Evidence Based Medicine en réadaptation du membre sup

La rééducation, la compensation, l'appareillage dans les troubles de la préhension et de la manipulation

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1. **Relation structure fonction**
   - Squelette osseux et fibreux
   - Neuro-anatomie
     - Organisation motricité
     - préhension
     - Effet entraînement
     - Plasticité dépendante de l'usage
     - Compétitions des représentations corticales
2. **Principes de la rééducation de la main**
   - Principes transversaux
   - Mobilisations passives et actives
   - Particularités chez l'hémiplégiques
3. **La compensation**
   - Faire autrement
   - Les orthèses dynamiques
   - SEF
   - Les aides techniques
   - Appareillages
   - BCI
   - Greffes

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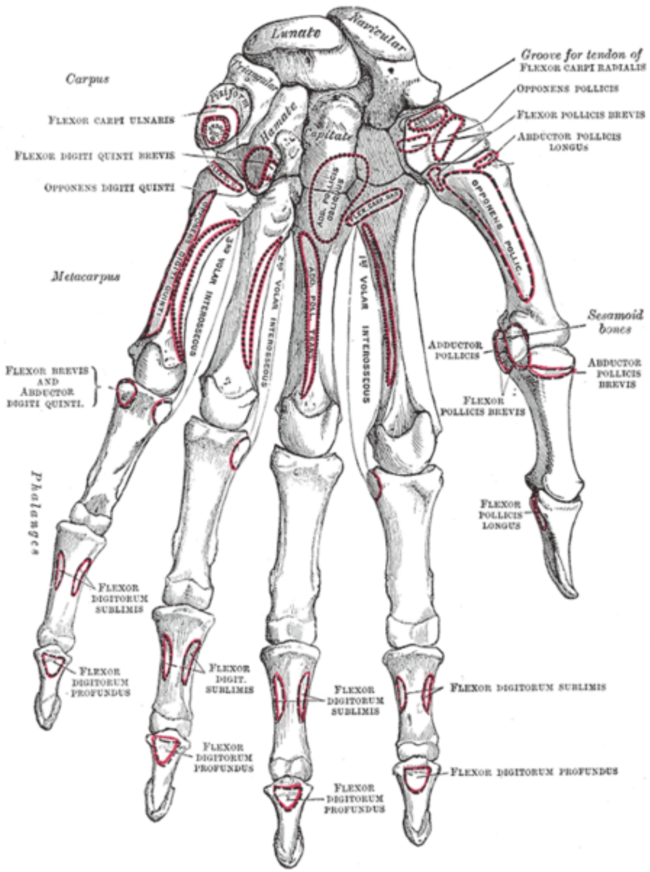
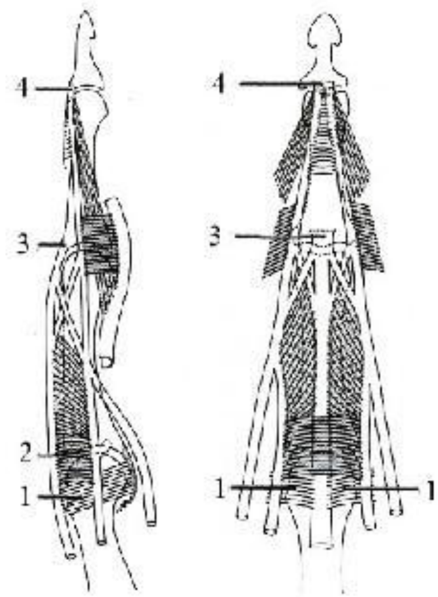
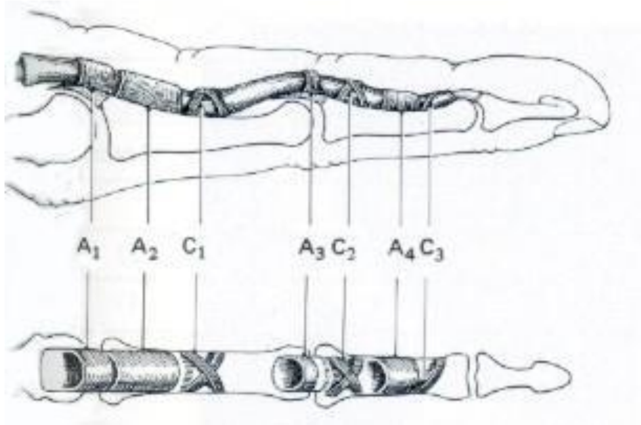
I - RELATION STRUCTURE FONCTION

Squelette osseux, squelette fibreux

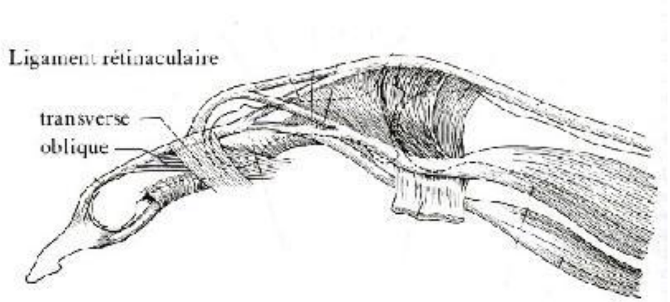


Insertions des extenseurs



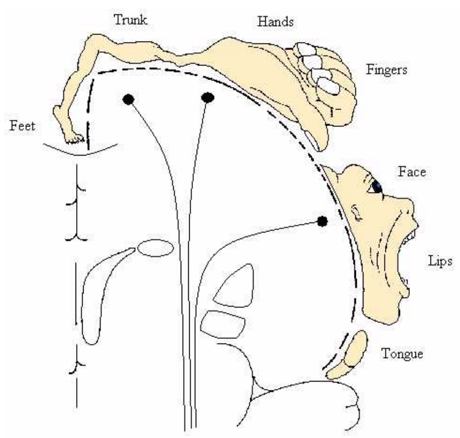


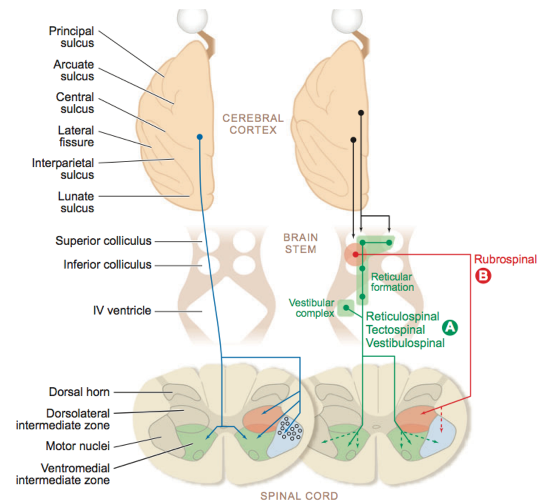
Poulies des fléchisseurs



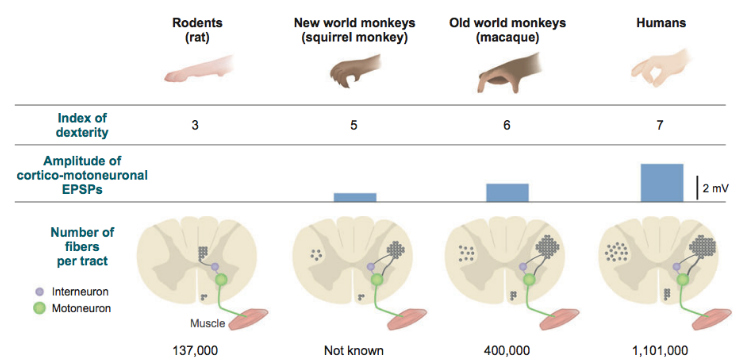
Squelette fibreux = risques d’enraidissements, adhérences

Organisation Neuro-anatomique





- Faisceau cortico-spinal = manipulation
- L'homonculus de Penfield = une vision simpliste
- Un rôle souvent sous-estimé des autres faisceaux



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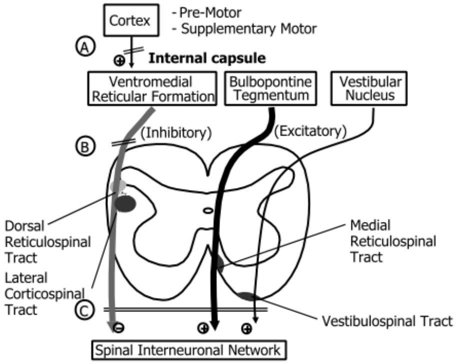
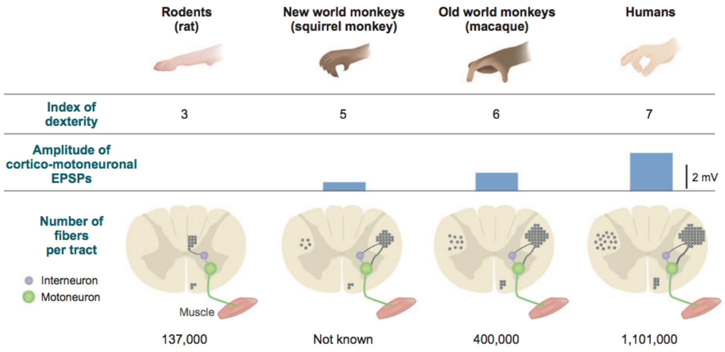
Lésion isolé du faisceau cortico-spinal

- Lésion du 1/3 moyen du bras postérieure de la capsule
- Pas de spasticité
- Pas de déficit de force
- Déficit de vitesse
- Maladresse déficit indépendance des doigts
- Fries W, Brain 1993





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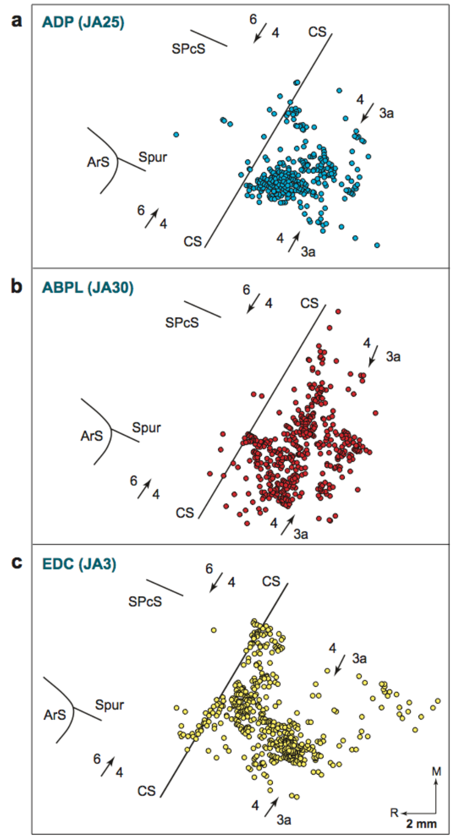
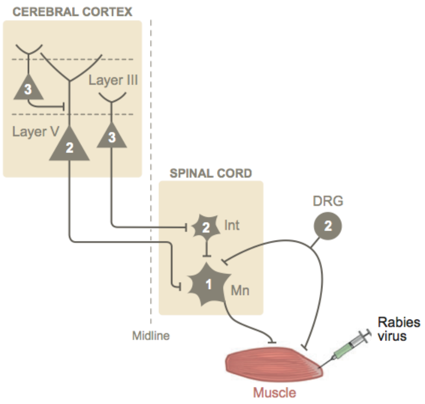
Faisceau cortico-spinal

- Un faisceau distribué, largement divergent
- Rôle majeur des collatérales inhibitrices



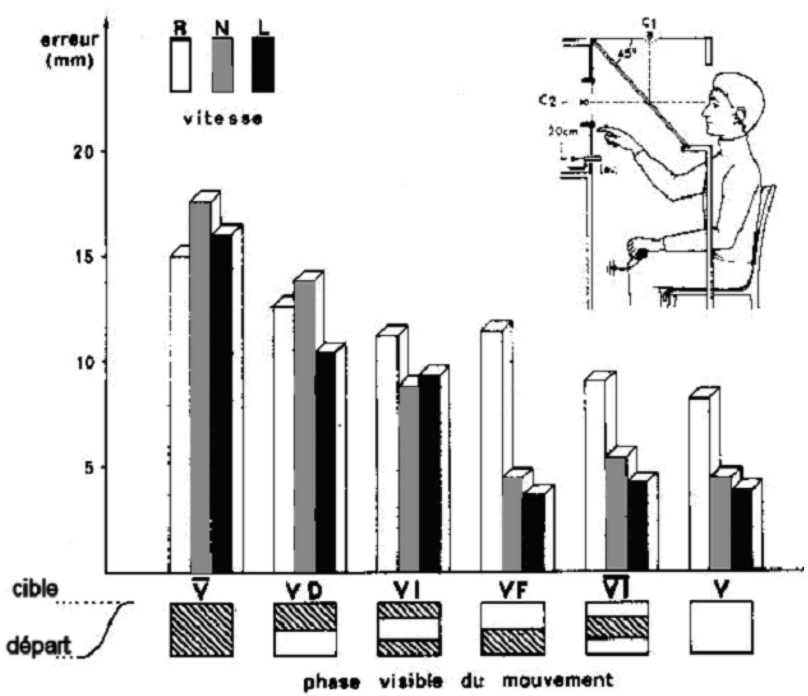


Muscle representation in the macaque motor cortex: An anatomical perspective

Jean-Alban Rathelot*† and Peter L. Strick*†‡§¶||

PNAS | May 23, 2006 | vol. 103 | no. 21 | 8257–8262

PRÉHENSION



DE LA COORDINATION VISUO-MOTRICE

A L'ORGANISATION DE LA SAISIE MANUELLE

par

J. Paillard et D. Beaubaton

In : HECAEN H., JEANNEROD M. (Eds). *Du contrôle de la motricité à l'organisation du geste.* Paris, Masson, **1978**, 225-260.

- Pointage (reaching) :
  - Phase ballistique
  - Phase de rétro-contrôle :
    - Visuel
    - Proprioceptif : vision, œil, main
  - Durée du mouvement (loi de fitt) TM = a+b.log2(2A/W)
    - Proportionnelle à l'amplitude
    - Inversement proportionnel à la taille de la cible W
- Saisie (grasp)
  - Conformation de la main à l'objet dès la phase ballistique

Increased Cortical Representation of the Fingers of the Left Hand in String Players

Thomas Elbert, Christo Pantev, Christian Wienbruch,
Brigitte Rockstroh, Edward Taub

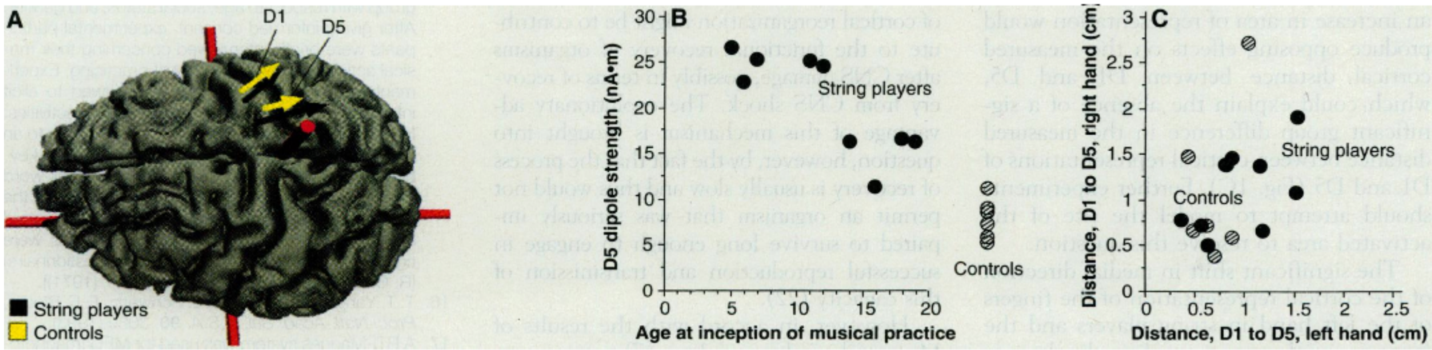


Fig. 1. (**A**) Equivalent current dipoles elicited by stimulation of the thumb (D1) and fifth finger (D5) of the left hand are superimposed onto an MRI (magnetic resonance imaging) reconstruction of the cerebral cortex of a control, who was selected to provide anatomical landmarks for the interpretation of the MEG-based localization. The arrows represent the location and orientation of the ECD vector for each of the two digits averaged across musicians (black) and controls (yellow). The length of the arrows represents the mean magnitude of the dipole moment for the two digits in each group. The average locations of D5 and D1 are shifted medially for the string players compared to controls; the shift is larger for D5 than for D1. The dipole moment is also larger for the musicians' D5, as indicated by the greater magnitude of the black arrow. (**B**) The magnitude of the dipole moment as a function of the age of inception of musical practice; string players are indicated by filled circles, control subjects by hatched circles. Note the larger dipole moment for individuals beginning musical practice before the age of 12. (**C**) Scatterplot of the Euclidean distances (in centimeters) between the cortical representations of D1 and D5. This distance for the musicians' left hands was greater than that in controls, but this difference is not statistically significant.

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SCIENCE 13OCTOBER 1995; VOL.270 : 305-37

Reorganization and plastic changes of the human brain associated with skill learning and expertise

Yongmin Chang*

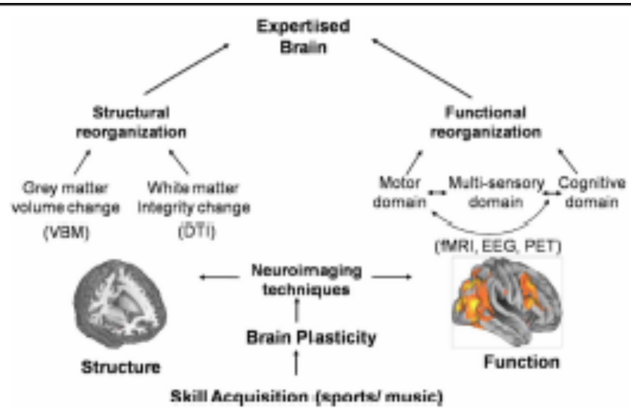


FIGURE 1 | Advances in neuro imaging technique have provided new insights into the neuroplastic changes underlying skill learning and expertise at both structural and functional levels. At structural level, a main finding is increased grey matter volume or density of brain areas associated with skill learning. In functional reorganization, functional imaging evidence has shown that functional neuroplasticity occurs not only in the motor domain but also in cognitive and perceptual domains associated with improved performance.

Study	Skill	Design	Method	Main findings
STRUCTURAL PLASTICITY				
Jacini et al., 2009	Sports	Cross-sectional	VBM	Judo players showed larger GM volume in frontal and prefrontal cortex
Jäncke et al., 2009	Sports	Cross-sectional	VBM, DTI	Golfers showed Larger GM volumes in premotor and parietal cortices; smaller FA along the internal and external capsule and the parietal operculum
Di Paola et al., 2013	Sports	Cross-sectional	VBM	Mountain climbers showed significantly larger vermian lobule volumes
Draganski et al., 2004	Sports	Longitudinal	VBM	Three months' practice-induced GM expansion in mid-temporal area and posterior intraparietal sulcus, followed by a decreased to baseline levels after 3 months with no practice
Bezzola et al., 2011	Sports	Longitudinal	VBM	Forty hours of golf training showed an association with gray matter increases in a task-relevant cortical network
Amunts et al., 1997	Music	Cross-sectional	MRI	Hand motor area was larger in professional musicians than in non-musicians
Gaser and Schlaug, 2003	Music	Cross-sectional	VBM	GM volume differences in sensorimotor cortex, premotor cortex, and cerebellum
Han et al., 2009	Music	Cross-sectional	VBM, DTI	Musician showed higher GM density in sensorimotor cortex and cerebellum; higher FA in internal capsule
Hyde et al., 2009	Music	Longitudinal	DBM	Fifteen months of musical training in early childhood showed structural change in brain areas which are known to be involved in control of playing a musical instrument
FUNCTIONAL PLASTICITY				
Pearce et al., 2000	Sports	Cross-sectional	TMS	Cortical representation of the hand used for playing is larger in professional racquet ball players
Milton et al., 2007	Sports	Cross-sectional	fMRI	Elite athletes showed neural efficiency in the cortical processes during the specific challenge in which they are highly practiced
Sekiguchi et al., 2011	Sports	Cross-sectional	fMRI	Elite rugby players differ in visuospatial abilities directly tied to their domain of expertise
Doyon et al., 2002	Sports	Longitudinal	fMRI	Shift of activation from the cerebellar cortex to the dentate nucleus during early learning, and from a cerebellar–cortical to a striatal–cortical network with extended practice
Cross et al., 2009	Sports	Longitudinal	fMRI	Emergence of action resonance processes in the human brain based on 5 day observational learning of dance sequence without physical practice
Lotze et al., 2003	Music	Cross-sectional	EMG	Professional violinists showed focused cerebral activations in the motor network as compared to amateur violinists during the imagination of violin-playing movements
Oechslin et al., 2013	Music	Cross-sectional	fMRI	Levels of musical expertise stepwise modulate higher order brain functioning
Bangert and Altenmüller, 2003	Music	Longitudinal	EEG	Auditory-sensorimotor co-activity occurred within only 20 min and the effect was enhanced after 5-week training, contributing elements of both perception and action to the mental representation of the instrument
Herdener et al., 2010	Music	Longitudinal	fMRI	Following the aural skills training, hippocampal responses to temporal novelty in sounds were increased

MRI, magnetic resonance imaging; VBM, voxel-based morphometry; GM, gray matter; DTI, diffusion tensor imaging; FA, fractional anisotropy; DBM, Deformation based morphometry; TMS, transcranial magnetic stimulation; fMRI, functional MRI; EMG, Electromyography; EEG, electroencephalography.

Front HumNeurosci 2014; Feb4, 8:35

Effet immobilisation

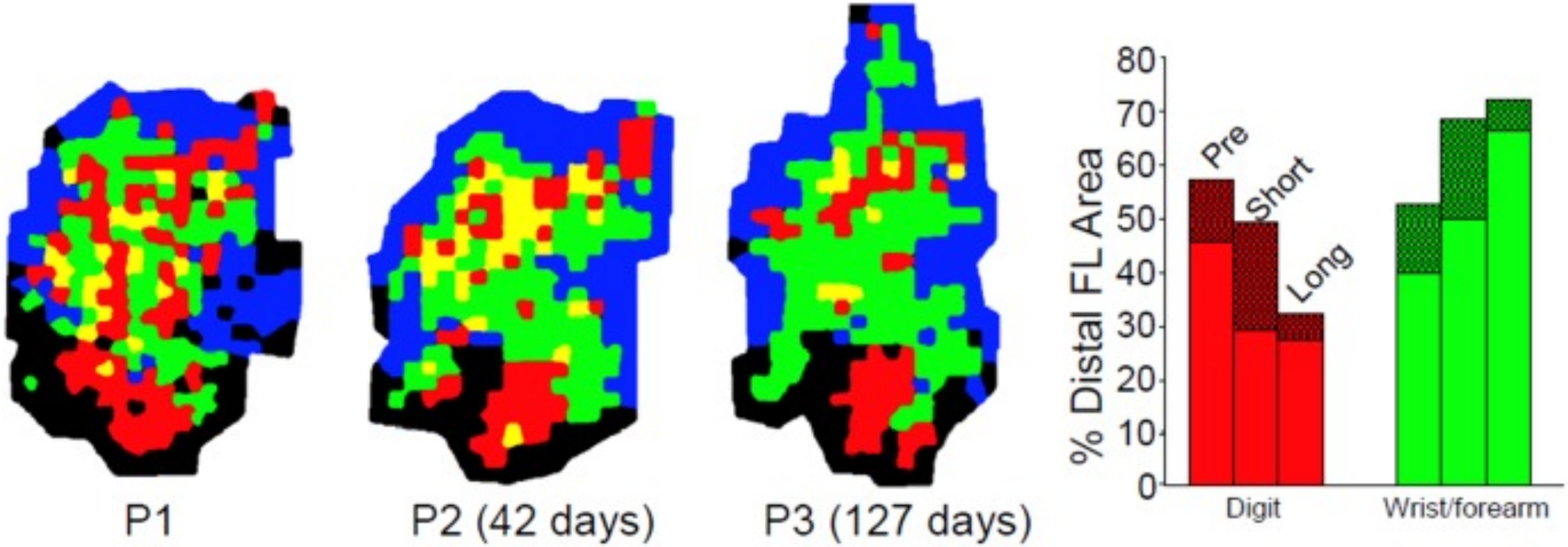
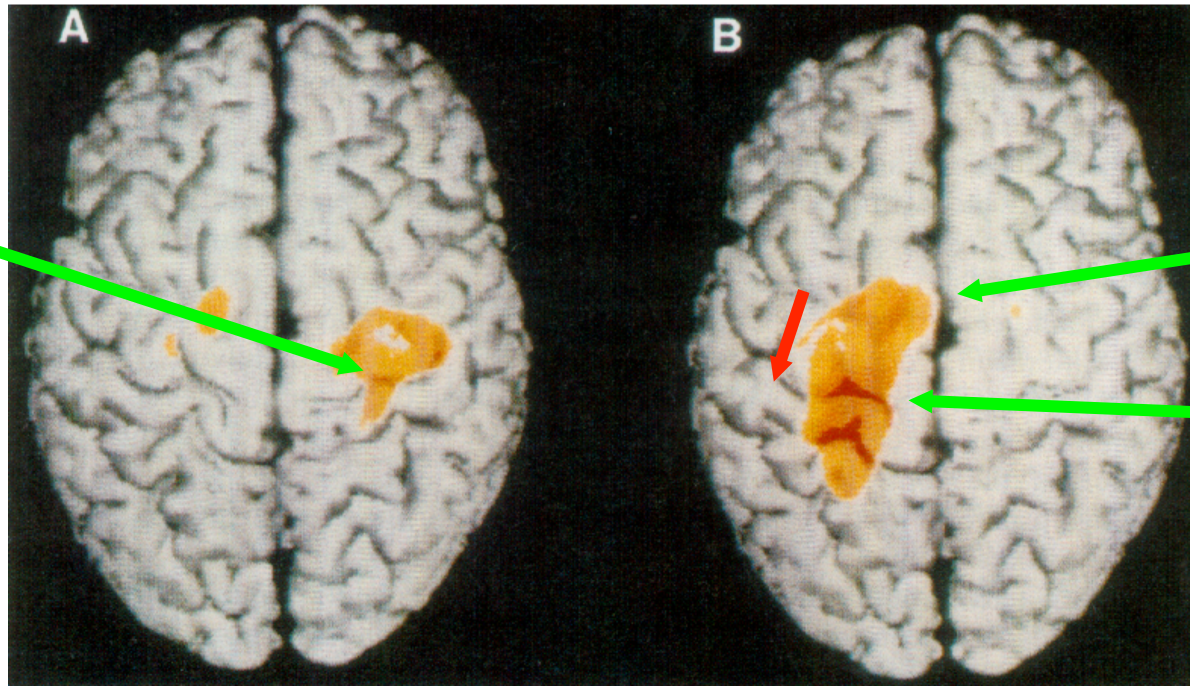


FIGURE 7 | Effects of disuse on motor maps in the absence of injury. The preferred forelimbs of normal, healthy adult squirrel monkeys were placed in soft, restrictive casts for periods up to 5 months. ICMS mapping studies showed a progressive decrease in digit representation and a progressive increase in wrist/forearm representation. These effects were reversible after removal of the cast. These studies demonstrate that disuse has a substantial impact on motor cortex representations independent of the injury-induced disuse and neuropathological changes associated with stroke or traumatic injury (Milliken et al., 2013).

