Effort Minimization & Physical Activity Behavior

Matthieu Boisgontier, MSKin, MSPT, PhD, HDR – June 17, 2021 – LIBM

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

OVERVIEW

1. Who is presenting today?
2. Physical inactivity
3. Dual-process models
4. Automatic attraction toward effort minimization
5. Executive control of physical activity
6. Retraining automatic processes

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

1. WHO IS PRESENTING TODAY?
1.1. Academic background

Kinesiology
- BSc
- MSc

Physiotherapy
- BSc
- MSc
- CAS

Neuroscience
- MSc

PhD

Post-doctorates

Assistant Professor

uOttawa

Faculty of Health Sciences

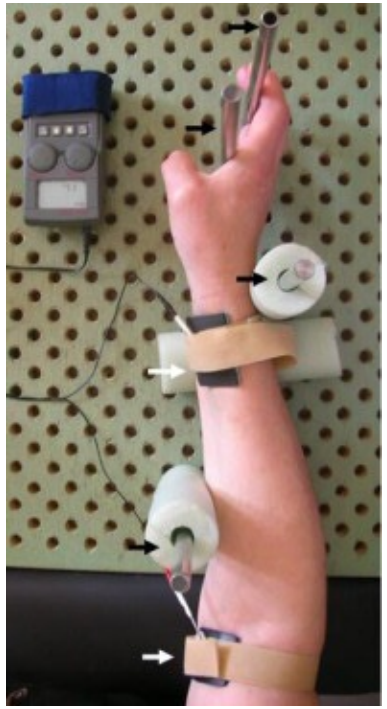
School of Rehabilitation Sciences

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

1. WHO IS PRESENTING TODAY?

1.2. Clinical background

Hand Rehabilitation



Neurorehabilitation

Geriatrics

Private Practice

Hydrotherapy

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

1. WHO IS PRESENTING TODAY?

1.3. Research topics

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@MattBoisgontier
http://matthieuboisgontier.com

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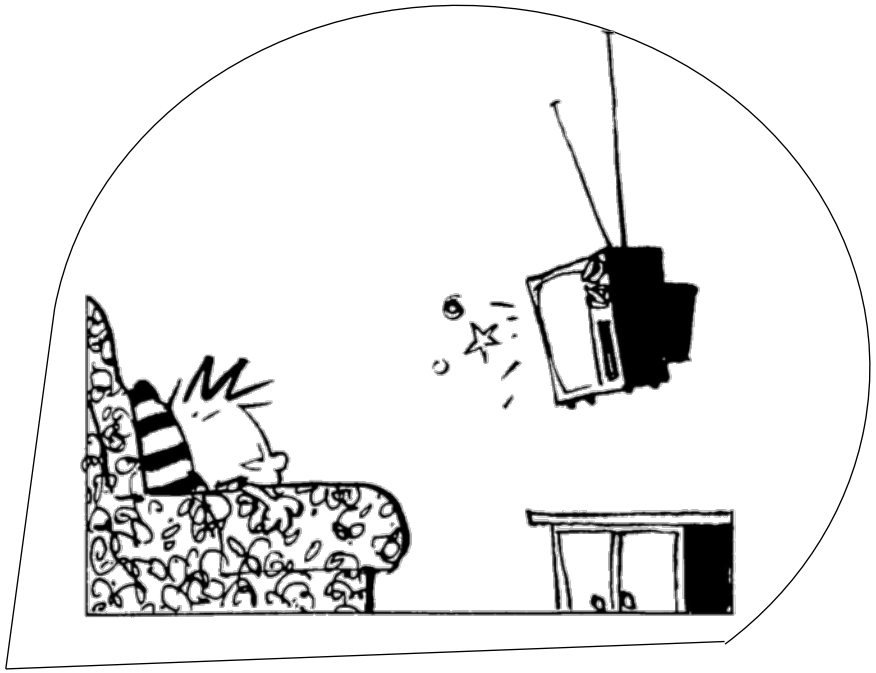
2. PHYSICAL INACTIVITY



THE LANCET

The pandemic of physical inactivity: global action for public health

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

Kohl, et al., Lancet, 2012

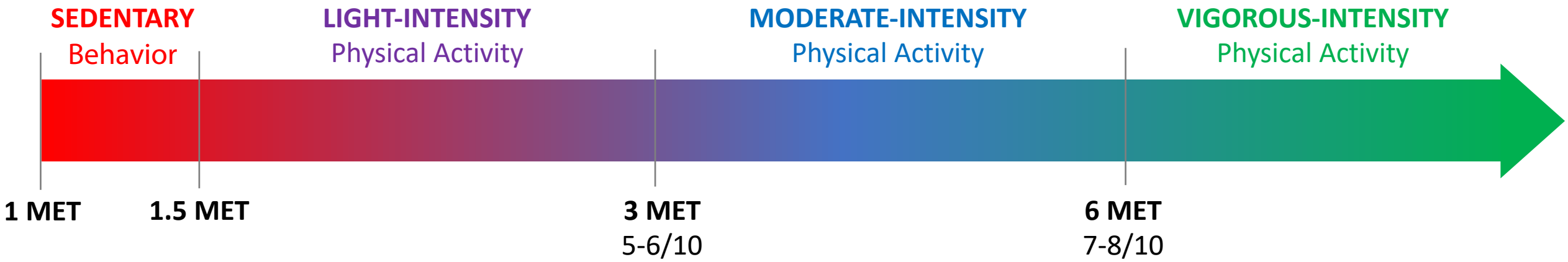
World Health Organization

2. PHYSICAL INACTIVITY

2.1. What are we talking about?

PHYSICAL ACTIVITY

Any bodily movement produced by skeletal muscles that requires **energy** expenditure.



1 **MET**abolic Equivalent = **O_2 consumption** at rest = 3.5 ml kg^{-1} min^{-1}

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

WHO, 2020

World Health Organization

2. PHYSICAL INACTIVITY

2.1. What are we talking about?

SPORT

Subcategory of physical activity
Performed within a **set of rules** and undertaken as part of leisure or competition

EXERCISE

Subcategory of physical activity
Planned, structured, repetitive, & purposeful
Objective: Improving or maintaining **physical fitness**

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

WHO, 2020

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2. PHYSICAL INACTIVITY

2.1. What are we talking about?

Physical inactivity

An **insufficient** physical activity level
to meet physical activity **recommendations**.

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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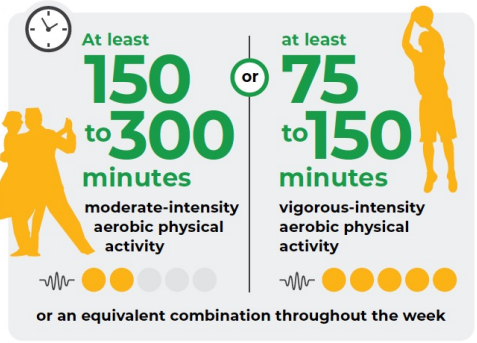
WHO, 2020

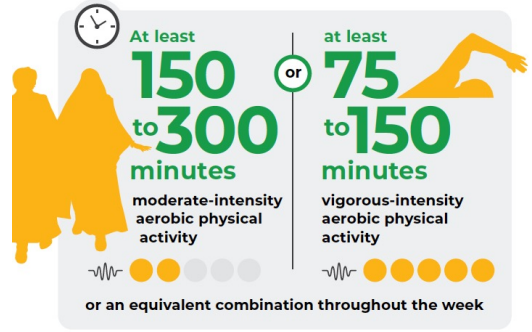
2. PHYSICAL INACTIVITY

2.2. WHO recommendations

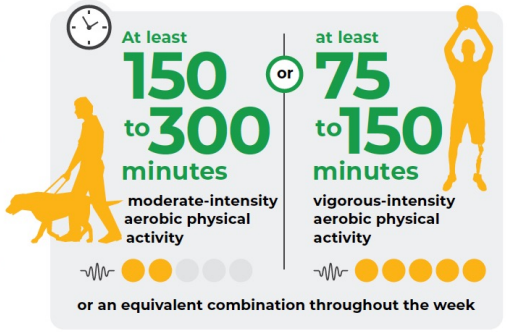
Children & Adolescents (5–17 years)
living with or without disability

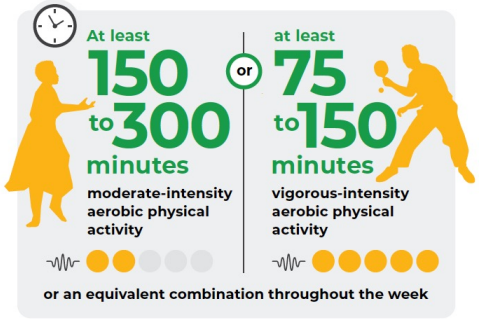
Adults & Older adults





Pregnant & Postpartum Women





Cancer survivors
People living with **hypertension,** type-2 **diabetes, HIV**, **disability**

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@MattBoisgontier
http://matthieuboisgontier.com

WHO, 2020

2. PHYSICAL INACTIVITY

2.2. WHO recommendations

Moderate-to-**V**igorous **P**hysical **A**ctivity **(MVPA)**

MODERATE-INTENSITY
Physical Activity

VIGOROUS-INTENSITY
Physical Activity

3 MET
5/10 of maximal capacity

6 MET
7/10

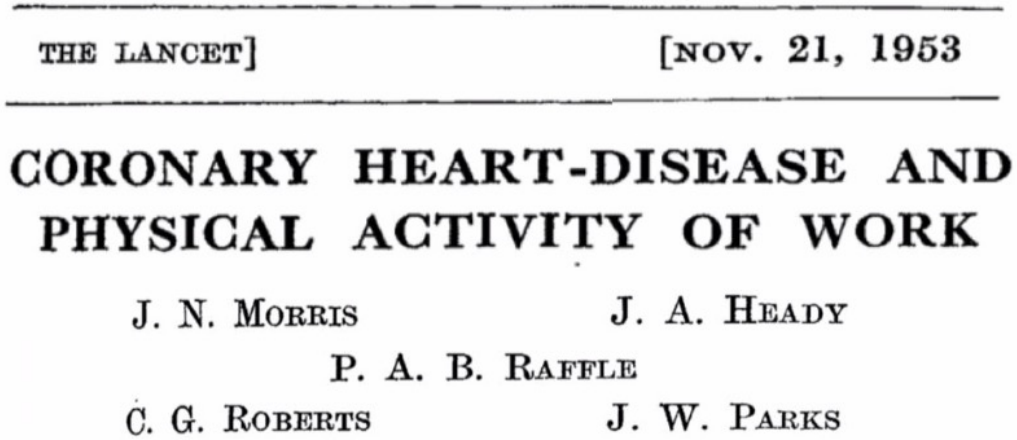
matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

WHO, 2020

2. PHYSICAL INACTIVITY

2.3. Why such recommendations?

↑ Cardiovascular Diseases
↑ Breast & Colon Cancer
↑ Type 2 Diabetes
↑ High Blood Pressure
↑ Overweight & Obesity
↑ Arthritis
↑ Depression
↑ Dementia
↑ Falls ↓ **Life Expectancy**



THE LANCET] [NOV. 21, 1953

CORONARY HEART-DISEASE AND PHYSICAL ACTIVITY OF WORK

J. N. MORRIS J. A. HEADY
P. A. B. RAFFLE
C. G. ROBERTS J. W. PARKS

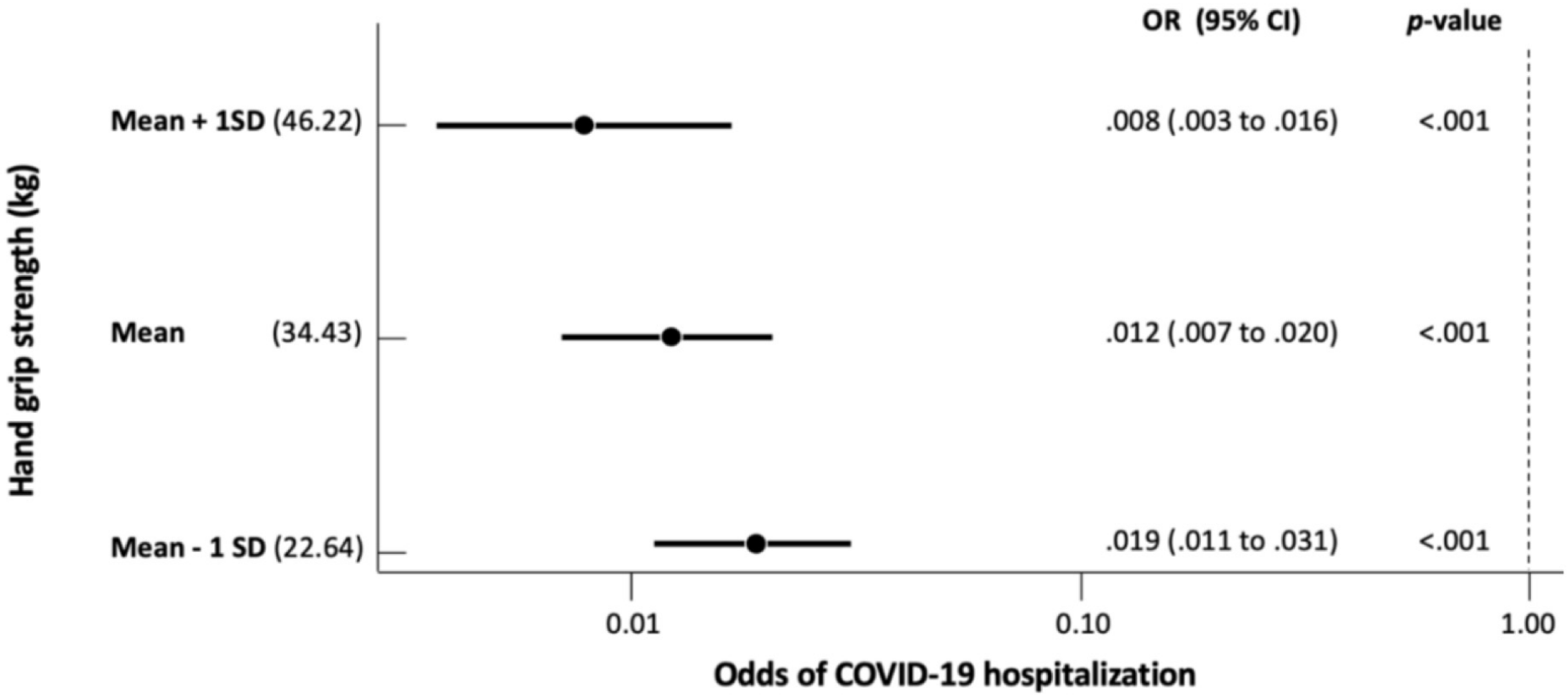
matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

