Fondazione Don Carlo Gnocchi Onlus

Monza, 9/4/14

Sclerosi Multipla: il volto quotidiano della malattia

La Fisioterapia nel terzo millennio: il supporto della robotica

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MIT

Argo Medical

Neurorehabilitation and Neural Repair

http://nnr.sagepub.com/

Improving Gait in Multiple Sclerosis Using Robot-Assisted, Body Weight Supported Treadmill Training

Albert C. Lo and Elizabeth W. Triche

Neurorehabil Neural Repair 2008 22: 661
DOI: 10.1177/1545968308318473

The online version of this article can be found at:
http://nnr.sagepub.com/content/22/6/661

https://research.brown.edu/myresearch/Albert_Lo

- 13 MS subjects
- EDSS: 5 (4-6)
- Intervention: 6 training sessions over 3 weeks:
  - Body weight supported treadmill training

Vs

  - (BWSTT) with robotic assistance

Robot: produzione di forze

Main outcome measure:

- 25-foot walk (T25FW),
- 6-minute test (6MW)

Table 4. T Versus R Mean (SD) and Median Change in Gait Measures From T1 to T2

	T		R			
	Mean (SD)	Median	Mean (SD)	Median	Kruskal–Wallis	*P* Value
T25FW (seconds)	−4.1 (3.0)	−4.4	−1.4 (2.6)	−1.4	2.49	.12
6MW (meters)	72.1 (54.8)	53	51.3 (69.7)	38	0.73	.39
DST (%)	−7.1 (3.9)	−5.9	−1.7 (3.9)	−1.9	3.45	.06
SLR	0.01 (0.05)	0.004	0.03 (0.06)	0.02	0.73	.39

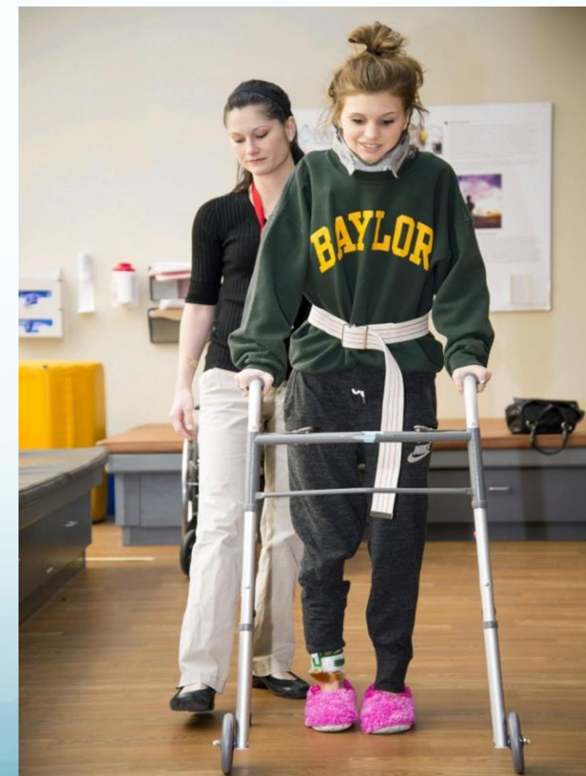
Abbreviations: T, body weight supported treadmill test (BWSTT) alone; R, BWSTT with robotic assistance; T25FW, average timed 25-foot walk; 6MW, 6-minute walk treadmill test; DST, double support time; SLR, step length ratio; SD, standard deviation.

RESEARCH PAPER *Multiple Sclerosis* 2008; **14**: 231–236

Robot-assisted gait training in multiple sclerosis: a pilot randomized trial

S Beer, B Aschbacher, D Manoglou, E Gamper, J Kool and J Kesselring

VS



- 35 MS subjects
- EDSS: 6.5 (6–7.5)
- Intervention: 15 sessions over three weeks :
  - robot-assisted gait training (RAGT)

Vs

  - Conventional walking training (CWT)
- Main outcome measure:
  - 20-m timed walking,
  - the 6-minute test (6MW)

Table 3 Primary and secondary outcome measures at baseline and after three weeks treatment

	RAGT			CWT		
Outcome measures	Baseline	Week	*P*	Baseline	Week	*P*
20 m-walking velocity, m/s (median, IQR)	0.21 (0.09–0.27)	0.27 (0.15–0.49)	0.003	0.24 (0.17–0.28)	0.31 (0.19–0.42)	0.026
6-min-walking distance, m (median, IQR)	74 (34–97)	81 (44–137)	0.006	87 (62–101)	83 (64–145)	0.211
Stride length, cm (median, IQR)	37 (29–47)	39 (28–52)	0.133	38 (28–49)	38 (31–44)	0.917
Strength knee-extensor right kp (mean, SD)	15.9 (7.5)	19.4 (7.5)	0.006	13.5 (7.5)	13.0 (6.0)	0.522
Strength knee-extensor left kp (mean, SD)	13.6 (6.3)	16.9 (6.4)	0.004	13.6 (9.4)	14.2 (8.7)	0.589

Multiple Sclerosis Journal
http://msj.sagepub.com/

Robot-assisted gait training in multiple sclerosis patients: a randomized trial

Isabella Schwartz, Anna Sajin, Elior Moreh, Iris Fisher, Martin Neeb, Adina Forest, Adi Vaknin-Dembinsky, Dimitrios Karusis and Zeev Meiner

Mult Scler 2012 18: 881 originally published online 6 December 2011
DOI: 10.1177/1352458511431075