Exemple d'envahissement du territoire cortical déafférenté en TEP (dans le cas d'une main amputée)

Mouvements du membre intact | Mouvements du membre amputé

Aire de la main intacte



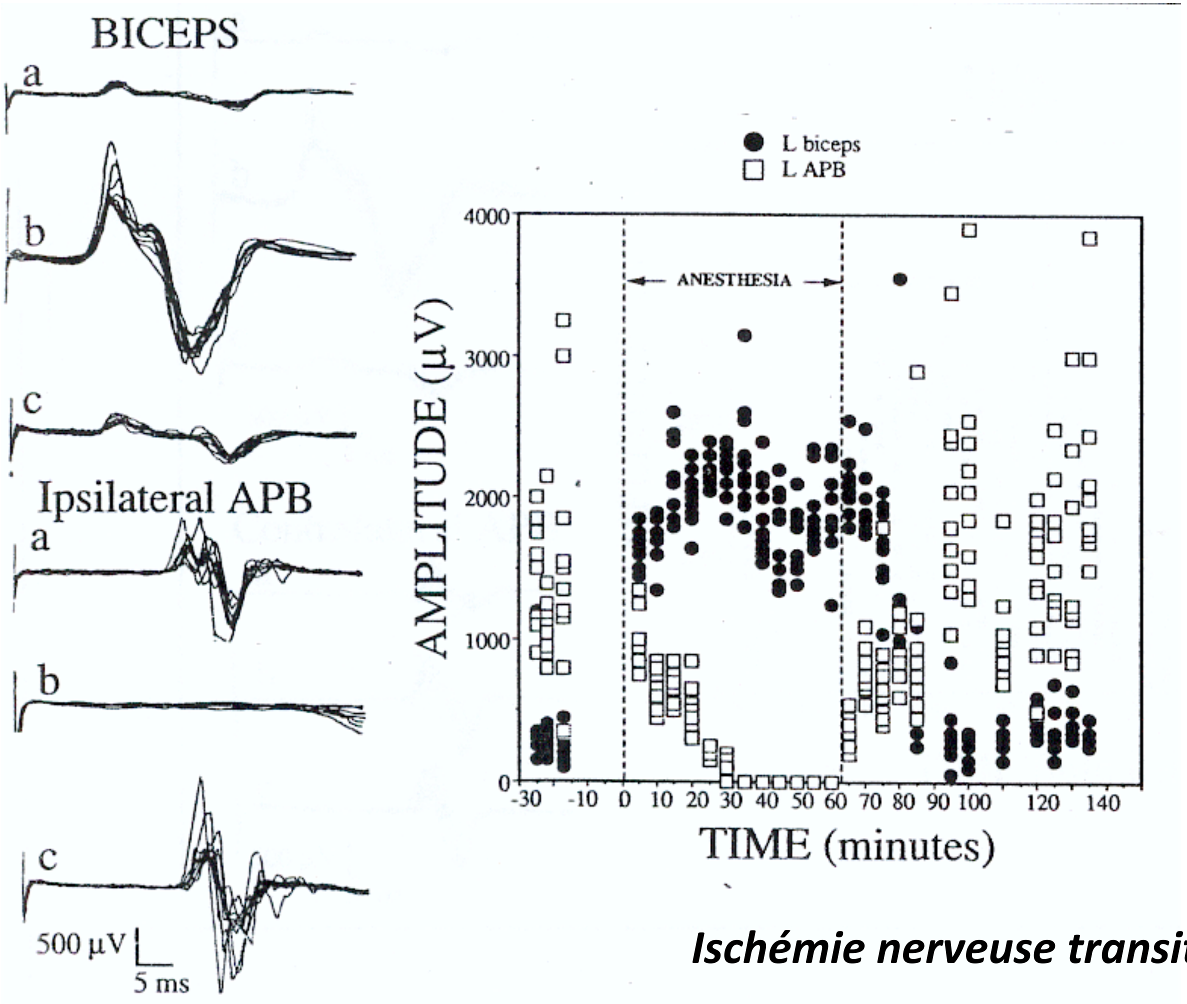
Aire de l'épaule avant amputation

Aire de la main avant amputation, envahie par l'aire de l'épaule après amputation

Mouvement de l'épaule (TEP):
montre que l'aire de l'épaule (côté amputé) envahit l'aire initiale de la main amputée (que l'on localise hypothétiquement symétrique à A)

Kew et al., J Neurophysiol 1994

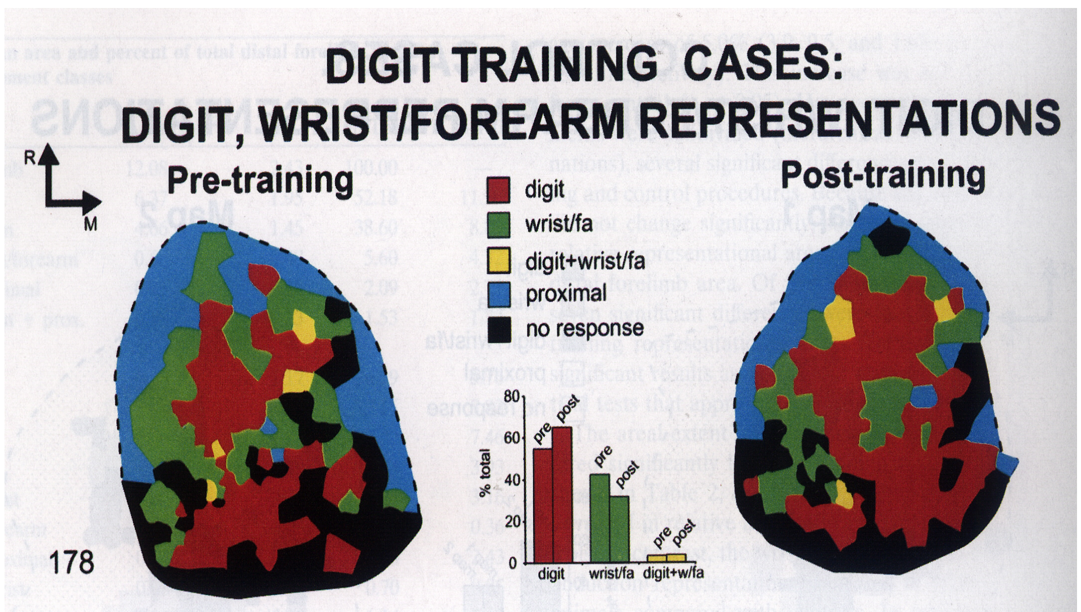
Compétition des représentations corticales



Ischémie nerveuse transitoire

« Rapid reversible modulation of human motor outputs after transient deafferentation of the forearm : a study with transcranial magnetic stimulation », Brasil-Neto et al. (1992) Neurology

NUDO et al
(J Neurosci 1996 -
Science 1996)



Plasticité dépendante de l’usage : mécanisme de compétition

Motor learning = shaping

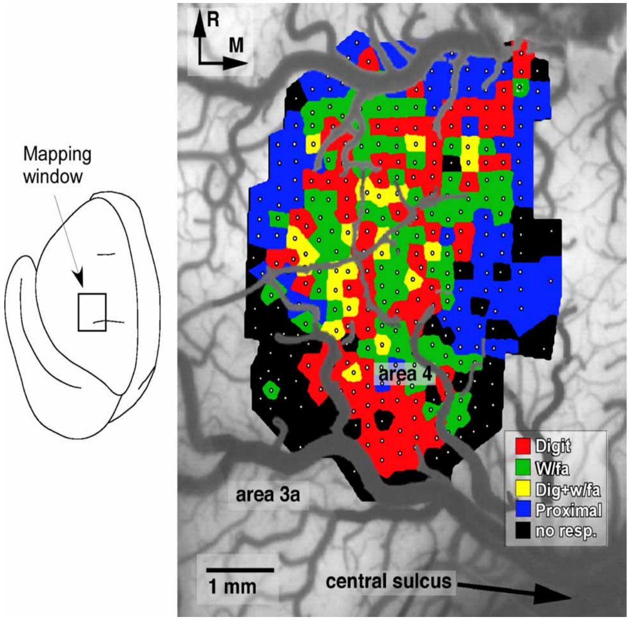


FIGURE 1 | Representation of distal forelimb movements in primary motor cortex (area 4) of a squirrel monkey. Under ketamine sedation, movements were evoked by intracortical microstimulation at each of 321 sites (small white dots) located approximately 250 µm apart. The distal forelimb representation is comprised of digit (red), wrist (w/fa; green), forearm (green) movements, as well as combinations of single-joint movements (yellow). This fractionated pattern of movement representations is due to the intermingling of corticospinal neurons that project to different subsets of motor neurons (Milliken et al., 2013).

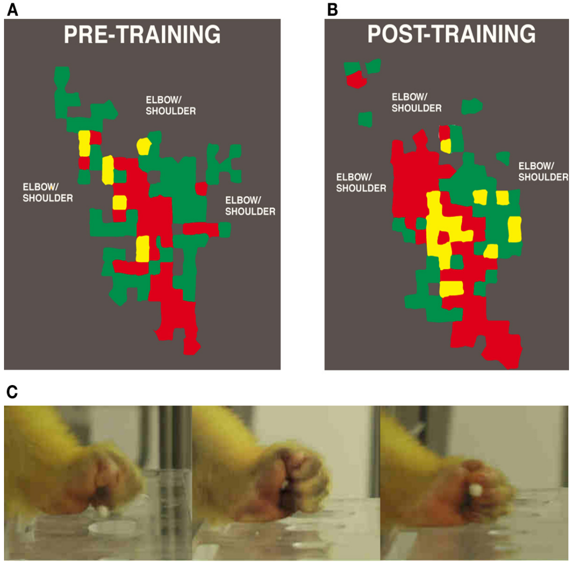


FIGURE 2 | Representation of distal forelimb representations in motor cortex after digit skill training as defined by intracortical microstimulation. Digit areas (red) expand after only 12 days of training. Combination movements that reflect the individual kinematics that the monkey employs also expand their representations. **(A)** Pre-training map. **(B)** Post-training map. **(C)** Still images of squirrel monkey retrieving food pellets from small wells (Nudo et al., 1996a).

Synthèse des aspects fondamentaux

- L'usage fait la fonction : répétition de tâche
- C'est de l'apprentissage moteur :
  - Personnalisé
  - Ni trop facile ni trop dur : taux de réussite à la tâche 60 à 80 %

II – PRINCIPE DE LA RÉÉDUCATION DE LA MAIN

Principes transversaux

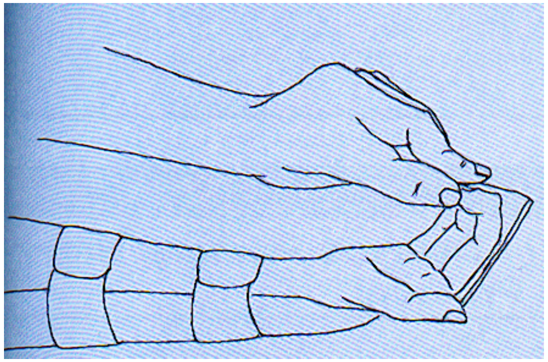
- Limiter la douleur, l'œdème et les adhérences
- Mobilisation précoce
  - Passive
  - Auto-passive : Orthèses
  - Actives
- Travail par tâches : préhension

Limiter la douleur, l'œdème et les adhérences

- Douleurs :
  - Traitements médicamenteux
  - Topiques locaux
  - Agents physiques : chaud, froid
  - TENS, vibrations, Ultrasons
  - Orhèses de posture
- Œdème et adhérences
  - Massage global et cicatrices
  - Contention
- Pathologie :
  - Traumatologie de la main
  - Post-chirurgie
  - Polyarthrite inflammatoire
  - SDRC de l'hémiplégique
  - Lésions nerveuses

Mobilisations passives

- Par le thérapeute :
  - Débute dès le 3° jours après lésion des tendons fléchisseurs
- Apprentissage mobilisation auto-passive
  - Patient compliant
- Orthèses
  - Lésions tendons des fléchisseurs : Orthèse de Kleinert



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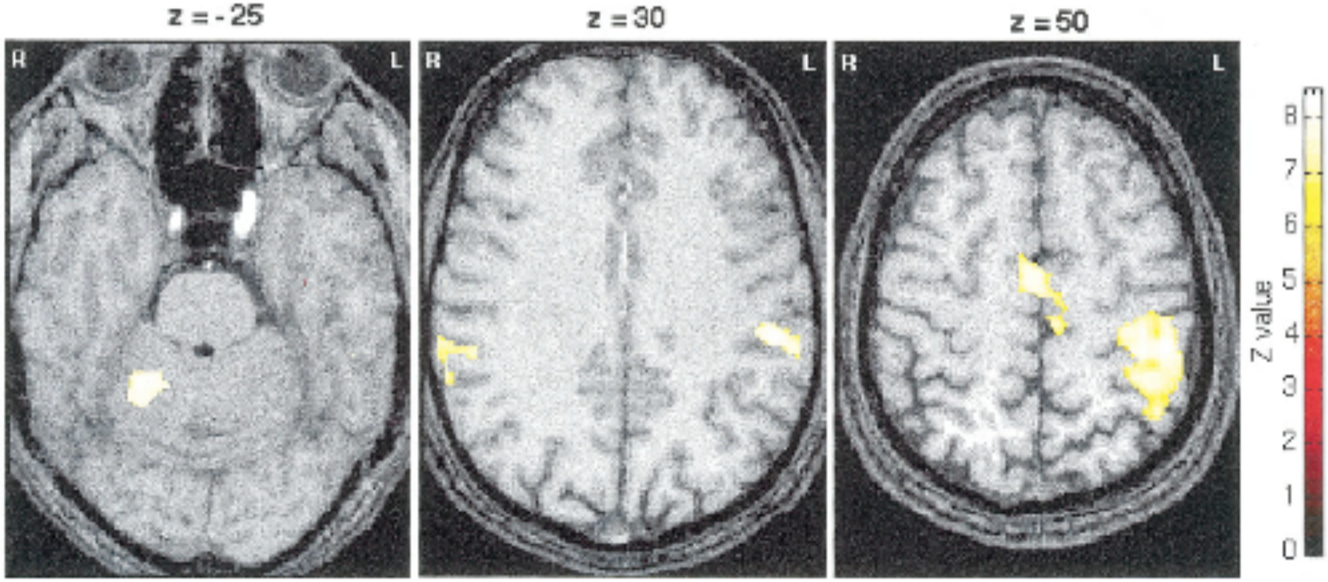
Mobilisation passive = activation motricité

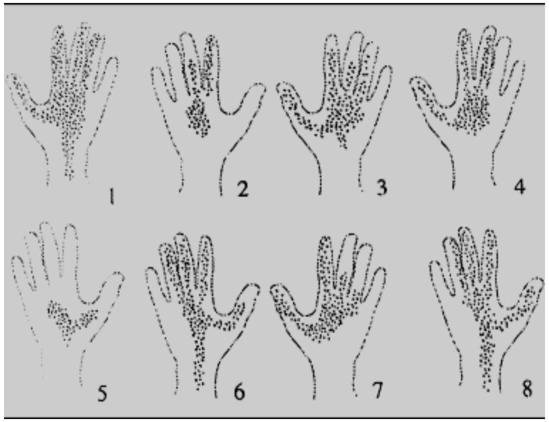


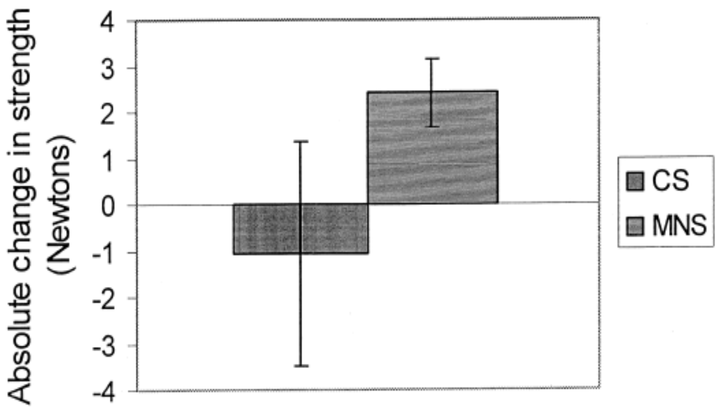
La mobilisation passive active le cortex sensori-moteur

Alary F et al, Neuroimage 1998

Chez les patients

- Etudes cliniques :
  - effets des stimulations électriques
  - EMS Powel et al stroke 1999
  - TENS Sonde et al Scand J Rehab Med 1998
  - Electroacupuncture Johanson et al, Neurology 1996
- Conforto et al Ann Neurol 2002
  - 8 hémiplégiques chroniques
  - Stimulation sensitive du médian
  - Augmentation de la force





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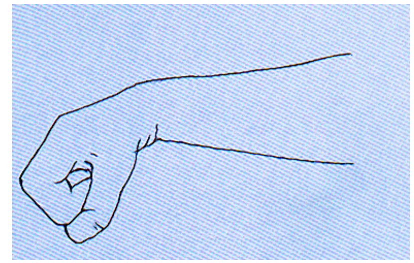
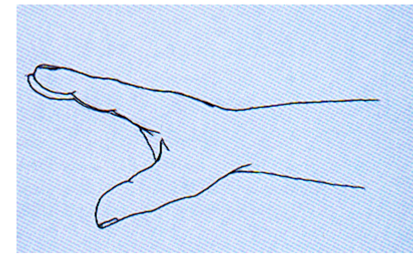
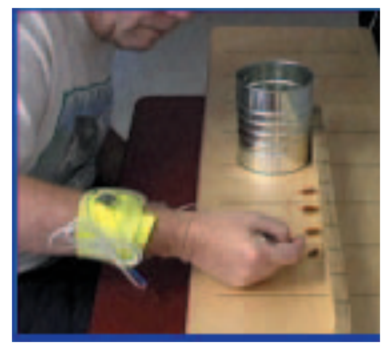
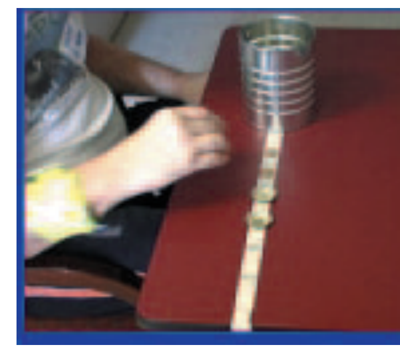
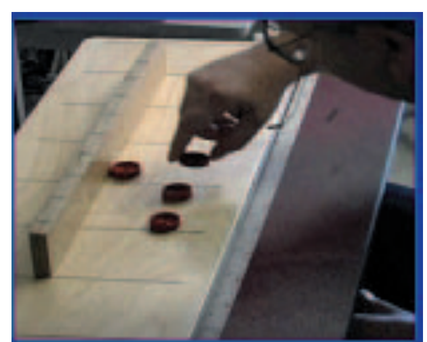
Mobilisations actives

- Le plus rapidement possible, mobilisations fonctionnelles
  - Prises variées
  - Dans des secteurs angulaires variés
  - Objets de tailles variables
  - De poids variables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A Systematic Review of Rehabilitation Protocols after Surgical Repair of the Extensor Tendons in Zones V−VIII of the Hand

ABSTRACT:

Study Design: Systematic review.

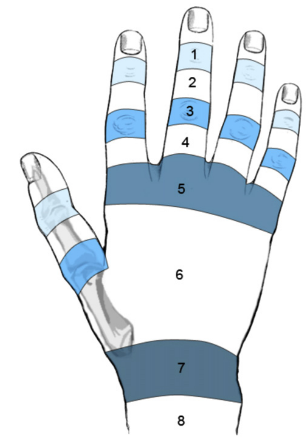
Introduction: Controversy exists as to which rehabilitation protocol provides the best outcomes for patients after surgical repair of the extensor tendons of the hand.

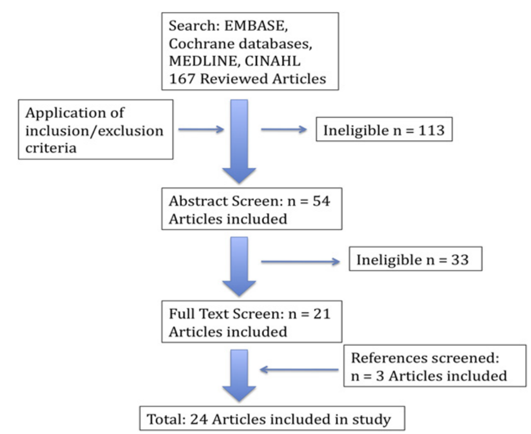
Purpose of the Study: To determine which rehabilitation protocol yields the best outcomes with respect to range of motion and grip strength in extensor zones V−VIII of the hand.

Methods: A comprehensive literature review and assessment was undertaken by two independent reviewers. Methodological quality of randomized controlled trials and cohort studies was assessed using the Scottish Intercollegiate Guidelines Network scale.

Results: Seventeen articles were included in the final analysis ($\kappa = 0.9$). From this total, seven evaluated static splinting, 12 evaluated dynamic splinting, and four evaluated early active splinting. Static splinting yielded "excellent/good" results ranging from 63% (minimum) to 100% (maximum) on the total active motion (TAM) classification scheme and TAM ranging from 185° (minimum) to 258° (maximum) across zones V−VIII. Dynamic splinting studies demonstrated a percentage of "excellent/good" results ranging from 81% (minimum) and 100% (maximum) and TAM ranging from 214° (minimum) and 261° (maximum). Early active splinting studies showed "excellent/good" results ranging from 81% (minimum) and 100% (maximum). Only one study evaluated TAM in zones V−VIII, which ranged from 160° (minimum) and 165° (maximum) when using two different early active modalities.

Conclusions: The available level 3 evidence suggests better outcomes when using dynamic splinting over static splinting. Additional studies comparing dynamic and early active motion protocols are required before a conclusive recommendation can be made.

