

Let's learn from the past “what's next” and give physical activity and cognition research ‘some soul’

Caterina Pesce

University of Rome “Foro Italico”

“Are active kids better learners?
The impact of PA, exercise and sport
on cognition”



#AIESEPConnect
#CoffeeWithColleagues
January 28, 2022



Objectives

1. A **historical view** on physical activity and cognition research: from detection to nuances

2. Complementing the focus on **PA dose** with that on **PA quality** in PA-cognition research

3. Searching for **causal mechanisms** that explain the effects of quality PA on cognition: the role of the **context**

4. **Holistic models** of physical, cognitive, social and emotional child development promotion through quality PA at the core of a whole-child, whole school, whole-community approach

Historical view: three main stages in PA and cognition research

Undifferentiated
and mainly atheoretical
view on the PA-
cognition relation;
Either cross-sectional
research, or small-size
interventions

Investigations of the
specific nature of the
effects:
First seminal works by
Kramer et al., 1999;
Colcombe & Kramer, 2003;
Hillman et al., 2008

Investigations of the
moderators and
mediators of PA
effects on cognition.
Impactful literature:
Etnier & Chang, 2009



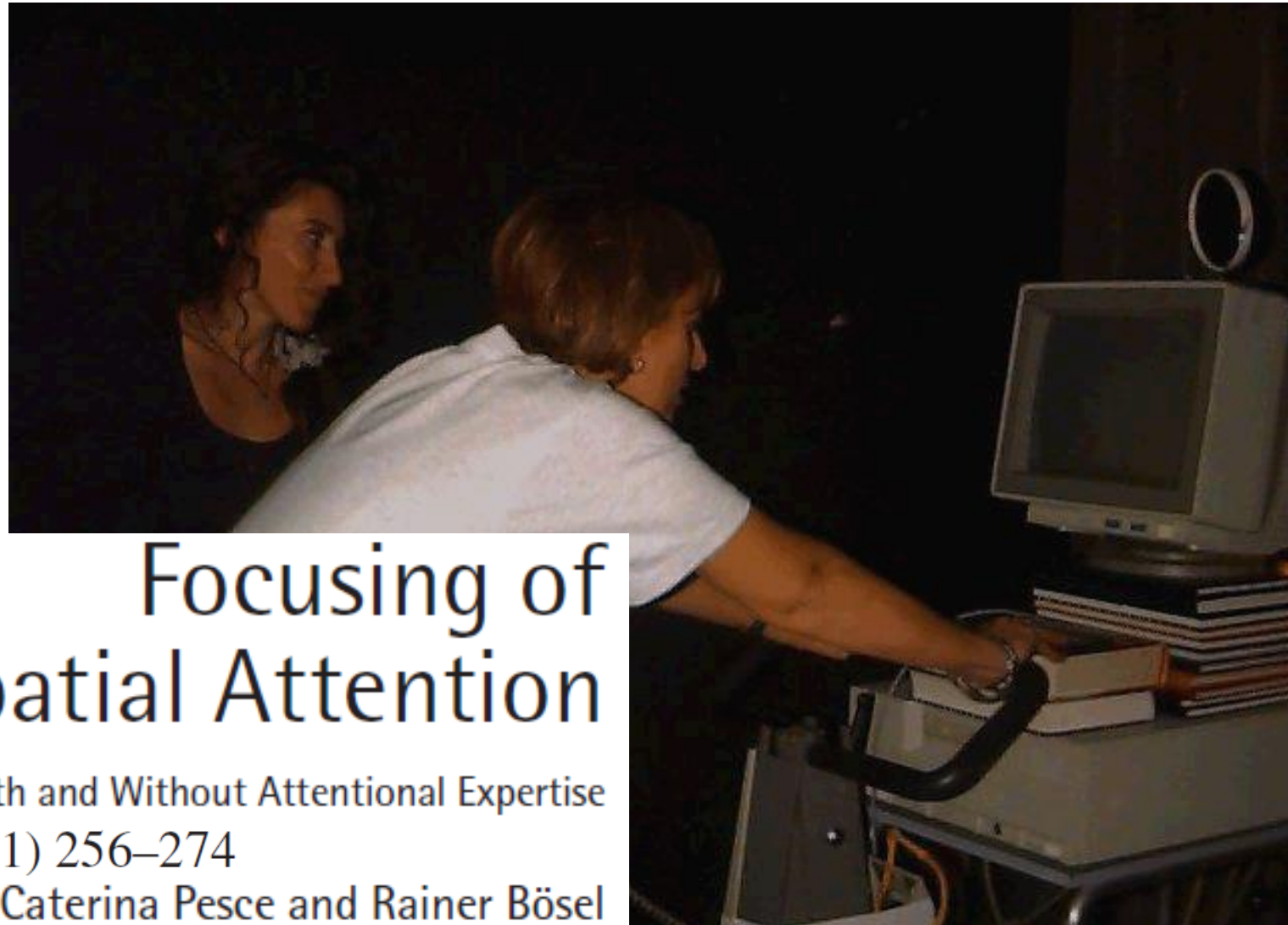
International Journal of Sport Psychology

VOL. 22 - N. 3/4 - JULY-DECEMBER 1991

Cognitive Psychophysiology as an Interface Between Cognitive and Sport Psychology

ALBERTO ZANI * and BRUNA ROSSI **

Once upon a time...