JoS
JOURNAL OF STROKE

Journal of Stroke 2013;15(3):174-181
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Review

Robot-assisted Therapy in Stroke Rehabilitation

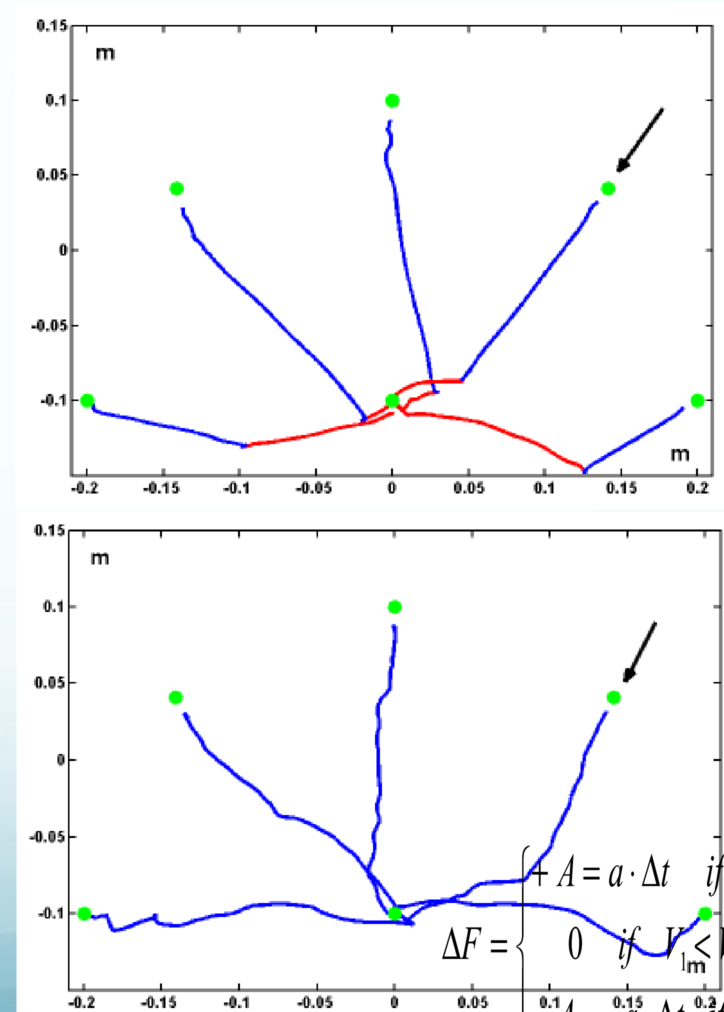
Won Hyuk Chang,[a] Yun-Hee Kim[a,b]

[a]Department of Physical and Rehabilitation Medicine, Stroke and Cerebrovascular Center, Samsung Medical Center, Sungkyunkwan University School of Medicine; [b]Samsung Advanced Institute for Health Science and Technology, Sungkyunkwan University, Seoul, Korea

- […] "There is no clear evidence that robotic gait training is superior to conventional physiotherapy in patients with chronic stroke"

Test for Selecting Upper Limb Robot Treatment in Stroke Patients: Triggered High-Stiffness vs. Adaptive Low-Stiffness Assistance

Ilaria Carpinella, Davide Cattaneo, Maurizio Ferrarin, Pietro Morasso, Valentina Squeri



$$\Delta F = \begin{cases} +A = a \cdot \Delta t & if \; V < V_1 \\ 0 & if \; V_1 < V < V_2 \\ -A = -a \cdot \Delta t & if \; V_2 < V \end{cases}$$

J Neurol (2007) 254:767–773
DOI 10.1007/s00415-006-0431-5

ORIGINAL COMMUNICATION

Sverker Johansson
Charlotte Ytterberg
Ingrid M. Claesson
Jenny Lindberg
Jan Hillert
Magnus Andersson
Lotta Widén Holmqvist
Lena von Koch

High concurrent presence of disability in multiple sclerosis

Associations with perceived health

"The presence of several concurrent disabilities, some significantly associated with high perceived physical and psychological impact"

BRIEF REPORT

Hand Strength and Perceived Manual Ability Among Patients With Multiple Sclerosis

Christine C. Chen, ScD, OTR/L, Nicole Kasven, MS, OTR/L, Herbert I. Karpatkin, MS, PT, Andrew Sylvester, MD

"Manual ability seems to be more associated with pinch than grip strengths, probably because finger strength and dexterity are both needed to perform many hand tasks."

PREVALENCE OF UNILATERAL AND BILATERAL UPPER LIMB DYSFUNCTION AT BODY FUNCTIONS, ACTIVITY AND PARTICIPATION LEVEL IN PERSONS WITH MULTIPLE SCLEROSIS

Bertoni, R BSc,[1§] Lamers I, MSc,[2§] Chen C, ScD,[3] Feys P, PhD[2]
Cattaneo D, PhD, [1]

	Total	Mild	Moderate	Severe Ambulant	Severe non Ambulant (n=35)
	(n=105)	(n=16)	(n=17)	(n=37)	
EDSS	0-8	0-3.5	4-5.5	6-6.5	7+
Age (y)	53.6 ±11.1	48.18±11.8	55.3±9.2	52.6±10.1	56.5±11.9
Disease duration (y)	18±11.0	10±9.1	17±10.1	16.7±9.7	23.4±11.2
Type of MS (RR/SP/PP)	34/58/13	11/03/02	06/11/00	14/17/6	3/27/5
EDSS	6.5 (5.5/7.5)	3 (2.5/3)	5 (4.5/5.5)	6.5 (6/6.5)	7.5 (7.5/8)