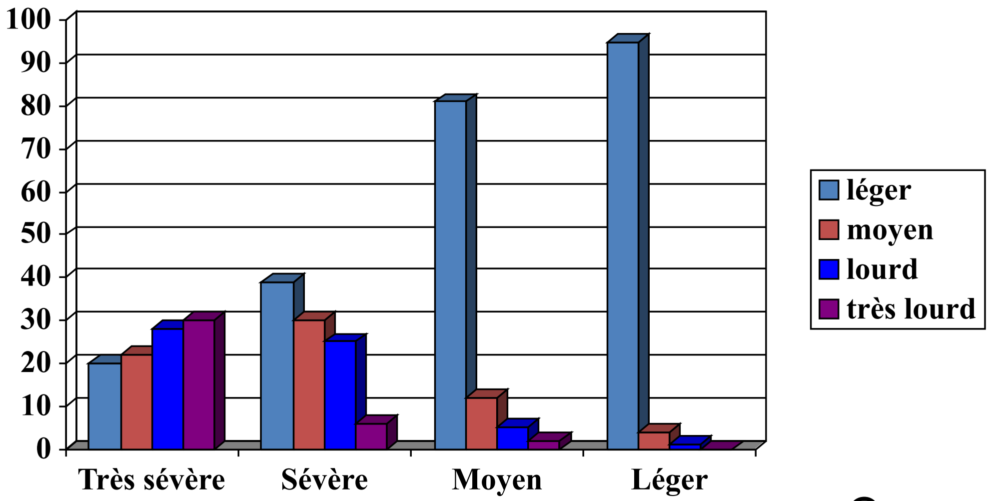


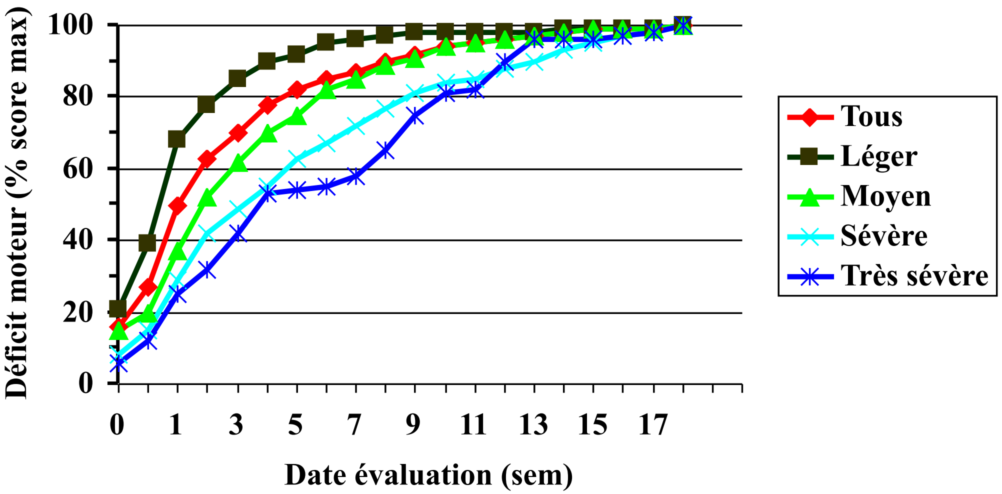


J HAND THER. 2011;24:365–73.

LES PARTICULARITES CHEZ L'HEMIPLEGIQUE

Le déficit moteur récupère après AVC





Jorgensen et al, Arch Phys Med Rehab, 1995

LA RÉCUPÉRATION DÉPEND DE L'INTÉGRITÉ DU FCX CORTICO-SPINAL

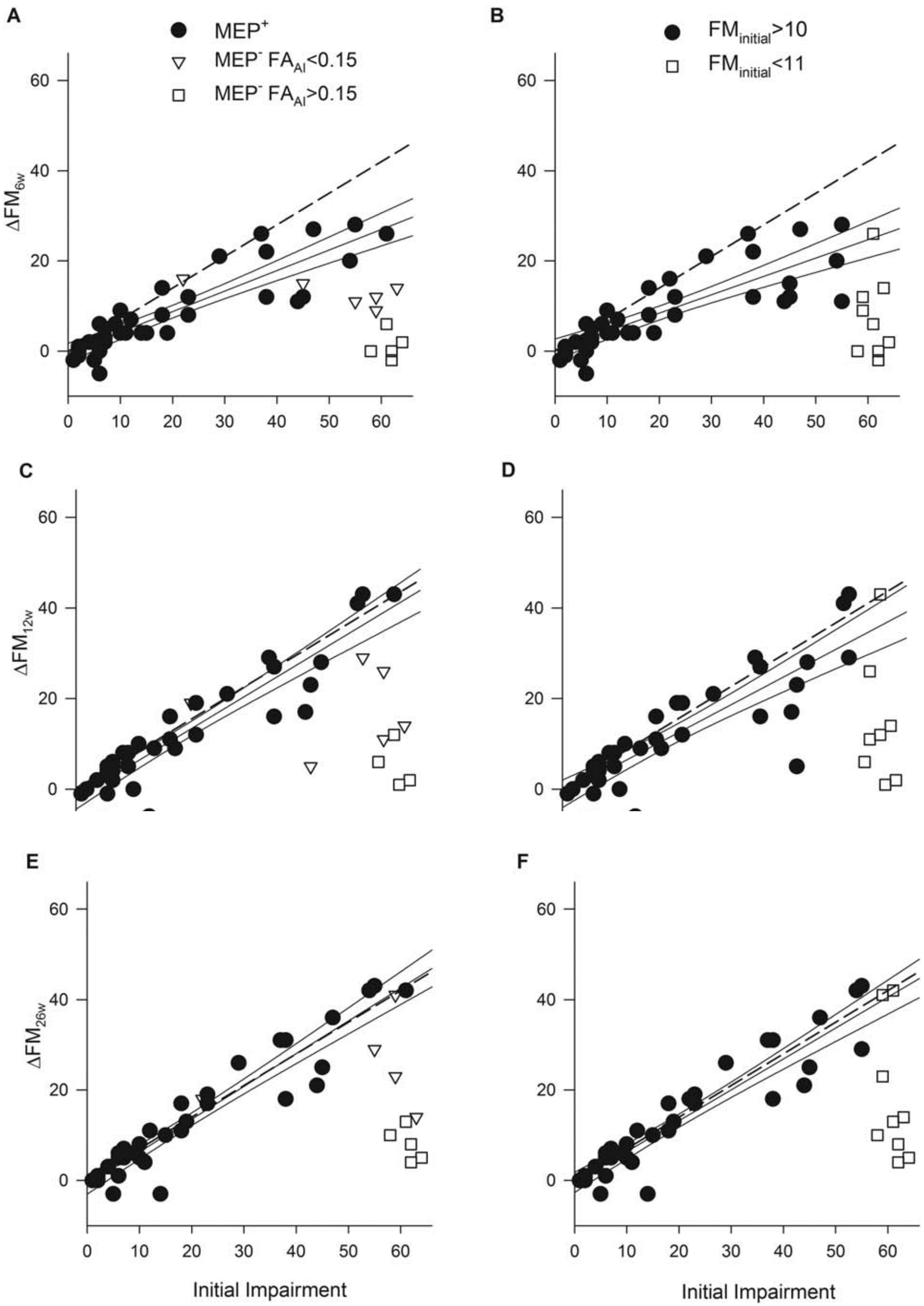


TABLE 3. Predictions for Achieving Proportional Recovery

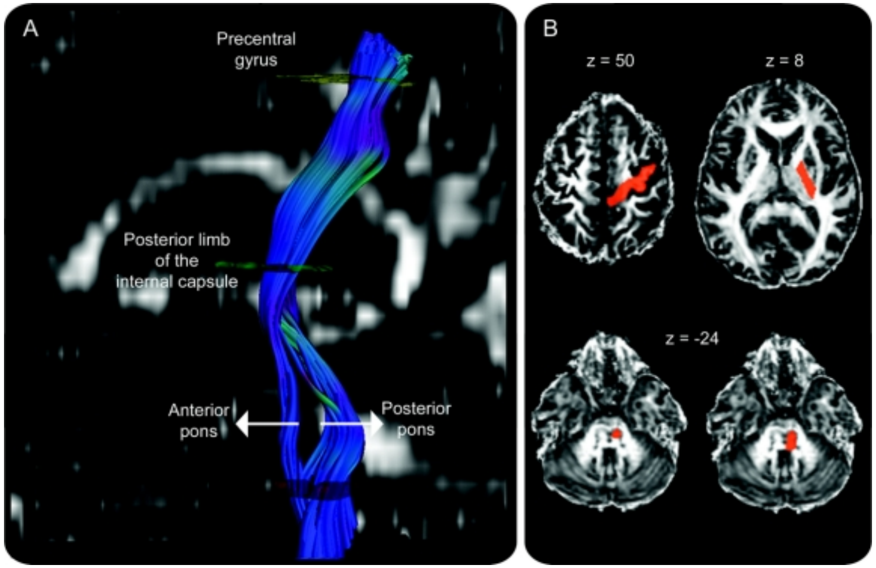
	Standardized Therapy		Variable Therapy
	$FM_{initial} > 10$	MEP^+	MEP^+
Positive predictive value	79.5	83.8	86.7
Negative predictive value	88.9	90.9	—
Sensitivity	96.9	96.9	—
Specificity	50.0	62.5	—

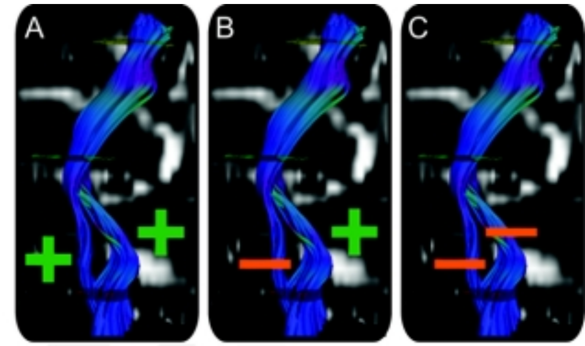
$FM_{initial}$ = initial FM score at 2w; MEP^+ = motor evoked potential status.

Proportional Recovery After Stroke Depends on Corticomotor Integrity

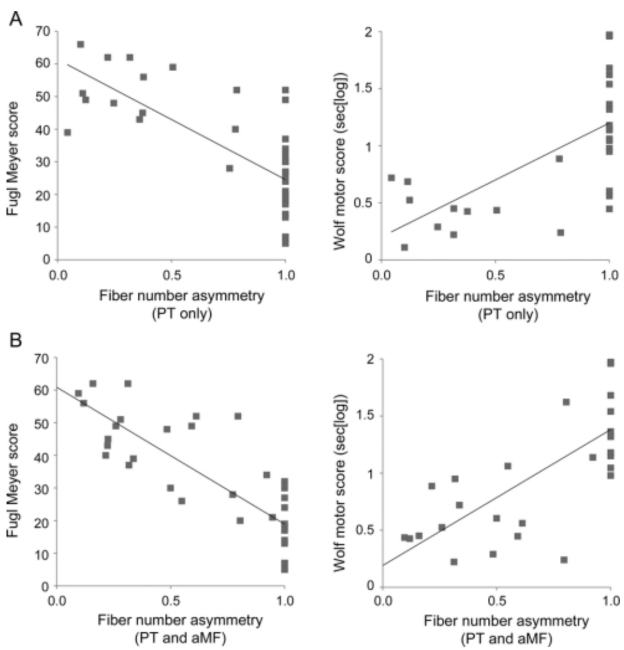
Winston D. Byblow, PhD,[1,2] Cathy M. Stinear, PhD,[1,3]
P. Alan Barber, MBChB, PhD,[1,3] Matthew A. Petoe, PhD,[1,3,4] and
Suzanne J. Ackerley, BPhty, PhD[1,3]

ANN NEUROL 2015;78:848–859

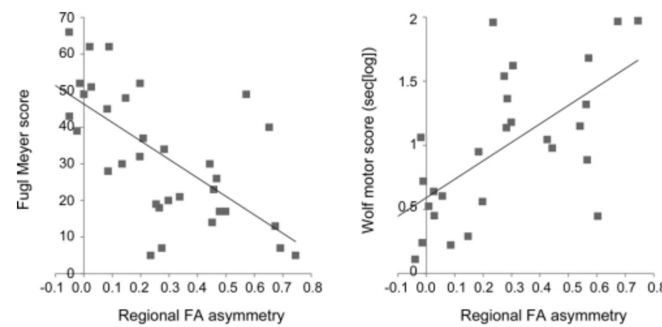




		Group 1 n = 14	Group 2 n = 8	Group 3 n = 13
Fiber number asymmetry scores	PT	0.4 ± 0.3	1.0 ± 0.0	1.0 ± 0.0
	PT+aMF	0.3 ± 0.2	0.7 ± 0.2	1.0 ± 0.0
Motor impairment	UE-FM	50.0 ± 10.6	33.6 ± 12.0	15.9 ± 8.8
	WMFT	0.5 ± 0.2	0.9 ± 0.4	1.5 ± 0.4



R. Lindenberg, MD
V. Renga, MD
L.L. Zhu
F. Betzler
D. Alsop, PhD
G. Schlaug, MD, PhD

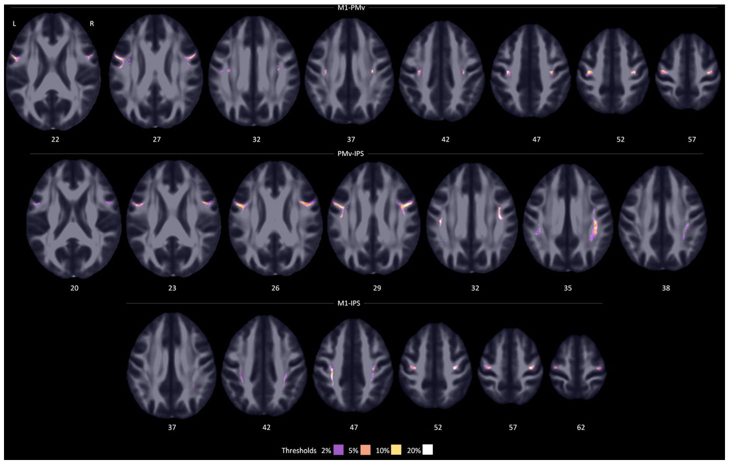


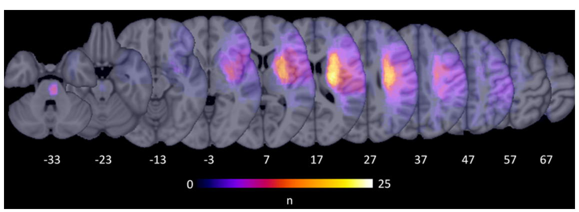
Structural integrity of corticospinal motor fibers predicts motor impairment in chronic stroke

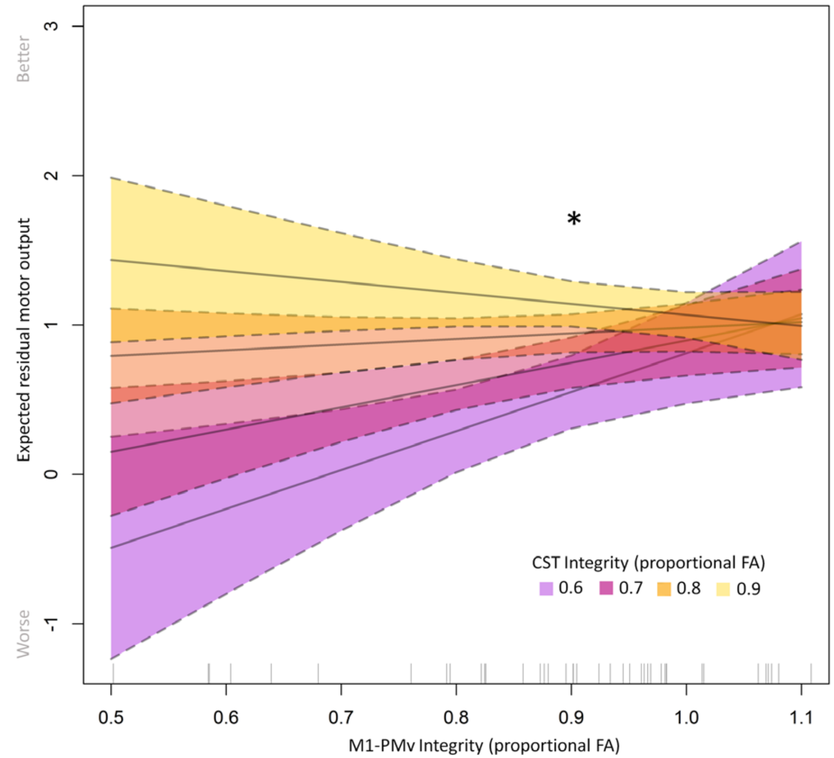
Neurology® 2010;74:280-287

Interactions Between the Corticospinal Tract and Premotor–Motor Pathways for Residual Motor Output After Stroke

Robert Schulz, MD; Eunhee Park, MD, PhD; Jungsoo Lee, PhD; Won Hyuk Chang, MD, PhD;
Ahee Lee, MS; Yun-Hee Kim, MD, PhD*; Friedhelm C. Hummel, MD*







Stroke. 2017;48:2805-2811

PEUT-ON PRÉDIRE LA RÉCUPÉRATION?

JoS
JOURNAL OF STROKE

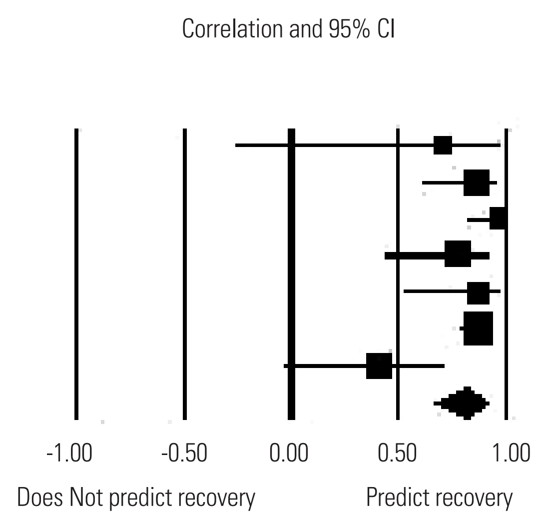
Vol. 18 / No. 1 / January 2016

Prediction of Upper Limb Motor Recovery after Subacute Ischemic Stroke Using Diffusion Tensor Imaging: A Systematic Review and Meta-Analysis

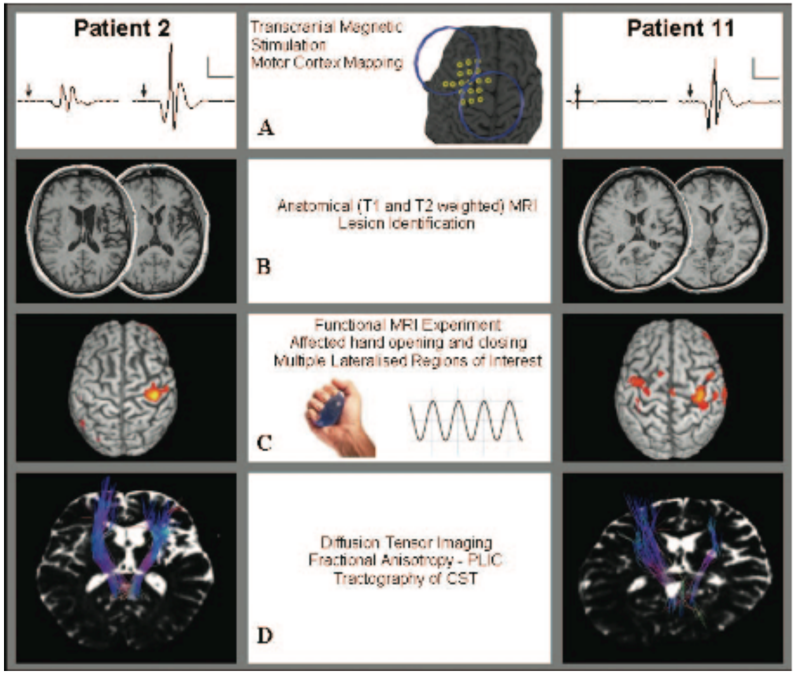
Pradeep Kumar, Prachi Kathuria, Pallavi Nair, Kameshwar Prasad

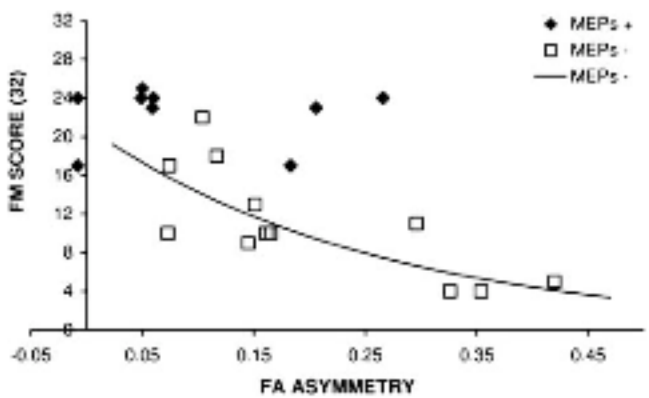
Department of Neurology, All India Institute of Medical Sciences, New Delhi, India

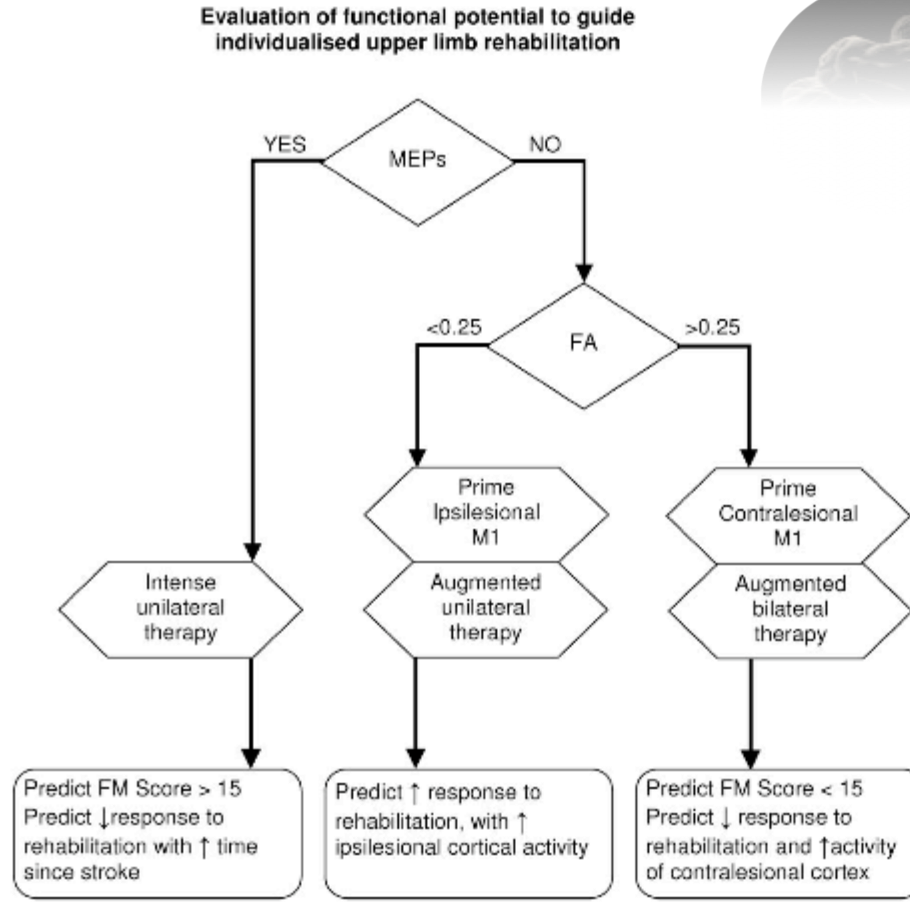
Study name	Statistics for each study				
	Correlation	Lower limit	Upper limit	Z-value	*P* value
Jang SH 2005 (IC)	0.701	-0.256	0.964	1.506	0.132
Jang SH 2005 (CR)	0.862	0.611	0.956	4.315	<0.001
Yu C 2009	0.962	0.825	0.992	4.831	<0.001
Song J 2014	0.768	0.440	0.915	3.661	<0.001
Gioisser BN 2014	0.870	0.532	0.969	3.527	<0.001
Pulg J 2011	0.869	0.789	0.920	10.034	<0.001
All GG 2012	0.410	-0.026	0.715	1.848	0.055
	0.820	0.669	0.906	6.513	<0.001



Association TMS & DTI





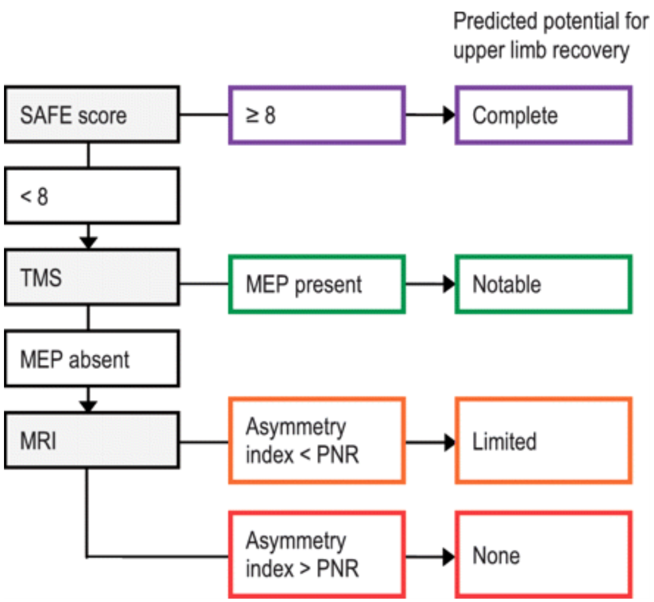


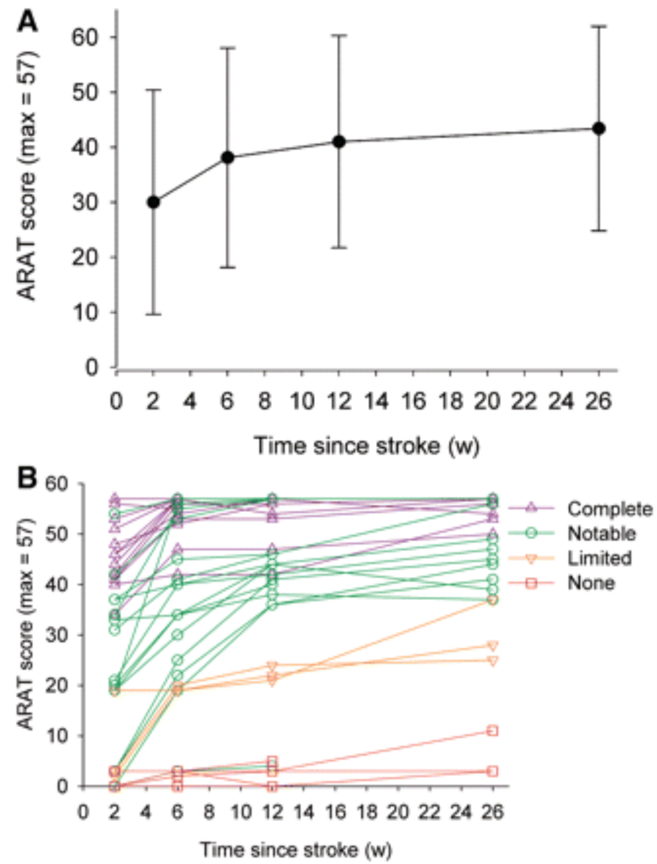
Stinear et al, Brain 2007

OXFORD
UNIVERSITY PRESS

From: **The PREP algorithm predicts potential for upper limb recovery after stroke**