Focusing of Visuospatial Attention

Electrophysiological Evidence from Subjects with and Without Attentional Expertise
Journal of Psychophysiology 15 (2001) 256–274

Caterina Pesce and Rainer Bösel

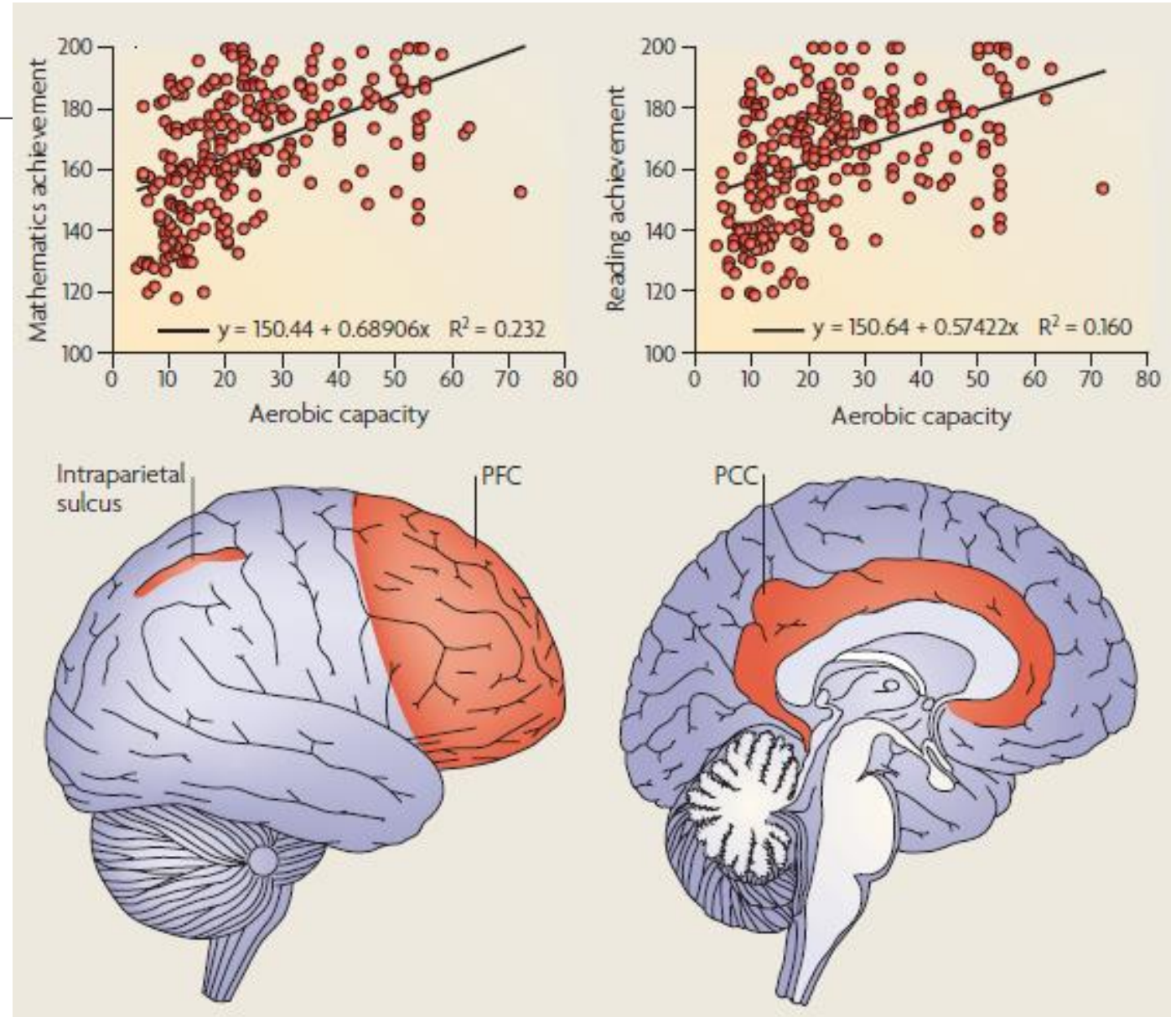
Be smart, exercise your heart: exercise effects on brain and cognition

