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**Mentally Simulated Motor Actions in Neurorehabilitation.  
A Pilot Study in Multiple Sclerosis**

**Indianapolis – May 27-30 2015**

**Andrea Tacchino PhD**  
*Rehabilitation Research Area– Italian Multiple Sclerosis Foundation*

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**Background**

NeuroImage 14, S103–S109 (2001) doi:10.1006/nimg.2001.0832, available online at <http://www.idealibrary.com> on **IDEAL**<sup>™</sup>

**Neural Simulation of Action: A Unifying Mechanism for Motor Cognition**


Marc Jeannerod<sup>1</sup>  
*Institut des Sciences Cognitives, 67 Boulevard Pinel, 69675 Bron, France*

**SIMULATION THEORY**  
***“...covert actions are in fact actions, except for the fact that they are not executed”***

**Decety (1989):** ***“...the time needed for performing a task mentally was the same as that needed for actually executing the same task”***

**Sirigu (1995):** ***“Imagined and executed movement times were highly correlated in normal individuals, and Fitts’ law accounted equally well for imagined and executed movements”***

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# Background

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Research Paper

## The relation between cognitive and motor dysfunction and motor imagery ability in patients with multiple sclerosis

Elke Heremans<sup>1,3</sup>, Anne-Marie D'hooge<sup>2</sup>, Sara De Bondt<sup>2</sup>, Werner Helsen<sup>3</sup> and Peter Feys<sup>1,3,4</sup>

Exp Brain Res DOI 10.1007/s00221-013-3617-y

MULTIPLE  
SCLEROSIS  
JOURNAL | MSJ

Multiple Sclerosis Journal  
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RESEARCH ARTICLE

### Imagined actions in multiple sclerosis patients: evidence of decline in motor cognitive prediction

Andrea Tacchino · Marco Bove · Ludovico Pedullà · Mario Alberto Battaglia · Charalambos Papaxanthis · Giampaolo Bricchetto

To investigate whether and which role Mental Imagery could play in neurorehabilitation



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# Materials and Methods

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### Subjects

- 17 healthy subjects (HS)
- 17 people with MS (PwMS)

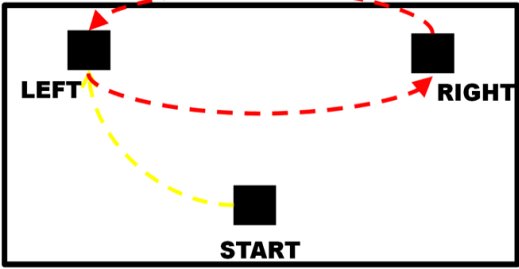
### Inclusion/Exclusion Criteria

- Righthanded
- McDonald criteria
- Stable phase of disease (no relapses in the last 3mo)
- MMSE < 24

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### Protocol

- 2.0 cm
- 1.5 cm
- 1.0 cm
- 0.5 cm



- First person MI
- Both hands
- Randomization
- As fast as possible

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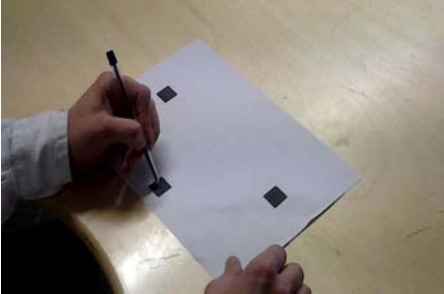
## Materials and Methods

Motor Execution

ME	ME	ME	ME	ME
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└─┬─┬─┬─┬─┘
└─┬─┬─┬─┬─┘
└─┬─┬─┬─┬─┘
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Cycle1   Cycle2   Cycle3   Cycle4   Cycle5

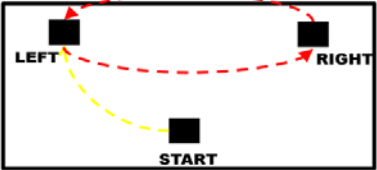


Mental Imagery

MI	MI	MI	MI	ME
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└─┬─┬─┬─┬─┘
└─┬─┬─┬─┬─┘