Morris et al., Lancet, 1953

2. PHYSICAL INACTIVITY

2.3. Why such recommendations?



N = 36,000
> 50 years

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@MattBoisgontier
http://matthieuboisgontier.com

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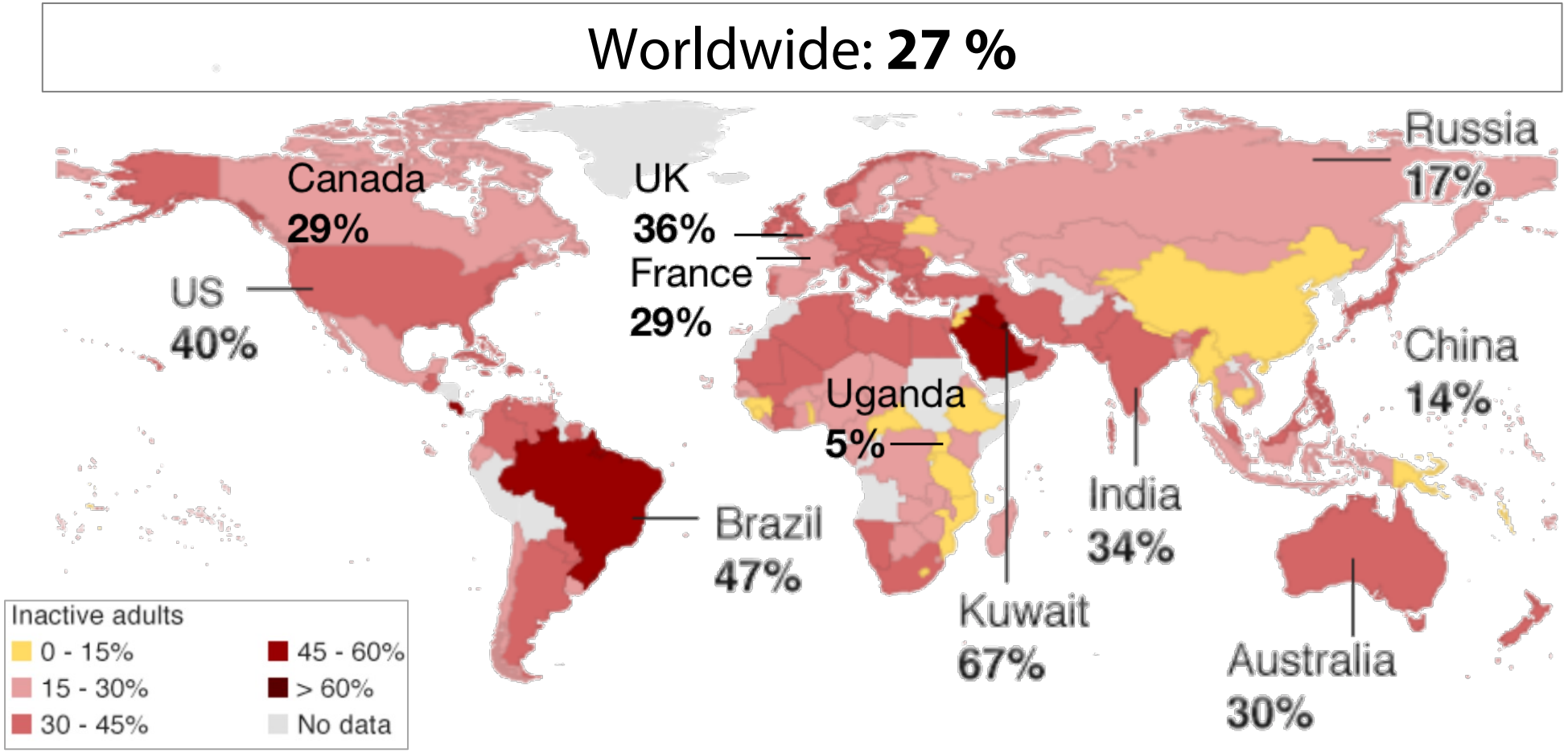
2. PHYSICAL INACTIVITY

2.4. How does it look like?



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@MattBoisgontier
http://matthieuboisgontier.com

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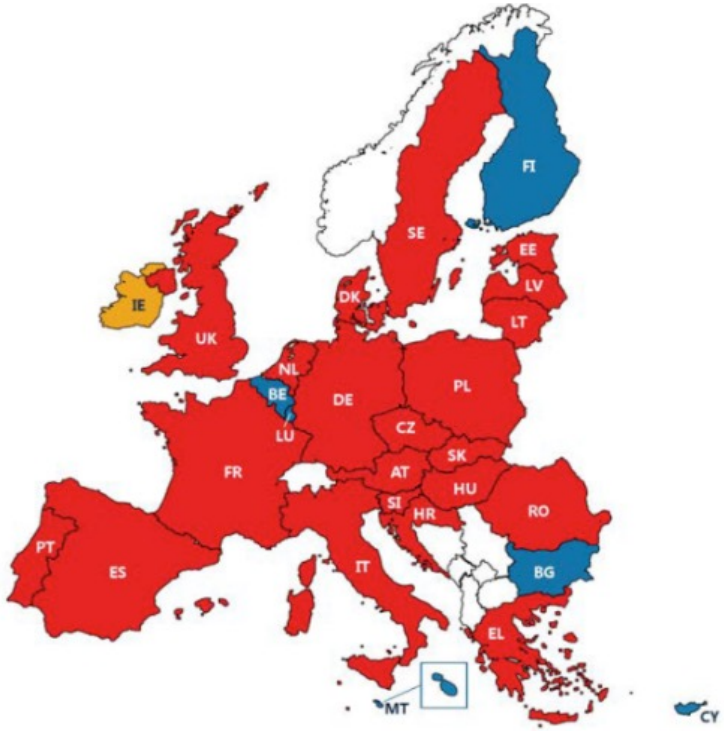
Guthold et al., Lancet Global Health, 2018

2. PHYSICAL INACTIVITY

2.4. How does it look like?

Evolution 2013 – 2017

Increase
Stable
Decrease



Despite gradually **scaling up actions promoting physical activity**, we are **becoming less active**.

From **2010 to 2016**, the number of inactive adults has **increased by 5% worldwide**, now affecting more than **1.4 billion** people.

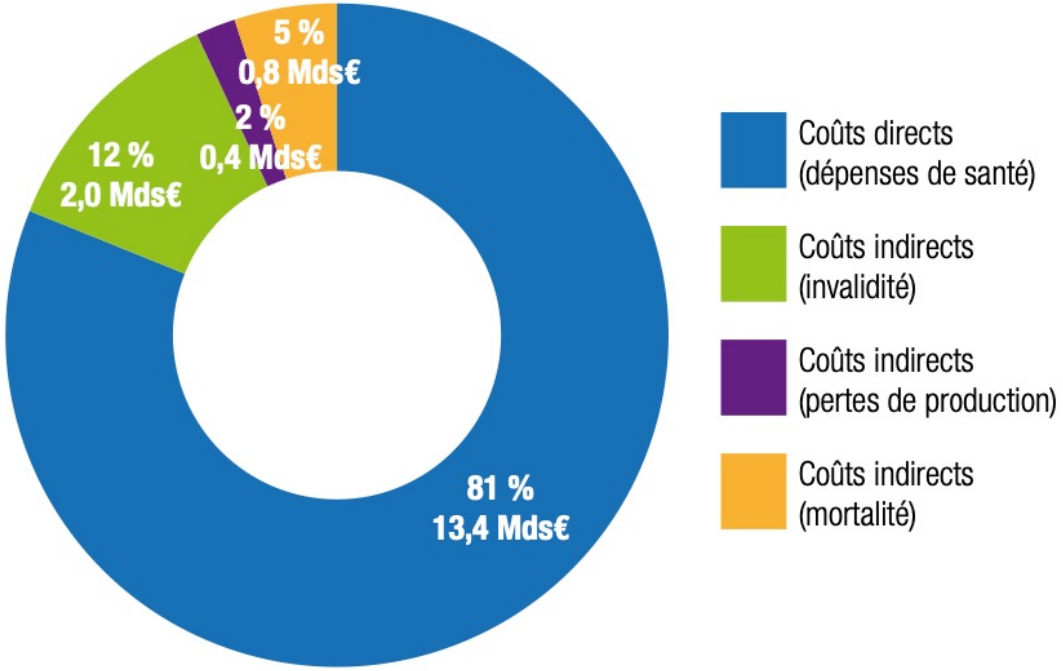
matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

European Commission, 2018; Guthold et al., Lancet Global Health, 2018

2. PHYSICAL INACTIVITY

2.5. Cost of physical inactivity



€17 billion

Estimated cost of physical inactivity
in France by type of cost (direct vs. indirect)

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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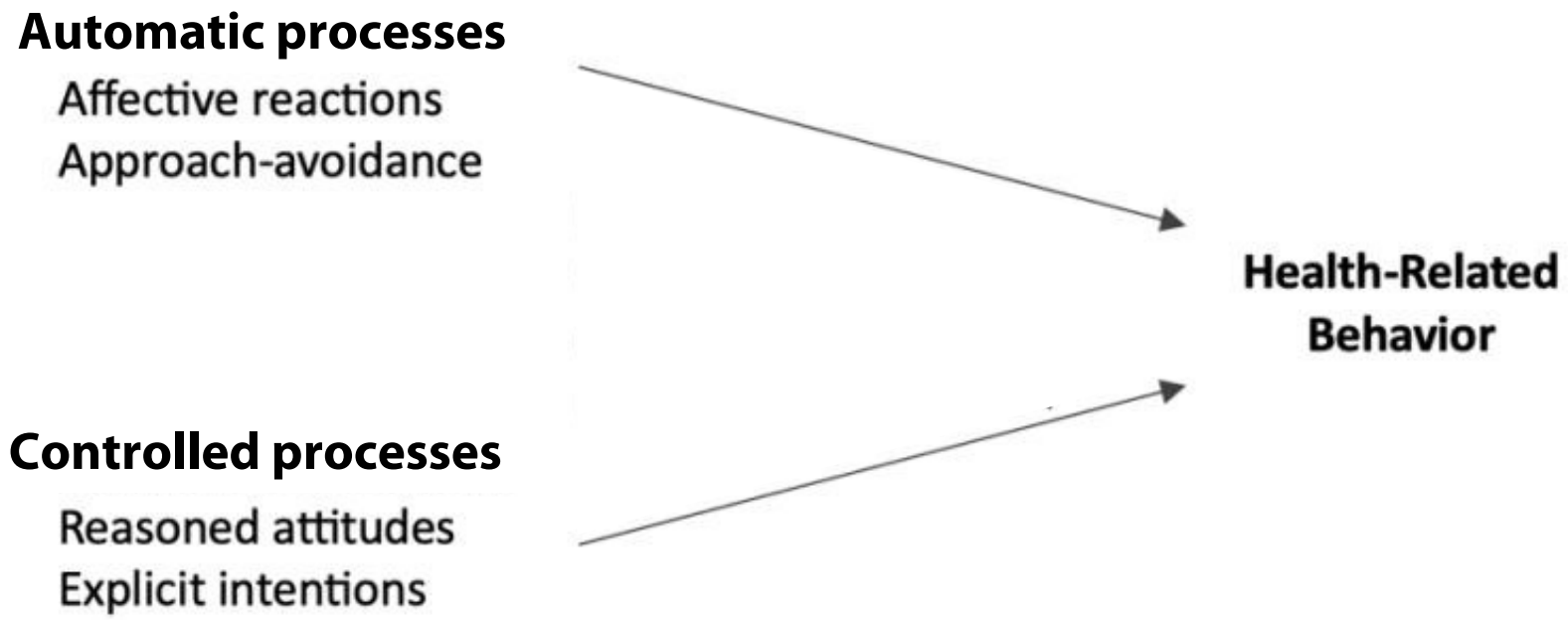
Sports.gouv.fr, 2018

3. DUAL-PROCESS MODELS



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@MattBoisgontier
http://matthieuboisgontier.com

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3. DUAL-PROCESS MODELS

3.1. Controlled & Automatic processes

Controlled processes

- Rely on higher brain functions
- Slow
- Deliberative
- Require cognitive resources
- Involve conscious awareness

Automatic processes

- Rely on learned associations
- Faster
- Initiated unintentionally
- Tax cognitive resources to a much lesser extent
- Do not require conscious awareness

→ Implicit Association Test (IAT)

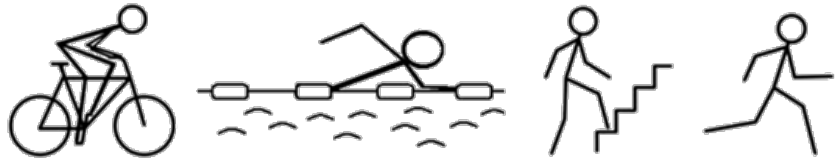
matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

3. DUAL-PROCESS MODELS

3.1. Controlled & Automatic processes

Implicit Association Test (IAT)