Charles H. Hillman, Kirk I. Erickson and Arthur F. Kramer

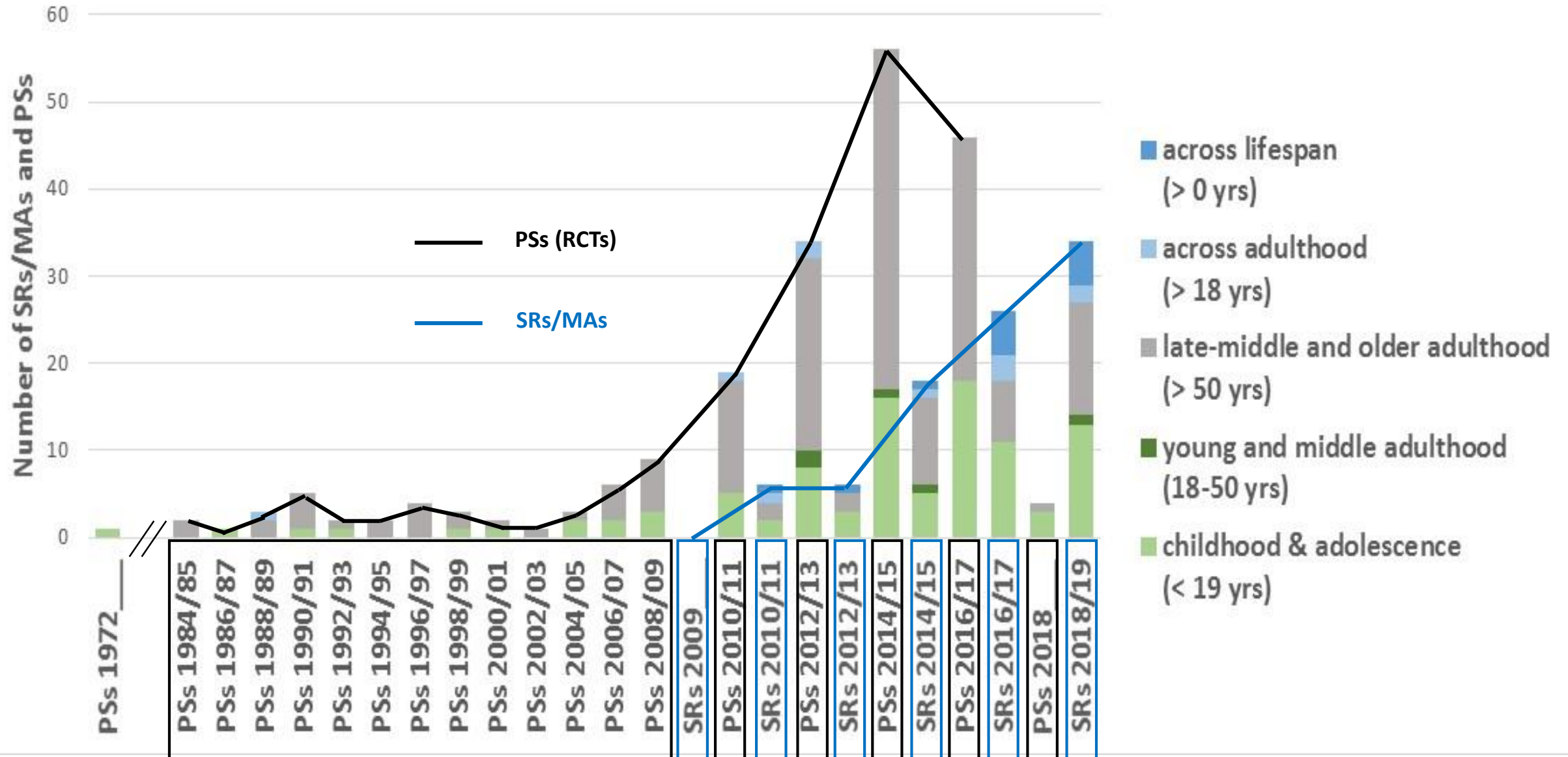
© 2008 Nature Publishing Group

At the end of the 'nature' stage':
a seminal review work
by Hillman, Erickson & Kramer (2008)

Key evidence on the selective effect
of aerobic fitness on academic
achievement and cognitive functions
supported by the prefrontal cortex:
executive functions



Systematic reviews/meta-analyses and primary studies (RCTs/cluster RCTs)



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Potential 'pathways' through which physical activity may influence cognition at developmental age (Best, 2010)

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graph TD; A([Potential 'pathways' through which physical activity may influence cognition at developmental age (Best, 2010)]) --> B([Metabolic demands of exercise]); A --> C([Cognitive task complexity]); A --> D([Coordinative task complexity]);
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Metabolic demands
of exercise

Cognitive
task complexity

Coordinative
task complexity



Contents lists available at ScienceDirect

Developmental Review

journal homepage: www.elsevier.com/locate/dr



Journal of Sport & Exercise Psychology, 2012, 34, 766–786
© 2012 Human Kinetics, Inc.

JOURNAL OF
SPORT & EXERCISE
PSYCHOLOGY
Official Journal of NASPSPA
www.JSEP-Journal.com
ORIGINAL RESEARCH

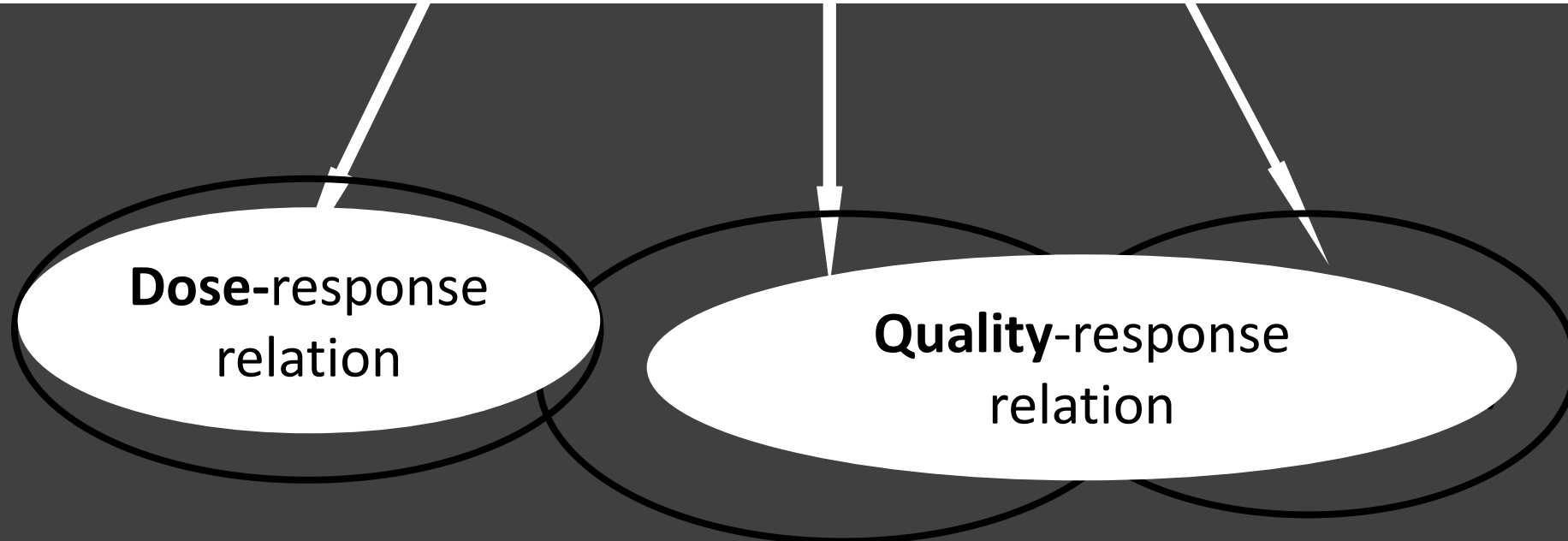
Shifting the Focus From Quantitative to Qualitative Exercise Characteristics in Exercise and Cognition Research