Body function

	n	Jamar (median Kg)	MI	MAS	FTRS	SWMT Index
Mild[1]	16	28.18 (19.67/36.25)	100 (88/100)	0 (0/0)	0 (0/1)	2 (2/3)
Moderate[2]	17	27.00 (16.30/33.67)	100 (76/100)	0 (0/0)	0 (0/1)	2 (2/3)
Severe ambulant	37	21.40 (17.67/30.67)	91 (80/100)	0 (0/0)	1 (0/2)	2 (2/3)
Severe non ambulant [4]	35	17.20 (8.67/26.27)	76 (64/100)	0 (0/0)	0.5 (0/1)	3 (2/3)

Mild strength impairment

No spasticity - low tremor

Early Sensory disorders

Activity

		ARAT	NHPT (peg/sec)
Mild[1]	(n=16)	57 (54/57)	0.38 (0.36/0.45)
Moderate[2]	(n=17)	56 (52/57)	0.31 (0.23/0.35)
Severe ambulant	(n=37)	54 (49/57)	0.28 (0.17/0.35)
Severe non ambulant [4]	(n=35)	45 (39/56)	0.17 (0.10/0.27)

Late gross movements deficits

Early Fine finger movements deficits

RESEARCH PAPER *Multiple Sclerosis* 2008; **14**: 330–342

Abnormal sensorimotor control, but intact force field adaptation, in multiple sclerosis subjects with no clinical disability

Maura Casadio[1,2], Vittorio Sanguineti[1], Pietro Morasso[1] and Claudio Solaro[3]

In MS subjects with no clinical disability, we assessed sensorimotor organization and their ability to adapt to an unfamiliar dynamical environment. Eleven MS subjects performed reaching movements while a robot generated a speed-dependent force field. Control and adaptation performance were compared with that of an equal number of control subjects. During a familiarization phase, when the robot generated no forces, the movements of MS subjects were more curved, displayed greater and more variable directional errors and a longer deceleration phase. During the force field phase, both MS and control subjects gradually learned to predict the robot-generated forces. The rates of adaptation were similar, but MS subjects showed a greater variability in responding to the force field. These results suggest that MS subjects have a preserved capability of learning to predict the effects of the forces, but make greater errors when actually using such predictions to generate movements. Inaccurate motor commands are then compensated later in the movement through an extra amount of sensory-based corrections. This indicates that early in the disease MS subjects have intact adaptive capabilities, but impaired movement execution. *Multiple Sclerosis* 2008; **14**: 330–342. http://msj.sagepub.com

Key words: motor adaptation; motor control; multiple sclerosis; robot therapy

From: Solaro C – Sanguineti V

J Rehabil Med 2009; 41: 966–970

ORIGINAL REPORT

ROBOT-BASED REHABILITATION OF THE UPPER LIMBS IN MULTIPLE SCLEROSIS: FEASIBILITY AND PRELIMINARY RESULTS

Ilaria Carpinella, Eng, MSc[1], Davide Cattaneo, PT[2], Suha Abuarqub, Eng, PhD[1] and Maurizio Ferrarin, Eng, PhD[1]

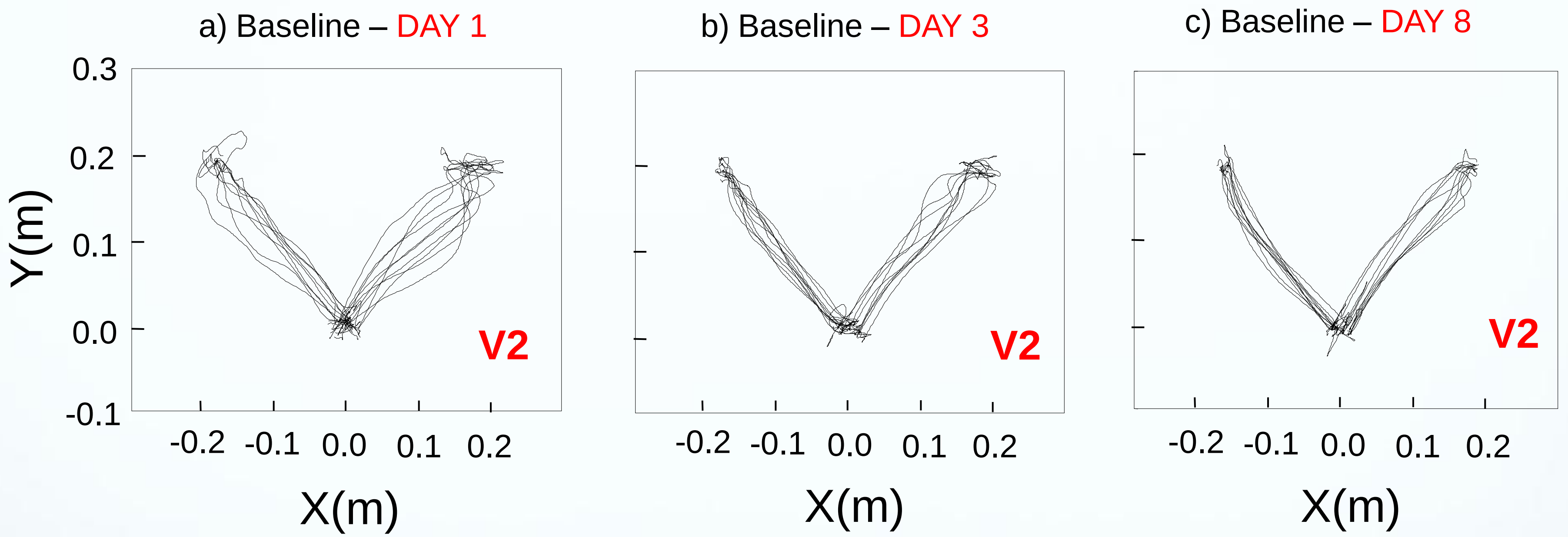
From the [1]Biomedical Technology Department and [2]LaRiCE: Gait and Balance Disorders Laboratory, Department of Neurorehabilitation, Found. Don C. Gnocchi Onlus, IRCCS, Milan, Italy