Brain. 2012;135(8):2527-2535. doi:10.1093/brain/aws146



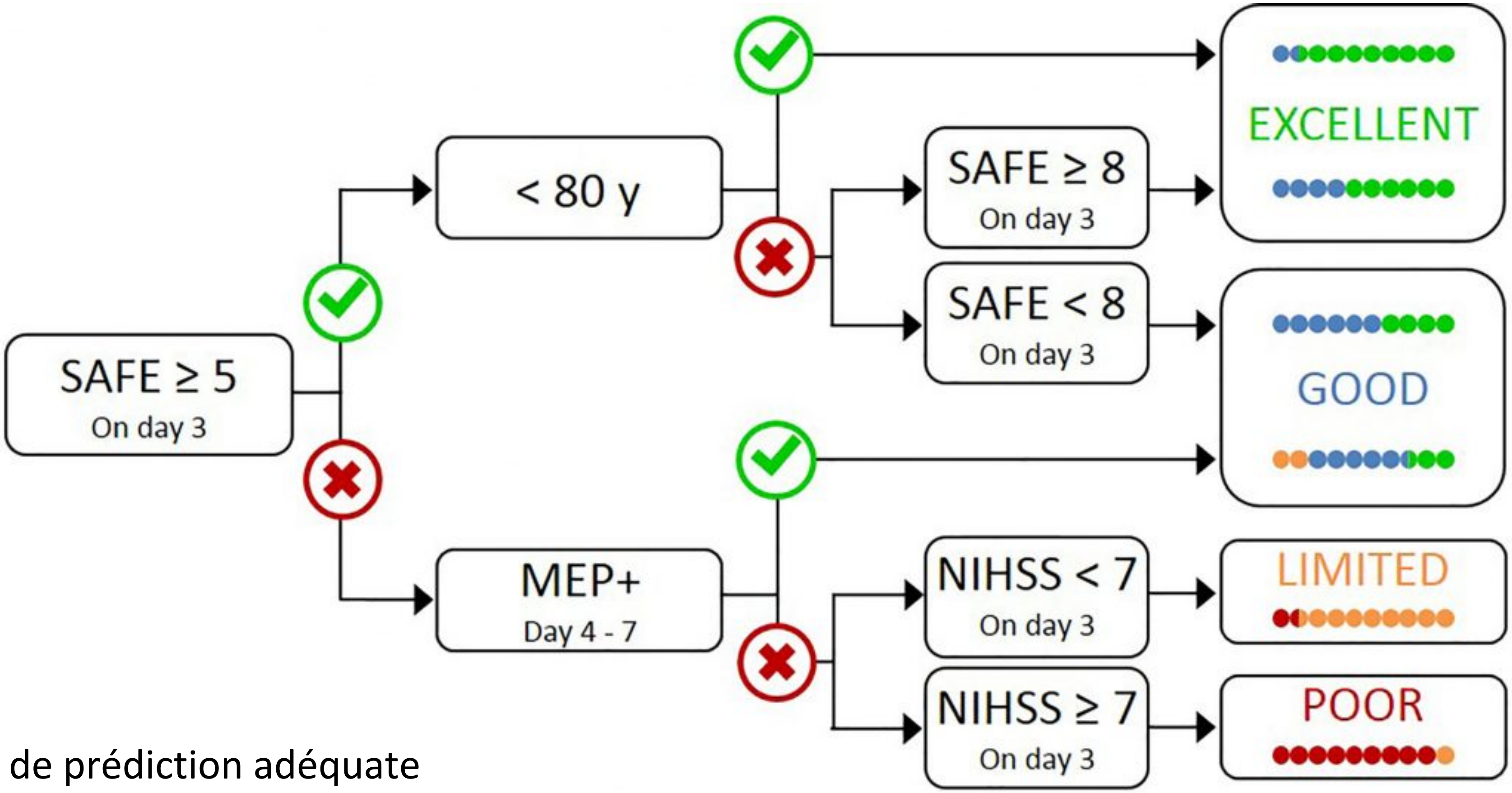


Sensibilité 73%
Spécificité 88%
Valeur prédictive positive 88%
Valeur prédictive négative 83%

Stinear C et al, Brain 2012

PREP2: A biomarker-based algorithm for predicting upper limb function after stroke

Cathy M. Stinear[1,2], Winston D. Byblow[2,3], Suzanne J. Ackerley[1,2], Marie-Claire Smith[1,2], Victor M. Borges[1,2] & P. Alan Barber[1,2,4]



75% de prédiction adéquate

Annals of Clinical and Translational Neurology 2017; 4(11): 811–820

When Does Return of Voluntary Finger Extension Occur Post-Stroke? A Prospective Cohort Study

Caroline Winters[1,2], Gert Kwakkel[1,2,3,4]*, Rinske Nijland[3], Erwin van Wegen[1,2], EXPLICIT-stroke consortium

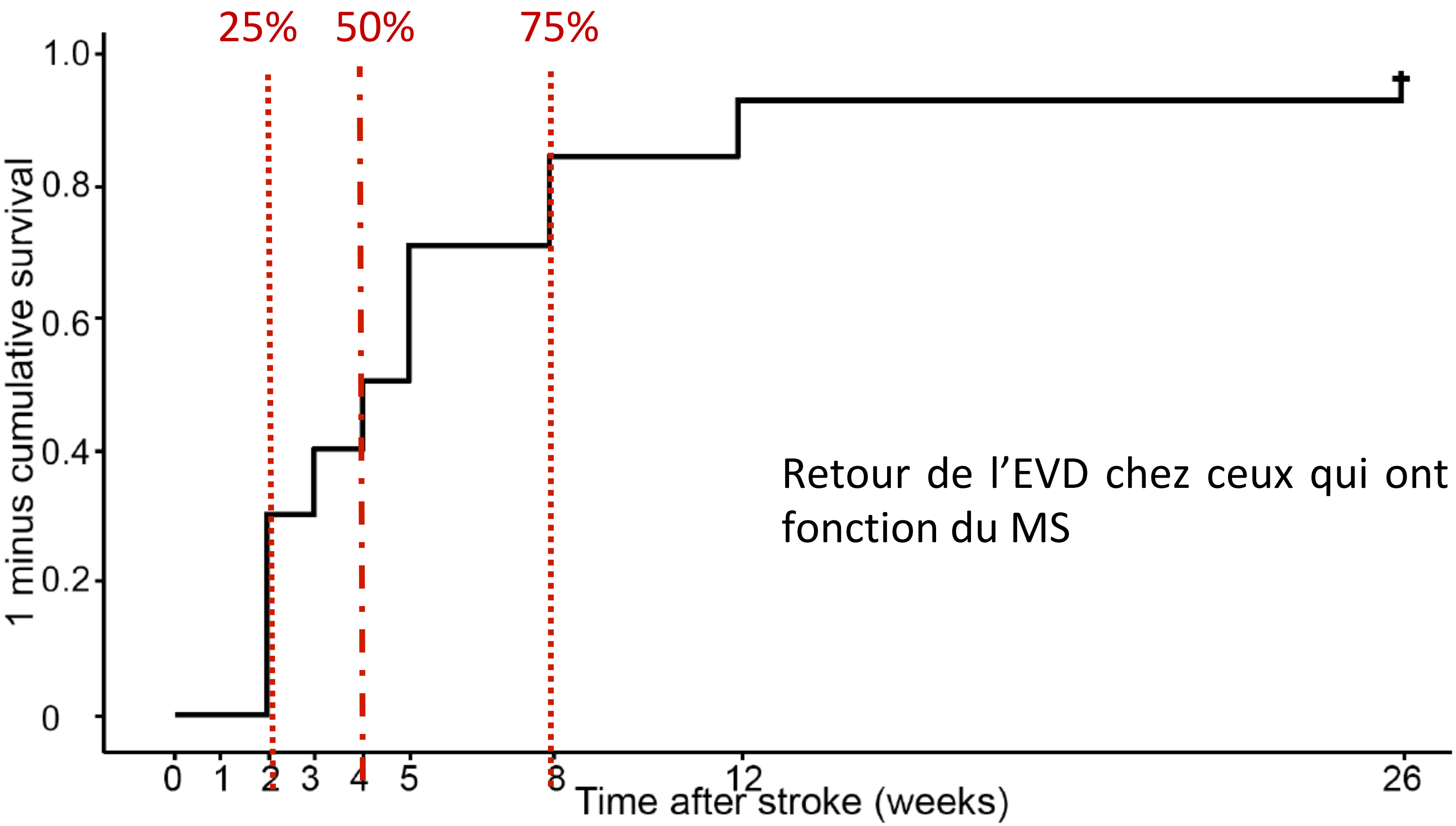
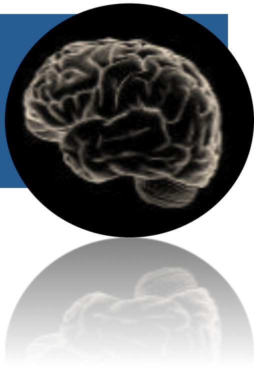


Fig 2. Kaplan-Meier cumulative 'event' curve for recovery of VFE in the group of patients who regain some upper limb capacity at 6 months post-stroke (N = 45). The numbers represent the number of patients with VFE at each time point (Fugl-Meyer Assessment hand sub item FE≥1).

PLOS ONE | DOI:10.1371/journal.pone.0160528 August 5, 2016

Y-A-T-IL DES TECHNIQUES SPÉCIFIQUES?

Efficacité de la rééducation après AVC



- **Consensus des études épidémiologiques**
  - *Ottenbacher et al. Stroke 1993,*
  - *Kwakkel et al, Stroke 2004,*
  - *Langhorne 2011,*
  - *Veerbeek 2014)*
- ***Methodologie de qualité croissante***
  - *Pedro score median = 4 avant 2004*
  - *Pedro score median = 6 après 2004*
- ***Des conclusions constantes***

What Is the Evidence for Physical Therapy Poststroke? A Systematic Review and Meta-Analysis

Janne Marieke Veerbeek[1], Erwin van Wegen[1], Roland van Peppen[2], Philip Jan van der Wees[3], Erik Hendriks[4], Marc Rietberg[1], Gert Kwakkel[1,5]*

1 Department of Rehabilitation Medicine, MOVE Research Institute Amsterdam, VU University Medical Center, Amsterdam, The Netherlands, 2 Department of Physiotherapy, University of Applied Sciences Utrecht, Utrecht, The Netherlands, 3 Scientific Institute for Quality of Healthcare (IQ healthcare), Radboud University Nijmegen Medical Center, Nijmegen, The Netherlands, 4 Department of Epidemiology, Maastricht University, Maastricht, The Netherlands, 5 Department of Neurorehabilitation, Reade Center for Rehabilitation and Rheumatology, Amsterdam, The Netherlands

Abstract

Background: Physical therapy (PT) is one of the key disciplines in interdisciplinary stroke rehabilitation. The aim of this systematic review was to provide an update of the evidence for stroke rehabilitation interventions in the domain of PT.

Methods and Findings: Randomized controlled trials (RCTs) regarding PT in stroke rehabilitation were retrieved through a systematic search. Outcomes were classified according to the ICF. RCTs with a low risk of bias were quantitatively analyzed. Differences between phases poststroke were explored in subgroup analyses. A best evidence synthesis was performed for neurological treatment approaches. The search yielded 467 RCTs (N = 25373; median PEDro score 6 [IQR 5–7]), identifying 53 interventions. No adverse events were reported. Strong evidence was found for significant positive effects of 13 interventions related to gait, 11 interventions related to arm-hand activities, 1 intervention for ADL, and 3 interventions for physical fitness. Summary Effect Sizes (SESs) ranged from 0.17 (95%CI 0.03–0.70; $I^2 = 0\%$) for therapeutic positioning of the paretic arm to 2.47 (95%CI 0.84–4.11; $I^2 = 77\%$) for training of sitting balance. There is strong evidence that a higher dose of practice is better, with SESs ranging from 0.21 (95%CI 0.02–0.39; $I^2 = 6\%$) for motor function of the paretic arm to 0.61 (95%CI 0.41–0.82; $I^2 = 41\%$) for muscle strength of the paretic leg. Subgroup analyses yielded significant differences with respect to timing poststroke for 10 interventions. Neurological treatment approaches to training of body functions and activities showed equal or unfavorable effects when compared to other training interventions. Main limitations of the present review are not using individual patient data for meta-analyses and absence of correction for multiple testing.

Conclusions: There is strong evidence for PT interventions favoring intensive high repetitive task-oriented and task-specific training in all phases poststroke. Effects are mostly restricted to the actually trained functions and activities. Suggestions for prioritizing PT stroke research are given.

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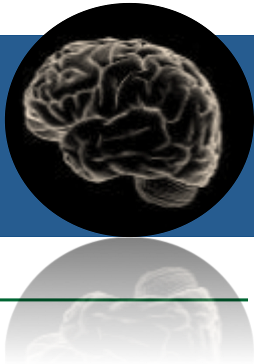
médecine physique et de réadaptation

Efficacité de la rééducation après AVC



- ***Rééducation améliore***
  - *Performance motrice*
  - *Marche*
  - *Autonomie : ADL*

- **Facteurs d'efficacité :**
  - Précocité :
    - Incertitude sur la première semaine
  - Intensité :
    - Tous les jours > 3 fois par semaine
    - 3H/j > 30mn/j
    - 3H>6H
  - Equipe Multidisciplinaire
    - Kiné
    - Ergo
    - Ortho

Stroke Care 2

Stroke rehabilitation

Peter Langhorne, Julie Bernhardt, Gert Kwakkel

Stroke is a common, serious, and disabling global health-care problem, and rehabilitation is a major part of patient care. There is evidence to support rehabilitation in well coordinated multidisciplinary stroke units or through provision of early supported provision of discharge teams. Potentially beneficial treatment options for motor recovery of the arm include constraint-induced movement therapy and robotics. Promising interventions that could be beneficial to improve aspects of gait include fitness training, high-intensity therapy, and repetitive-task training. Repetitive-task training might also improve transfer functions. Occupational therapy can improve activities of daily living; however, information about the clinical effect of various strategies of cognitive rehabilitation and strategies for aphasia and dysarthria is scarce. Several large trials of rehabilitation practice and of novel therapies (eg, stem-cell therapy, repetitive transcranial magnetic stimulation, virtual reality, robotic therapies, and drug augmentation) are underway to inform future practice.

Lancet 2011; 377: 1693–702

See Editorial page 1625

See World Report page 1639

This is the second in a Series of two papers about stroke care

Academic Section of Geriatric Medicine, Institute of Cardiovascular and Medical Sciences, University of Glasgow, Royal Infirmary, Glasgow, UK (Prof P Langhorne PhD); Stroke

Panel 2: **Summary of evidence for complex rehabilitation interventions (delivered by a service or therapist) and their recommendation in clinical guidelines**

Beneficial or likely to be beneficial

- Multidisciplinary stroke-unit care to improve independence;[15,16] recommended (A)
- Early supported discharge services to improve independence;[17,18] recommended (A)
- Therapy-based rehabilitation services at home (within 1 year of stroke) to improve ADL;[19] recommended (A,B)
- Outpatient (day-hospital, community team) rehabilitation services to improve ADL;[20] selected use (A,B)
- Rehabilitation services in long-term care settings to improve ADL;[21] not mentioned or selected use (B)
- Occupational therapy services to improve ADL;[22] recommended (A,B)
- Occupational therapy services at home to improve ADL and extended ADL;[23] recommended (A)

LES TECHNIQUES D’HIER

La méthode Bobath

- Méthode globale (1970)
- Initialement développée chez le paralysé cérébral
- Proposée chez l'hémiplégique
- Hiérarchie développementale
- Prohibition de l'exercice physique et du renforcement musculaire
- Membre sup :
  - Proximo-distale : l'épaule, coude, main
  - Tardif pour la main
  - Mouvements non finalisés

Brunstrom

- Globale
- Utilisation des réflexes pour récupérer une motricité volontaire
- ..l'opposé de Bobath

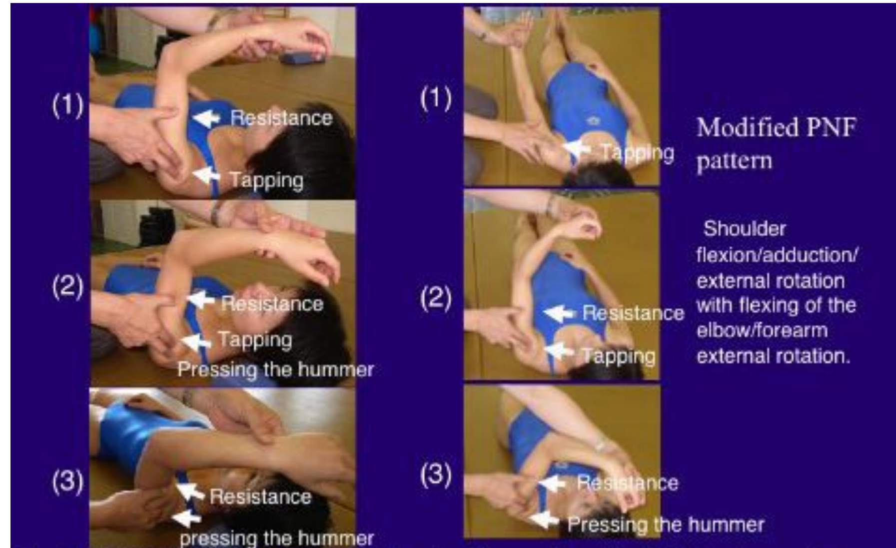


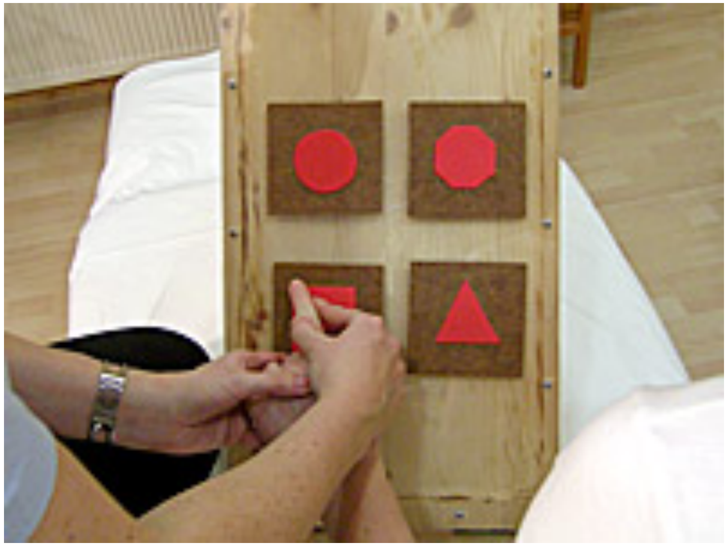
Fig. 7 Facilitation to elicit flexion of the shoulder and modified PNF pattern, using tapping and rubbing on target muscle.

(Kawahira K, et al: J Rehab Med 36: 159, 2004)

Fig. 8 Repetition of facilitation exercise on hemiplegic lower limb and functional evaluation

Perfetti

- Méthode sensori-motrice
- Mouvement finalisé
  - Stade I : Mobilisation proprioceptive les yeux fermés.
  - Stade II : mouvement actif aidé yeux fermé
  - Stade III : mouvement actif yeux ouvert.
- Compréhension suffisante
- Sensibilité suffisante



Quelles techniques ?

- **Plusieurs techniques, des concepts très différents:**

  Bobath

  Brunnstrom

  Perfetti…

⇨ ***Mais pas de différence entre les techniques** (11 essais comparatifs, Cochrane database review 2004)*

The Effectiveness of the Bobath Concept in Stroke Rehabilitation

What is the Evidence?

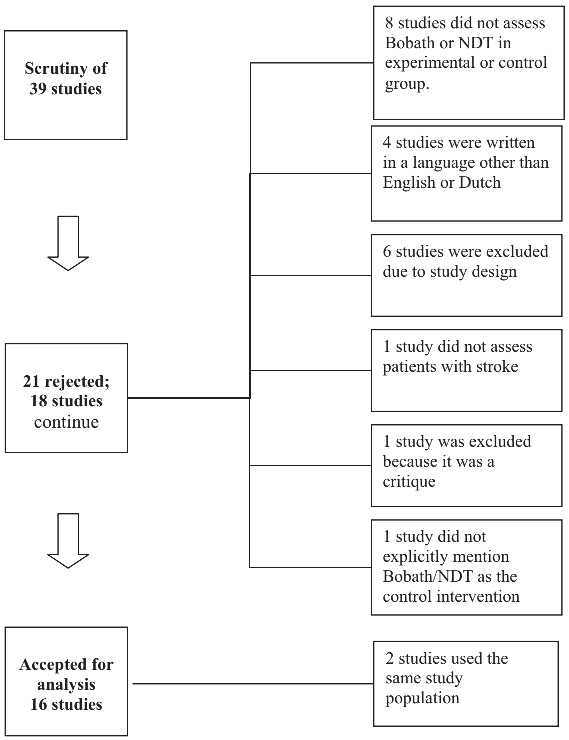
Boudewijn J. Kollen, PhD; Sheila Lennon, PhD; Bernadette Lyons, MSc; Laura Wheatley-Smith, BSc; Mark Scheper, MSc; Jaap H. Buurke, PhD; Jos Halfens; Alexander C.H. Geurts, MD, PhD; Gert Kwakkel, PhD

Background and Purpose—In the Western world, the Bobath Concept or neurodevelopmental treatment is the most popular treatment approach used in stroke rehabilitation, yet the superiority of the Bobath Concept as the optimal type of treatment has not been established. This systematic review of randomized, controlled trials aimed to evaluate the available evidence for the effectiveness of the Bobath Concept in stroke rehabilitation.

Method—A systematic literature search was conducted in the bibliographic databases MEDLINE and CENTRAL (March 2008) and by screening the references of selected publications (including reviews). Studies in which the effects of the Bobath Concept were investigated were classified into the following domains: sensorimotor control of upper and lower limb; sitting and standing, balance control, and dexterity; mobility; activities of daily living; health-related quality of life; and cost-effectiveness. Due to methodological heterogeneity within the selected studies, statistical pooling was not considered. Two independent researchers rated all retrieved literature according to the Physiotherapy Evidence Database (PEDro) scale from which a best evidence synthesis was derived to determine the strength of the evidence for both effectiveness of the Bobath Concept and for its superiority over other approaches.

Results—The search strategy initially identified 2263 studies. After selection based on predetermined criteria, finally, 16 studies involving 813 patients with stroke were included for further analysis. There was no evidence of superiority of Bobath on sensorimotor control of upper and lower limb, dexterity, mobility, activities of daily living, health-related quality of life, and cost-effectiveness. Only limited evidence was found for balance control in favor of Bobath. Because of the limited evidence available, no best evidence synthesis was applied for the health-related quality-of-life domain and cost-effectiveness.

Conclusions—This systematic review confirms that overall the Bobath Concept is not superior to other approaches. Based on best evidence synthesis, no evidence is available for the superiority of any approach. This review has highlighted many methodological shortcomings in the studies reviewed; further high-quality trials need to be published. Evidence-based guidelines rather than therapist preference should serve as a framework from which therapists should derive the most effective treatment. **(*Stroke*. 2009;40:e89-e97.)**



LES TECHNIQUES D’AUJOURD’HUI

La base

- Lutter contre les douleurs
- Mobiliser
- Entretenir la mobilité articulaire
- Étirements postures

Dexterity in the mobilization phase

Therapeutic positioning of the paretic arm

93 ◖ It has been demonstrated that therapeutic positioning of the paretic arm results in preservation of the passive exorotation of the shoulder of patients with a stroke. (Level 1)

Studied for ER (✓).

Continuous passive motion (CPM) for the shoulder

118 ◐ It is plausible that the use of a continuous passive motion (CPM) device by patients with a stroke is not more effective in terms of the stability of the shoulder joint, muscle strength, selective movements, resistance to passive movements, pain, and performance of basic activities of daily living than other interventions. (Level 2)

Studied for ER (=).