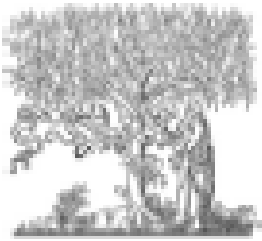
Effects of physical activity on children's executive function:
Contributions of experimental research on aerobic exercise

John R. Best

Caterina Pesce

University of Rome "Foro Italico"





ELSEVIER

Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Developmental Cognitive Neuroscience

journal homepage: <http://www.elsevier.com/locate/dcn>

Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not

Adele Diamond^{*}, Daphne S. Ling

Commentary

On mindful and mindless physical activity and executive function: A response to Diamond and Ling (2016)

Charles H. Hillman^{a,*}, Edward McAuley^b, Kirk I. Erickson^c, Teresa Liu-Ambrose^d,
Arthur F. Kramer^{a,b}



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Commentary

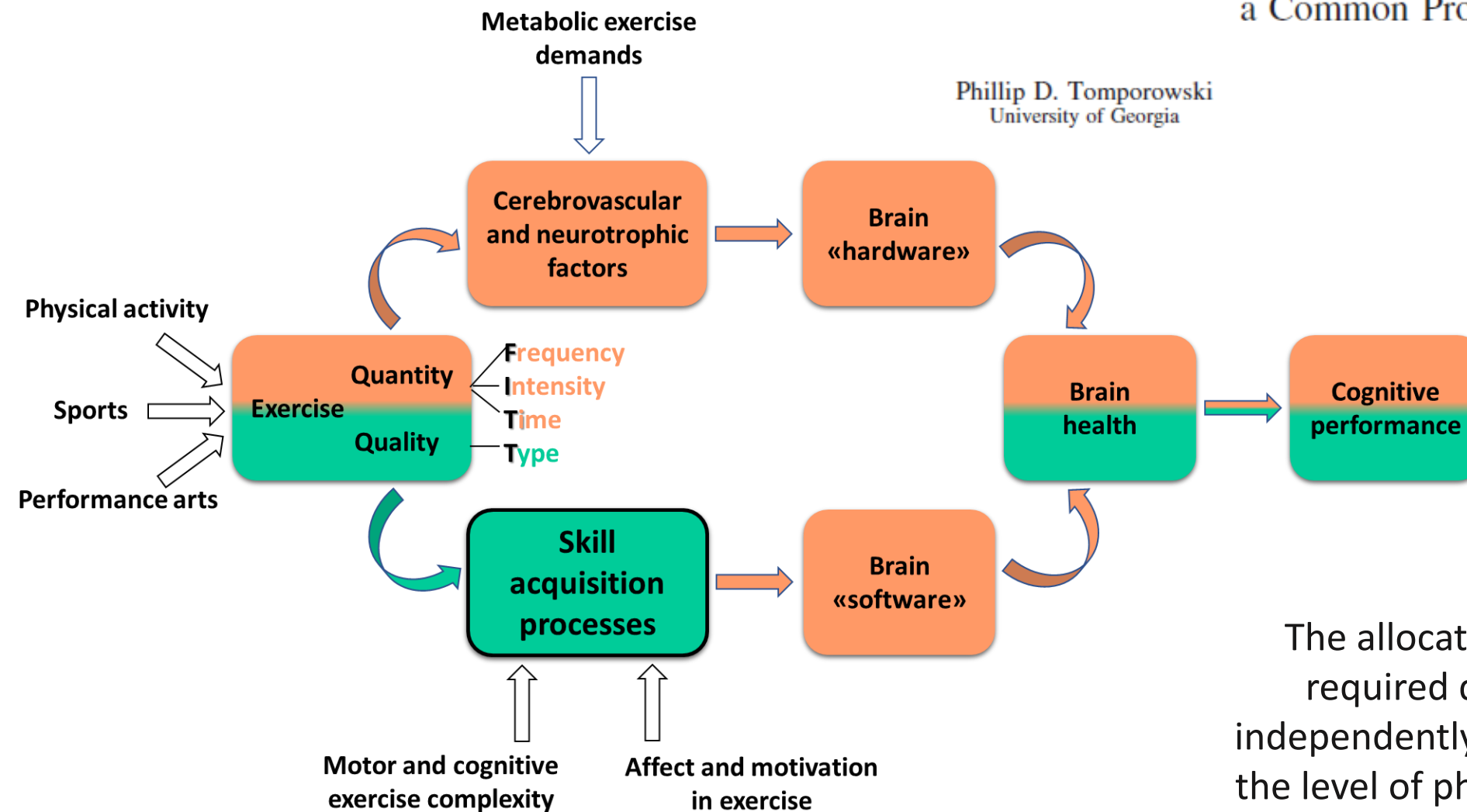
Aerobic-Exercise and resistance-training interventions have been among the least effective ways to improve executive functions of any method tried thus far

Adele Diamond*, Daphne S. Ling

Exercise, Sports, and Performance Arts Benefit Cognition Via a Common Process

Phillip D. Tomporowski
University of Georgia

Caterina Pesce
University of Rome “Foro Italico”



The allocation of mental resources required during skill acquisition, independently from or interactively with the level of physical energy expenditure, is essential to reap cognitive benefits

First Position Stand of the ACSM on exercise and cognition in children:

Outlook: More research is necessary to determine mechanisms and (...) strategies to transition into practice

Positive conclusions:

PA has a positive influence on cognition as well as brain structure and function



Med Sci Sport Exerc 2016
**AMERICAN COLLEGE
of SPORTS MEDICINE**
POSITION STAND

**Physical Activity,
Fitness, Cognitive
Function, and
Academic Achievement
in Children: A
Systematic Review**

This pronouncement was written for the American College of Sports Medicine by Joseph E. Donnelly, Ed.D, FACSM (Co-Chair); Charles H. Hillman, Ph.D. Co-Chair; Darla Castelli, Ph.D.; Jennifer L. Etnier, Ph.D., FACSM; Sarah Lee, Ph.D.; Phillip Tomporowski, Ph.D., FACSM; Kate Lambourne, Ph.D.; and Amanda N. Szabo-Reed, Ph.D.