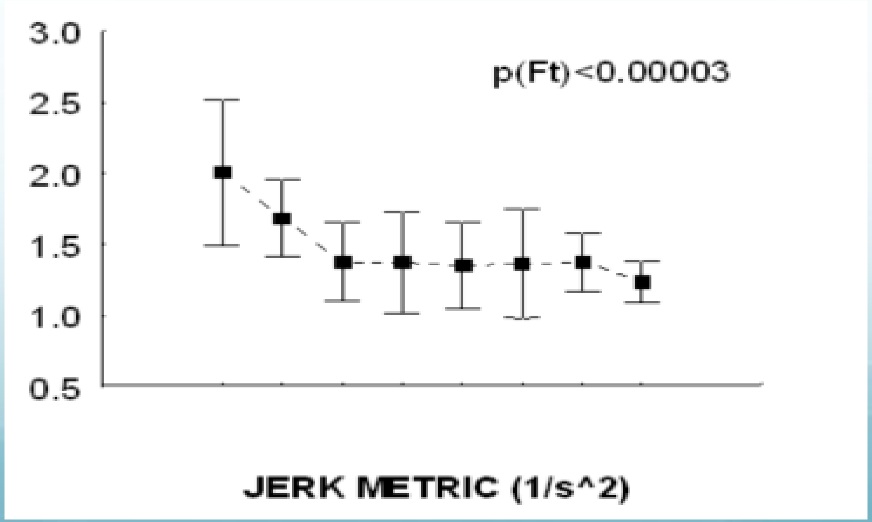
Table I. *Demographic and clinical data of participating patients with multiple sclerosis (MS)*

Patient	Age, years/ sex	MS type	Disease duration, years	Most evident symptom (upper limb)	EDSS
P1	63/F	Sec prog	23	Clumsiness	6
P2	37/F	Relap rem	14	Tremor	6
P3	60/F	Sec prog	29	Clumsiness	6
P4	32/F	Relap rem	1	Clumsiness	5
P5	37/M	Sec prog	17	Weakness	6
P6	45/M	Prim prog	16	Clumsiness	4.5
P7	48/M	Sec prog	13	Weakness	6.5

EDSS: Expanded Disability Status Scale; F: female; L: left; M: male; Prim prog: primary progressive; R: rigl prog: secondary progressive.

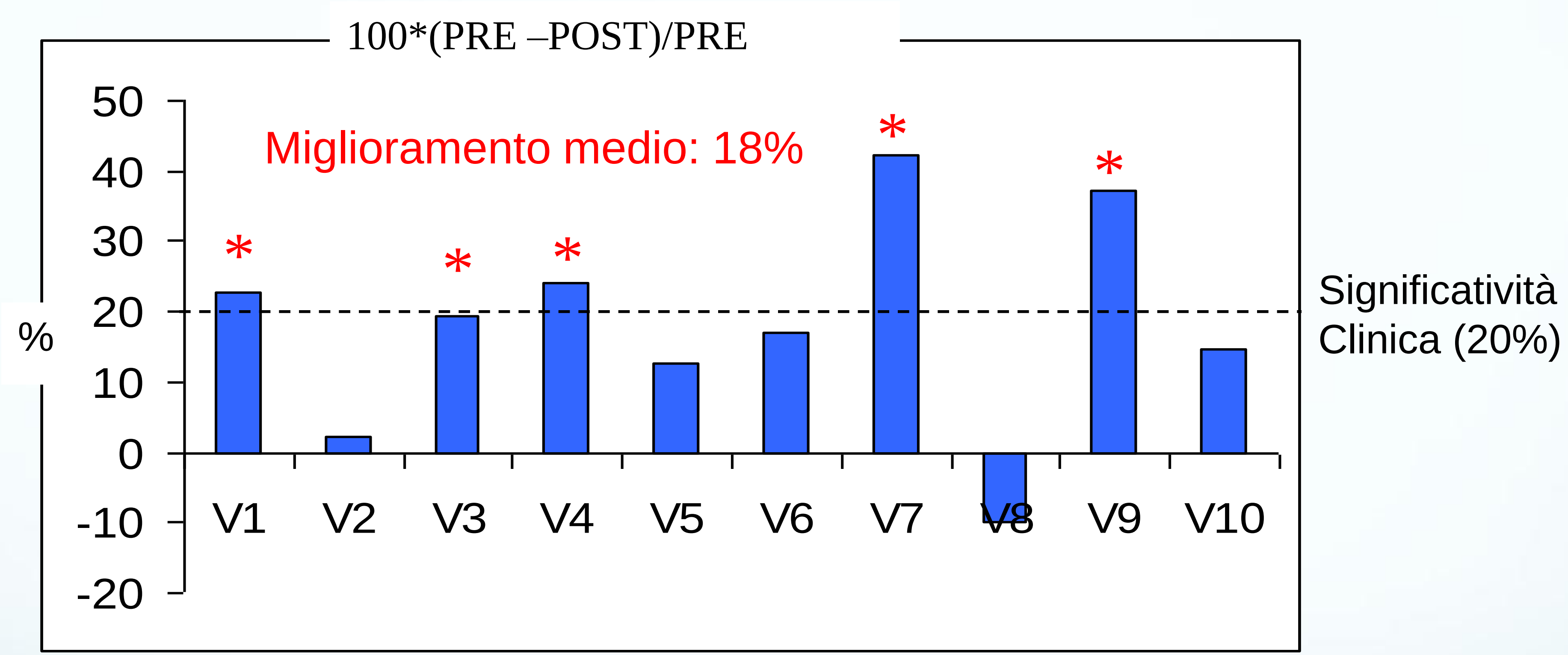
Risultati – Test strumentali - Traiettorie di reaching