Cycle1   Cycle2   Cycle3   Cycle4   Cycle5



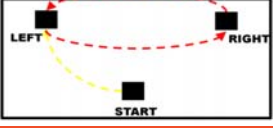
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## Materials and Methods



- Retroreflective marker on a pen tip
- Tracking with cameras of BTS



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# Results

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RESEARCH ARTICLE

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# Results

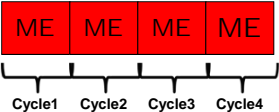
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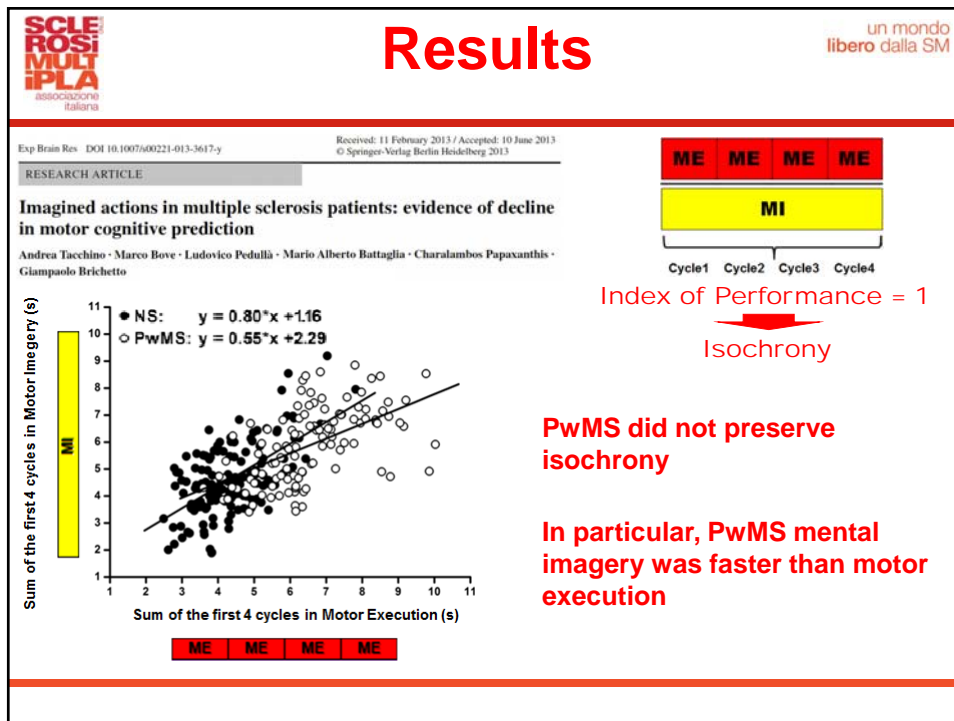
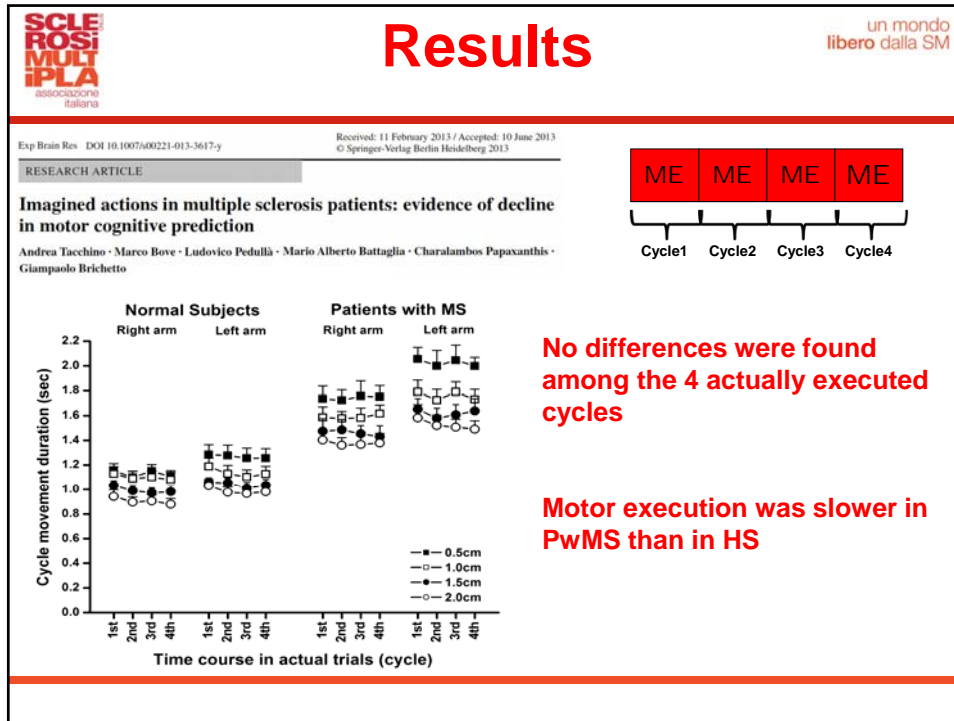
RESEARCH ARTICLE