Review

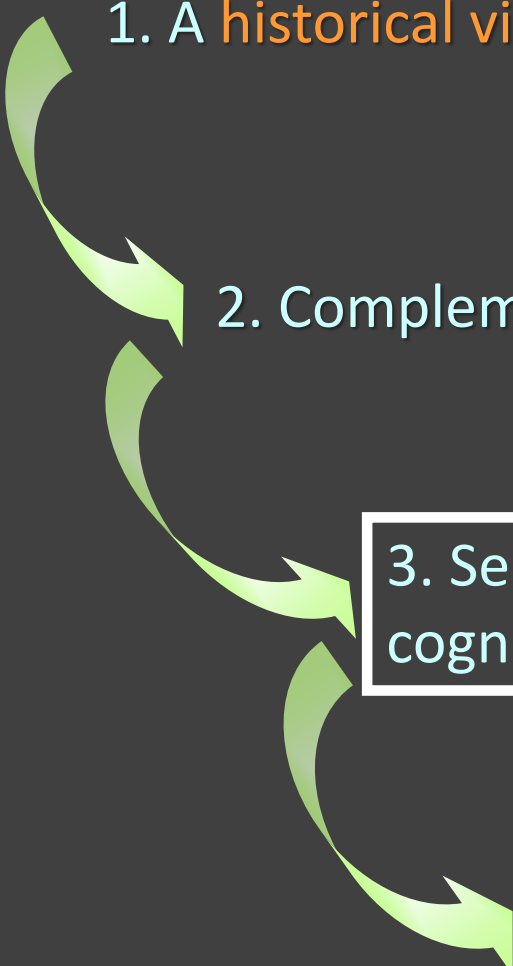
**Effects of physical activity interventions on
cognitive and academic performance in children and
adolescents: a novel combination of a systematic
review and recommendations from an expert panel**

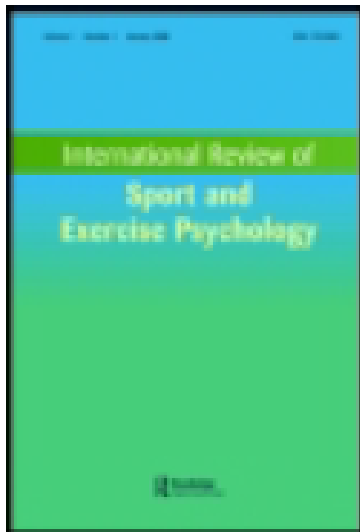
Amika S Singh,¹ Emi Saliasi,¹ Vera van den Berg,¹ Léonie Uijtdewilligen,²
Renate H M de Groot,³ Jelle Jolles,⁴ Lars B Andersen,⁵ Richard Bailey,⁶ Yu-Kai Chang,⁷
Adele Diamond,⁸ Ingegerd Ericsson,⁹ Jennifer L Etnier,¹⁰ Alicia L Fedewa,¹¹
Charles H Hillman,¹² Terry McMorris,¹³ Caterina Pesce,¹⁴ Uwe Pühse,¹⁵
Phillip D Tomporowski,¹⁶ Mai J M Chinapaw¹

Expert panel priorities: Investigating the effects of different types of interventions and understanding mediating mechanisms

Inconclusive conclusions! There is currently inconclusive evidence for the beneficial effects of PA interventions on cognitive and overall academic performance in children.

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- 



International Review of Sport and Exercise Psychology

June 2021

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/rirs20>

Effects of chronic physical activity on cognition across the lifespan: a systematic meta-review of randomized controlled trials and realist synthesis of contextualized mechanisms

Caterina Pesce, Spyridoula Vazou, Valentin Benzing, Celia Álvarez-Bueno, Sofia Anzeneder, Myrto Foteini Mavilidi, Liliana Leone & Mirko Schmidt

Problems likely underlying inconclusive conclusions: selection of higher-quality studies for strength of evidence

- high heterogeneity of assessment tools (25!) and inconsistency in
 - (i) quality vs risk of bias assessment outcomes;
 - (ii) outcomes with same assessment tools for same studies in different reviews
- (93% for PEDro and 76% for Cochrane tools! But ‘only’ 22% and 16% different categorization above/below the threshold of at least moderate quality)

Methodological quality level	Higher quality	NA or equal number of higher/lower ratings	Lower quality	Total PSs
PSs per quality level (n) (%)	78 (38%)	61 (30%)	64 (32%)	203 (100%)
Inconsistent ratings across SRs (n) (%)	23 (11%)	25 (12%)	22 (11%)	70 (34%)

Pesce et al. 2021. Effects of chronic physical activity on cognition across the lifespan: a systematic meta-review of randomized controlled trials and realist synthesis of contextualized mechanisms. International Review of Sport and Exercise Psychology.