From: Carpinella et al 2009

Risultati – Test clinici – 9HPT



- il 90% dei pazienti migliorano lo score 9HPT

- il 50% dei pazienti ottiene un miglioramento clinicamente significativo (>=20%)

Fondazione Don Carlo Gnocchi Onlus — POLO TECNOLOGICO — BIOMEDICAL TECHNOLOGY DEPARTMENT

From: Carpinella et al 2009

IEEE TRANSACTIONS ON NEURAL SYSTEMS AND REHABILITATION ENGINEERING, VOL. 20, NO. 3, MAY 2012

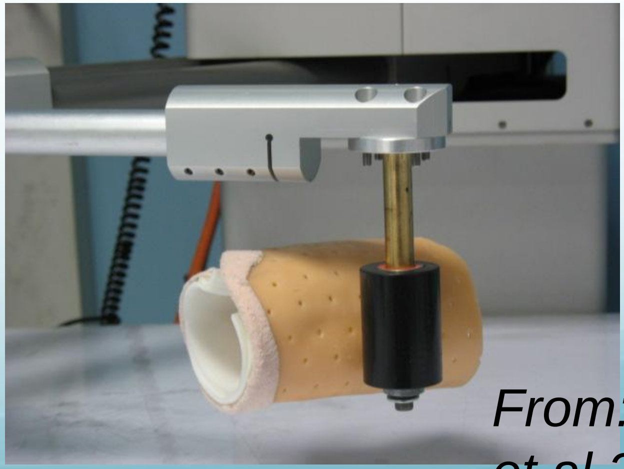
Robot Training of Upper Limb in Multiple Sclerosis: Comparing Protocols With or WithoutManipulative Task Components

Ilaria Carpinella, Davide Cattaneo, Rita Bertoni, and Maurizio Ferrarin, *Member, IEEE*

IDEA: implementazione di un programma di robot-terapia che coinvolgesse anche l'uso della *mano* e la manipolazione di *oggetti reali*