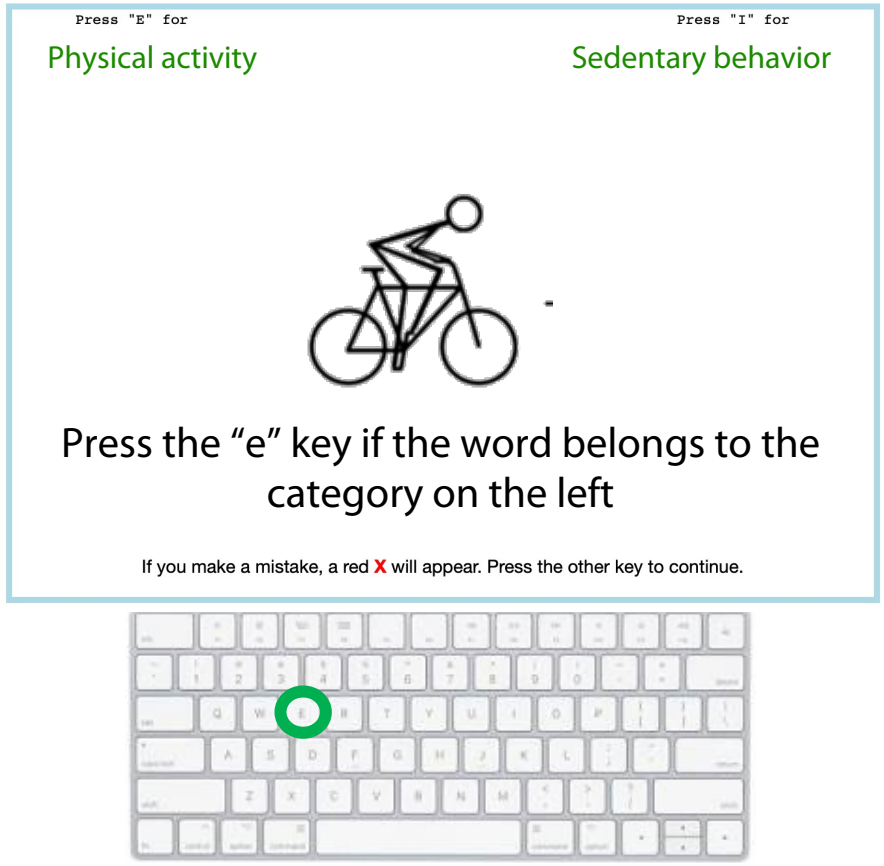
	Category	Items
Evaluation	Good	Delight, Fabulous, Smiling, Fantastic, Cheer, Triumph, Appealing, Celebrate
Evaluation	Bad	Ugly, Nasty, Disgust, Abuse, Scorn, Angry, Annoy, Hatred
Concepts	Physical activity	
Concepts	Sedentary behavior	

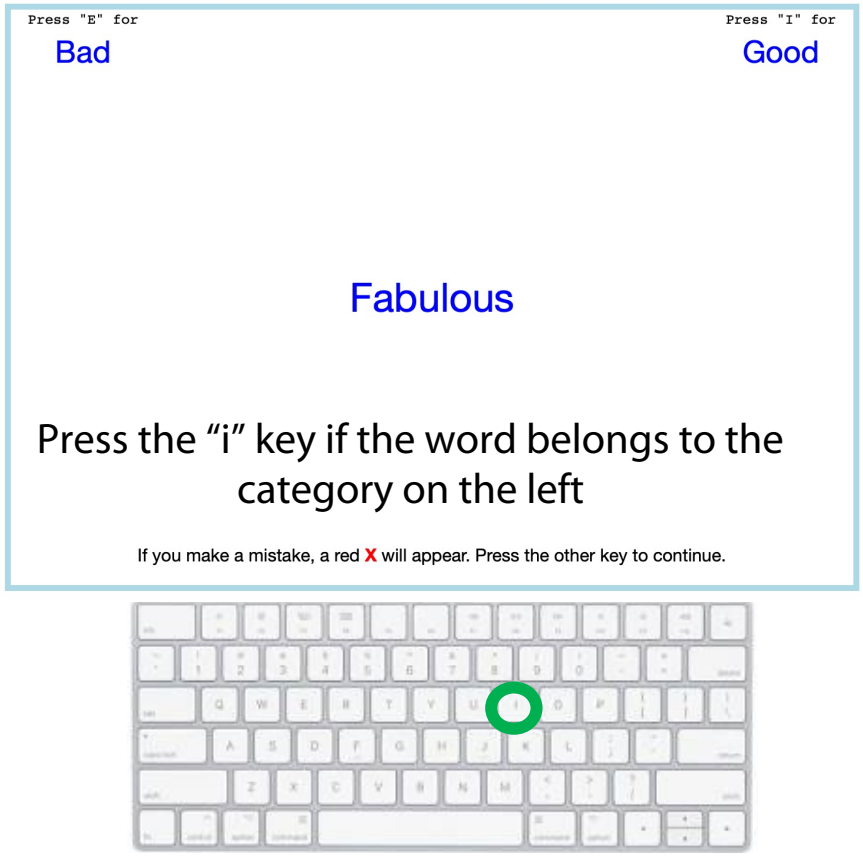
Sort words or images into categories
that are on the left and right side of the computer screen

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

3. DUAL-PROCESS MODELS

3.1. Controlled & Automatic processes





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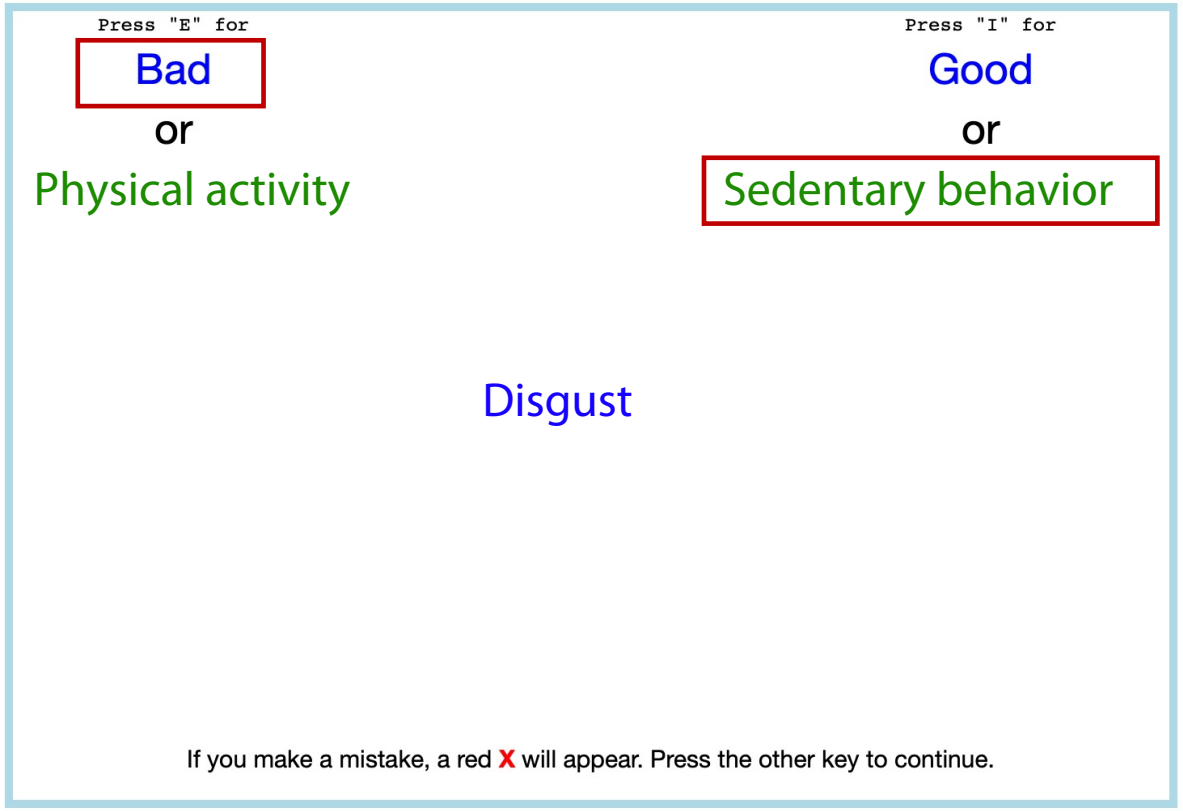
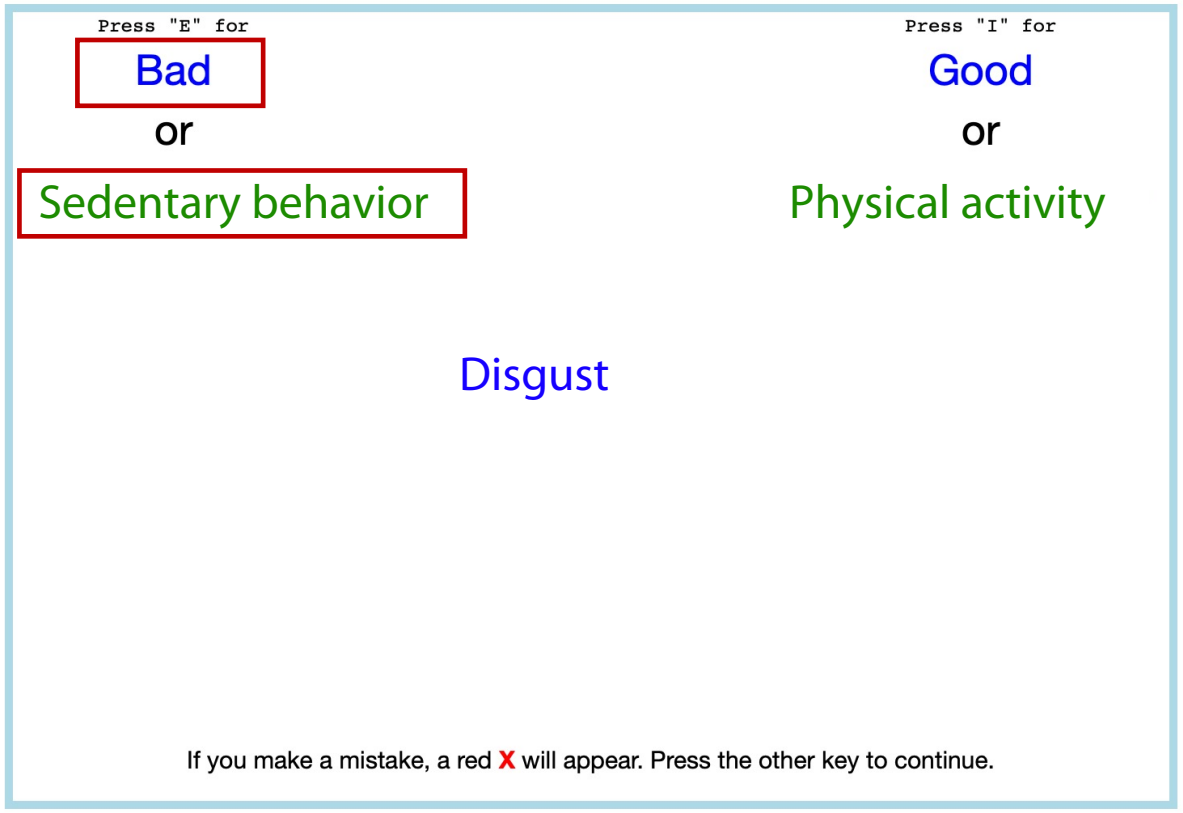
@MattBoisgontier
http://matthieuboisgontier.com

3. DUAL-PROCESS MODELS

3.1. Controlled & Automatic processes





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@MattBoisgontier
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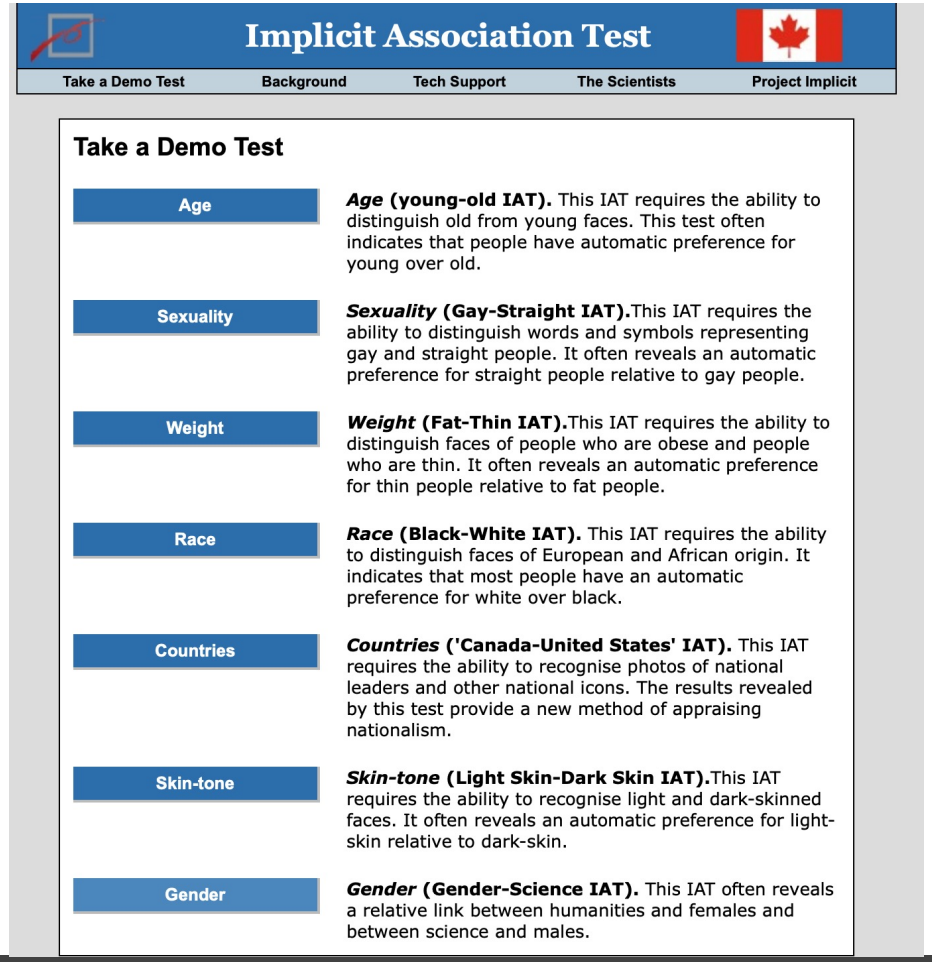
3. DUAL-PROCESS MODELS