Problems likely underlying inconclusive conclusions: role of **multiple moderators** Child and adolescent research

Strongest/most consistent evidence:

PA with skill involvement deliberately set higher than the comparator activity (e.g.,
PA with motor skill learning challenges vs. routine physical fitness exercises)

Strong/convincing evidence:

Comparator activity physically active as the intervention activity
Face-to-face delivery mode by experts
Qualitatively enriched PA
Group-based delivery type

Moderate/probable evidence:

PA in school settings

Insufficient evidence

Settings other
than school

Pesce, C., Vazou, S., Benzing, V., Alvarez-Bueno, C., Anzeneder, S., Mavilidi, M., Leone, L., & Schmidt, M. (2021).

Effects of chronic physical activity on cognition across the lifespan: a systematic meta-review of randomized controlled trials and realist synthesis of contextualized mechanisms. *International Review of Sport and Exercise Psychology* (online first).

 OPEN ACCESS



Realist review

Rebecca Hunter ^a, Trish Gorely ^a, Michelle Beattie ^a and Kevin Harris ^b

INTERNATIONAL REVIEW OF SPORT AND EXERCISE PSYCHOLOGY
<https://doi.org/10.1080/1750984X.2021.2001838>

 **Routledge**
Taylor & Francis Group

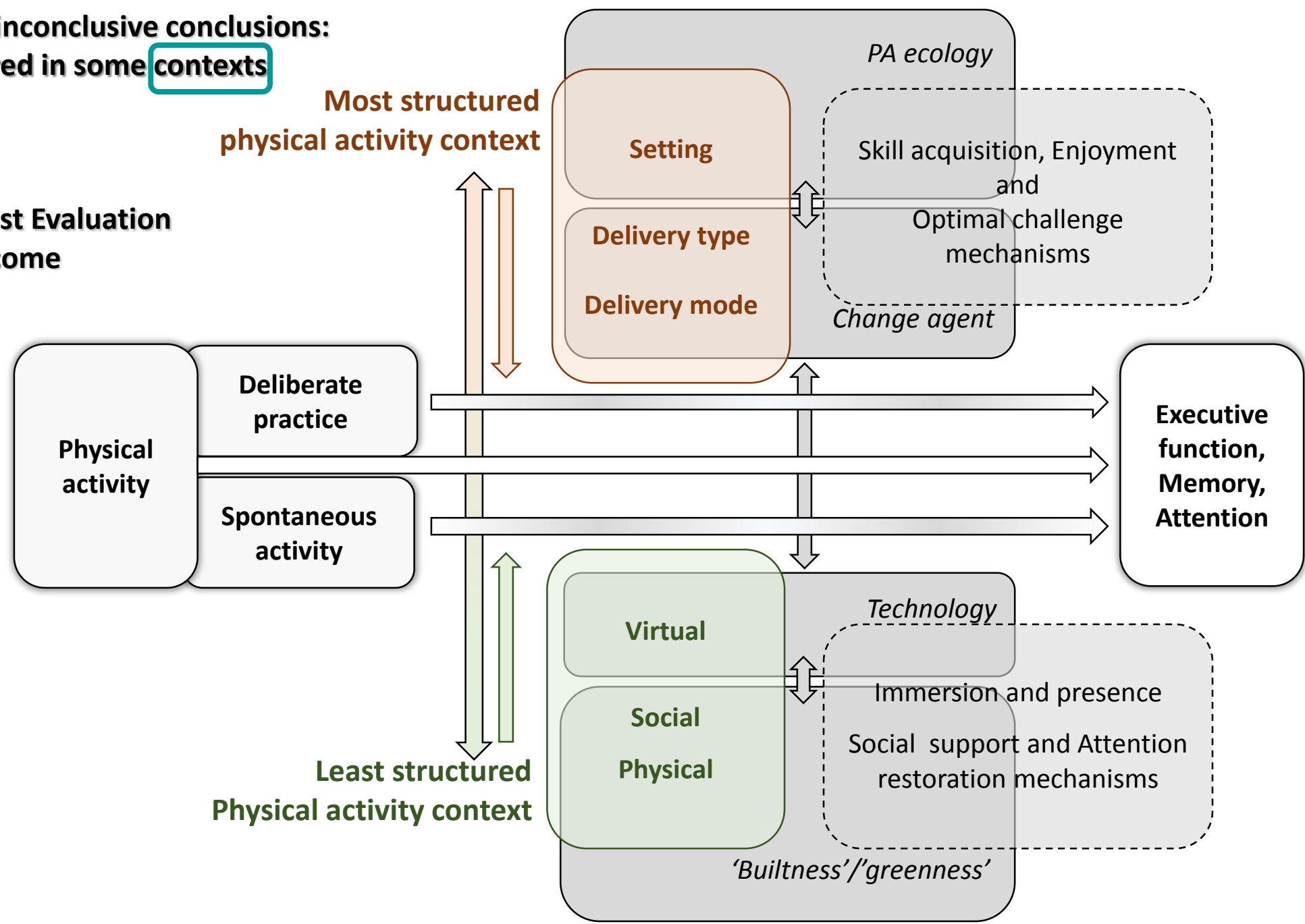


Complex interventions

Geoff Bates


Problems likely underlying inconclusive conclusions:
mechanisms may be triggered in some **contexts**
and not in others

**Programme Theory for Realist Evaluation
of Context-Mechanism-Outcome
Configurations**



Pesce, C., Vazou, S., Benzing, V., Alvarez-Bueno, C., Anzeneder, S., Mavilidi, M., Leone, L., & Schmidt, M. (2021). Effects of chronic physical activity on cognition across the lifespan: a systematic meta-review of randomized controlled trials and realist synthesis of contextualized mechanisms. *IRSEP*.