Les bases

- Favoriser les mouvements actifs
- Orienter vers la tâche : pointage et préhension
- l’activité : cuisiner, ADL….
- Personnalisé : adapté aux capacités du patient = évaluation
- Kinésithérapie
- Ergothérapie

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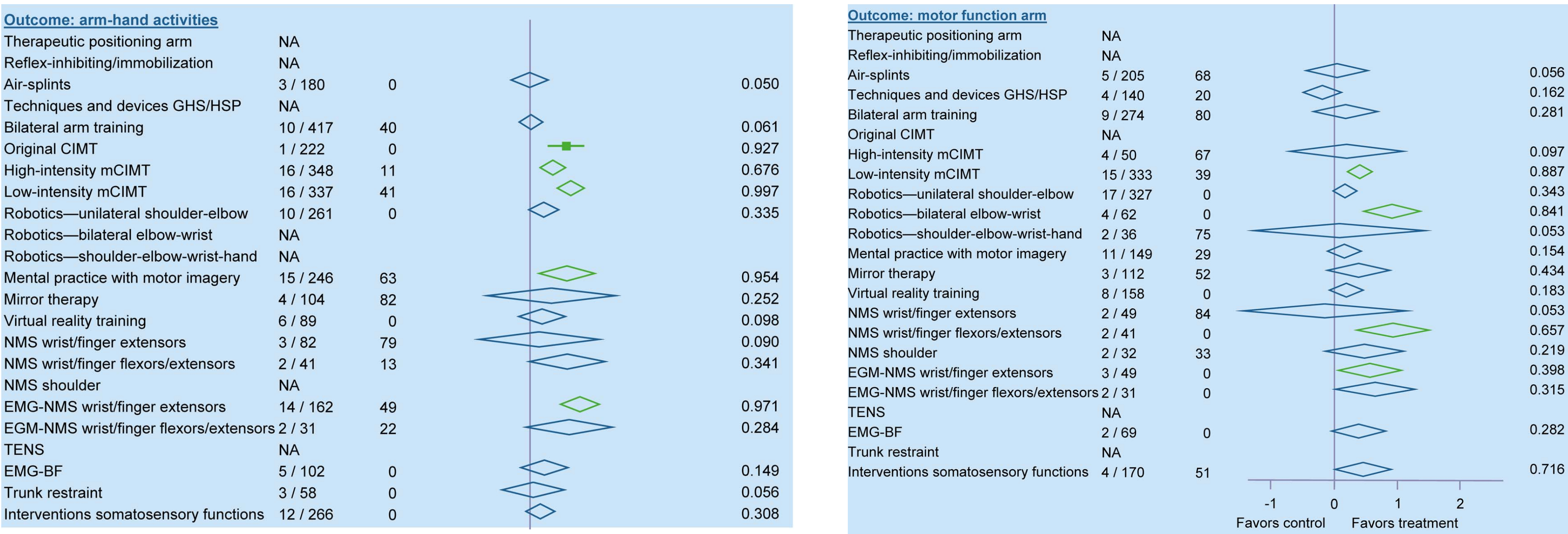
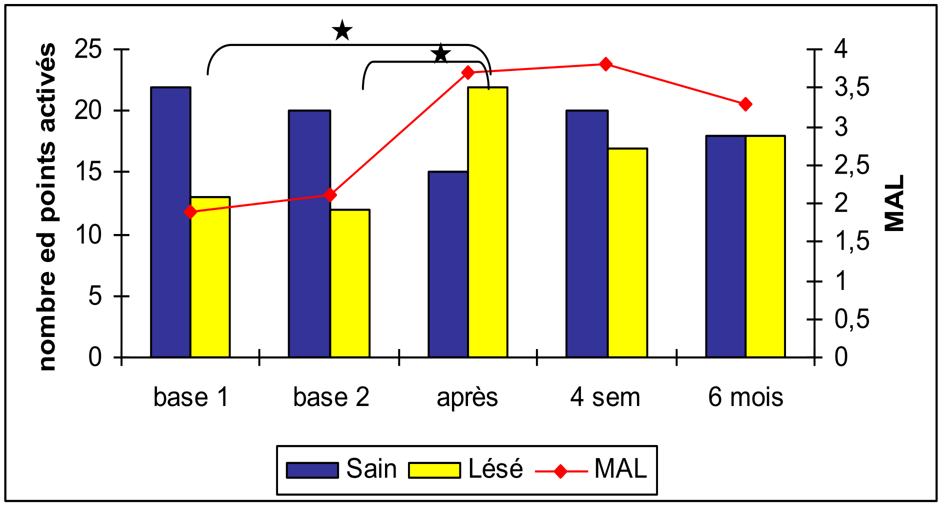
What Is the Evidence for Physical Therapy Poststroke? A Systematic Review and Meta-Analysis

Janne Marieke Veerbeek[1], Erwin van Wegen[1], Roland van Peppen[2], Philip Jan van der Wees[3], Erik Hendriks[4], Marc Rietberg[1], Gert Kwakkel[1,5]*



Thérapie contrainte



Liepert et al. 2000

Original CIMT	1 / 222	0	0.927
High-intensity mCIMT	16 / 348	11	0.676
Low-intensity mCIMT	16 / 337	41	0.997

- Déficit modéré
- Souvent impossible initialement
- Orienté vers la tâche

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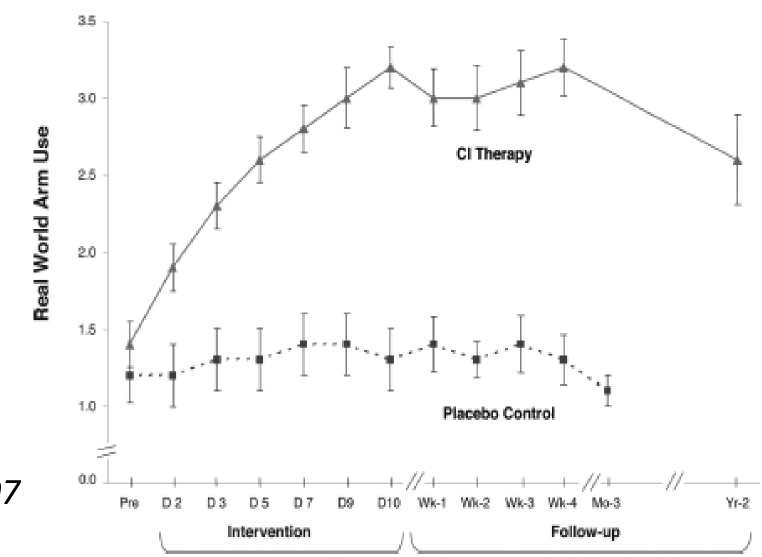


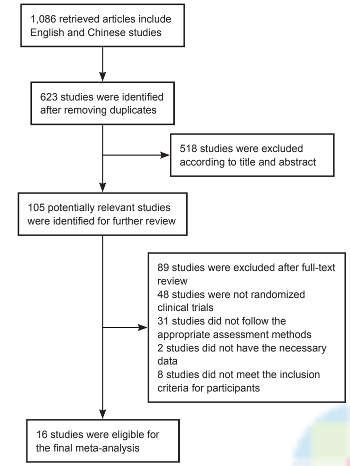
Taub et al, 2007

NEURAL REGENERATION RESEARCH
September 2017, Volume 12, Issue 9
www.nrronline.org

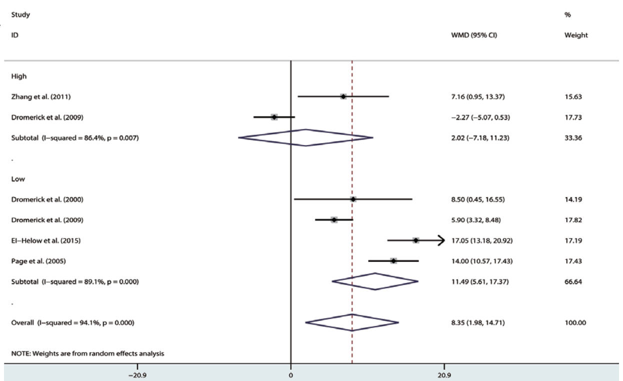
RESEARCH ARTICLE

Constraint-induced movement therapy in treatment of acute and sub-acute stroke: a meta-analysis of 16 randomized controlled trials

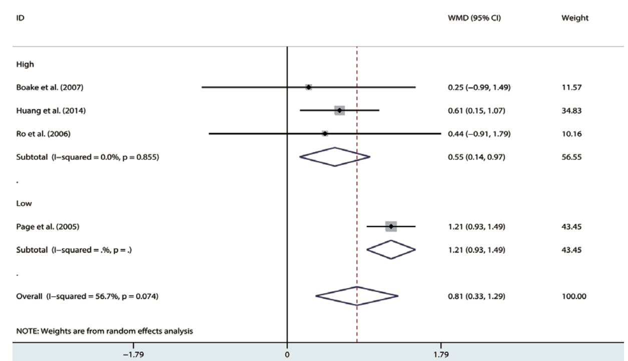
Xi-hua Liu[1, 2, #], Juan Huai[1, #], Jie Gao[3], Yang Zhang[1], Shou-wei Yue[1, *]
1 Department of Physical Medicine & Rehabilitation, Qilu Hospital, Shandong University, Jinan, Shandong Province, China
2 Department of Physical Medicine & Rehabilitation, The Affiliated Hospital of Shandong Traditional Chinese Medicine University, Jinan, Shandong Province, China
3 Shandong Institute of Prevention and Control for Endemic Disease, Jinan, Shandong Province, China



A

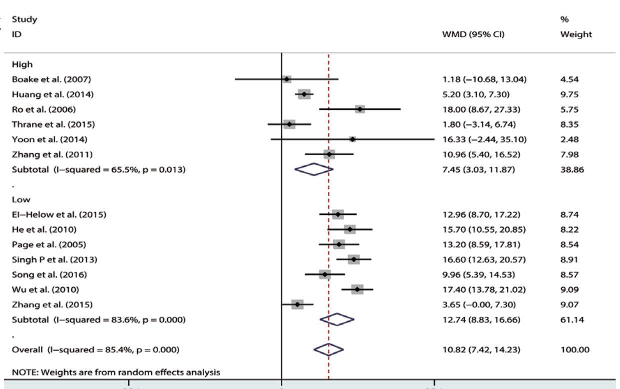


ARAT

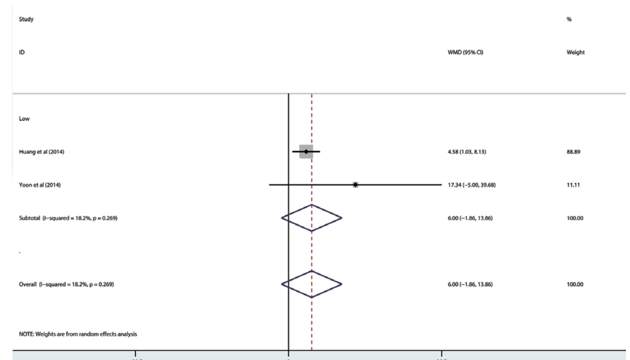


Qualité du mouvement

C



Fugl Meyer



WMFT

'Original' Constraint-Induced Movement Therapy (CIMT)
98 It has been demonstrated that original CIMT improves the dexterity, perceived use of arm and hand, quality of arm and hand movements, and quality of life of patients with a stroke. (Level 1)
Studied for LR (✓).

High-intensity modified Constraint-Induced Movement Therapy (mCIMT)
99 It has been demonstrated that high-intensity CIMT improves the dexterity, perceived use of arm and hand, and quality of arm and hand movements of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Low-intensity modified Constraint-Induced Movement Therapy (mCIMT)
100 It has been demonstrated that low-intensity mCIMT improves the selective movements, dexterity, perceived use of arm and hand, quality of arm and hand movements, and performance of basic activities of daily living of patients with a stroke. (Level 1)
Selective movements studied for ER (✓) and RC (✓), dexterity for ER (✓), LR (✓), and RC (✓) and perceived use and quality of movements for ER (✓), LR (✓), and RC (✓).

Rééducation assistée par robotique

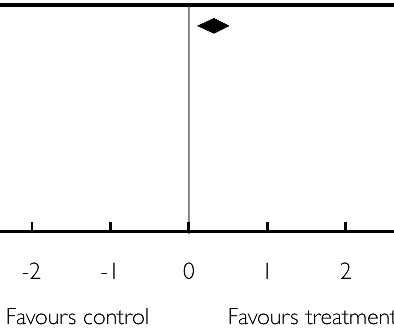
(. . . *Continued*)

Study or subgroup	Treatment		Control		Std. Mean Difference	Weight	Std. Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI		IV,Random,95% CI
Total (95% CI)	**488**		**469**			**100.0 %**	**0.31 [0.09, 0.52]**

Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 55.54$, df = 23 (P = 0.00016); $I^2 = 59\%$

Test for overall effect: Z = 2.82 (P = 0.0049)

Test for subgroup differences: Not applicable



Mehrholz J, Pohl M, Platz T, Kugler J, Elsner B.
Electromechanical and robot-assisted arm training for improving activities of daily living, arm function, and arm muscle strength after stroke. *Cochrane Database of Systematic Reviews* 2018, Issue 9. Art. No.: CD006876.

Effects of Robot-Assisted Therapy for the Upper Limb After Stroke: A Systematic Review and Meta-analysis

Neurorehabilitation and Neural Repair
2017, Vol. 31(2) 107–121
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DOI: 10.1177/1545968316666957
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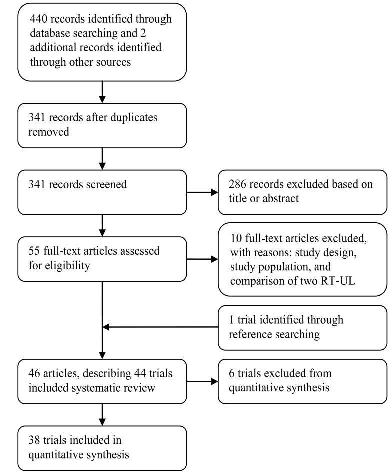
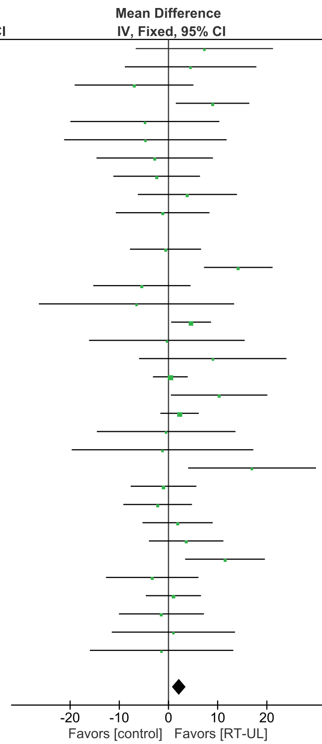
SAGE



Janne M. Veerbeek, PhD[1,2,3], Anneli C. Langbroek-Amersfoort, MSc[4], Erwin E. H. van Wegen, PhD[1,2,3], Carel G. M. Meskers, PhD, MD[1,2,3,5], and Gert Kwakkel, PhD[1,2,3,5,6]

	Experimental			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Aisen, 1997	31.2	15.18	10	23.9	16.64	10	1.0%	7.30 [-6.66, 21.26]
Ang, 2014	32.8	11.5	8	28.3	14.5	7	1.0%	4.50 [-8.87, 17.87]
Araújo de, 2011	40.83	6.15	6	47.83	13.78	6	1.3%	-7.00 [-19.07, 5.07]
Brokaw, 2014	27.57	8.77	7	18.6	4.22	5	3.3%	8.97 [1.49, 16.45]
Burgar, 2011	33.4	15.26	17	38.2	20.36	9	0.8%	-4.80 [-19.95, 10.35]
Burgar, 2011	33.5	21.79	19	38.2	20.36	9	0.7%	-4.70 [-21.22, 11.82]
Byl, 2013	27.8	7.92	5	30.6	6.92	2	1.3%	-2.80 [-14.64, 9.04]
Byl, 2013	28.2	4.6	5	30.6	6.92	3	2.4%	-2.40 [-11.21, 6.41]
Conroy, 2011	23.24	14.7	20	19.39	12.5	10	1.8%	3.85 [-6.23, 13.93]
Conroy, 2011	18.2	10.6	18	19.39	12.5	9	2.0%	-1.19 [-10.71, 8.33]
Daly, 2005	30.5	6.38	0	32.5	7.06	6		Not estimable
Fasoli, 2004	15.7	10.95	30	16.3	15.81	26	3.5%	-0.60 [-7.83, 6.63]
Hesse, 2005	24.6	14.9	22	10.4	7.5	22	3.8%	14.20 [7.23, 21.17]
Hesse, 2014	25.7	16.5	25	31.1	19.1	25	1.9%	-5.40 [-15.29, 4.49]
Hollestein 2011	20.5	12.8	7	27	21.8	6	0.5%	-6.50 [-26.35, 13.35]
Housman, 2009	24.9	5.9	14	20.3	5	14	11.3%	4.60 [0.55, 8.65]
Hsieh, 2011	40	10.47	6	40.33	11.86	3	0.7%	-0.33 [-16.15, 15.49]
Hsieh, 2011	49.33	8.34	6	40.33	11.86	3	0.8%	9.00 [-5.99, 23.99]
Klamroth-Marganska, 2014	23.65	7.1	38	23.27	8.2	35	14.9%	0.38 [-3.15, 3.91]
Liao, 2012	51.2	8.82	10	40.9	13.14	10	1.9%	10.30 [0.49, 20.11]
Lo, 2010	23.57	10.7	47	21.31	8.4	46	12.2%	2.26 [-1.65, 6.17]
Lum, 2002	29.46	17.99	13	29.93	19.38	14	0.9%	-0.47 [-14.57, 13.63]
Masiero, 2011	42.66	15.79	11	43.87	25.72	10	0.5%	-1.21 [-19.68, 17.26]
Masiero, 2014	56	9.64	14	39	24.46	16	1.1%	17.00 [3.99, 30.01]
McCabe, 2015	31.3	6.2	6	32.3	7.9	12	4.2%	-1.00 [-7.68, 5.68]
McCabe, 2015	31.3	6.2	6	33.5	8.3	11	3.8%	-2.20 [-9.18, 4.78]
Page, 2013	22.86	7.01	8	21	7.54	8	3.6%	1.86 [-5.27, 8.99]
Reinkensmeyer, 2012	27.4	11.4	13	23.8	8	13	3.2%	3.60 [-3.97, 11.17]
Sale, 2014 (II)	35.46	12.24	26	23.96	17.51	27	2.8%	11.50 [3.39, 19.61]
Susanto, 2015	37	12.48	9	40.3	7.54	10	2.1%	-3.30 [-12.70, 6.10]
Timmermans, 2014	55	7.41	11	54	5.93	11	5.9%	1.00 [-4.61, 6.61]
Wu, 2012	47.14	10.97	14	48.57	12.32	14	2.5%	-1.43 [-10.07, 7.21]
Yang, 2012	47	8.4	7	46	11.1	4	1.2%	1.00 [-11.53, 13.53]
Yang, 2012	44.6	10	7	46	11.1	3	0.9%	-1.40 [-15.98, 13.18]
Total (95% CI)			**465**			**419**	**100.0%**	**2.23 [0.87, 3.59]**

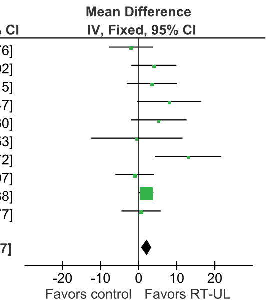
Heterogeneity: Chi² = 45.95, df = 32 (P = 0.05); I² = 30%
Test for overall effect: Z = 3.21 (P = 0.001)



Motor control

	Experimental			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Lum, 2006	21.5	2.5	10	23.5	4	2	6.1%	-2.00 [-7.76, 3.76]
Lum, 2006	27.5	3.2	9	23.5	4	2	5.8%	4.00 [-1.92, 9.92]
Lum, 2006	27	4.2	5	23.5	4	2	4.6%	3.50 [-3.15, 10.15]
Masiero, 2006	21.1	8.9	10	13.1	10.38	10	2.8%	8.00 [-0.47, 16.47]
Masiero, 2007	12.8	7.64	15	7.5	12.23	15	3.8%	5.30 [-2.00, 12.60]
Masiero, 2011	29.33	9.86	11	29.87	17.05	10	1.4%	-0.54 [-12.61, 11.53]
Masiero, 2014	35	6.67	14	22	16.31	16	2.7%	13.00 [4.28, 21.72]
Rabadi, 2008	8.03	5.57	10	9.05	6.04	10	7.8%	-1.02 [-6.11, 4.07]
Volpe, 2000	12	3	30	10	4	26	57.5%	2.00 [0.12, 3.88]
Volpe, 2008	15.73	6.63	11	15.1	5.38	10	7.6%	0.63 [-4.51, 5.77]
Total (95% CI)			**125**			**103**	**100.0%**	**2.15 [0.73, 3.57]**

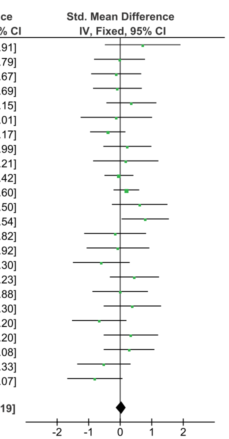
Heterogeneity: Chi² = 13.06, df = 9 (P = 0.16); I² = 31%
Test for overall effect: Z = 2.96 (P = 0.003)



Proximal motor control

	Experimental			Control				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Brokaw, 2014	26.71	12.6	7	19	3.32	5	1.7%	0.71 [-0.49, 1.91]
Burgar, 2011	-55.2	70.09	17	-53.6	76.37	9	3.7%	-0.02 [-0.83, 0.79]
Burgar, 2011	-64.2	82.82	19	-53.6	76.37	9	3.8%	-0.13 [-0.92, 0.67]
Conroy, 2011	-84.25	35.7	18	-81.09	33.3	10	4.0%	-0.09 [-0.86, 0.69]
Conroy, 2011	-67.12	40.2	20	-81.09	33.3	9	3.8%	0.35 [-0.44, 1.15]
Daly, 2005	-1,648	314.4	6	-1,593	496.7	6	1.9%	-0.12 [-1.26, 1.01]
Hesse, 2014	14.1	15.5	25	20.3	15.4	25	7.6%	-0.39 [-0.96, 0.17]
Hu, 2009	26	11.1	15	23.4	11.1	12	4.1%	0.23 [-0.53, 0.99]
Hwang, 2012	-76	87	9	-98.5	159.6	6	2.2%	0.18 [-0.86, 1.21]
Klamroth-Marganska, 2014	-60.5	23	38	-59.44	29	35	11.3%	-0.04 [-0.50, 0.42]
Lo, 2010	-62.44	37.7	47	-69.21	30.4	46	14.4%	0.20 [-0.21, 0.60]
Masiero, 2011	24.83	10.38	11	17.8	11.49	10	3.1%	0.62 [-0.26, 1.50]
Masiero, 2014	22	6.67	14	14	11.86	16	4.3%	0.79 [0.05, 1.54]
McCabe, 2015	-1,463	573	6	-1,367	566	12	2.5%	-0.16 [-1.14, 0.82]
McCabe, 2015	-1,463	573	6	-1,417	637	11	2.4%	-0.07 [-1.07, 0.92]
Rabadi, 2008	62.21	4.9	10	65.44	5.41	10	2.9%	-0.60 [-1.50, 0.30]
Reinkensmeyer, 2012	2	4.1	13	0.6	1.1	13	3.9%	0.45 [-0.33, 1.23]
Sale, 2014 (I)	9.09	13.5	11	9.11	12.02	9	3.1%	-0.00 [-0.88, 0.88]
Susanto, 2015	31.33	8.01	9	28.5	5.95	10	2.9%	0.39 [-0.52, 1.30]
Timmermans, 2014	34	11.86	11	43	14.08	11	3.2%	-0.67 [-1.53, 0.20]
Volpe, 2008	65	6.63	11	62.9	5.06	10	3.2%	0.34 [-0.52, 1.20]
Wu, 2013	-4.51	2.21	18	-5.26	3.26	9	3.7%	0.28 [-0.52, 1.08]
Wu, 2013	-8.79	7.57	18	-5.26	3.26	8	3.3%	-0.52 [-1.36, 0.33]
Yoo, 2013	-43.4	15.9	11	-33.3	6.3	11	3.1%	-0.80 [-1.68, 0.07]
Total (95% CI)			**370**			**312**	**100.0%**	**0.04 [-0.12, 0.19]**

Heterogeneity: Chi² = 23.40, df = 23 (P = 0.44); I² = 2%
Test for overall effect: Z = 0.47 (P = 0.64)



Limb activity

Robot assisted training for the upper limb after stroke (RATULS): a multicentre randomised controlled trial

Helen Rodgers, Helen Bosomworth*, Hermano I Krebs, Frederike van Wijck, Denise Howel, Nina Wilson, Lydia Aird, Natasha Alvarado, Sreeman Andole, David L Cohen, Jesse Dawson, Cristina Fernandez-Garcia, Tracy Finch, Gary A Ford, Richard Francis, Steven Hogg, Niall Hughes, Christopher I Price, Laura Ternent, Duncan L Turner, Luke Vale, Scott Wilkes, Lisa Shaw*