3.1. Controlled & Automatic processes



matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

3. DUAL-PROCESS MODELS

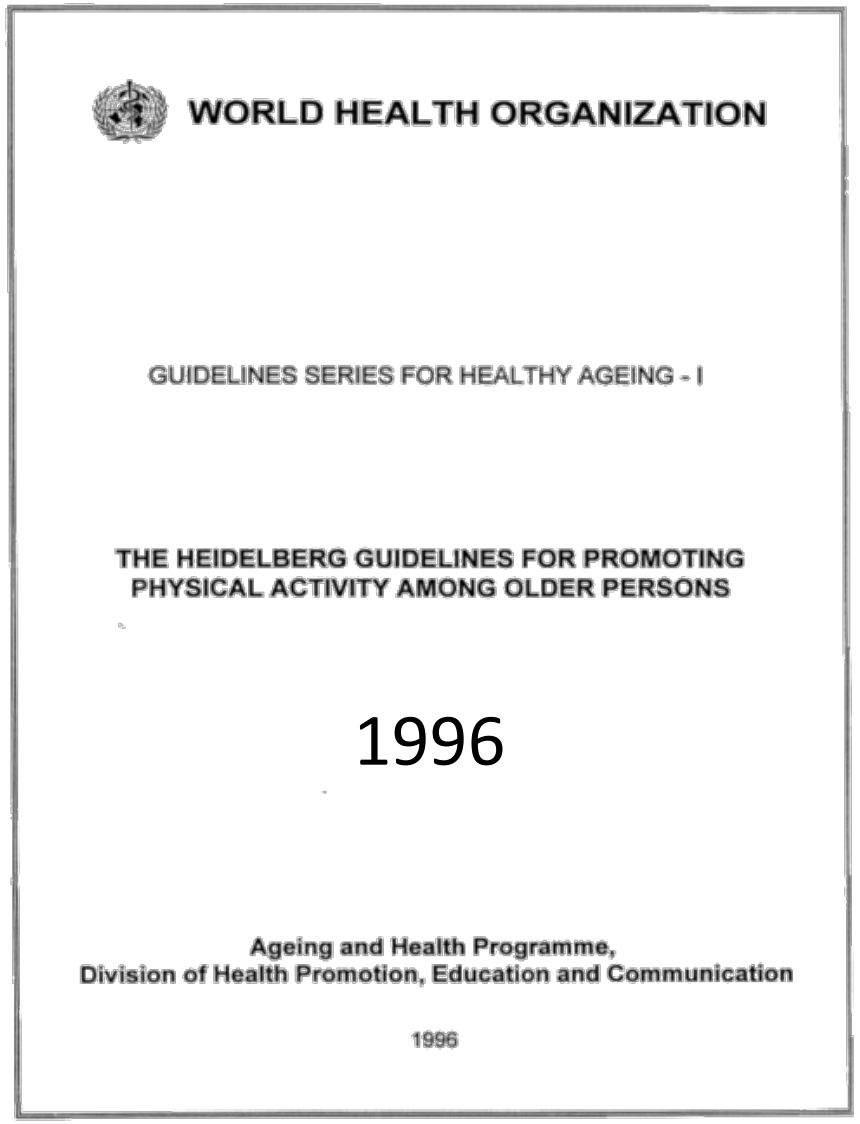
3.2. Current approaches in physical activity

thebmj

Promoting physical activity to patients

September 2019

"Even a brief discussion within a consultation can lead to change"



WORLD HEALTH ORGANIZATION

GUIDELINES SERIES FOR HEALTHY AGEING - I

THE HEIDELBERG GUIDELINES FOR PROMOTING PHYSICAL ACTIVITY AMONG OLDER PERSONS

1996

Ageing and Health Programme,
Division of Health Promotion, Education and Communication

1996

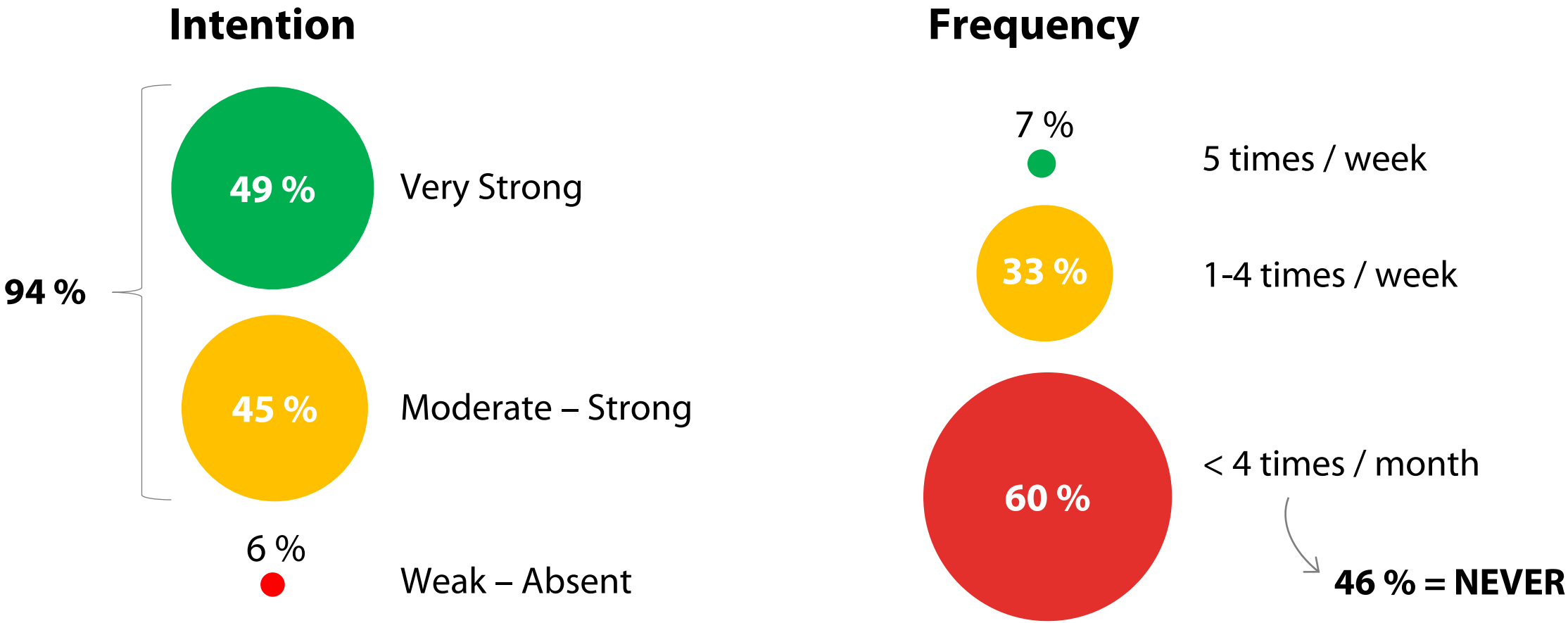
matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

Haseler et al., BMJ, 2019; WHO, 1996

3. DUAL-PROCESS MODELS

3.3. Intention–behavior gap



matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

European Commission, 2018

3. DUAL-PROCESS MODELS

3.3. Intention–behavior gap

Aware of the positive effects & **Intention to be physically active**

BUT Intention is **not sufficient** as plans are often not executed

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

Rhodes et al., Ann Behav Med, 2008

4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

Systematic Review

Sports Medicine

Rewarding value of physical inactivity behaviors - 2018

Point of View

PTJ

Physical Inactivity = Impulse Disorder - 2020

Impulse Disorder

Repeated failure to resist an impulse to minimize effort

Theory

AMERICAN COLLEGE OF SPORTS MEDICINE · FOUNDED 1954 ·

Theory of effort minimization in physical activity (TEMPA) - 2021

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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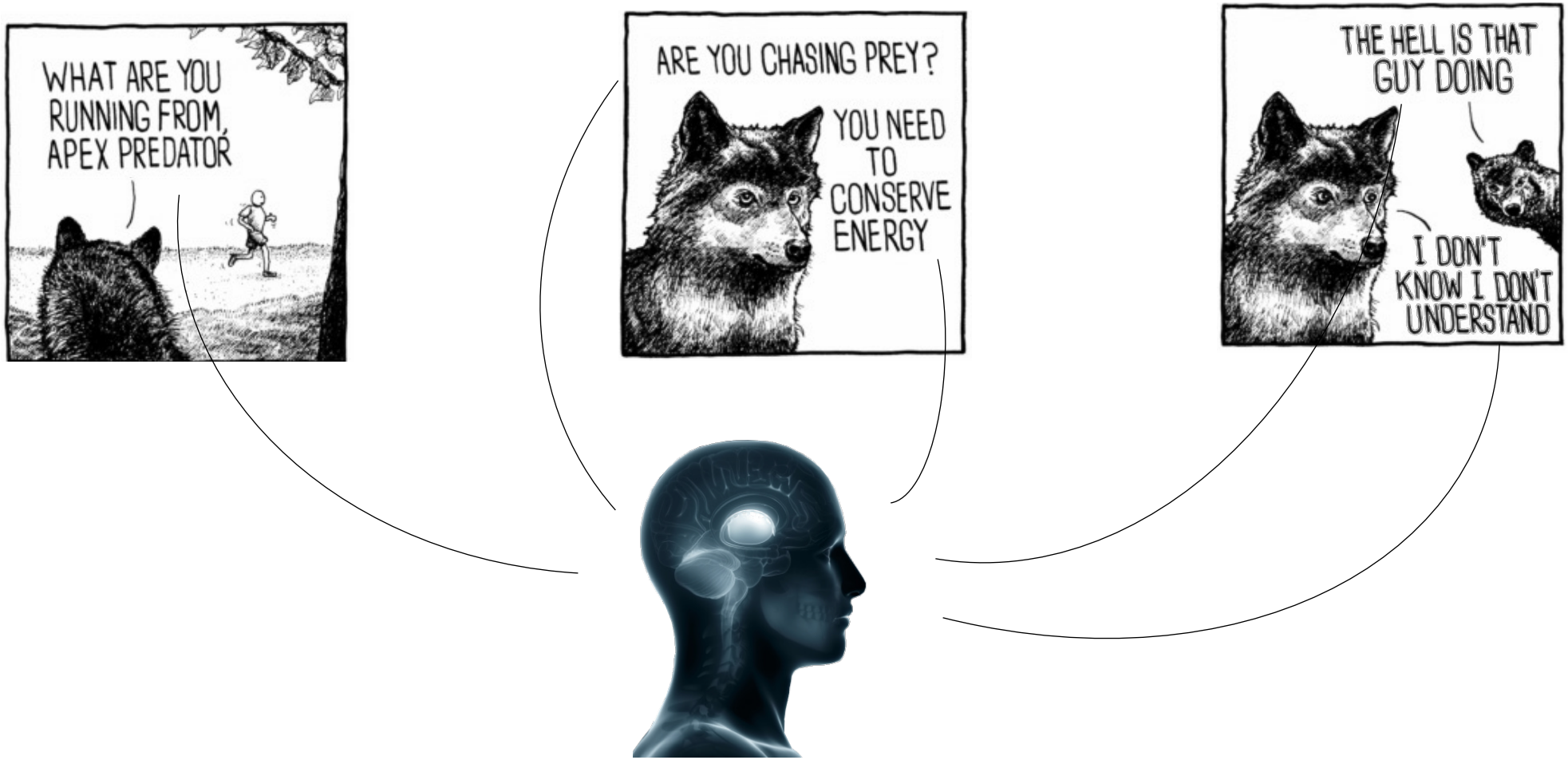
4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

4.1. Evolution



matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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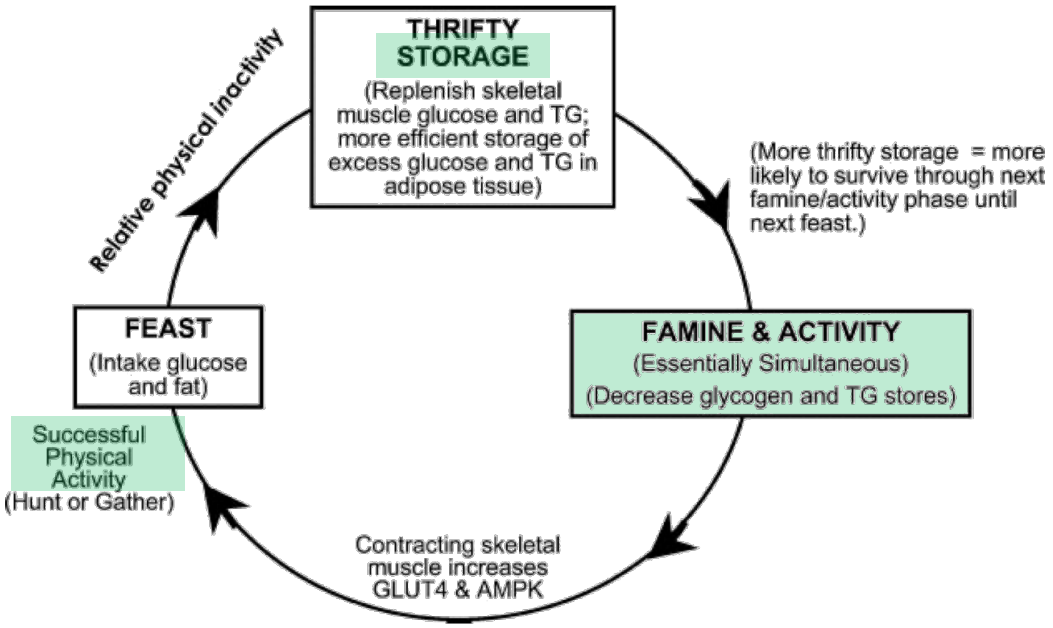
Jake Thompson. It's jogging season again

4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

4.1. Evolution



Food availability & **physical activity** = **same cycle**

Alternating periods of **food scarcity** & **abundance** are associated with **higher & lower physical activity**, respectively

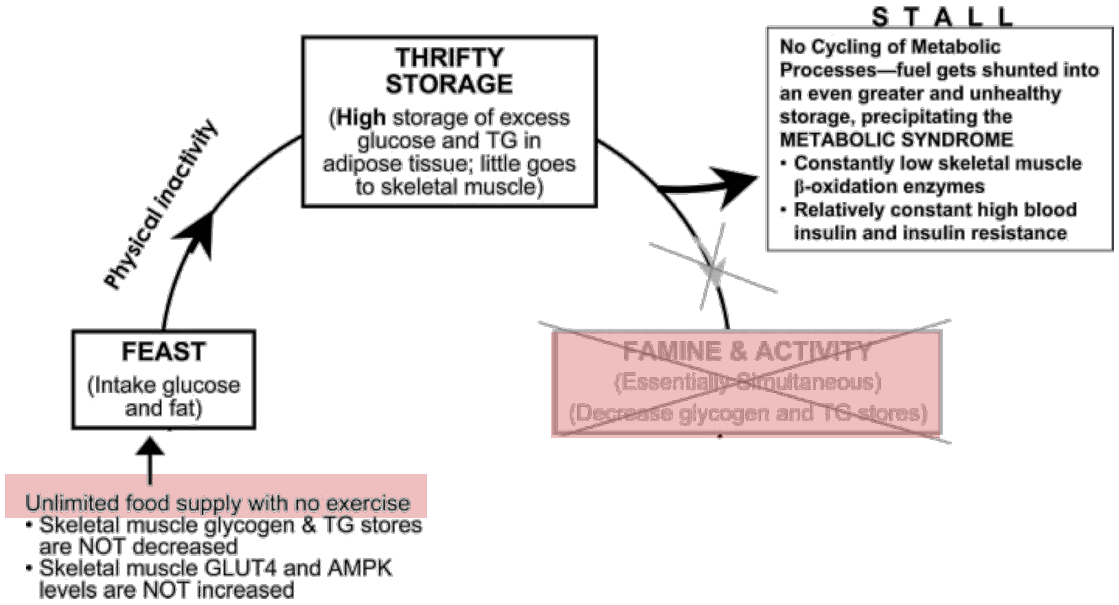
matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

Chakravarthy & Booth, J Appl Physiol, 2004; Cheval & Boisgontier, Exerc Sport Sci Rev, 2021

4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

4.1. Evolution



In our modern societies,

energy-dense food is **abundant & cheaper**,

food scarcity is often not a trigger of physical activity anymore.

