkinson's who exercise fare better over time than those who are not active.
- Physical activity should be initiated early in the diagnosis and be a life-long commitment.
- Engaging in aerobic activity, along with other activities for strength, flexibility and balance, improves Parkinson's symptoms and sense of well-being.

Why Aerobic Activities?

- Aerobic activities make the body's large muscles move in a rhythmic manner for a sustained period of time
- Aerobic activities improve physical fitness, including strength and endurance
- Aerobic activities have a positive effect on slowness and stiffness, as well as mood, and quality of life

Examples: brisk walking, swimming, cycling, dancing, water aerobics, skating, hiking, treadmill or elliptical, Wii

Why Strengthening Activities?

- Strengthening activities improve muscle strength, walking speed, posture and overall physical fitness
- Improving strength will help everyday activities, such as getting up from a chair, easier to manage

Examples: yard work or gardening, weights/resistance (free weights, elastic bands, body weight)

Why Flexibility Activities?

- Flexibility or stretching exercises improve mobility, increase range of motion, and reduce stiffness
- Improving range of motion affects posture and walking ability making everyday activities easier

Examples: Tai Chi, stretching

Why Balance Activities?

- Balance activities improve posture and stability
- Better balance reduces the fear of falling and helps in performing daily tasks

Examples: Yoga, hiking, Wii

Get Started

- ✔ Consult your doctor before starting an exercise program, especially if you have other health issues or are over 60
- ✔ Work with a physical therapist/physiotherapist to develop a specific program that meets your needs. A physiotherapist can ensure you are performing activities safely and that they are right for you
- ✔ Choose a variety of activities to reduce boredom
- ✔ Have fun! Choosing activities you like will help you stay with a program

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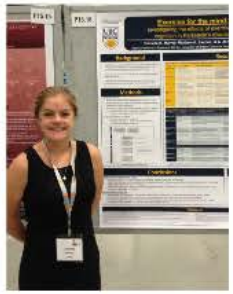
Questions?



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Parkinson Canada

CENTER OF EXCELLENCE
NATIONAL PARKINSON FOUNDATION

PACIFIC PARKINSON'S Research Centre

UBC Neuroscience