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Focus on children and adolescents: Structured, virtual reality and spontaneous PA as enriched contexts with physical, emotional, cognitive, social, spatial and/or restorative properties that trigger specific mechanisms

Context	Mechanism [underlying biological]	Outcome	Type of change in cognitive capacity
Physically laden (+)	Physical effort, Sleep efficiency [brain changes]	Executive function Memory Attention	Capacity boosting
Emotionally laden (/)	Enjoyment, Positive mood		
Cognitively laden (+)	Cognitive engagement, Motor skill learning [brain changes]		Capacity building
Socially laden (+)	Social engagement, Social support [brain activation]		
Spatial properties (+)	Spatial engagement [brain changes]		
Restorative and stress- relief properties (/)	Attention restoration, Stress reduction, [HPA axis regulation]		Capacity restoring

Pesce, C., Vazou, S., Benzing, V., Alvarez-Bueno, C., Anzeneder, S., Mavilidi, M., Leone, L., & Schmidt, M. (2021). Effects of chronic physical activity on cognition across the lifespan: a systematic meta-review of randomized controlled trials and realist synthesis of contextualized mechanisms. *IRSEP*.

Focus on children and adolescents: Structured, virtual reality and spontaneous PA as enriched contexts with physical, emotional, cognitive, social, spatial and/or restorative properties that trigger specific mechanisms

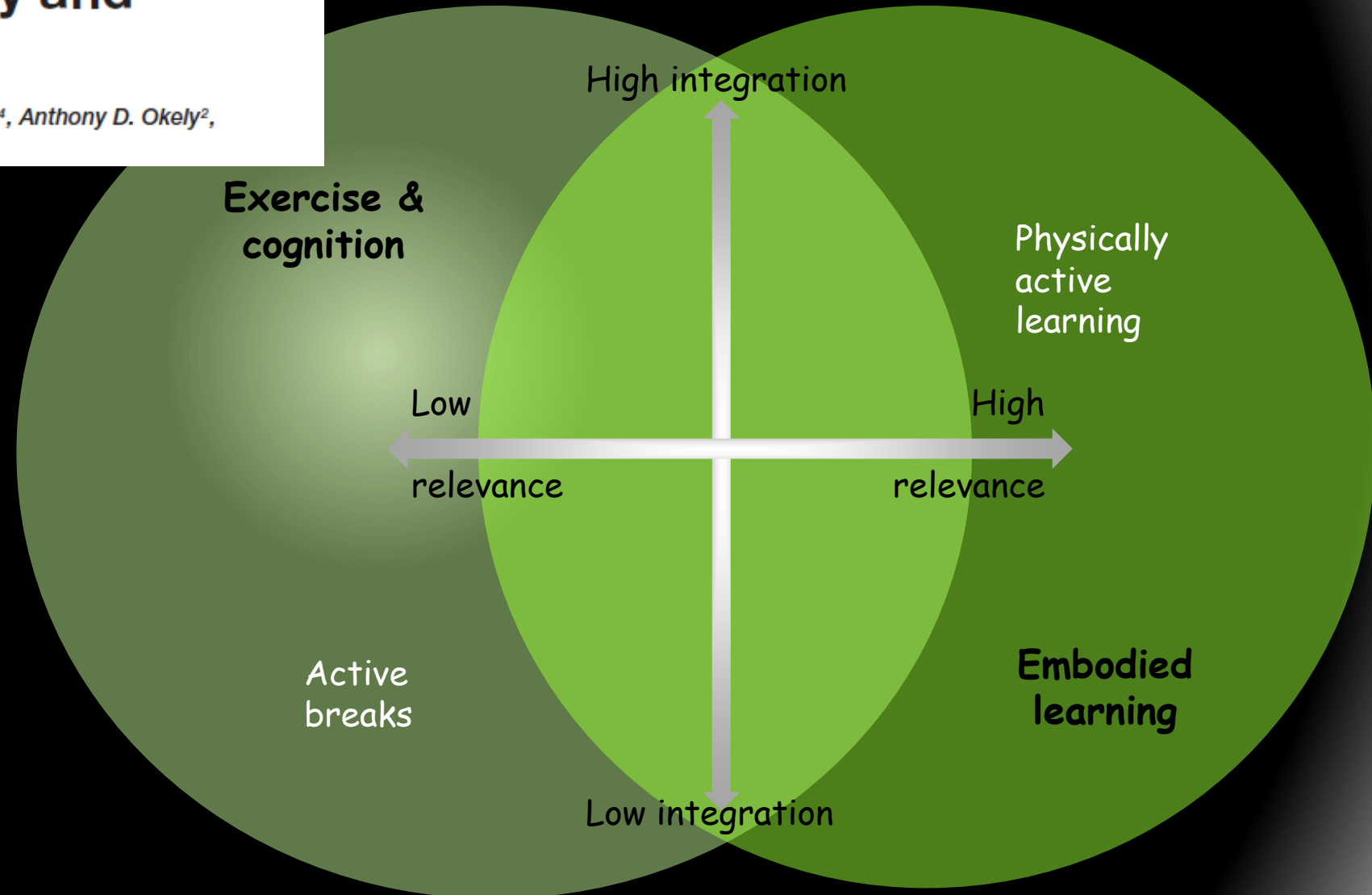
Context	Mechanism [underlying biological]	Outcome	Type of change in cognitive capacity
Physically laden (+)	Physical effort, Sleep efficiency [brain changes]	Executive function Memory Attention	Activity breaks
Emotionally laden (/)	Enjoyment, Positive mood		
Cognitively laden (+)	Cognitive engagement, Motor skill learning [brain changes]		Physically active learning (PAL)
Socially laden (+)	Social engagement, Social support [brain activation]		
Spatial properties (+)	Spatial engagement [brain changes]		Mindful movements
Restorative and stress-relief properties (/)	Attention restoration, Stress reduction, [HPA axis regulation]		Outdoor education

Pesce, C., Vazou, S., Benzing, V., Alvarez-Bueno, C., Anzeneder, S., Mavilidi, M., Leone, L., & Schmidt, M. (2021). Effects of chronic physical activity on cognition across the lifespan: a systematic meta-review of randomized controlled trials and realist synthesis of contextualized mechanisms. *IRSEP*.