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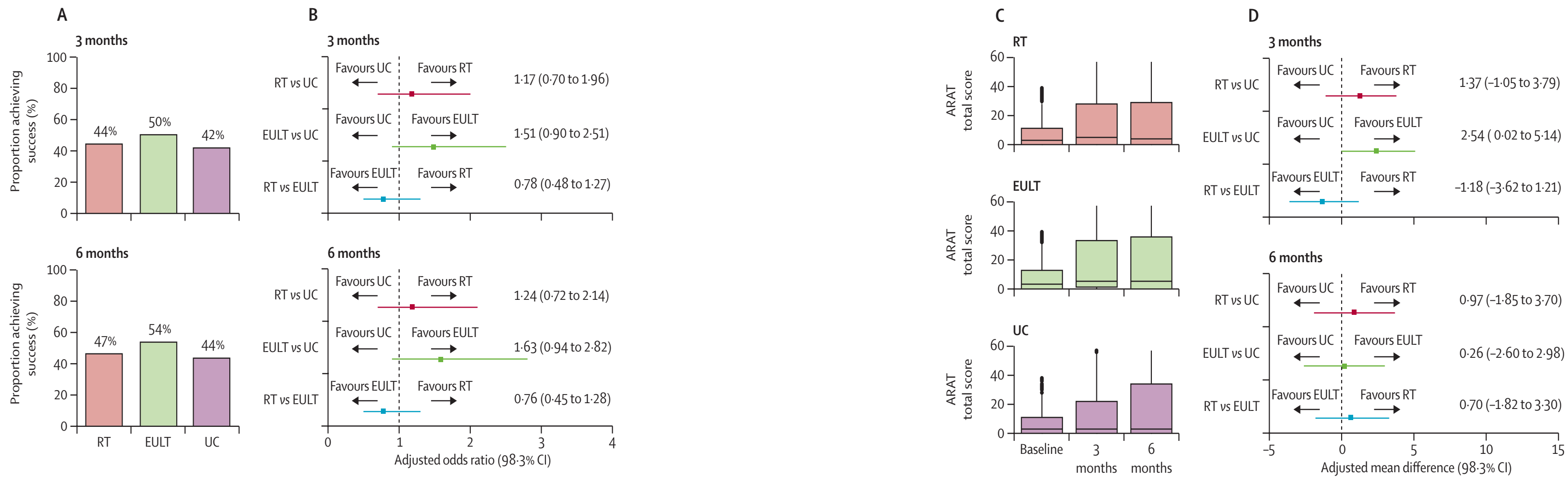
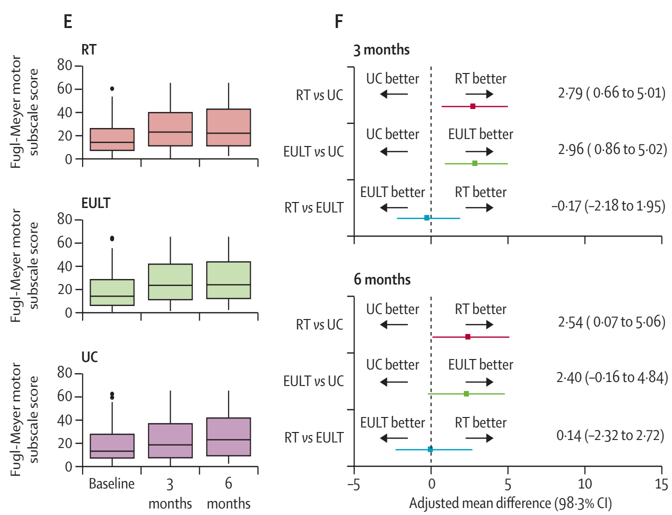
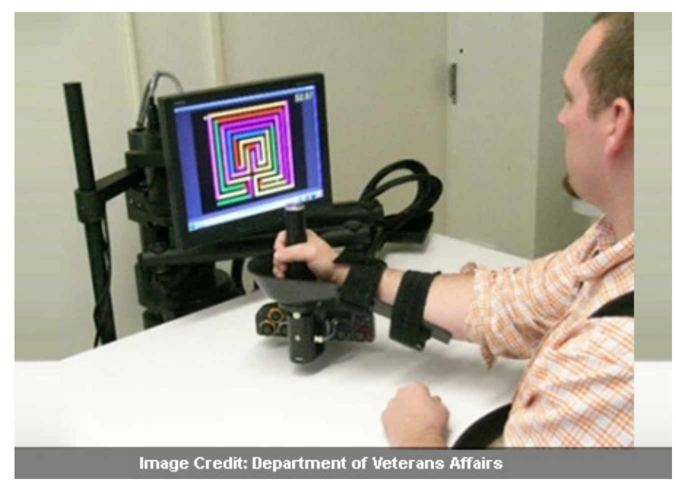


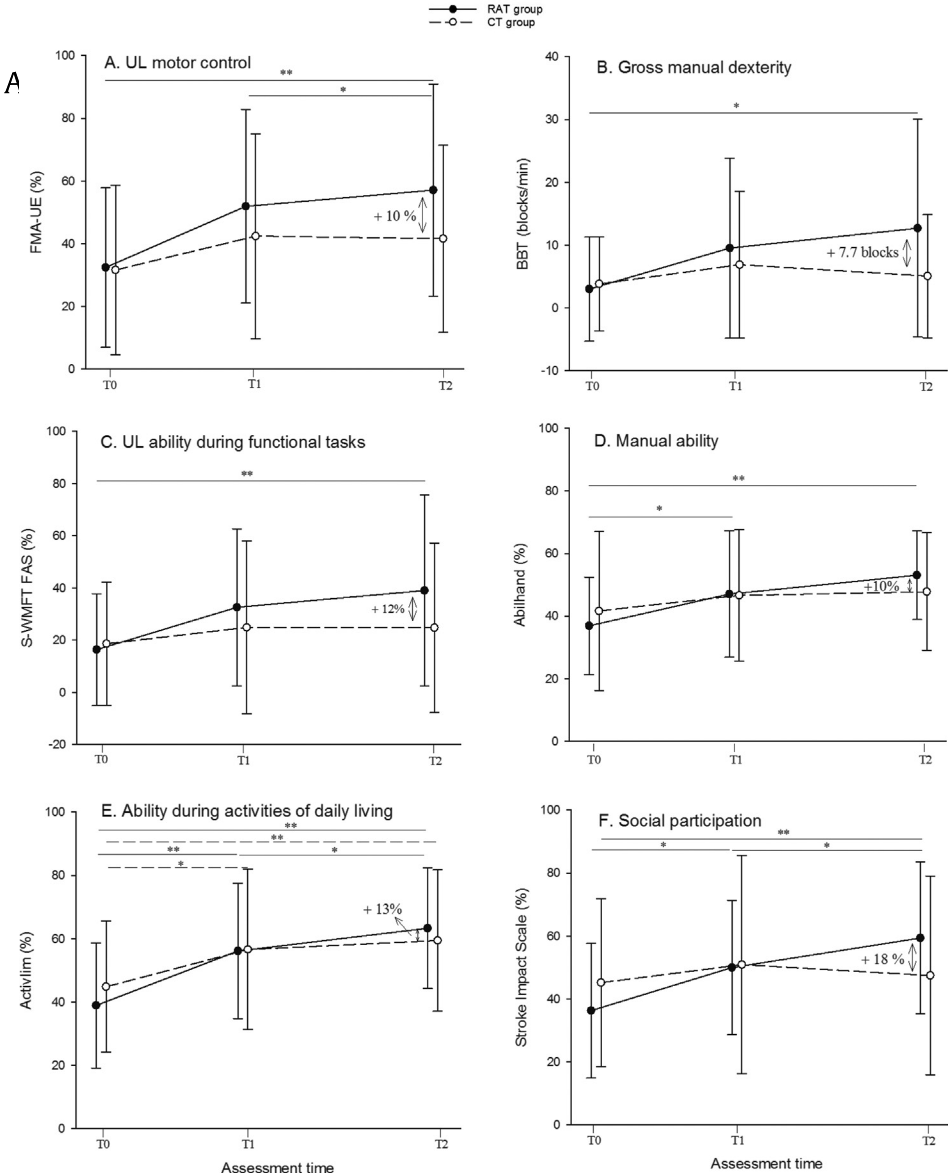
www.thelancet.com Published online May 22, 2019 http://dx.doi.org/10.1016/S0140-6736(19)31055-4





Effectiveness of upper-limb robotic-assisted therapy in the early rehabilitation phase after stroke: A single-blind, randomised, controlled trial

Stéphanie Dehem [a,b,*], Maxime Gilliaux [a,b,c,d], Gaëtan Stoquart [a,b,e], Christine Detrembleur [a,b], Géraldine Jacquemin [f,g], Sara Palumbo [f], A
Thierry Lejeune [a,b,e]



Annals of Physical and Rehabilitation Medicine 62 (2019) 313–320

Robot-assisted training of the paretic arm

102 It has been demonstrated that unilateral robot-assisted training of the paretic shoulder and elbow of patients with a stroke improves the selective movements and muscle strength of the paretic arm and reduces atypical pain in the paretic arm. (Level 1)
Selective movements and muscle strength of the arm studied for ER (✓), LR (✓), and RC (✓), atypical pain for ER (•) and LR (✓).

103 It has been demonstrated that bilateral robot-assisted training of the elbow and wrist improves the selective movements and muscle strength of the arm of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

104 It remains unclear whether robot-assisted training in which the arm and hand are trained simultaneously is more effective for patients with a stroke in terms of selective movements and muscle strength than other interventions. (Level 1)
Studied for ER (=) and RC (=).

de Fysiotherapeut

Royal Dutch Society for Physical Therapy

KNGF Guideline

Stroke

- Pas couramment utilisé en France
- Pourtant de belles descriptions dans la littérature :
  - Hémiplégique
  - tétraplégique

STIMULATIONS ÉLECTRIQUES FONCTIONNELLES

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

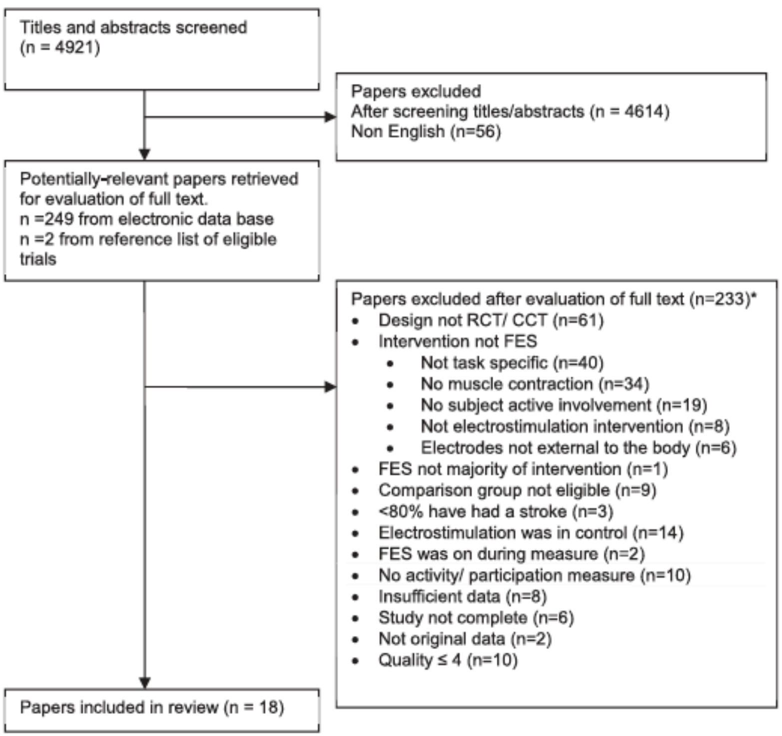
Archives of Physical Medicine and Rehabilitation 2015;96:934-43

REVIEW ARTICLE (META-ANALYSIS)

Functional Electrical Stimulation Improves Activity After Stroke: A Systematic Review With Meta-Analysis

CrossMark

Owen A. Howlett, MaOT,[a,b] Natasha A. Lannin, PhD,[a,c,d] Louise Ada, PhD,[e] Carol McKinstry, PhD[a]



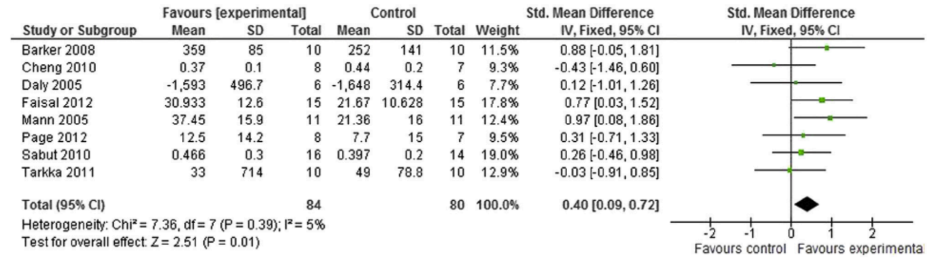


Fig 3 SMD (95% CI) of the effect of FES compared with nil/placebo on activity by pooling data from 8 comparisons (n = 164). Abbreviations: IV, inverse variance; Std., standard.

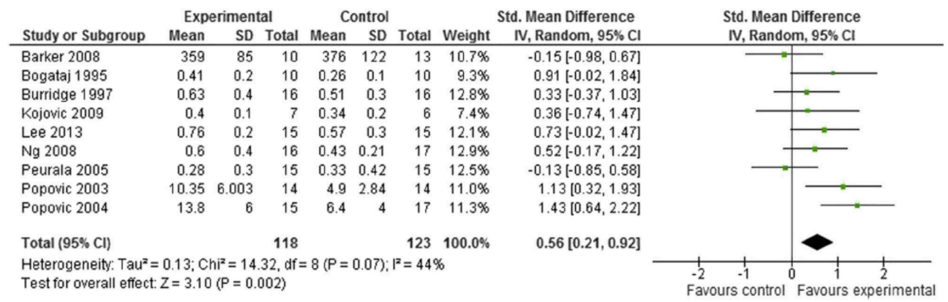


Fig 4 SMD (95% CI) of the effect of FES compared with training alone on activity by pooling data from 9 comparisons (n = 241). Abbreviations: IV, inverse variance; Std., standard.

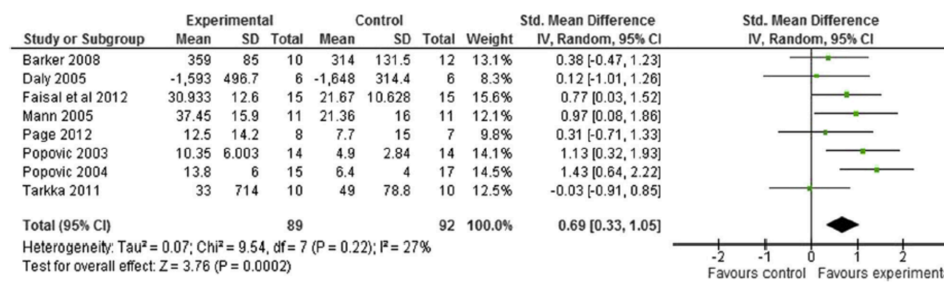


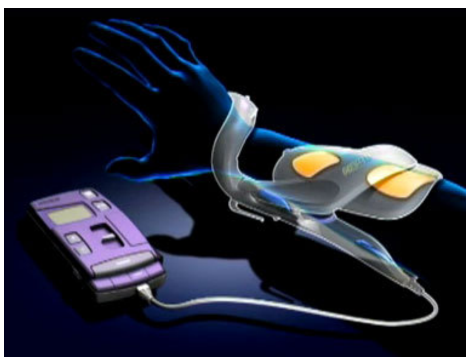
Fig 5 SMD (95% CI) of the effect of upper-limb FES compared with a control on activity by pooling data from 8 comparisons (n = 181). Abbreviations: IV, inverse variance; Std., standard.

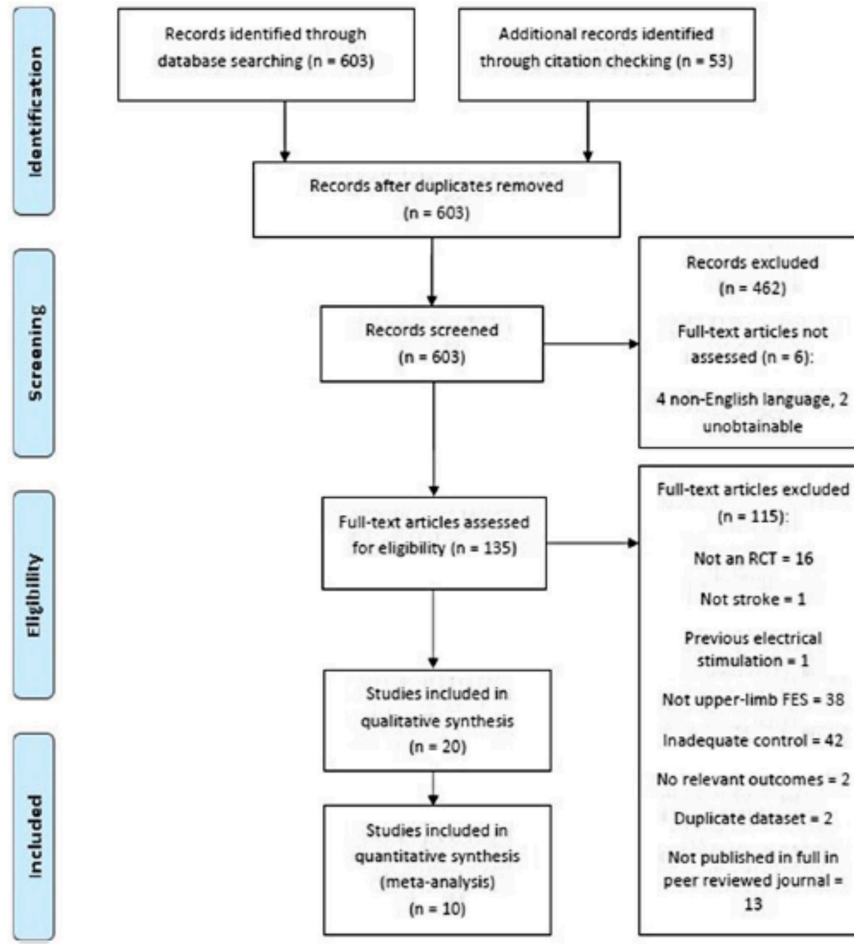
RESEARCH Open Access

Effectiveness of upper limb functional electrical stimulation after stroke for the improvement of activities of daily living and motor function: a systematic review and meta-analysis

John Eraifej[1*†], William Clark[1†], Benjamin France[1†], Sebastian Desando[1†] and David Moore[2]

Eraifej *et al. Systematic Reviews* (2017) 6:40
DOI 10.1186/s13643-017-0435-5





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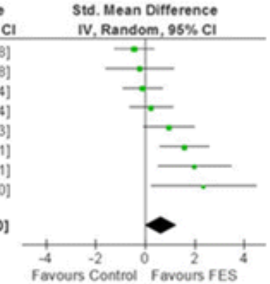
Study or Subgroup		FES Mean	FES SD	FES Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Duarte 2011	CAHAI	27.8	13.1	13	35.4	20.6	11	15.5%	-0.43 [-1.25, 0.38]
Popovic 2002 HFG	UEFT	9.25	1.1	4	9.5	0.95	4	10.7%	-0.21 [-1.61, 1.18]
McCabe 2015	AMAT	1,367	566	12	1,417	637	11	15.4%	-0.08 [-0.90, 0.74]
Chan 2009	FIM	80.2	6.8	10	77.6	12	10	14.9%	0.26 [-0.63, 1.14]
Popovic 2003 HFG	UEFT	18.8	10.9	8	9.6	6.3	8	13.4%	0.98 [-0.08, 2.03]
Thrasher 2008	FIM	30.9	6.57	10	17.91	8.77	11	13.7%	1.60 [0.59, 2.61]
Popovic 2003 LFG	UEFT	1.9	1.1	6	0.2	0.1	6	9.9%	2.01 [0.51, 3.51]
Popovic 2002 LFG	UEFT	6.75	2.28	4	1.5	1.5	4	6.5%	2.37 [0.23, 4.50]
Total (95% CI)				**67**			**65**	**100.0%**	**0.64 [-0.02, 1.30]**

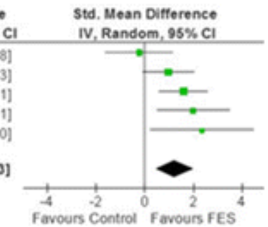
Heterogeneity: $Tau^2 = 0.56$; $Chi^2 = 20.36$, df = 7 (P = 0.005); $I^2 = 66\%$
Test for overall effect: Z = 1.90 (P = 0.06)



b

Study or Subgroup		Favours Control Mean	Favours Control SD	Favours Control Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Popovic 2002 HFG	UEFT	9.25	1.1	4	9.5	0.95	4	19.2%	-0.21 [-1.61, 1.18]
Popovic 2003 HFG	UEFT	18.8	10.9	8	9.6	6.3	8	25.8%	0.98 [-0.08, 2.03]
Thrasher 2008	FIM	30.9	6.57	10	17.91	8.77	11	26.9%	1.60 [0.59, 2.61]
Popovic 2003 LFG	UEFT	1.9	1.1	6	0.2	0.1	6	17.5%	2.01 [0.51, 3.51]
Popovic 2002 LFG	UEFT	6.75	2.28	4	1.5	1.5	4	10.6%	2.37 [0.23, 4.50]
Total (95% CI)				**32**			**33**	**100.0%**	**1.24 [0.46, 2.03]**

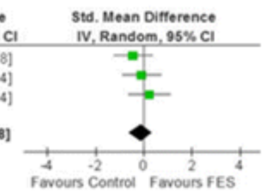
Heterogeneity: $Tau^2 = 0.33$; $Chi^2 = 6.96$, df = 4 (P = 0.14); $I^2 = 43\%$
Test for overall effect: Z = 3.10 (P = 0.002)



c

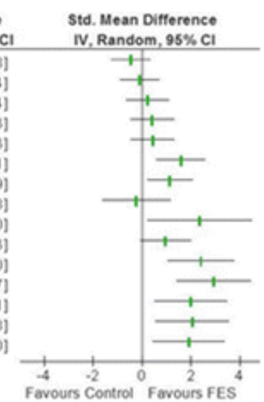
Study or Subgroup		Favours Control Mean	Favours Control SD	Favours Control Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Duarte 2011	CAHAI	27.8	13.1	13	35.4	20.6	11	35.2%	-0.43 [-1.25, 0.38]
McCabe 2015	AMAT	1,367	566	12	1,417	637	11	34.8%	-0.08 [-0.90, 0.74]
Chan 2009	FIM	80.2	6.8	10	77.6	12	10	30.0%	0.26 [-0.63, 1.14]
Total (95% CI)				**35**			**32**	**100.0%**	**-0.10 [-0.59, 0.38]**

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 1.27$, df = 2 (P = 0.53); $I^2 = 0\%$
Test for overall effect: Z = 0.42 (P = 0.67)



d

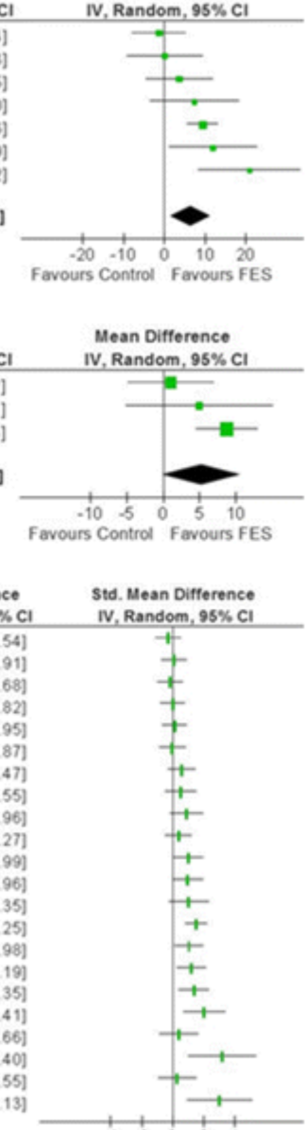
Study or Subgroup		FES Mean	FES SD	FES Total	Control Mean	Control SD	Control Total	Std. Mean Difference IV, Random, 95% CI
Duarte 2011	CAHAI	27.8	13.1	13	35.4	20.6	11	-0.43 [-1.25, 0.38]
McCabe 2015	AMAT	1,367	566	12	1,417	637	11	-0.08 [-0.90, 0.74]
Chan 2009	FIM	80.2	6.8	10	77.6	12	10	0.26 [-0.63, 1.14]
Shindo 2011	MAL AOU	0.82	0.71	10	0.55	0.44	10	0.44 [-0.45, 1.33]
	MAL QOM	0.89	0.66	10	0.62	0.49	10	0.44 [-0.45, 1.33]
Thrasher 2008	FIM	30.9	6.57	10	17.91	8.77	11	1.60 [0.59, 2.61]
	BIS	49.09	14.55	10	32.73	12.73	11	1.15 [0.21, 2.09]
Popovic 2002 HFG	UEFT	9.25	1.1	4	9.5	0.95	4	-0.21 [-1.61, 1.18]
Popovic 2002 LFG	UEFT	6.75	2.28	4	1.5	1.5	4	2.37 [0.23, 4.50]
Popovic 2003 HFG	UEFT	18.8	10.9	8	9.6	6.3	8	0.98 [-0.08, 2.03]
	MAL AOU	59.7	12.5	8	28.7	11.7	8	2.42 [1.04, 3.80]
	MAL QOM	66.7	11.4	8	32.5	10.6	8	2.94 [1.41, 4.47]
Popovic 2003 LFG	UEFT	1.9	1.1	6	0.2	0.1	6	2.01 [0.51, 3.51]
	MAL AOU	16.7	8.3	6	3.3	1.7	6	2.06 [0.55, 3.58]
	MAL QOM	11.5	6.1	6	2.3	1.2	6	1.93 [0.46, 3.40]