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The diagram consists of four red rectangular boxes, each containing the letters 'ME' in white. These boxes are arranged horizontally. Below each box is a bracket that spans the width of the box. The brackets are labeled 'Cycle1', 'Cycle2', 'Cycle3', and 'Cycle4' from left to right. The labels are positioned below the brackets.



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## Questions

**What about the fifth actually executed movement after the first four actually executed movements?**

ME ME ME ME ME

Cycle1 Cycle2 Cycle3 Cycle4 Cycle5

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## Questions

**What about the fifth actually executed movement after the first four actually executed movements?**

**No differences were found in ANOVA between the fifth actually executed cycle and each one of the other 4 actually executed cycles**

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**What about the fifth actually executed movement after the first four actually executed movements?**

**No differences were found in ANOVA between the fifth actually executed cycle and each one of the other 4 actually executed cycles**

**This result was found for both groups**


**No effects of the first four movements on the fifth movement**

## Questions

**Is there an influence of faster mental imagery in MS on actual movements?**

**Is it possible to use faster mental imagery in MS to improve motor execution?**

**If so, is it possible to use potential effects of faster mental imagery in MS for rehabilitative protocols?**

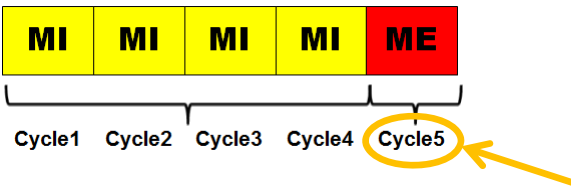


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# Questions


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## What about the fifth actually executed movement after the first four mentally imagined movements?



MI MI MI MI ME

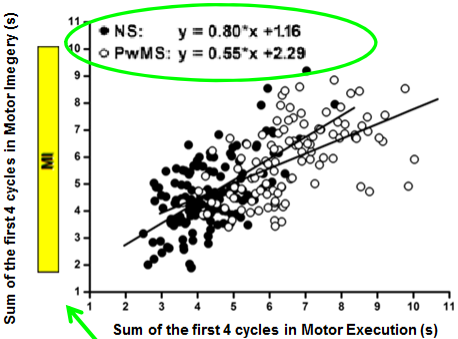
Cycle1 Cycle2 Cycle3 Cycle4 Cycle5



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# Results

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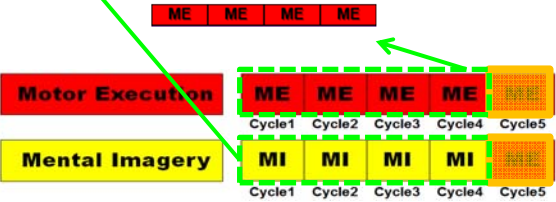