A Narrative Review of School-Based Physical Activity for Enhancing Cognition and Learning: The Importance of Relevancy and Integration

Myrto Foteini Mavilidi^{1,2†}, Margina Ruiters^{3†}, Mirko Schmidt⁴, Anthony D. Okely², Sofie Loyens⁵, Paul Chandler² and Fred Paas^{2,3}*

 **frontiers** 2018
in Psychology



A Narrative Review of School-Based Physical Activity for Enhancing Cognition and Learning: The Importance of Relevancy and Integration

Myrto Foteini Mavilidi^{1,2*}, Margina Ruit
Sofie Loyens⁵, Paul Chandler² and Fre



Daly-Smith et al.

International Journal of Behavioral Nutrition and Physical Activity
<https://doi.org/10.1186/s12966-021-01221-9>

(2021) 18:151


International Journal of Behavioral
Nutrition and Physical Activity

RESEARCH

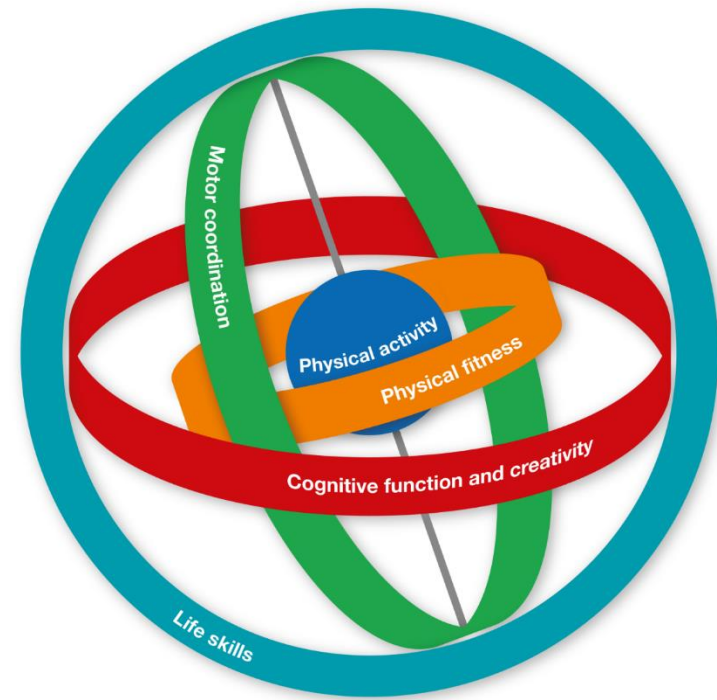
Open Access



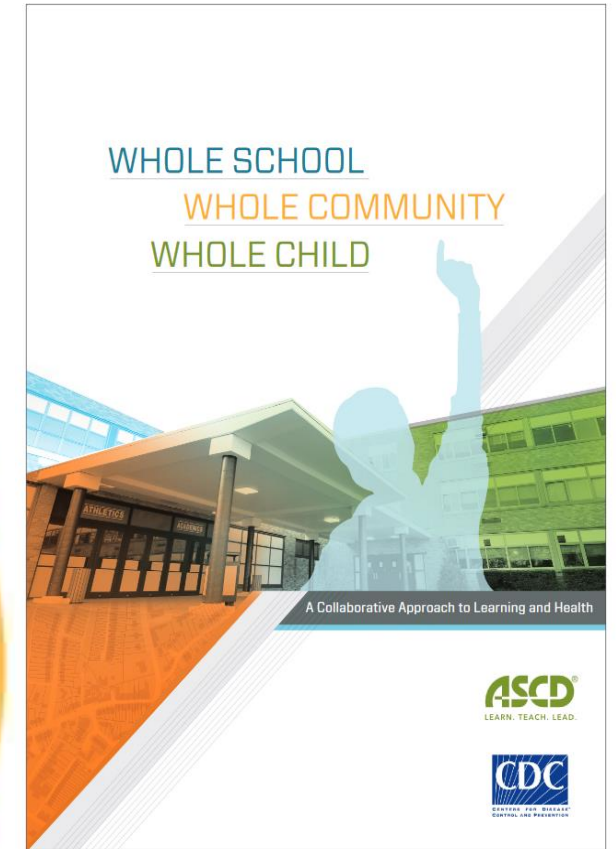
Behaviours that prompt primary school teachers to adopt and implement physically active learning: a meta synthesis of qualitative evidence

Andrew Daly-Smith^{1,2,3*} , Jade L. Morris⁴, Emma Norris⁵, Toni L. Williams^{6,7}, Victoria Archbold⁶, Jouni Kallio⁸, Tuija H. Tammelin⁸, Amika Singh^{1,9}, Jorge Mota¹⁰, Jesper von Seelen¹¹, Caterina Pesce¹², Jo Salmon¹³, Heather McKay^{14,15}, John Bartholomew¹⁶ and Geir Kare Resaland¹

A holistic conceptual model of synergistic relationship to inform policy development



Pesce, C., Marchetti, R., Motta, A., & Bellucci, M. (2016).
Playing with variability to
promote motor, cognitive and
citizenship development.
Porgiano (PG): Calzetti Mariucci.



**Whole School,
Whole Community,
Whole Child Approach**

Collaboration between Association for Curriculum and Supervision (ACSD)
and Centers for Disease Control and Prevention (CDC)

**Are active kids
better
learners?**

It depends...

...on us!



Editorial

Giving physical activity and cognition research 'some soul': focus on children and adolescents

Caterina Pesce ^{1*}, Rafael Ballester ² and Valentin Benzing ³