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

Chakravarthy & Booth, J Appl Physiol, 2004; Cheval & Boisgontier, Exerc Sport Sci Rev, 2021

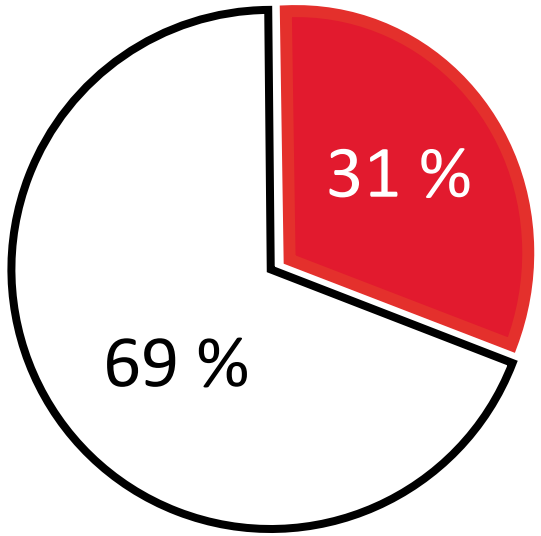
4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

4.2. Evidence from genetics

420 Monozygotic
352 Dizygotic

Sedentary Behaviors

% of explained variance



Genetic Factors

Environmental Factors

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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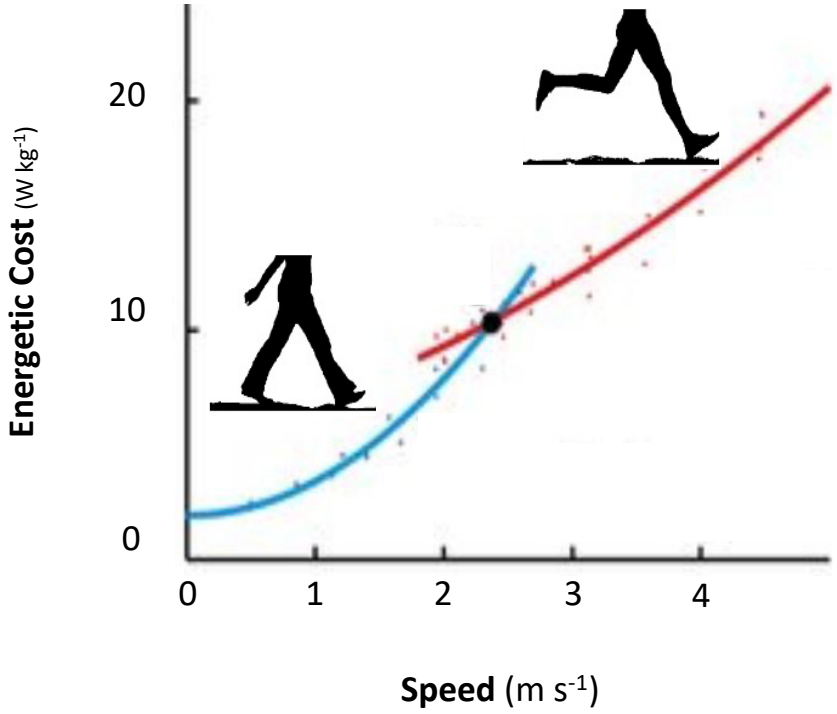
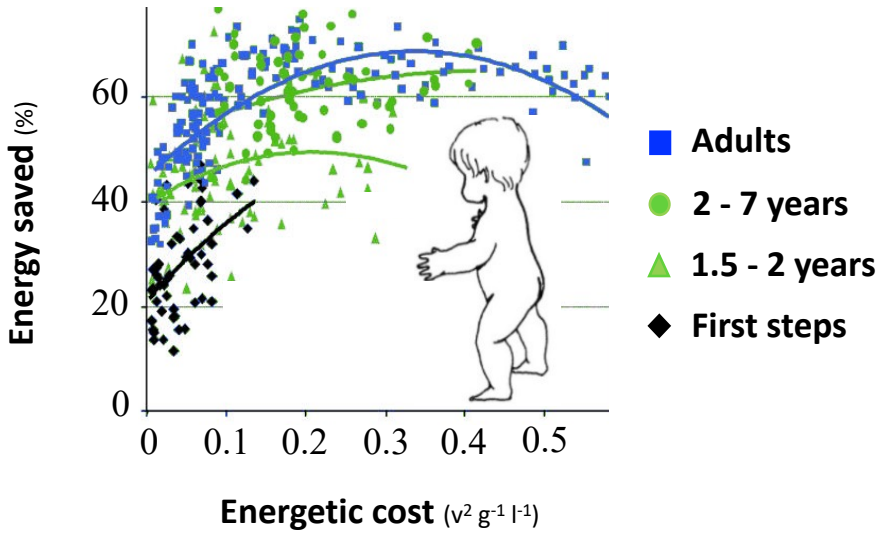
den Hoed et al., Am J Clin Nutr, 2013

4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

4.3. Evidence from biomechanics





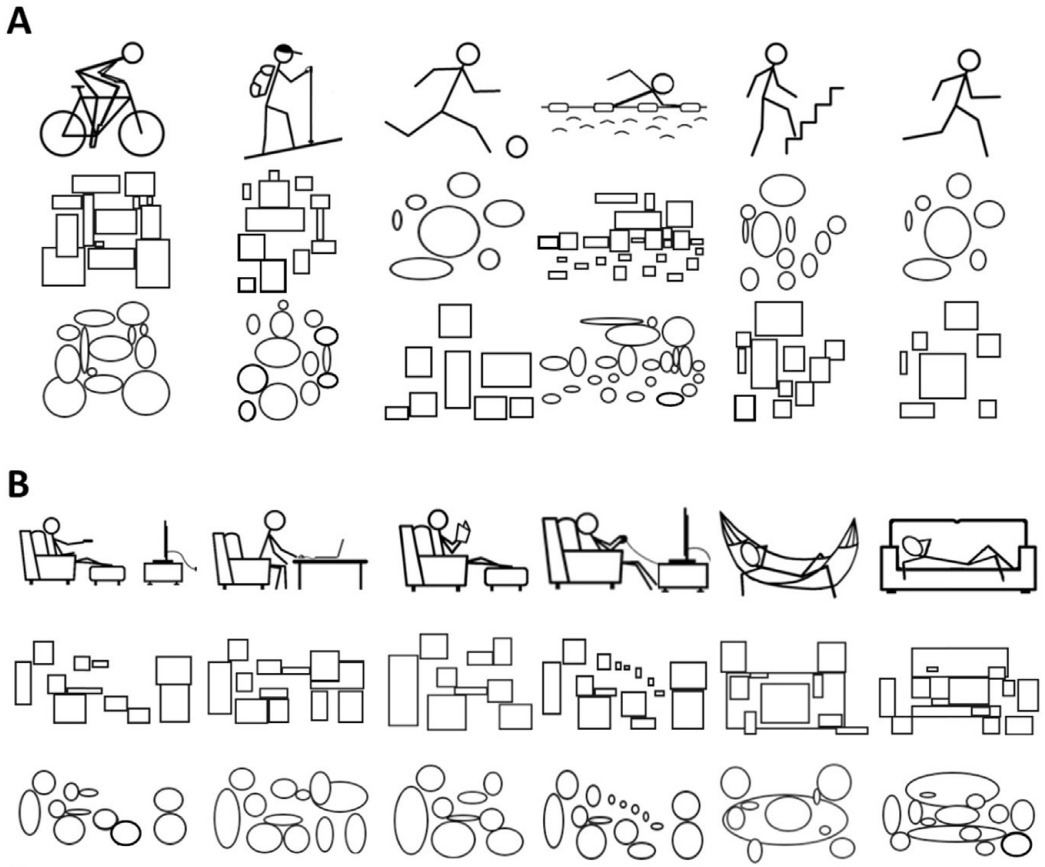
matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

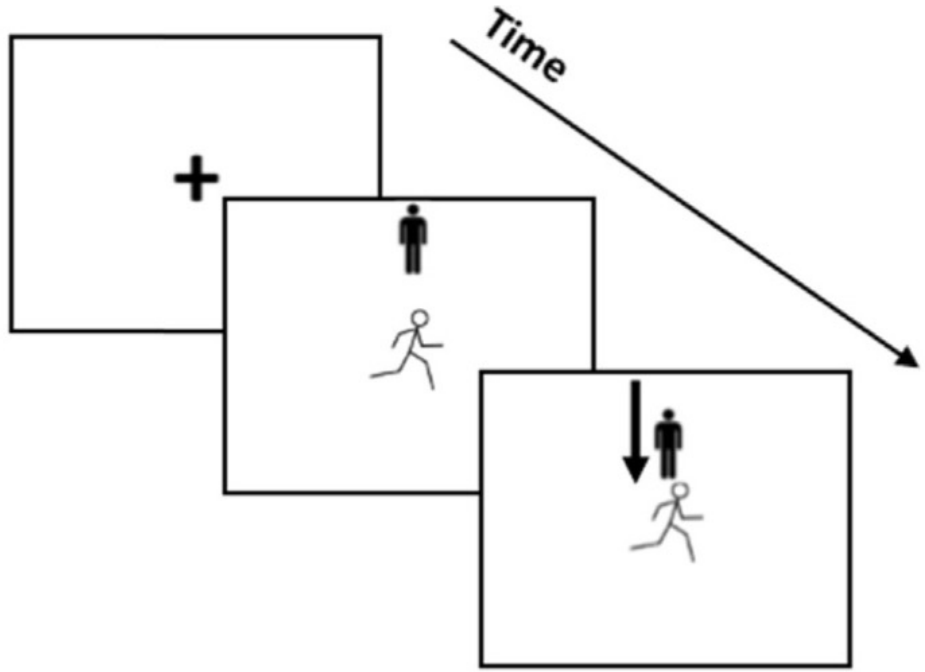
uOttawa

Long & Srinivasan, J R Soc Interface, 2013; Ivanenko et al. Exerc Sport Sci Rev., 2007.

4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

4.4. Evidence from neuroscience





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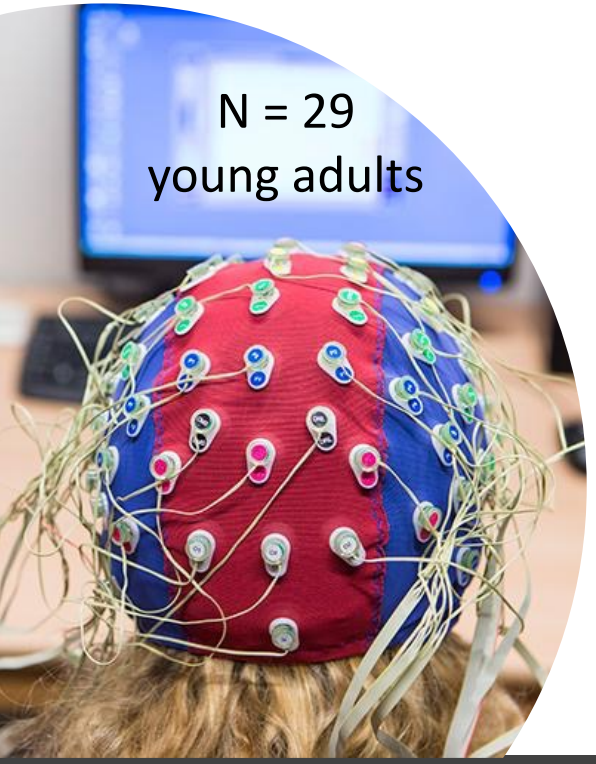
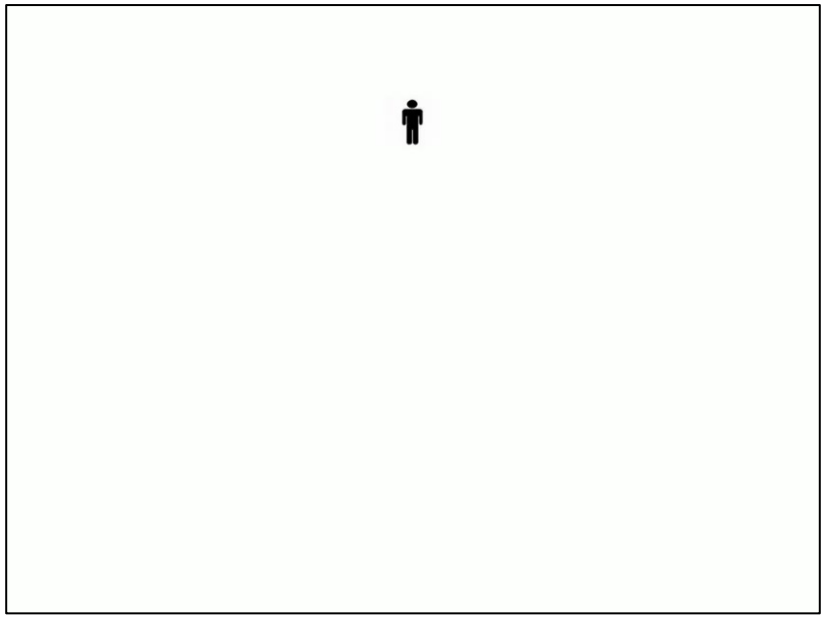
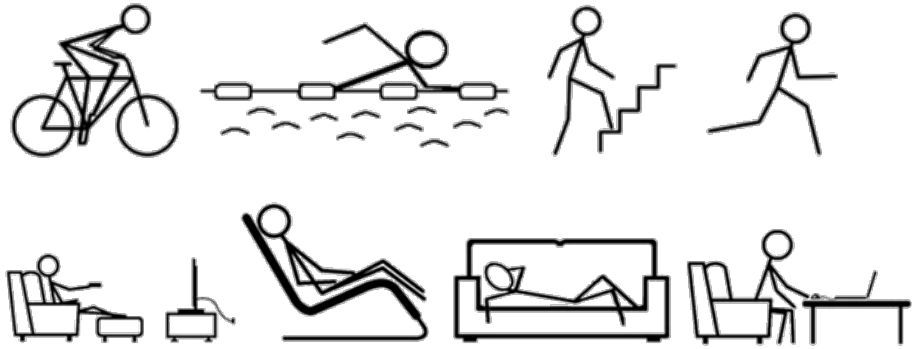
4. AUTOMATIC ATTRACTION TOWARD EFFORT MINIMIZATION