Sum of the first 4 cycles in Motor Imagery (s)

Sum of the first 4 cycles in Motor Execution (s)

● NS:  $y = 0.80 \cdot x + 1.16$

○ PwMS:  $y = 0.55 \cdot x + 2.29$



ME ME ME ME

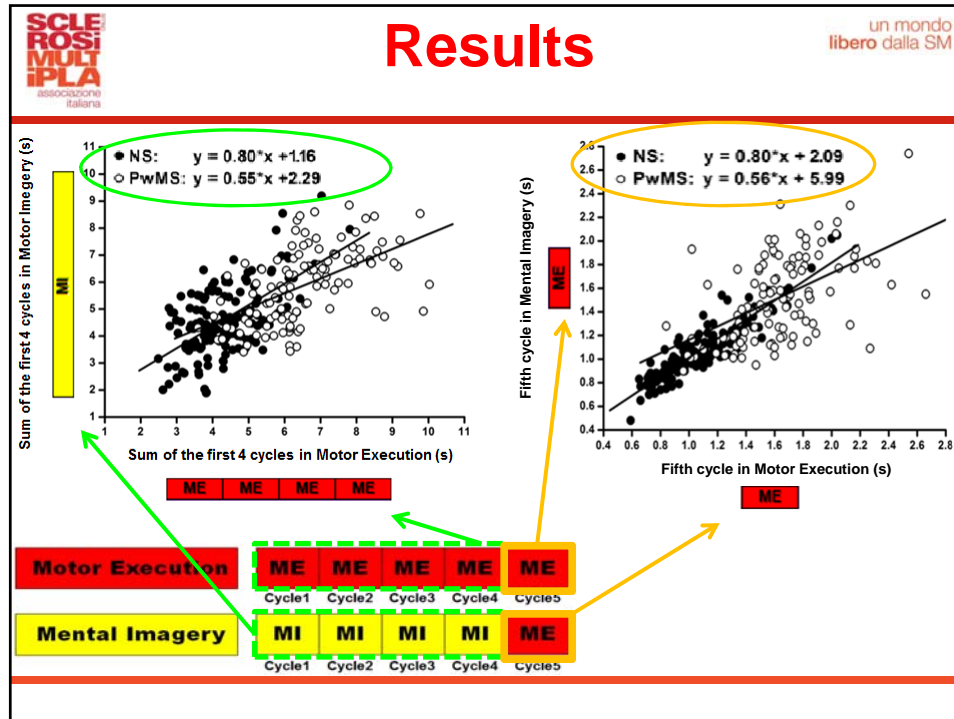
Motor Execution ME ME ME ME

Cycle1 Cycle2 Cycle3 Cycle4 Cycle5

Mental Imagery MI MI MI MI

Cycle1 Cycle2 Cycle3 Cycle4 Cycle5





**Questions**

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**What about the fifth actually executed movement after the first four mentally imagined movements?**

**Differences were found in ANOVA between the fifth actually executed movement after mental imagery only in PwMS group**

**A short-term effect of mental imagery seems to be present on motor execution in MS**

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**Conclusions**

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**Mental imagery seems to influence, speeding up,  
the actual execution of a movement**

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**Conclusions**

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**Mental imagery seems to influence, speeding up,  
the actual execution of a movement**

**Although actual movements were executed as fast  
as possible, probably PwMS did not perform the  
task at their floor level maintaining residual abilities  
to speed up movements**

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## Conclusions

**Mental imagery seems to influence, speeding up, the actual execution of a movement**


**Although actual movements were executed as fast as possible, probably PwMS did not perform the task at their floor level maintaining residual abilities to speed up movements**

**When speed improvement is one of the goal of a neurorehabilitative protocol, mental imagery could play an important role in the treatment**

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# THANKS!!!

A scenic view of a city skyline, likely Chicago, with a large body of water in the foreground and a fountain. The sky is clear blue, and the water is a deep blue. The city buildings are visible in the background, and there are trees and a path in the foreground.