SEF & ADL

FMA

BBT



a

Study or Subgroup	FES Mean	FES SD	FES Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
McCabe 2015	32.3	7.9	12	33.5	8.3	11	17.4%	-1.20 [-7.84, 5.44]
Duarte 2011	31.2	10.5	13	31	12.7	11	13.2%	0.20 [-9.23, 9.63]
Chan 2009	25.9	8.9	10	22.1	9.9	10	14.9%	3.80 [-4.45, 12.05]
Shindo 2011	43.5	10.5	10	36	14.3	10	11.3%	7.50 [-3.50, 18.50]
Yun 2011	20.7	5.1	20	11.2	6.9	20	22.1%	9.50 [5.74, 13.26]
Shimodozono 2014	29.9	13.7	9	17.9	9.5	9	11.4%	12.00 [1.11, 22.89]
Thrasher 2008	30.6	15.49	10	9.64	13.71	11	9.6%	20.96 [8.40, 33.52]
Total (95% CI)			**84**			**82**	**100.0%**	**6.72 [1.76, 11.68]**

Heterogeneity: Tau² = 25.25; Chi² = 15.70, df = 6 (P = 0.02); I² = 62%
Test for overall effect: Z = 2.66 (P = 0.008)

b

Study or Subgroup	FES Mean	FES SD	FES Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Duarte 2011	7.5	8.1	13	6.4	6.7	11	35.7%	1.10 [-4.82, 7.02]
Cauraugh 2003	19.5	7.59	10	14.5	11.27	6	19.4%	5.00 [-5.17, 15.17]
Shin 2008	31.86	4.77	7	23	3.24	7	44.9%	8.86 [4.59, 13.13]
Total (95% CI)			**30**			**24**	**100.0%**	**5.34 [-0.06, 10.75]**

Heterogeneity: Tau² = 12.20; Chi² = 4.39, df = 2 (P = 0.11); I² = 54%
Test for overall effect: Z = 1.94 (P = 0.05)

c

Study or Subgroup		FES Mean	FES SD	FES Total	Control Mean	Control SD	Control Total	Std. Mean Difference IV, Random, 95% CI
Barker 2009	MAS HM	0.5	0.97	10	0.92	1.66	13	-0.29 [-1.12, 0.54]
	MAS UAF	2.2	1.14	10	2.08	1.5	13	0.09 [-0.74, 0.91]
McCabe 2015	FMA	32.3	7.9	12	33.5	8.3	11	-0.14 [-0.96, 0.68]
Duarte 2011	FMA	31.2	10.5	13	31	12.7	11	0.02 [-0.79, 0.82]
	BBT	7.5	8.1	13	6.4	6.7	11	0.14 [-0.66, 0.95]
Shindo 2011	ARAT	30.9	15.7	10	31.1	18.2	10	-0.01 [-0.89, 0.87]
	FMA	43.5	10.5	10	36	14.3	10	0.57 [-0.33, 1.47]
Cauraugh 2003 5s	BBT	19.5	7.59	10	14.5	11.27	6	0.52 [-0.51, 1.55]
Cauraugh 2003 10s	BBT	27.8	15.5	10	14.5	11.27	6	0.89 [-0.18, 1.96]
Chan 2009	FMA	25.9	8.9	10	22.1	9.9	10	0.39 [-0.50, 1.27]
	FTHUE	3.7	0.5	10	3.1	0.6	10	1.04 [0.09, 1.99]
Shimodozono 2014	FMA	29.9	13.7	9	17.9	9.5	9	0.97 [-0.02, 1.96]
Thorsen 2013	ARAT	11.2	7.33	5	3.5	6.25	6	1.04 [-0.26, 2.35]
Yun 2011	FMA	20.7	5.1	20	11.2	6.9	20	1.53 [0.82, 2.25]
Thrasher 2008	RELHT	9.48	8.28	10	1.92	5.28	11	1.06 [0.13, 1.98]
	CMSA	2.29	1.53	10	0.76	0.76	11	1.24 [0.28, 2.19]
	FMA	30.6	15.49	10	9.64	13.71	11	1.38 [0.41, 2.35]
Shin 2008	BBT	31.86	4.77	7	23	3.24	7	2.03 [0.66, 3.41]
Hara 2008 Group A	9HPT	-109.6	50.1	5	-127.8	30.3	5	0.40 [-0.86, 1.66]
	10CMT	-38.4	18.7	5	-127.8	30.3	5	3.21 [1.02, 5.40]
Hara 2008 Group B	9HPT	-112.2	59.1	5	-127.8	30.3	5	0.30 [-0.95, 1.55]
	10CMT	-43.2	18.9	5	-127.8	30.3	5	3.03 [0.92, 5.13]

SEF & récupération motrice

Electrostimulation of the paretic arm using surface electrodes

NMS of the paretic wrist and finger extensors

108 ◖ It has been demonstrated that neuromuscular electrostimulation (NMS) of the paretic wrist and finger extensors of patients with a stroke is not more effective in terms of selective movements, muscle strength, active range of motion for wrist and finger extension, and dexterity than other interventions. (Level 1)
Studied for ER (=) and RC (=).

NMS of the paretic wrist and finger flexors and extensors

109 ◖ It has been demonstrated that neuromuscular stimulation (NMS) of the paretic wrist and finger flexors and extensors of patients with a stroke improves selective movements and muscle strength. (Level 1)
Studied for ER (✓).

NMS of the paretic shoulder muscles

110 ◖ It has been demonstrated that neuromuscular electrostimulation (NMS) of the paretic shoulder muscles of patients with a stroke reduces glenohumeral subluxation. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

EMG-NMS of the paretic wrist and finger extensors

111 ◖◗ It has been demonstrated that EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic wrist and finger extensors of patients with a stroke improves selective movements, active range of motion, and dexterity. (Level 1)
Studied for ER (✓) and RC (✓).

EMG-NMS of the paretic wrist and finger flexors and extensors

112 It remains unclear whether EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic wrist and finger flexors and extensors of patients with a stroke is more effective in terms of selective movements and dexterity than other interventions. (Level 1)
Studied for ER (✓) and RC (✓).

TENS for the paretic arm

113 It has been demonstrated that transcutaneous electrical nerve stimulation (TENS) is not more effective in terms of resistance against passive movements and the performance of basic activities of daily living by patients with a stroke than other interventions. (Level 1)
Studied for ER (=) and RC (=).

EMG-BF for the paretic arm and hand

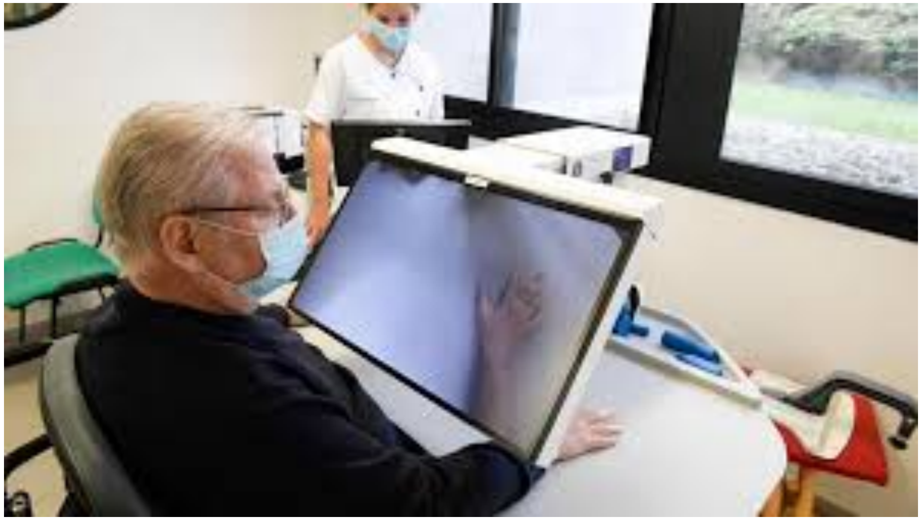
114 It remains unclear whether EMG biofeedback (EMG-BF) for the paretic arm is more effective for patients with a stroke in terms of selective movements, active range of motion, and dexterity than other interventions. (Level 1)
Studied for LR (=) and RC (=).

de Fysiotherapeut
Royal Dutch Society for Physical Therapy

KNGF Guideline

Stroke

Thérapie Mirroir



Technique initialement proposée pour lutter contre les douleurs neuropathiques
Peut être pratiqué même sur les déficits sévères
Pas assez de données pour être recomandéés

REALITE VIRTUELLE

Cochrane Library

Cochrane Database of Systematic Reviews

Virtual reality for stroke rehabilitation (Review)

Laver KE, George S, Thomas S, Deutsch JE, Crotty M

Analysis 1.2. Comparison 1 Virtual reality versus conventional therapy: effect on upper limb function post-treatment, Outcome 2 Upper limb function (Fugl Meyer).

Review: Virtual reality for stroke rehabilitation

Comparison: 1 Virtual reality versus conventional therapy: effect on upper limb function post-treatment

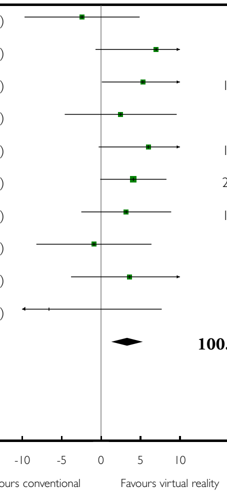
Outcome: 2 Upper limb function (Fugl Meyer)

Study or subgroup	Virtual reality N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Byl 2013	5	28.2 (4.6)	5	30.6 (6.92)		7.7 %	-2.40 [-9.68, 4.88]
da Silva Cameirao 2011	8	60.375 (7.614)	8	53.38 (8.087)		6.9 %	7.00 [-0.70, 14.70]
Housman 2009	14	24.9 (7.4)	14	19.6 (6.7)		14.9 %	5.30 [0.07, 10.53]
Kiper 2011	40	48.9 (15.2)	40	46.4 (17.1)		8.1 %	2.50 [-4.59, 9.59]
Piron 2007	25	51.4 (9.8)	13	45.4 (9.3)		10.1 %	6.00 [-0.35, 12.35]
Piron 2009	18	53.6 (7.7)	18	49.5 (4.8)		23.1 %	4.10 [-0.09, 8.29]
Piron 2010	27	49.7 (10.1)	20	46.5 (9.7)		12.5 %	3.20 [-2.51, 8.91]
Subramanian 2013	32	43 (15.2)	32	43.9 (14.7)		7.6 %	-0.90 [-8.23, 6.43]
Sucar 2009	11	30 (12.4)	11	26.36 (2.33)		7.3 %	3.64 [-3.82, 11.10]
Zucconi 2012	11	45.2 (20.3)	11	51.8 (13.1)		2.0 %	-6.60 [-20.88, 7.68]
Total (95% CI)	**191**		**172**			**100.0 %**	**3.30 [1.29, 5.32]**

Heterogeneity: Chi^2 = 7.80, df = 9 (P = 0.55); I^2 =0.0%

Test for overall effect: Z = 3.21 (P = 0.0013)

Test for subgroup differences: Not applicable



Analysis 1.3. Comparison 1 Virtual reality versus conventional therapy: effect on upper limb function post-treatment, Outcome 3 Hand function (grip strength).

Review: Virtual reality for stroke rehabilitation

Comparison: 1 Virtual reality versus conventional therapy: effect on upper limb function post-treatment

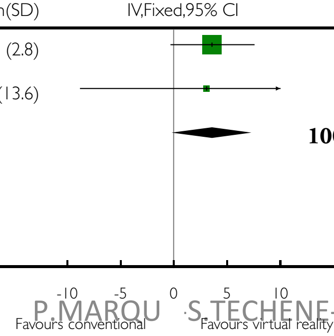
Outcome: 3 Hand function (grip strength)

Study or subgroup	Virtual reality N	Mean(SD)	Comparison intervention N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Housman 2009	14	9.2 (7)	14	5.6 (2.8)		90.1 %	3.60 [-0.35, 7.55]
Saposnik 2010	9	24.6 (9.67)	7	21.5 (13.6)		9.9 %	3.10 [-8.79, 14.99]
Total (95% CI)	**23**		**21**			**100.0 %**	**3.55 [-0.20, 7.30]**

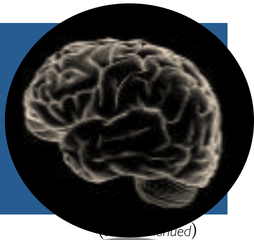
Heterogeneity: Chi^2 = 0.01, df = 1 (P = 0.94); I^2 =0.0%

Test for overall effect: Z = 1.86 (P = 0.063)

Test for subgroup differences: Not applicable



Réalité virtuelle et rééducation



Study or subgroup	Virtual reality N	Mean(SD)	Conventional therapy N	Mean(SD)	Std. Mean Difference IV,Fixed,95% CI	Weight	Std. Mean Difference IV,Fixed,95% CI
Saposnik 2010	9	-19.8 (3.4)	7	-27.4 (8.7)		1.3 %	1.15 [0.06, 2.24]
Saposnik 2016	71	-64.1 (104)	70	-39.8 (35.5)		13.8 %	-0.31 [-0.64, 0.02]
Subramanian 2013	32	43 (15.2)	32	43.9 (14.7)		6.4 %	-0.06 [-0.55, 0.43]
Sucar 2009	11	30 (12.4)	11	26.36 (2.33)		2.1 %	0.39 [-0.45, 1.24]
Thielbar 2014	7	50.4 (10.4)	7	43.6 (8.1)		1.3 %	0.68 [-0.41, 1.77]
Zucconi 2012	11	45.2 (20.3)	11	51.8 (13.1)		2.1 %	-0.37 [-1.22, 0.47]
Total (95% CI)	**533**		**505**			**100.0 %**	**0.07 [-0.05, 0.20]**

Heterogeneity: $Chi^2 = 38.37$, df = 22 (P = 0.02); $I^2 = 43\%$
Test for overall effect: Z = 1.14 (P = 0.25)
Test for subgroup differences: Not applicable

-2 -1 0 1 2
Favours conventional Favours virtual reality

Review: Virtual reality for stroke rehabilitation

Comparison: 3 Additional virtual reality intervention: effect on upper limb function post intervention

Outcome: 1 Upper limb function (composite measure)

Study or subgroup	Virtual reality N	Mean(SD)	No intervention N	Mean(SD)	Std. Mean Difference IV,Fixed,95% CI	Weight	Std. Mean Difference IV,Fixed,95% CI
Cho 2012	15	21.6 (5.4)	14	17.7 (3.4)		13.5 %	0.83 [0.07, 1.60]
Coupar 2012 (1)	4	40.75 (17.23)	2	44.25 (24.96)		2.7 %	-0.14 [-1.85, 1.56]
Coupar 2012 (2)	4	44 (15.98)	2	44.25 (24.96)		2.7 %	-0.01 [-1.71, 1.69]
Jang 2005	5	58 (6.24)	5	55 (3.74)		4.8 %	0.53 [-0.75, 1.80]
Kim 2011a	15	64 (26.7)	13	61.2 (18.2)		14.2 %	0.12 [-0.63, 0.86]
Kwon 2012	13	62.92 (3.45)	13	61.85 (4.54)		13.2 %	0.26 [-0.52, 1.03]
Manlapaz 2010	8	21 (2)	8	18.5 (1.31)		6.2 %	1.40 [0.27, 2.53]
Shin 2014	9	51.1 (7.8)	7	40.7 (9.8)		6.7 %	1.13 [0.04, 2.21]
Sin 2013	18	47.72 (15.34)	17	34.59 (20.72)		16.7 %	0.71 [0.02, 1.39]
Standen 2011	9	-2.68 (1.6)	9	-2.86 (1.4)		9.2 %	0.11 [-0.81, 1.04]
Yavuzer 2008	10	3 (1.5)	10	2.8 (0.9)		10.2 %	0.15 [-0.72, 1.03]
Total (95% CI)	**110**		**100**			**100.0 %**	**0.49 [0.21, 0.77]**

Heterogeneity: $Chi^2 = 8.36$, df = 10 (P = 0.59); $I^2 = 0.0\%$
Test for overall effect: Z = 3.43 (P = 0.00061)
Test for subgroup differences: Not applicable

-2 -1 0 1 2
Favours conventional Favours virtual reality

(1) Low intensity training

(2) High intensity training

Mirror therapy for the paretic arm and hand

105 ◖ It remains unclear whether mirror therapy for the paretic arm and hand of patients with a stroke is more effective in terms of selective movements, resistance to passive movements, pain, and dexterity than other interventions. (Level 1)
Studied for LR (=) and RC (=).

Virtual reality training of the paretic arm and hand

106 ◗ It has been demonstrated that virtual reality training of the paretic arm and hand as an add-on to regular exercise therapy for patients with a stroke improves the performance of basic activities of daily living. (Level 1)
Studied for ER (✓) and RC (✓).

Rééducation troubles sensitifs

Interventions to improve the somatosensory functions of the paretic arm and hand

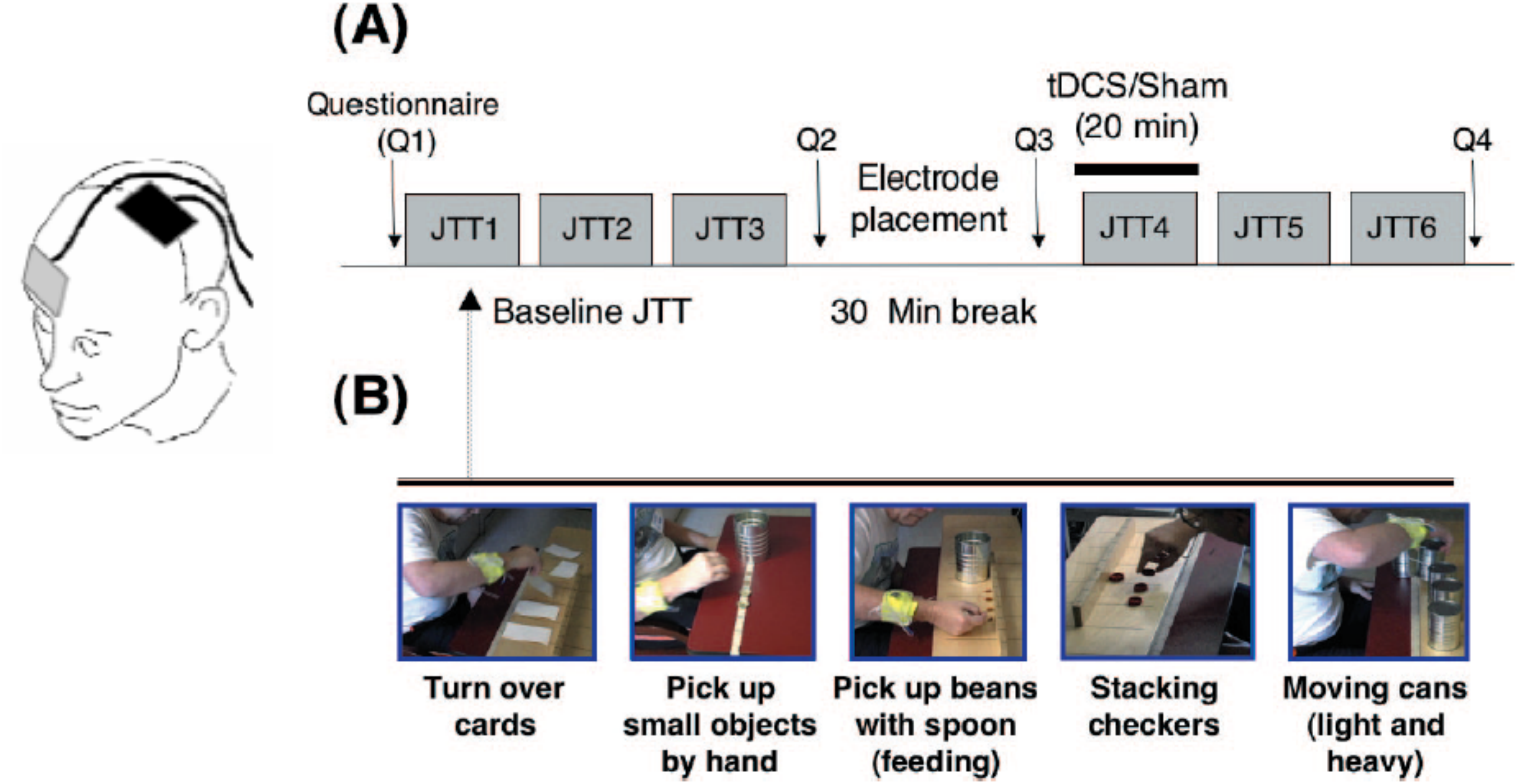
117 ◖ It has been demonstrated that interventions to improve the somatosensory functions of the paretic arm and hand of patients with a stroke improve the somatosensory functions and reduce the resistance to passive movements. (Level 1)

Studied for ER (✓), LR (✓) and RC (✓).

- Recommandée niveau 1

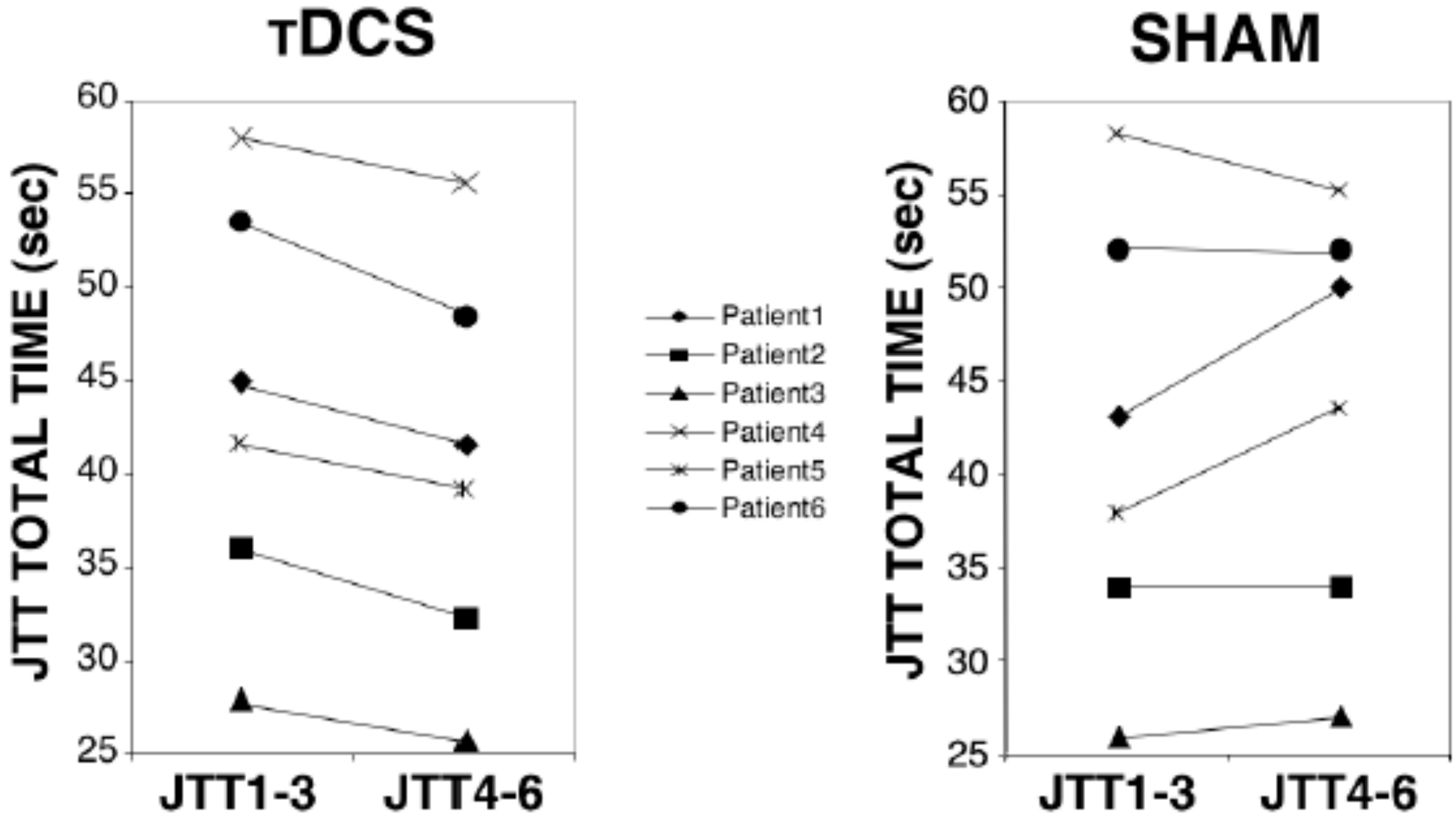
LES TECHNIQUES NON ENCORE MATURES

Stimulations cérébrales non invasives



A paradigme expérimental :JTT = Jebsen Taylor Test
JTT1,JTT2, JTT3 familiarisation avec le test, puis mise en place des électrodes de stimulation: stimulation effective ou placebo,
puis JTT4 = test passé pendant le stimulation, JTT5 et JTT6 tests après la stimulation
Questionnaire : questions concernant la fatigue l'attention, les sensations douloureuses
B épreuves du JTT: tourner les cartes, prendre des petits objets dans la main, prendre des cacahouètes avec une cuillère, empiler des pions déplacer des boites lourdes ou légères

Hummel, et al. Brain 2005



Amélioration significative du temps mis pour réalisé le Jebsen Taylor test lors de la stimulation électrique directe transcranienne (tDCS).