4.4. Evidence from neuroscience







Approach Physical Activity

Avoid Sedentary Behaviors

→ **More brain activity** required to avoid sedentary behaviors

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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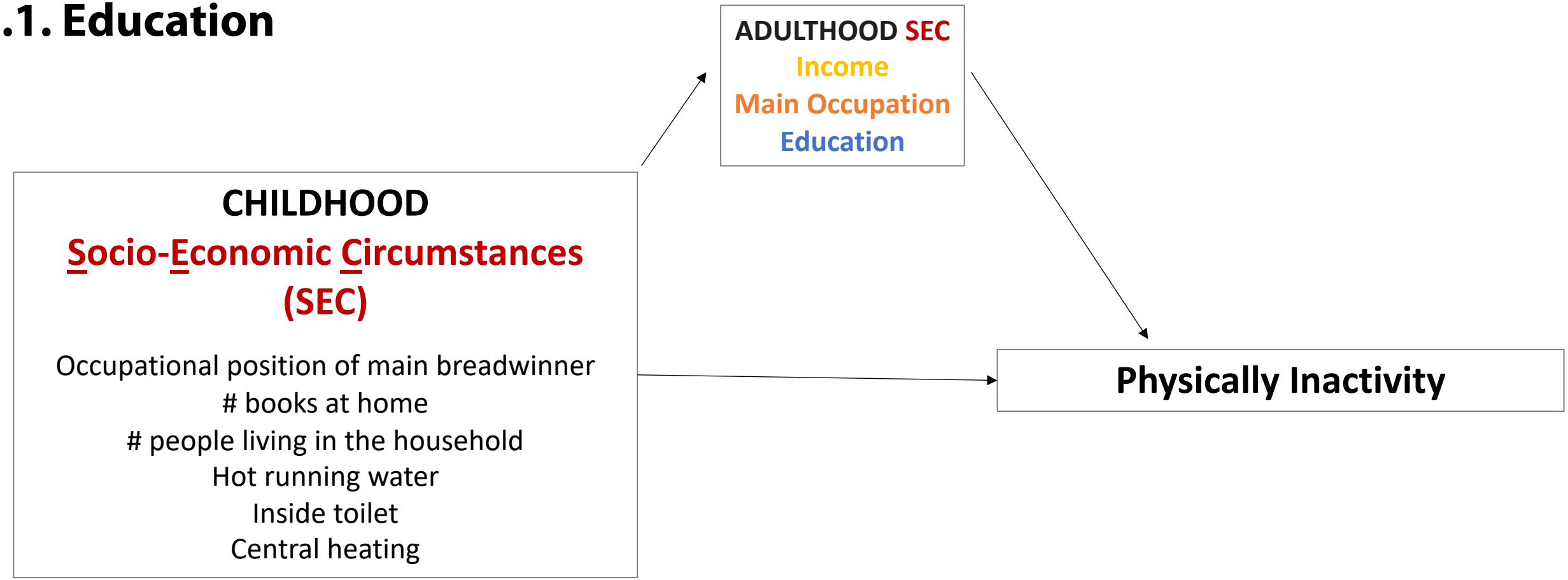
Cheval, […], & Boisgontier, Neuropsychologia, 2018.

5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.1. Education



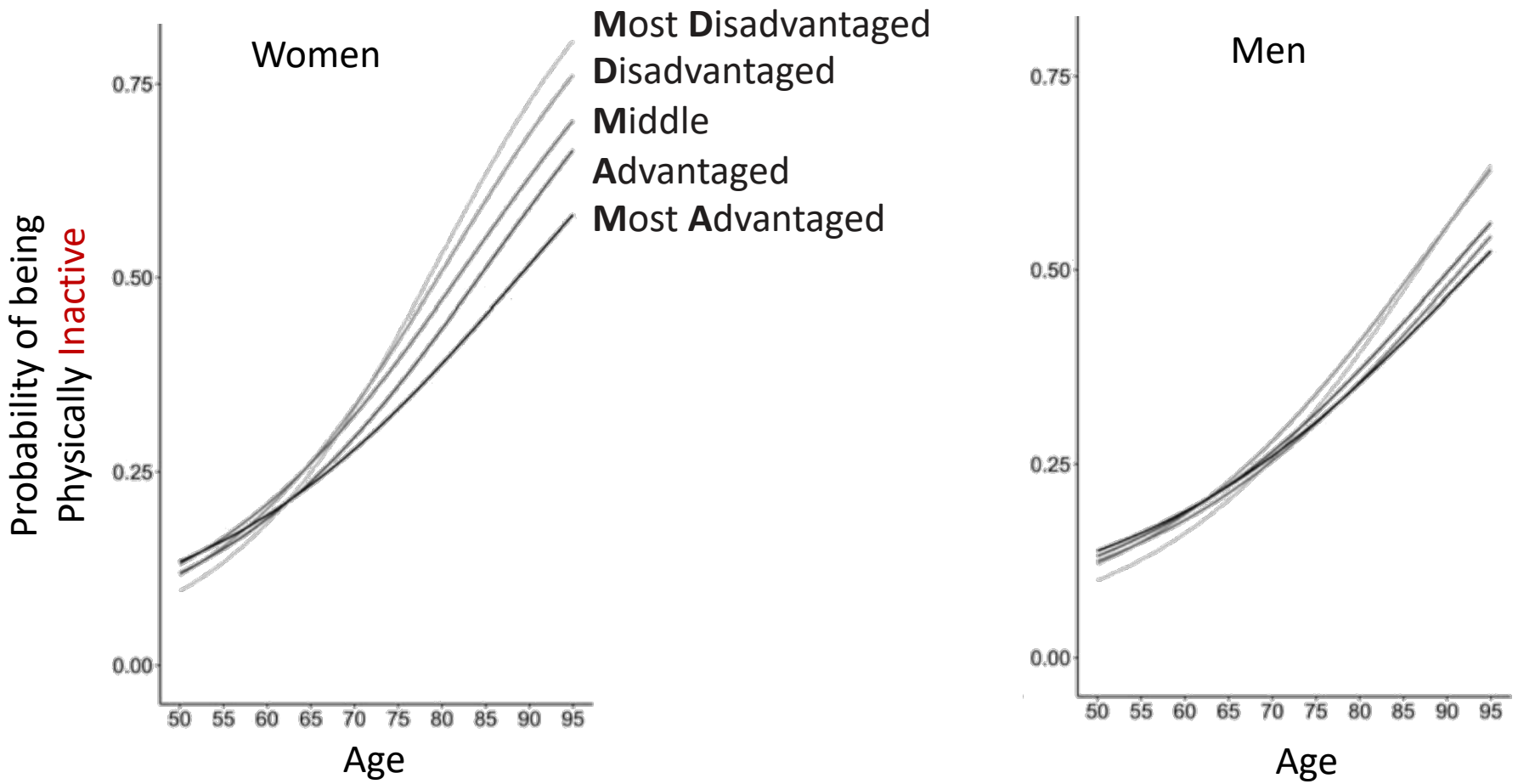
MA = most advantaged; **A** = advantaged;
M = middle; **D** = disadvantaged; **MD** = most disadvantaged

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.1. Education

Early-life SEC → Physical Inactivity



matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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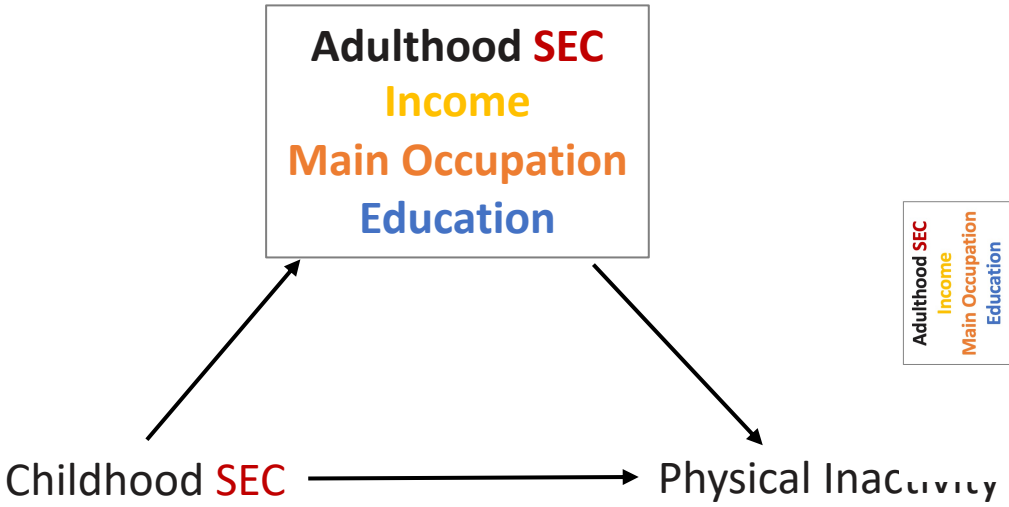
5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

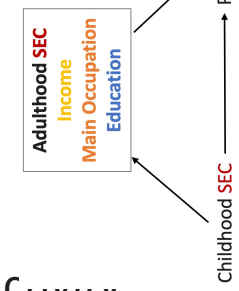
5.1. Education

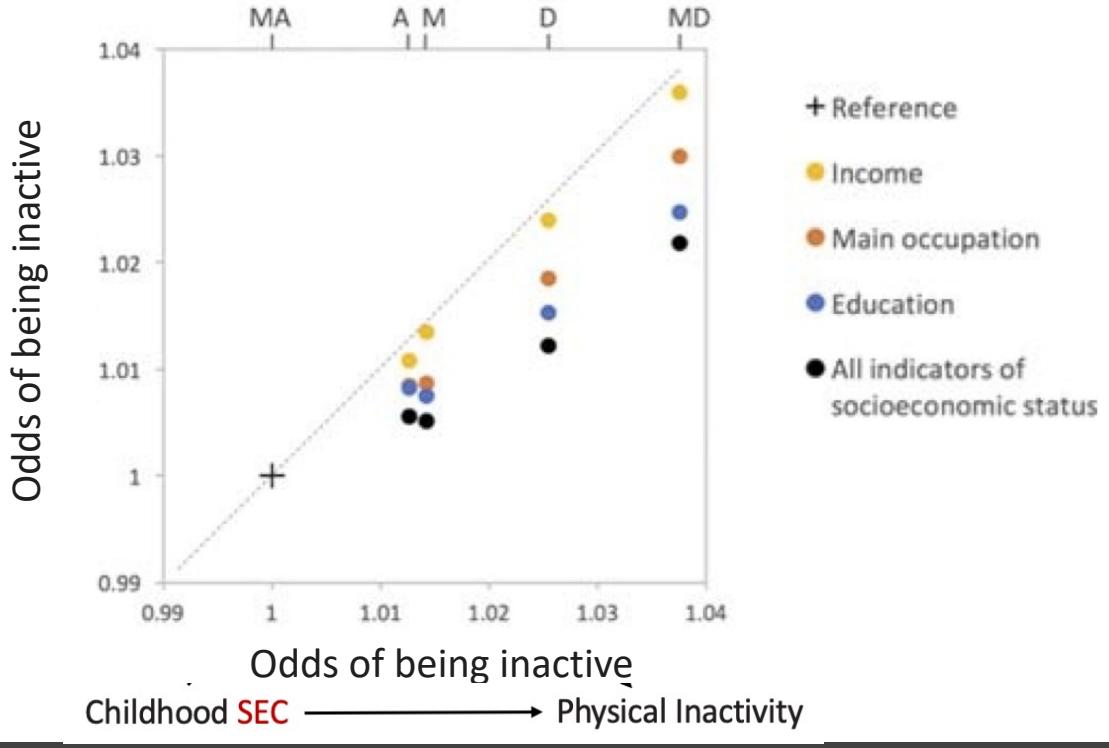
Association between **Childhood SEC** & **physical inactivity**

Childhood SEC

MA = most advantaged = reference (**+**); **A** = advantaged;
M = middle; **D** = disadvantaged; **MD** = most disadvantaged







matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

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Cheval et al., Med Sci Sports Exerc, 2018.

5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.2. Which came first: The chicken or the egg?