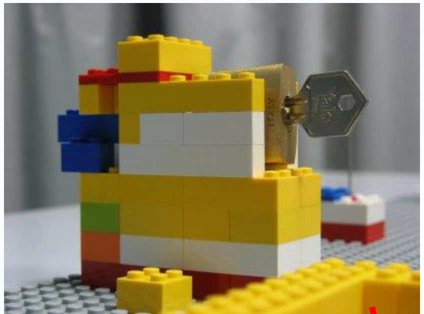
Manopola tradizionale

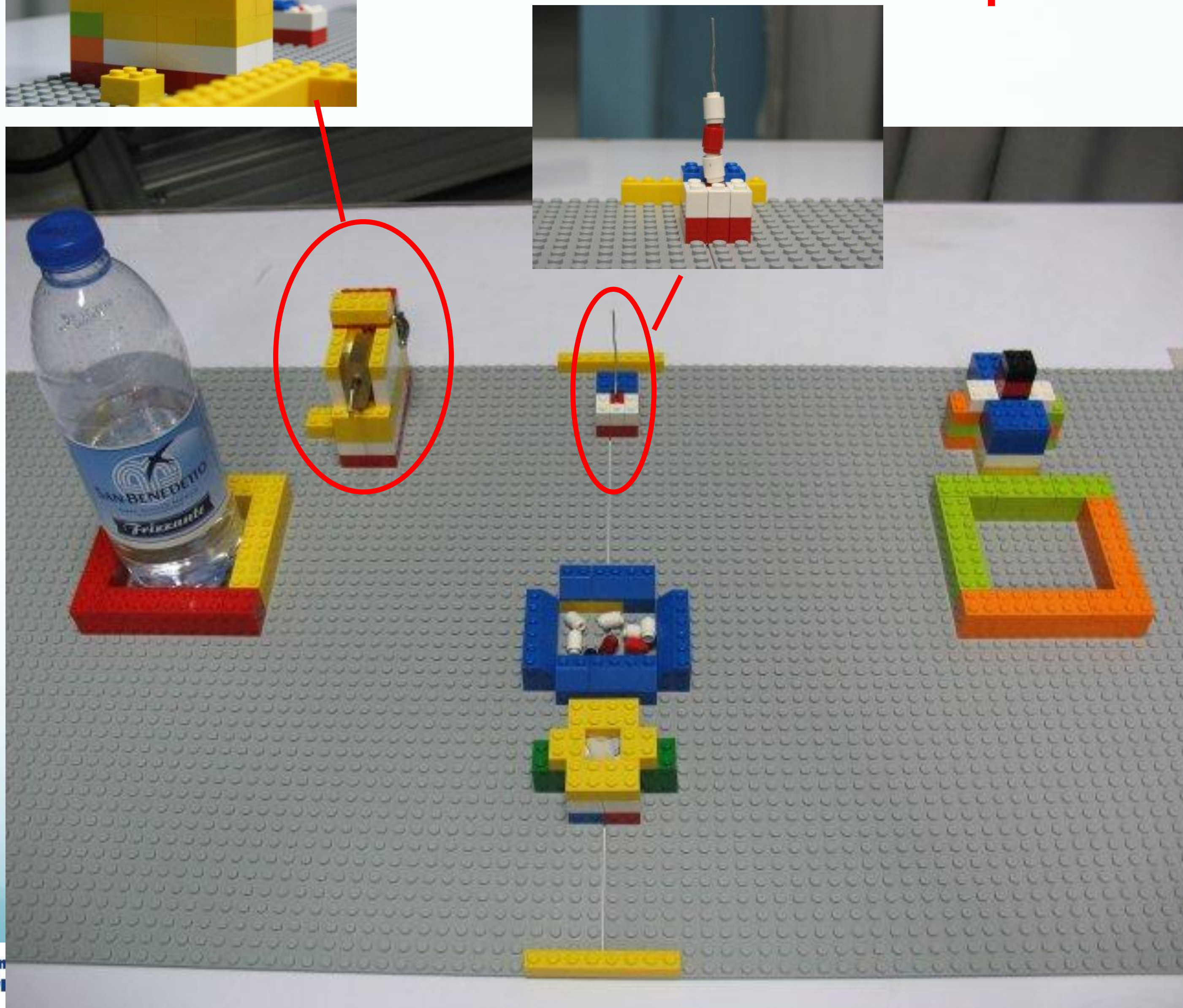
Manopola funzionale



From: Carpinella et al 2009

Training “funzionale” – Set Up





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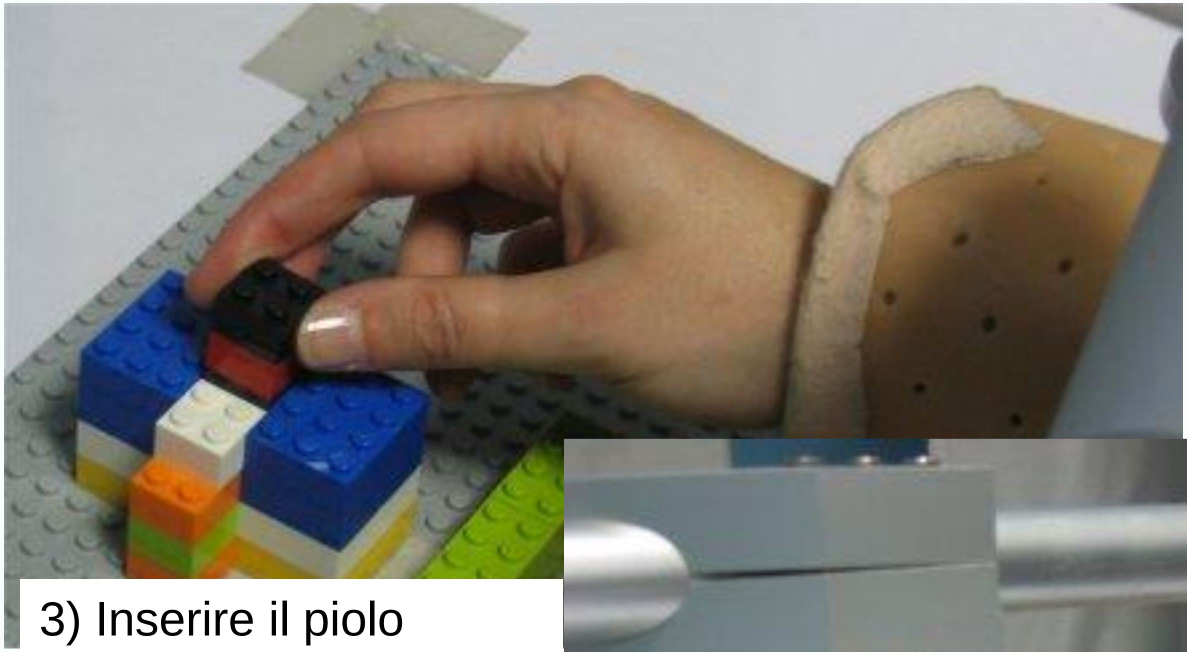
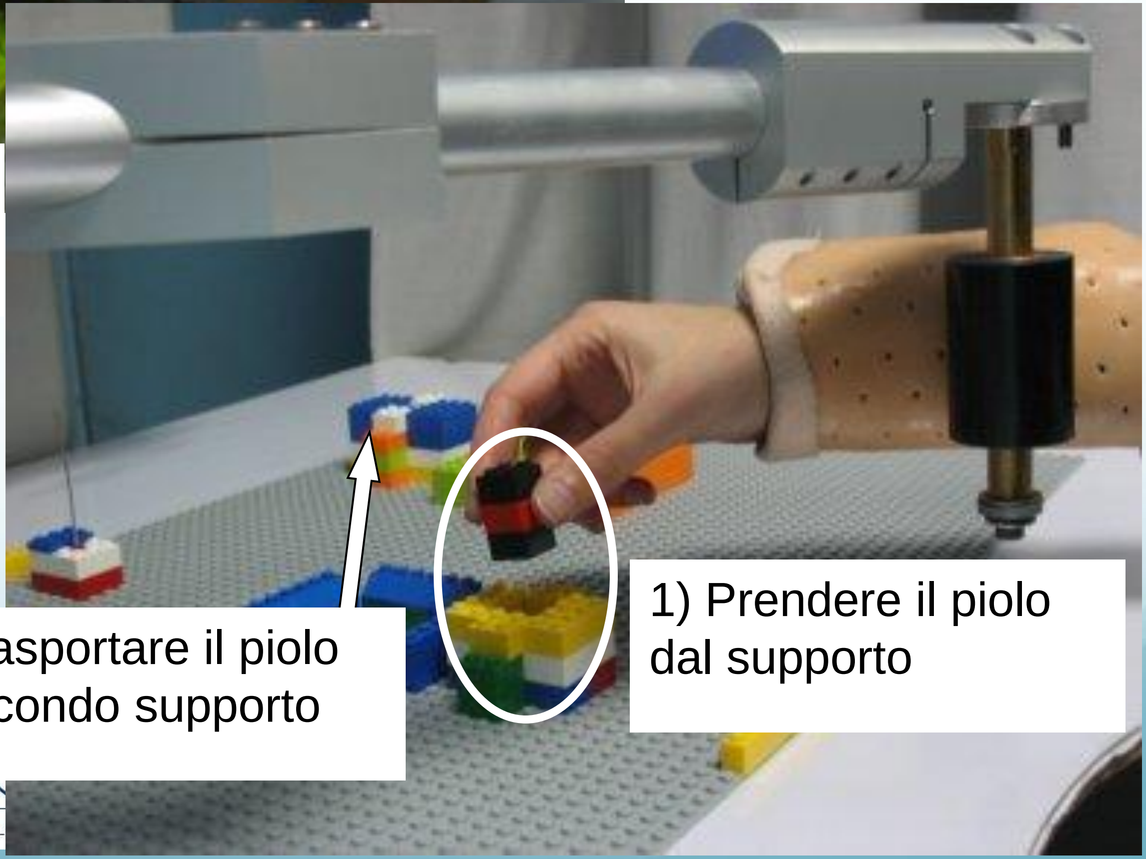
Training “funzionale” – Esercizio 1