Cognition or Physical activity

Mendelian randomization (genetic variants)
to test **causal relationship** (age: 8-96 years)

General cognitive function

- Verbal & numerical reasoning
- Scores on neuropsychological tests

Physical activity

- Acceleration in milli-gravities (mg)
  - > 100 mg & < 425 mg = **moderate** physical activity
  - ≥ 425 mg = **vigorous** physical activity

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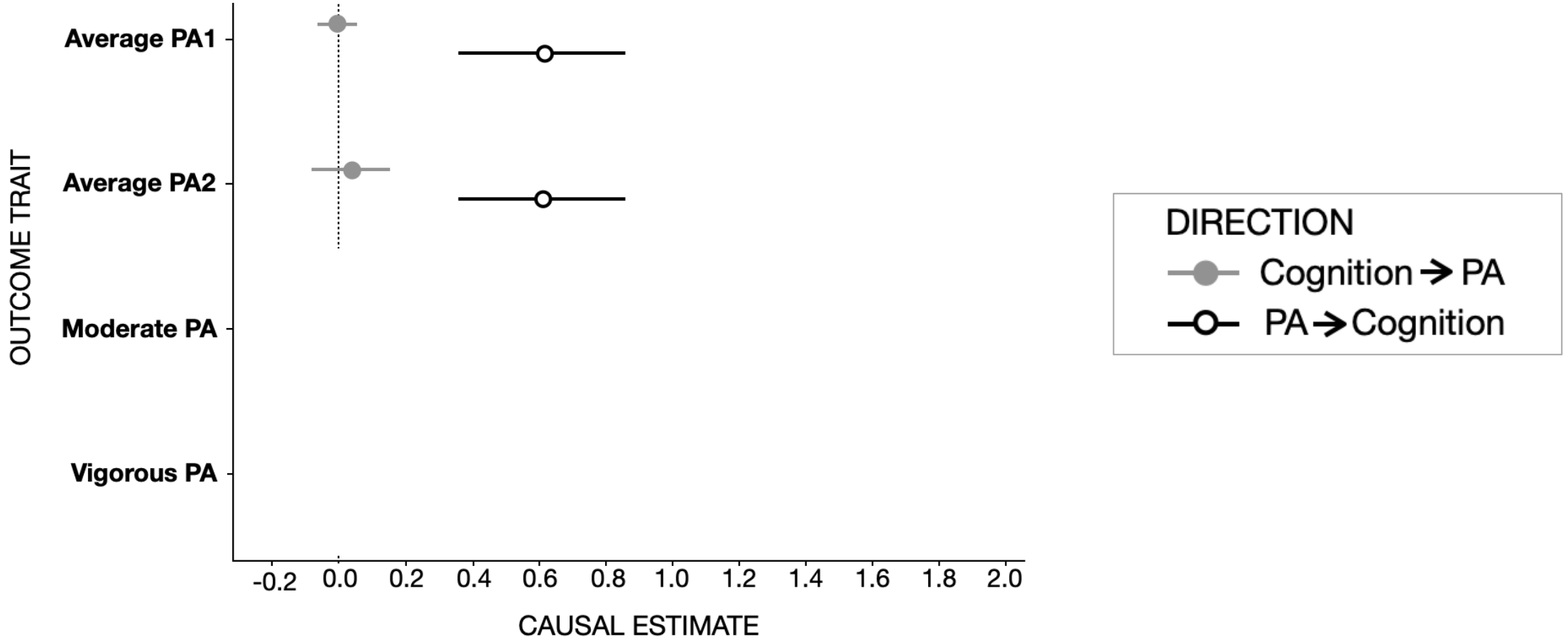
uOttawa

5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.2. Which came first: The chicken or the egg?



matthieu.boisgontier@uOttawa.ca
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5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.2. Which came first: The chicken or the egg?

Cognitive resources

- **Delayed recall** (10 words)
- **Verbal fluency**: Name as many animals as possible in 1 min
- **Education**: Primary, secondary, tertiary

Physical activity frequency

- Times/week
  - *More than 1/week*
  - *1/week*
  - *1-3/month*
  - *Rarely* or *never*

N = 105,206
> 50 years

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
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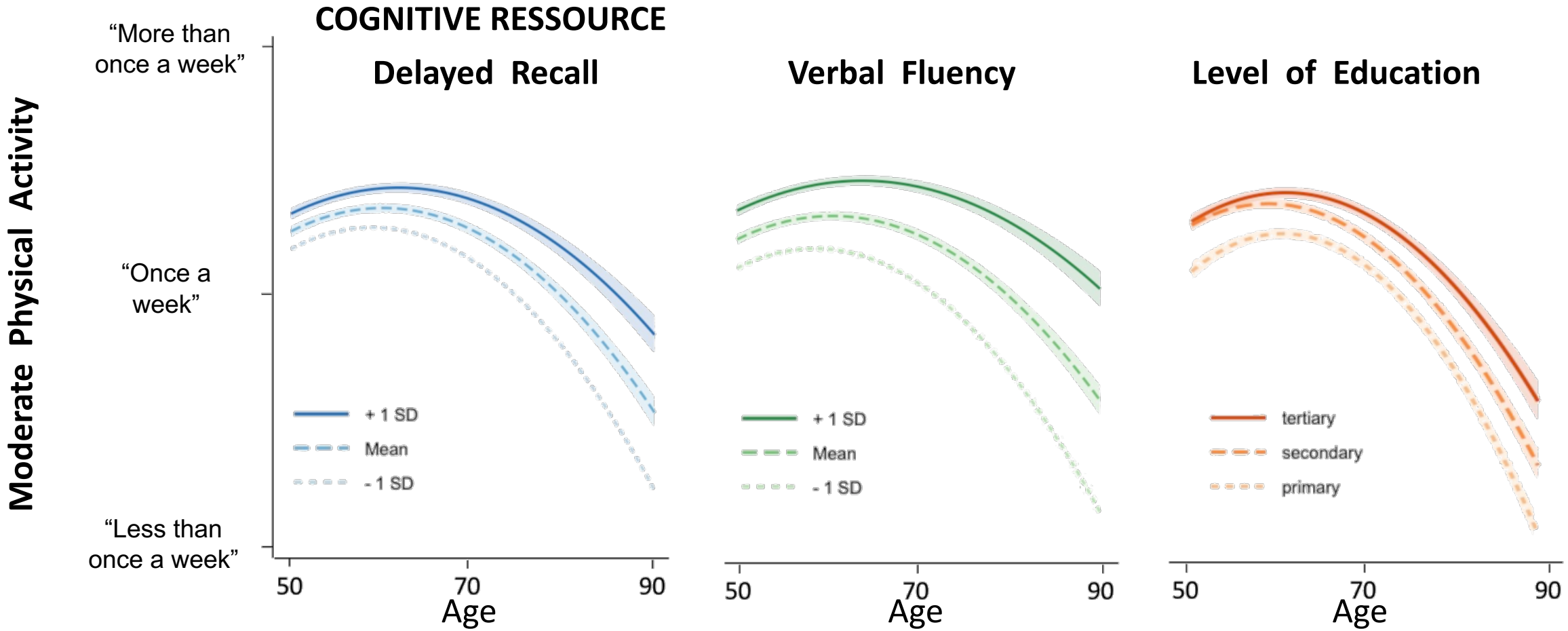
5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.2. Which came first: The chicken or the egg?



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5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

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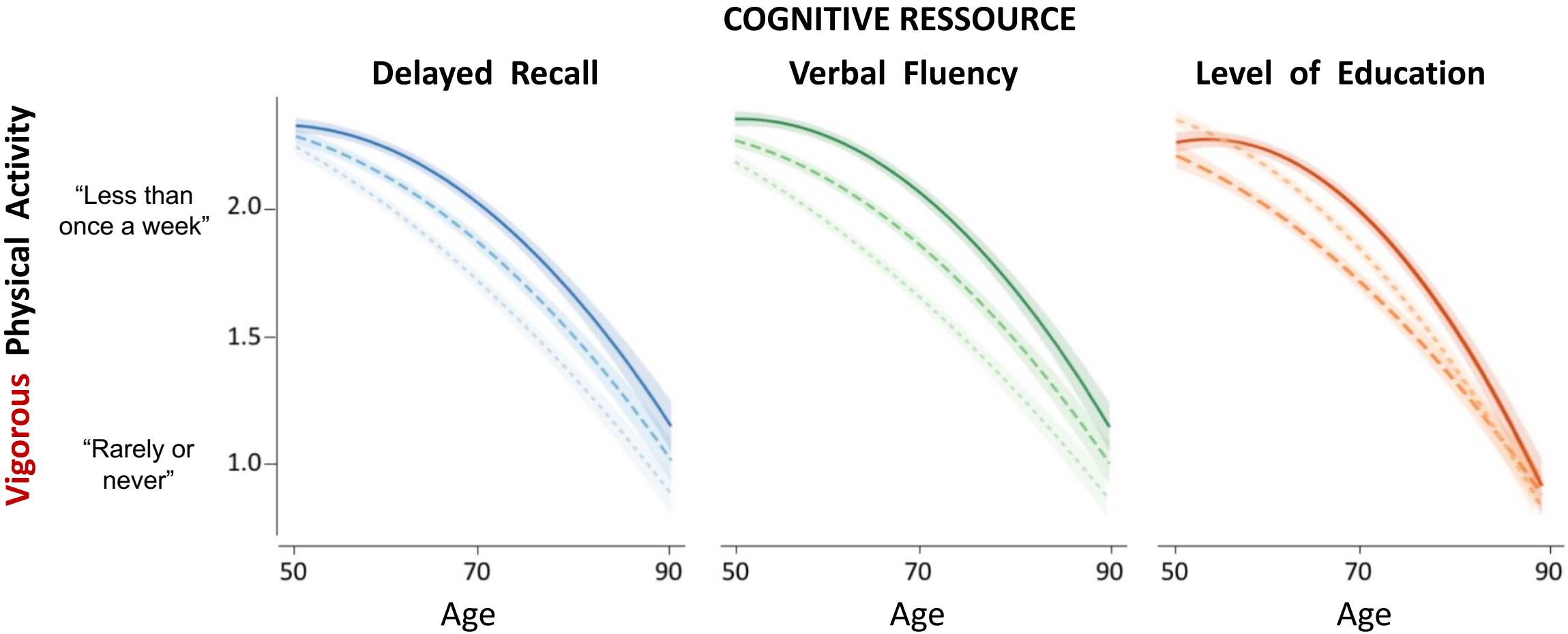

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5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

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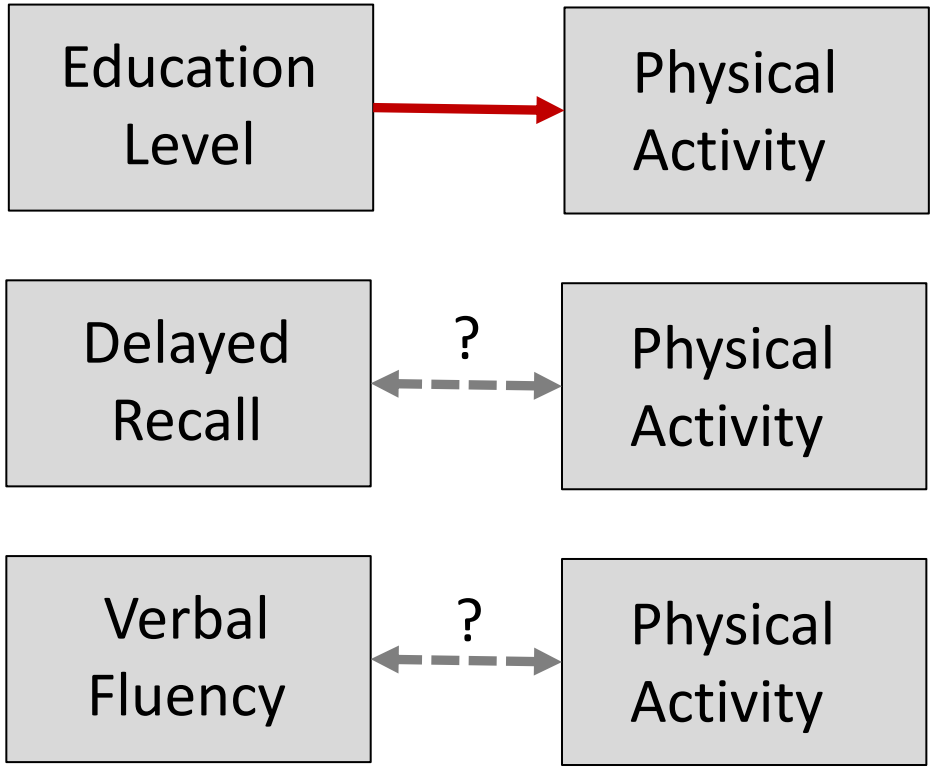

matthieu.boisgontier@uOttawa.ca
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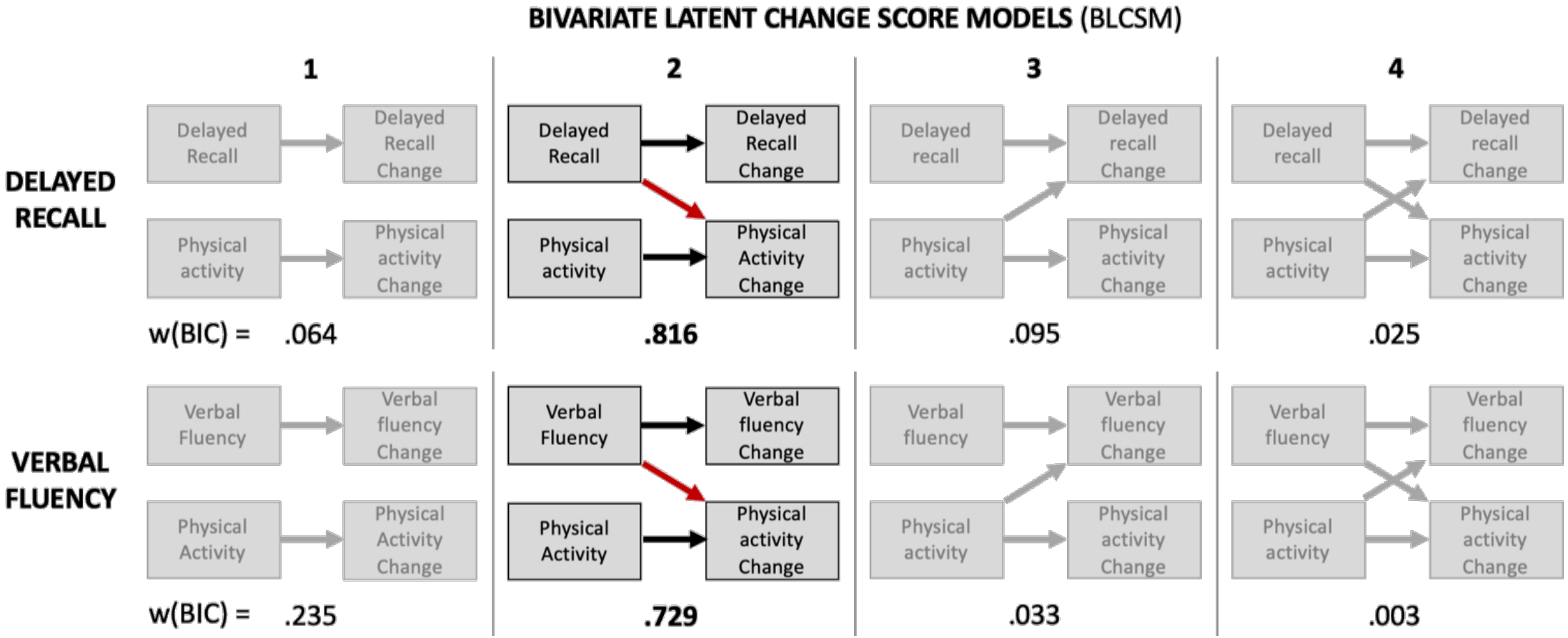
5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.2. Which came first: The chicken or the egg?



matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
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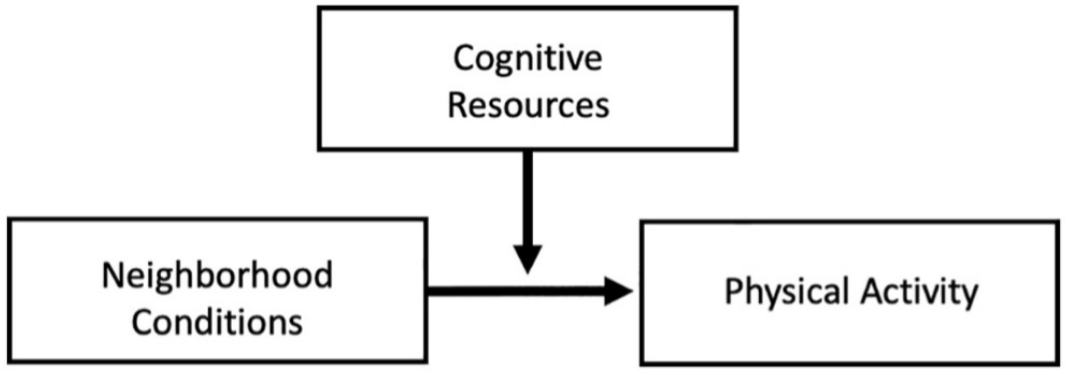
5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.3. Executive control & Physical activity & **Neighborhood conditions**

Neighborhood Conditions

- ACCESS
  - Sufficient **facilities within reasonable walking distance** (pharmacy, medical care, grocery)
  - Sufficient possibilities for **public transportation**
- NUISANCES
  - **Pollution**, noise or other environmental problems
  - **Vandalism** or **crime**



N = 28,393

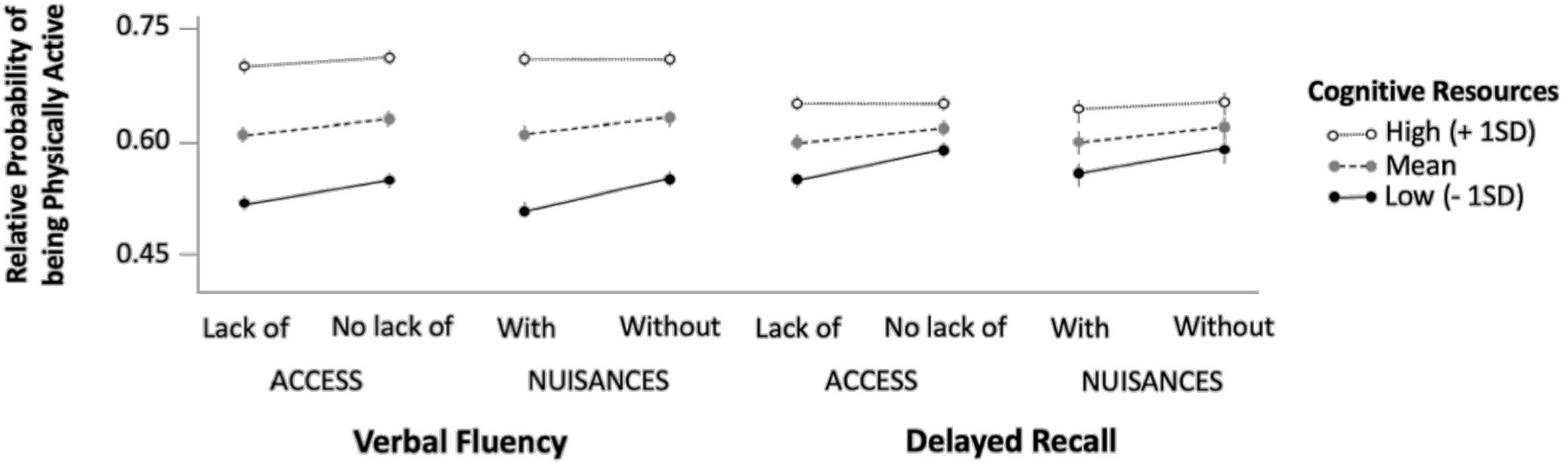
> 50 years

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com

uOttawa

5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.3. Neighborhood conditions & Executive control of physical activity



matthieu.boisgontier@uOttawa.ca
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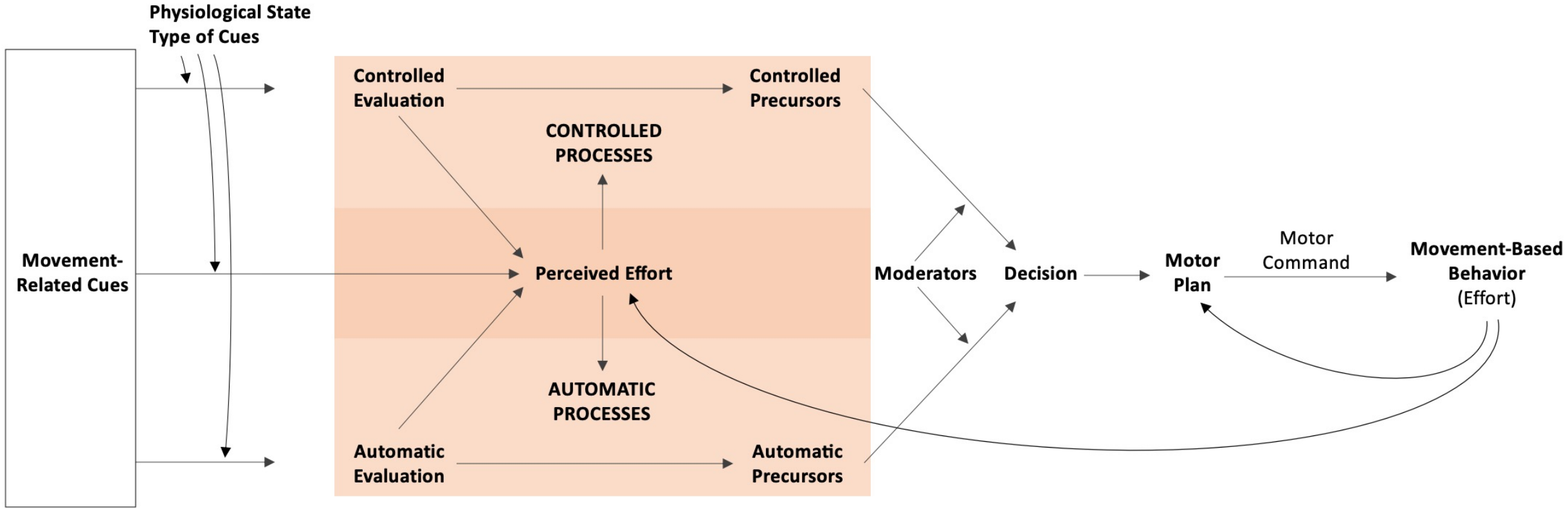
5. EXECUTIVE CONTROL OF PHYSICAL ACTIVITY

5.4. The theory of effort minimization in physical activity (TEMPA)



matthieu.boisgontier@uOttawa.ca
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uOttawa

6. RETRAINING AUTOMATIC PROCESSES

1 – **Fitness**
2 – **Energetic expenditure**
3 – **Time**

4 – **Sex**
5 – **Age**
6 – **Hunger**





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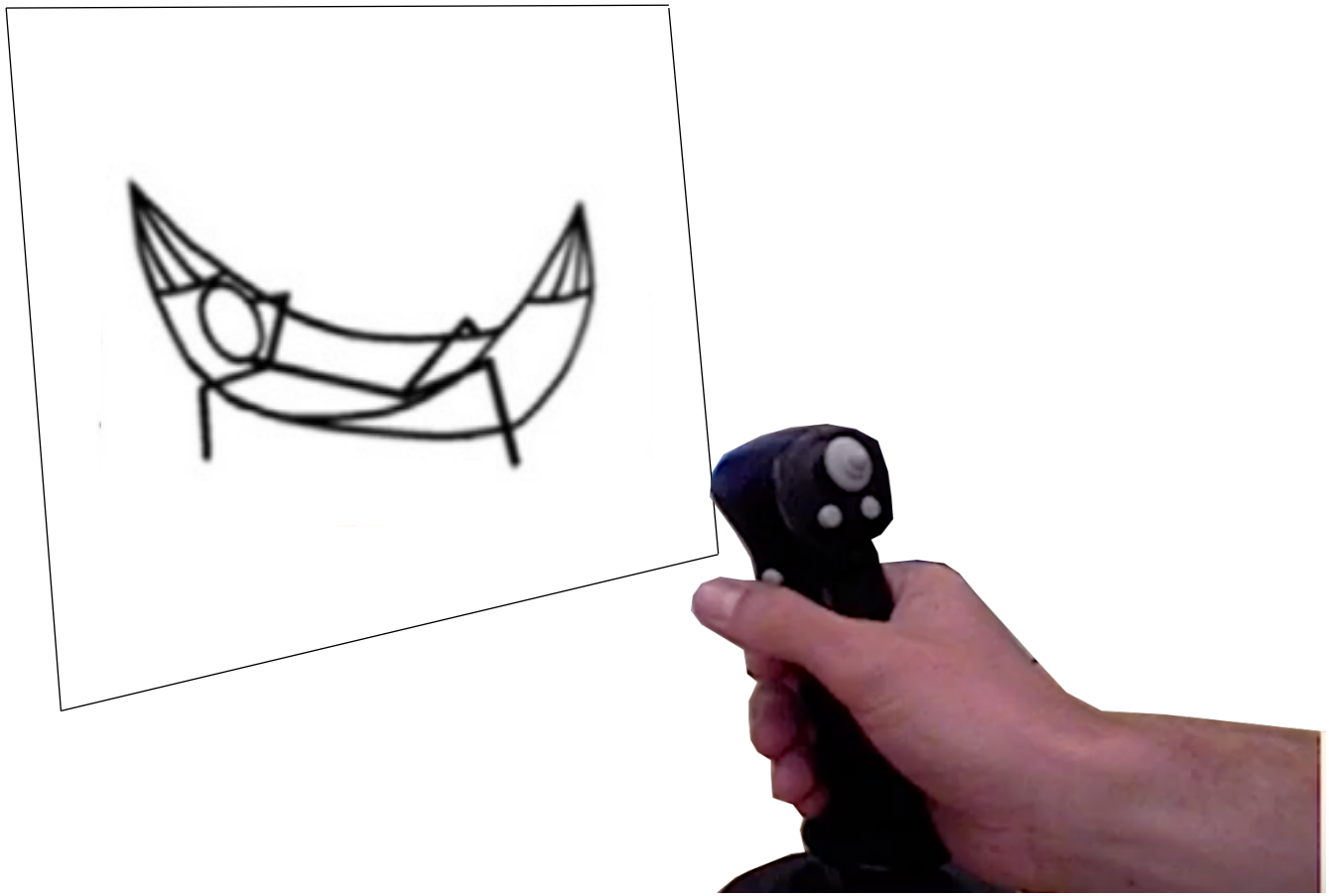
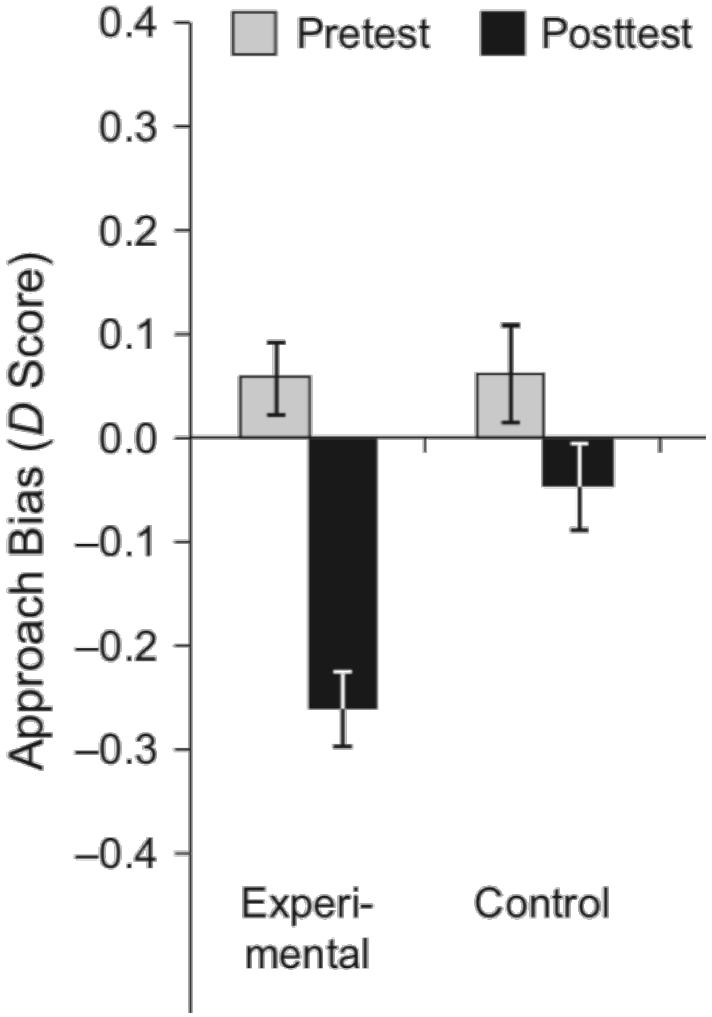
6. RETRAINING AUTOMATIC PROCESSES





matthieu.boisgontier@uOttawa.ca
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http://matthieuboisgontier.com

uOttawa

Effort Minimization & Physical Activity Behavior

Matthieu Boisgontier, MSKin, MSPT, PhD, HDR – June 17, 2021 – LIBM

matthieu.boisgontier@uOttawa.ca
@MattBoisgontier
http://matthieuboisgontier.com