3) Inserire il piolo
nel secondo supporto

$$F = Fr + Fp$$

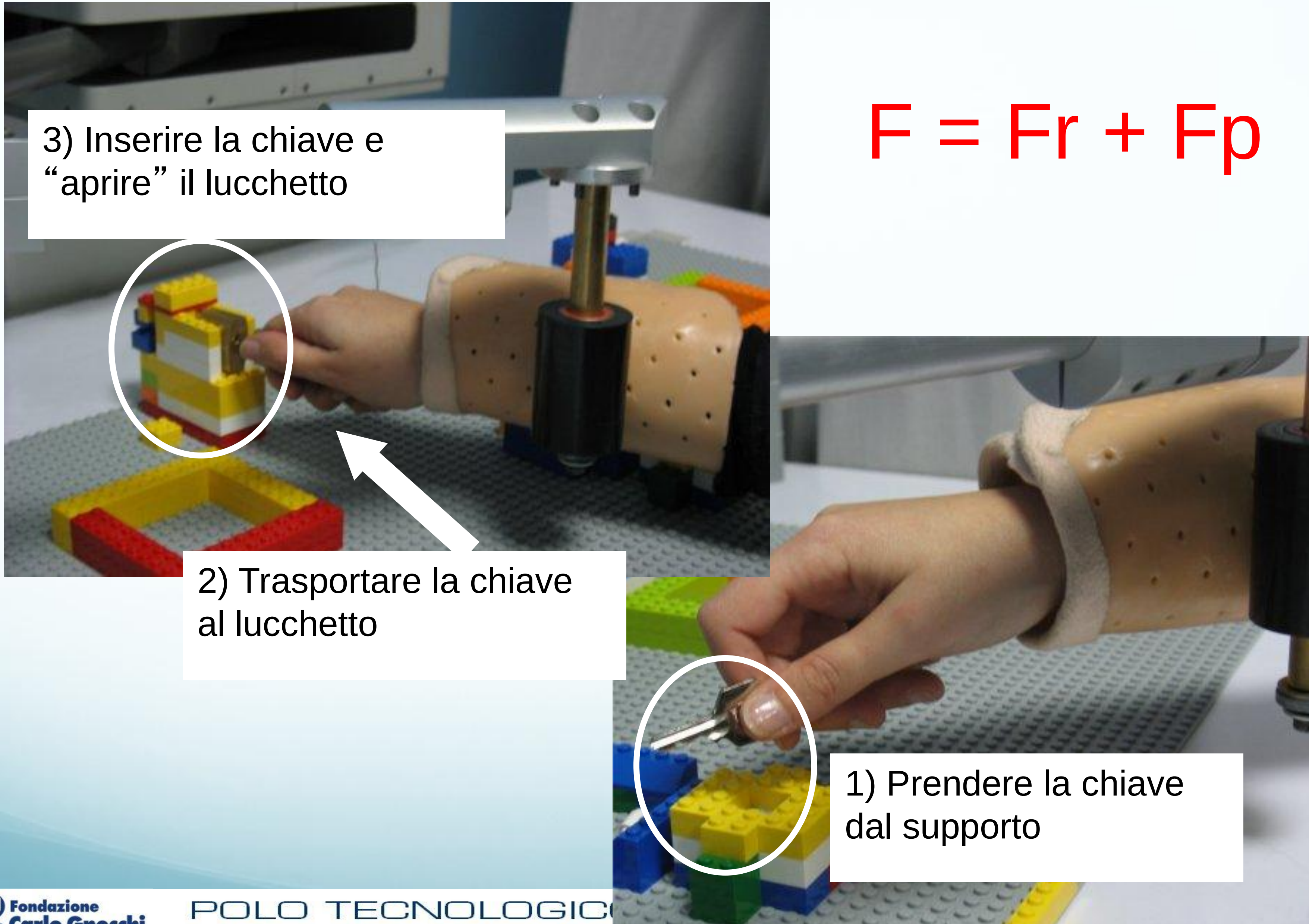


1) Prendere il piolo
dal supporto

2) Trasportare il piolo
al secondo supporto

Training “funzionale”- Esercizio 2

$$F = Fr + Fp$$



Protocollo di robot-terapia "funzionale"

Valutazione PRE → Trattamento 8 sessioni (45 min) → Valutazione POST

Baseline: 20 mov. di reaching "virtuale", F=0;

Training: 120 mov, F=Fr+Fp

- Indici quantitativi estratti dalle traiettorie di reaching (*durata, jerk metric, deviazione laterale*)

- Test clinici: *9HPT, ARAT*

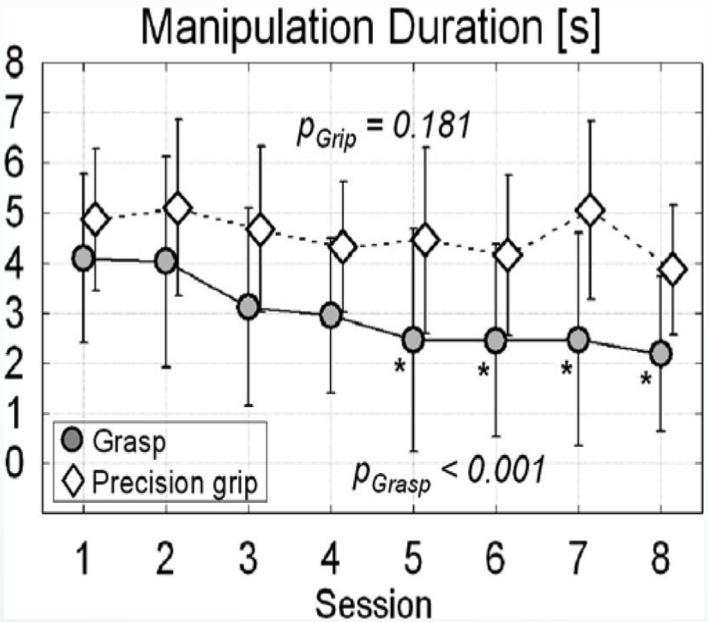


Fig. 4. Duration (mean $\pm 95\%$ confidence interval) of manipulation tasks, involving grasp and precision grip, executed by MS subjects during the eight sessions of the RMT protocol. ANOVA p-values related to the effect of session and significant differences with respect to session $1(^*)$ are reported.

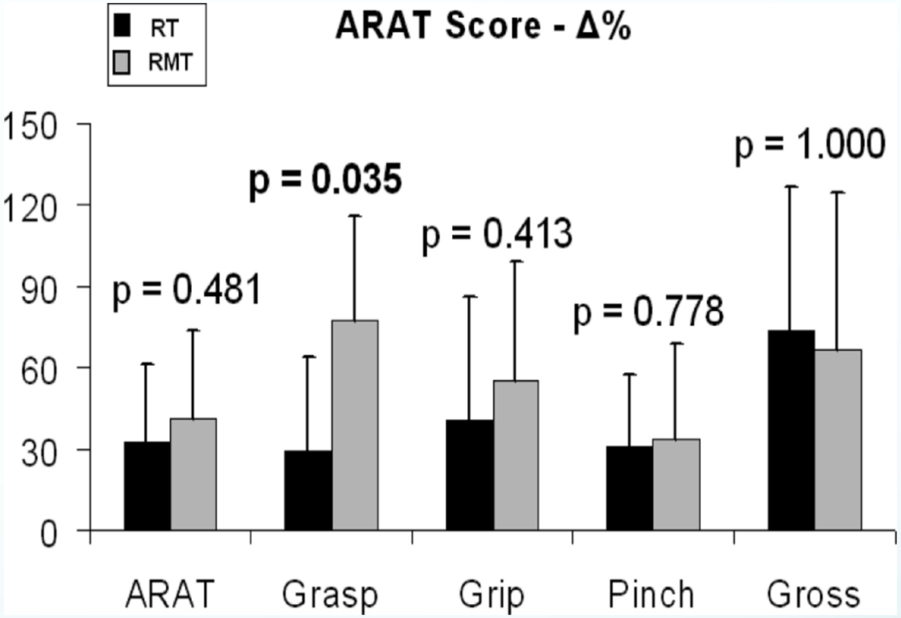


Fig. 5. Post treatment percentage change in ARAT total score and sub-scores. $\Delta\% = 100^*(\text{Post-Pre})/(\text{Max. score -Pre})$. Column: mean; whisker: standard deviation. P-value from Mann Whitney U test comparing RT and RMT groups are reported.

Conclusions

- The most important advantage of using robot is the ability to deliver high-dosage and high-intensity training
- Comparable effects on gait (grasp?) function between the robot-assisted therapy and conventional gait (Upper Limb?) training.
- But…robot-assisted therapy in combination with conventional physiotherapy produces greater improvement in gait function (arm?)