Effets bénéfiques chez tous les patients

Absence de modification lors de la stimulation placébo (sham)

Hummel, et al. Brain 2005

Cochrane Library
Cochrane Database of Systematic Reviews

Elsner B, Kugler J, Pohl M, Mehrholz J.
Transcranial direct current stimulation (tDCS) for improving activities of daily living, and physical and cognitive functioning, in people after stroke.
Cochrane Database of Systematic Reviews 2016, Issue 3. Art. No.: CD009645.
DOI: 10.1002/14651858.CD009645.pub3.

Transcranial direct current stimulation (tDCS) for improving activities of daily living, and physical and cognitive functioning, in people after stroke (Review)

Elsner B, Kugler J, Pohl M, Mehrholz J

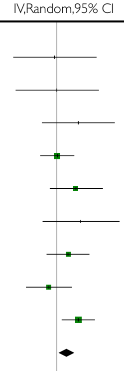
Analysis 1.1. Comparison 1 tDCS versus any type of placebo or passive control intervention, Outcome 1 Primary outcome measure: ADLs at the end of the intervention period.

Review: Transcranial direct current stimulation (tDCS) for improving activities of daily living, and physical and cognitive functioning, in people after stroke

Comparison: 1 tDCS versus any type of placebo or passive control intervention

Outcome: 1 Primary outcome measure: ADLs at the end of the intervention period

Study or subgroup	Favours sham tDCS N	Mean(SD)	Sham tDCS N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Absolute values							
Bolognini 2011	7	2.3 (3.6)	7	2.5 (2.6)		3.8 %	-0.06 [-1.11, 0.99]
Di Lazzaro 2014a	7	-3 (1)	7	-3 (1.3)		3.8 %	0.0 [-1.05, 1.05]
Di Lazzaro 2014b	10	-2.4 (1.17)	9	-3.1 (1.38)		5.0 %	0.53 [-0.39, 1.45]
Hesse 2011	64	56.4 (13.5)	32	56.3 (15.5)		23.3 %	0.01 [-0.42, 0.43]
Khedr 2013	27	52 (24.5)	13	41 (18)		9.3 %	0.48 [-0.19, 1.15]
Kim 2010	11	86.1 (14.4)	7	71 (34.4)		4.4 %	0.60 [-0.37, 1.57]
Lee 2014	39	69.9 (16.6)	20	64.3 (24.5)		14.3 %	0.28 [-0.26, 0.82]
Tedesco Triccas 2015b	22	1.2 (2.1)	24	1.6 (1.8)		12.5 %	-0.20 [-0.78, 0.38]
Wu 2013a	45	76.2 (19.6)	45	65.4 (20.4)		23.7 %	0.54 [0.11, 0.96]
Subtotal (95% CI)	**232**		**164**			**100.0 %**	**0.24 [0.03, 0.44]**



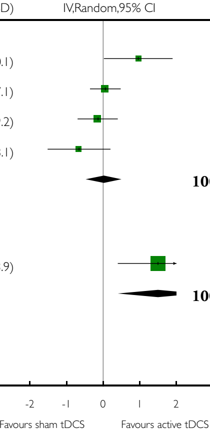
Analysis 1.4. Comparison 1 tDCS versus any type of placebo or passive control intervention, Outcome 4 Secondary outcome measure: upper extremity function to the end of follow-up.

Review: Transcranial direct current stimulation (tDCS) for improving activities of daily living, and physical and cognitive functioning, in people after stroke

Comparison: 1 tDCS versus any type of placebo or passive control intervention

Outcome: 4 Secondary outcome measure: upper extremity function to the end of follow-up

Study or subgroup	Active tDCS N	Mean(SD)	Sham tDCS N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Absolute values							
Di Lazzaro 2014b	10	0.8 (0.1)	10	0.7 (0.1)		17.1 %	0.96 [0.02, 1.89]
Hesse 2011	63	23.4 (16.3)	32	22.5 (17.1)		34.7 %	0.05 [-0.37, 0.48]
Rossi 2013	25	13.6 (11.2)	25	15.2 (9.2)		29.2 %	-0.15 [-0.71, 0.40]
Tedesco Triccas 2015b	11	32.1 (16.7)	11	44.2 (18.1)		19.0 %	-0.67 [-1.53, 0.20]
Subtotal (95% CI)	**109**		**78**			**100.0 %**	**0.01 [-0.48, 0.50]**
Heterogeneity: $Tau^2 = 0.13$; $Chi^2 = 6.67$, df = 3 (P = 0.08); $I^2 = 55\%$							
Test for overall effect: Z = 0.05 (P = 0.96)							
2 Change scores							
Kim 2010	11	23.9 (13.7)	7	2.3 (13.9)		100.0 %	1.49 [0.40, 2.59]
Subtotal (95% CI)	**11**		**7**			**100.0 %**	**1.49 [0.40, 2.59]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.67 (P = 0.0076)							
Test for subgroup differences: $Chi^2 = 5.86$, df = 1 (P = 0.02), $I^2 = 83\%$							



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Multiple sessions of transcranial direct current stimulation and upper extremity rehabilitation in stroke: A review and meta-analysis

L. Tedesco Triccas [a,*], J.H. Burridge [a], A.M. Hughes [a], R.M. Pickering [b], M. Desikan [c], J.C. Rothwell [c], G. Verheyden [d]

Study or Subgroup	Real tDCS + Rehab Mean	Real tDCS + Rehab SD	Real tDCS + Rehab Total	Sham tDCS/No stim + Rehab Mean	Sham tDCS/No stim + Rehab SD	Sham tDCS/No stim + Rehab Total	Weight	Std. Mean Difference IV, Fixed, 95% CI	Year
Kim et al., 2010	48.9	15.2	11	49.3	10.2	6	7.6%	-0.03 [-1.02, 0.97]	2010
Lindenberg et al., 2010	43.8	12.3	10	41	11.8	10	9.7%	0.22 [-0.66, 1.10]	2010
Hesse et al., 2011	19	12.45	64	19.2	15	32	41.5%	-0.01 [-0.44, 0.41]	2011
Bolognini et al., 2011	31.7	31.1	7	29	20.3	5	5.7%	0.09 [-1.06, 1.24]	2011
Nair et al., 2011	33.7	12.9	7	32.3	9.8	7	6.8%	0.11 [-0.93, 1.16]	2011
Viana et al., 2014	50.6	13.4	10	46.9	12.4	10	9.6%	0.27 [-0.61, 1.16]	2014
Lee et al., 2014	47.7	21.3	20	41.6	21.3	20	19.2%	0.28 [-0.34, 0.90]	2014
Total (95% CI)			**129**			**90**	**100.0%**	**0.11 [-0.17, 0.38]**	

Heterogeneity: Chi² = 0.89, df = 6 (P = 0.99); I² = 0%
Test for overall effect: Z = 0.76 (P = 0.44)

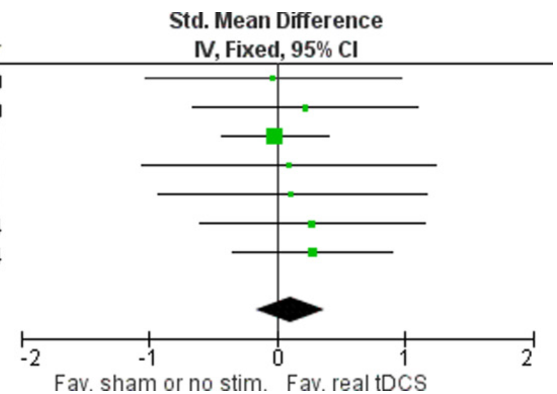
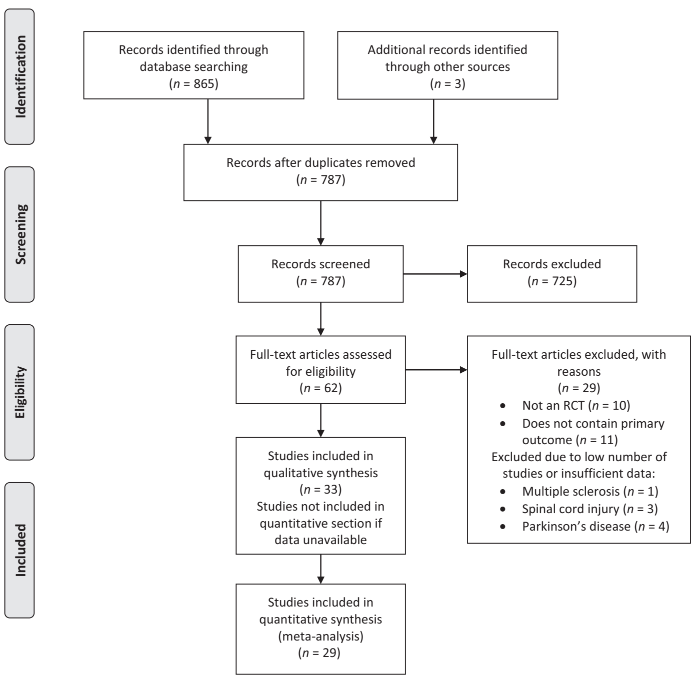
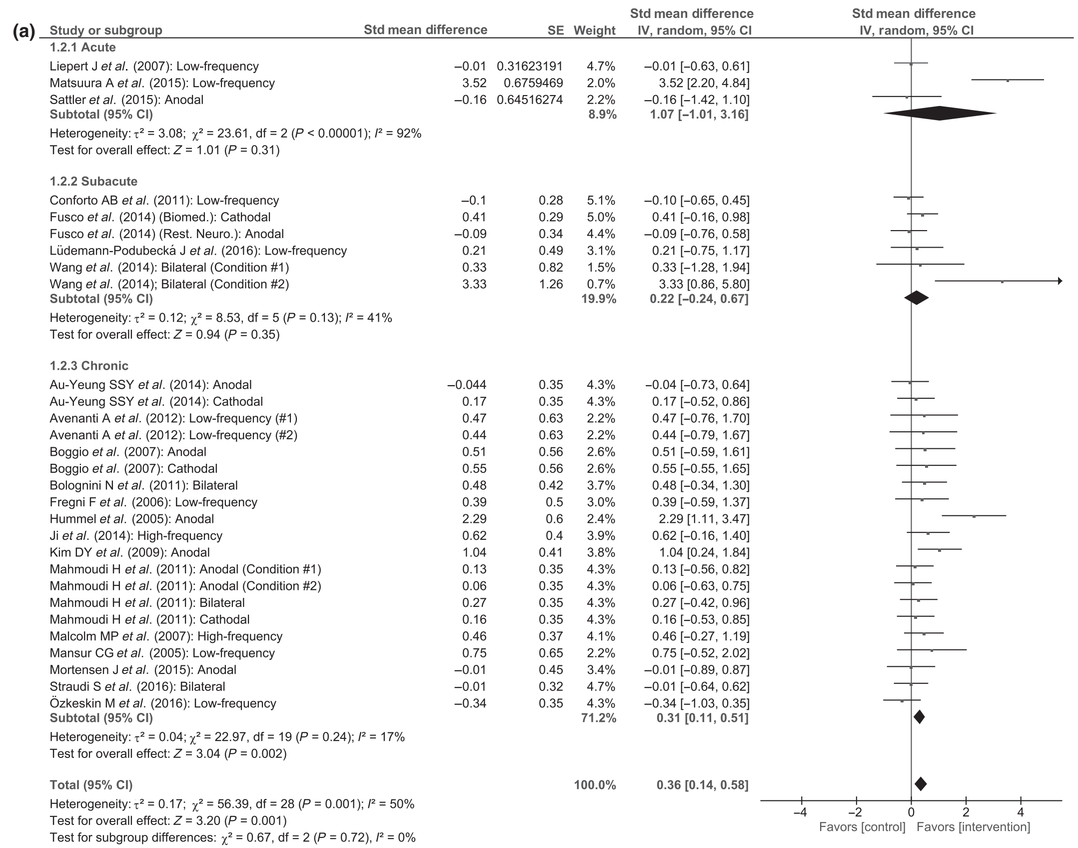


Fig. 3. Effect of real tDCS versus sham tDCS for UE global motor impairments measured by FMA at immediate post-intervention.

Non-invasive brain stimulation for fine motor improvement after stroke: a meta-analysis

A. T. O'Brien[a,*,†], F. Bertolucci[a,b,*], G. Torrealba-Acosta[c], R. Huerta[d], F. Fregni[a] and A. Thibaut[a,e,†]





European Journal of Neurology 2018, **25:** 1017–1026

3 décennies de recherche…. beaucoup de désillusions

- Des études sur une session positive
- Déceptions des essais sur plusieurs sessions :
  - ≈20 études : 15 à 65 sujets (petits effectifs)
  - La moitié négatives
- Des méta-analyses:
  - Positives mais avecune taille d'effet faible
  - Négatives

Cochrane Library
Cochrane Database of Systematic Reviews

Transcranial direct current stimulation (tDCS) for improving function and activities of daily living in patients after stroke (Review)

Elsner B, Kugler J, Pohl M, Mehrholz J

frontiers in Human Neuroscience
REVIEW
published: 15 May 2015
doi: 10.3389/fnhum.2015.00265

Non-invasive brain stimulation: an interventional tool for enhancing behavioral training after stroke

*Maximilian J. Wessel[1†], Máximo Zimerman[1,2†] and Friedhelm C. Hummel[1,3]**

frontiers in PSYCHIATRY
REVIEW ARTICLE
published: 12 November 2012
doi: 10.3389/fpsyt.2012.00088

Systematic review of parameters of stimulation, clinical trial design characteristics, and motor outcomes in non-invasive brain stimulation in stroke

*Bamidele O. Adeyemo[1,2], Marcel Simis[1,3†], Debora Duarte Macea[1,4†] and Felipe Fregni[1,5]**

Cochrane Library
Cochrane Database of Systematic Reviews

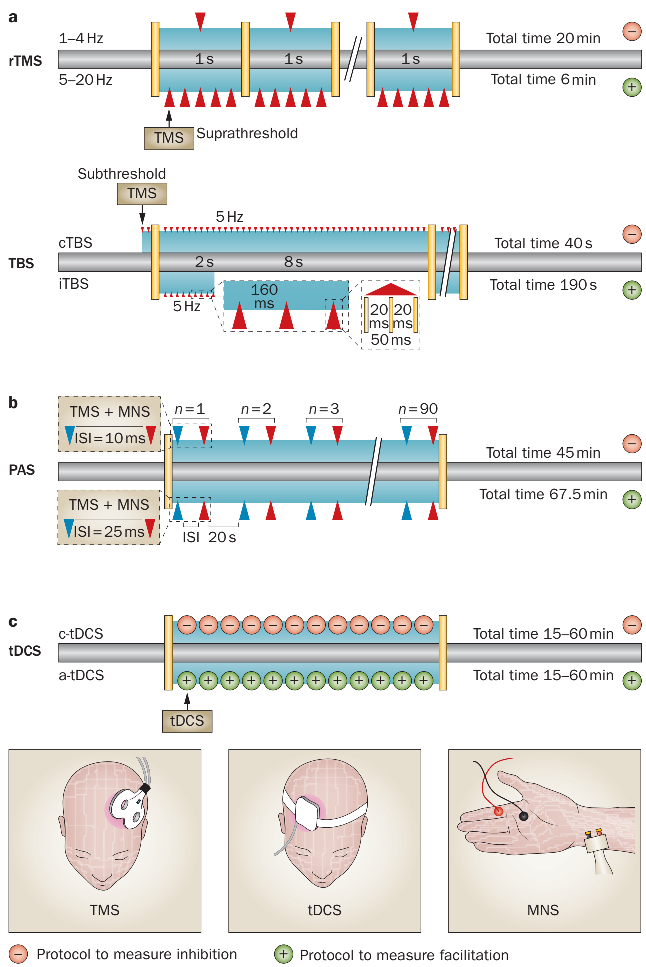
Repetitive transcranial magnetic stimulation for improving function after stroke (Review)

Hao Z, Wang D, Zeng Y, Liu M

Di Pino, G. *et al. Nat. Rev. Neurol.* **10**, 597–608 (2014);

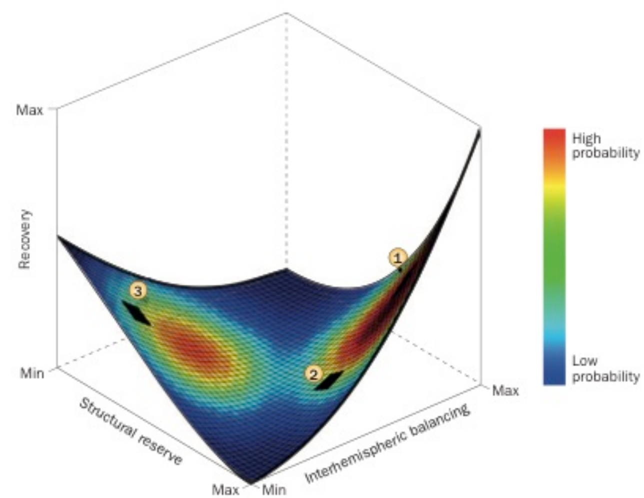
Modulation of brain plasticity in stroke: a novel model for neurorehabilitation

Giovanni Di Pino, Giovanni Pellegrino, Giovanni Assenza, Fioravante Capone, Florinda Ferreri, Domenico Formica, Federico Ranieri, Mario Tombini, Ulf Ziemann, John C. Rothwell and Vincenzo Di Lazzaro



Key points

- Noninvasive brain stimulation (NIBS) is a promising approach to enhance recovery after stroke, but its beneficial effect is limited and the technique is not yet ready for broad clinical use
- We suggest that the disappointments in NIBS trials are related to over-reliance on the interhemispheric competition and vicariation models of recovery, which are oversimplified and do not apply to all patients with stroke
- The concept of 'structural reserve' integrates the effects that interhemispheric inhibition and vicariation exert on the unlesioned residual network
- We propose a unified 'bimodal balance–recovery model' that takes into account this individual residual network
- The model could be used to tailor treatment for individual patients and increase the efficacy of NIBS in stroke rehabilitation



III - LA COMPENSATION

Faire autrement

- Utilisation du pouce dans le même plan que les doigts longs :
  - Paralysie basse du médian
- Effet ténodèse :
  - Le tétraplégique
  - Enraidissement des fléchisseurs des doigts
  - Préhension par extension du poignet





Les orthèses dynamiques

- Orthèses de fonctions
  - Paralysie radiale

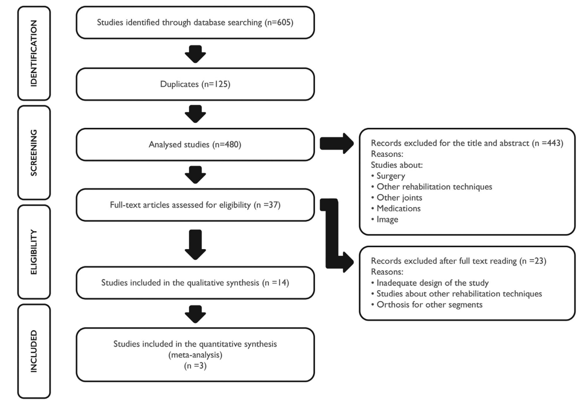
  - Paralysie médian

  - Arthrose

Orthosis for rhizarthrosis: A systematic review and meta-analysis

Sandra Mara Meireles, Anamaria Jones, Jamil Natour*

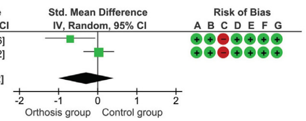
Rheumatology Division, Universidade Federal de São Paulo, Escola Paulista de Medicina, São Paulo, SP, Brazil



PAIN - SHORT TERM

	Orthosis group			Control group				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Carreira 2010	-2	2.37068	20	-0.3	2.35995	20	43.7%	-0.70 [-1.35, -0.06]
Rannou 2009	-10.1	22.2486	55	-10.7	22.3817	46	56.3%	0.03 [-0.36, 0.42]
Total (95% CI)			**75**			**66**	**100.0%**	**-0.29 [-1.00, 0.42]**

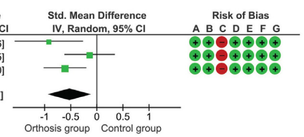
Heterogeneity: Tau² = 0.19; Chi² = 3.64, df = 1 (P = 0.06); I² = 73%
Test for overall effect: Z = 0.81 (P = 0.42)



PAIN - LONG TERM

	Orthosis group			Control group				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Carreira 2010	-2.2	2.45967	20	0.1	2.44134	20	24.9%	-0.92 [-1.58, -0.26]
Kjeken 2011	-1.4	21.9117	32	2.2	28.9468	34	34.8%	-0.14 [-0.62, 0.35]
Rannou 2009	-22.2	23.0755	52	-7.9	23.4787	45	40.3%	-0.61 [-1.02, -0.20]
Total (95% CI)			**104**			**99**	**100.0%**	**-0.52 [-0.94, -0.11]**

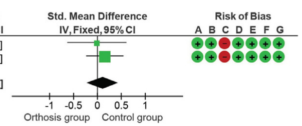
Heterogeneity: Tau² = 0.07; Chi² = 4.01, df = 2 (P = 0.13); I² = 50%
Test for overall effect: Z = 2.48 (P = 0.01)



FUNCTION - SHORT TERM

	Orthosis group			Control group				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Carreira 2010	7.3	24.4002	20	7.6	23.4267	20	28.5%	-0.01 [-0.63, 0.61]
Rannou 2009	1.3	10.2879	54	-0.3	10.2835	47	71.5%	0.15 [-0.24, 0.55]
Total (95% CI)			**74**			**67**	**100.0%**	**0.11 [-0.22, 0.44]**

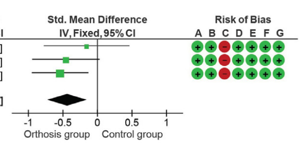
Heterogeneity: Chi² = 0.20, df = 1 (P = 0.66); I² = 0%
Test for overall effect: Z = 0.63 (P = 0.53)



FUNCTION - LONG TERM

	Orthosis group			Control group				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Carreira 2010	-10.5	24.6903	20	-6.7	22.6451	20	20.4%	-0.16 [-0.78, 0.46]
Kjeken 2011	-0.4	0.5547	32	0.1	1.4054	34	32.8%	-0.46 [-0.95, 0.03]
Rannou 2009	-1.9	11.2	49	4.3	11.53	46	46.8%	-0.54 [-0.95, -0.13]
Total (95% CI)			**101**			**100**	**100.0%**	**-0.44 [-0.72, -0.15]**

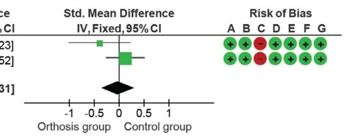
Heterogeneity: Chi² = 1.04, df = 2 (P = 0.60); I² = 0%
Test for overall effect: Z = 3.04 (P = 0.002)



PINCH STRENGHT - SHORT TERM

	Orthosis group			Control group				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Carreira 2010	-0.6	1.2728	20	0	1.697	20	28.0%	-0.39 [-1.02, 0.23]
Rannou 2009	5.1	41.1582	56	-0.2	42.7287	46	72.0%	0.13 [-0.26, 0.52]
Total (95% CI)			**76**			**66**	**100.0%**	**-0.02 [-0.35, 0.31]**

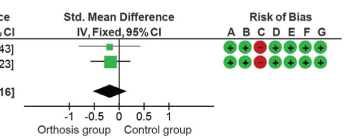
Heterogeneity: Chi² = 1.89, df = 1 (P = 0.17); I² = 47%
Test for overall effect: Z = 0.11 (P = 0.91)



PINCH STRENGHT - LONG TERM

	Orthosis group			Control group				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI
Carreira 2010	-0.7	1.4212	20	-0.4	1.6279	20	29.4%	-0.19 [-0.81, 0.43]
Rannou 2009	5.4	50.2046	50	14.4	52.2239	46	70.6%	-0.17 [-0.58, 0.23]
Total (95% CI)			**70**			**66**	**100.0%**	**-0.18 [-0.52, 0.16]**

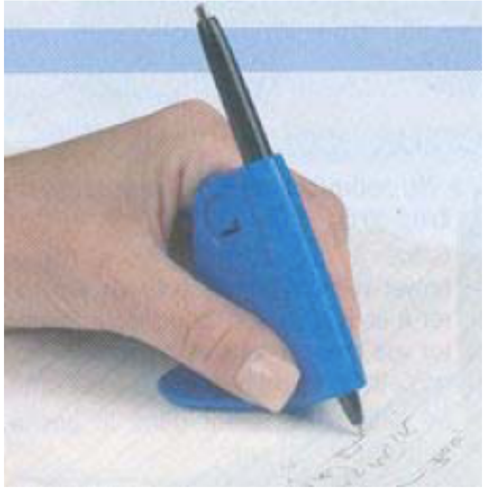
Heterogeneity: Chi² = 0.00, df = 1 (P = 0.96); I² = 0%
Test for overall effect: Z = 1.05 (P = 0.30)

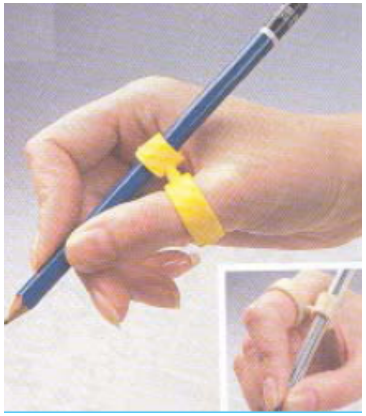


Seminars in Arthritis and Rheumatism 000 (2018) 1–13

Les aides techniques

- Activités et participations
- Personnalisées
- Ergothérapie

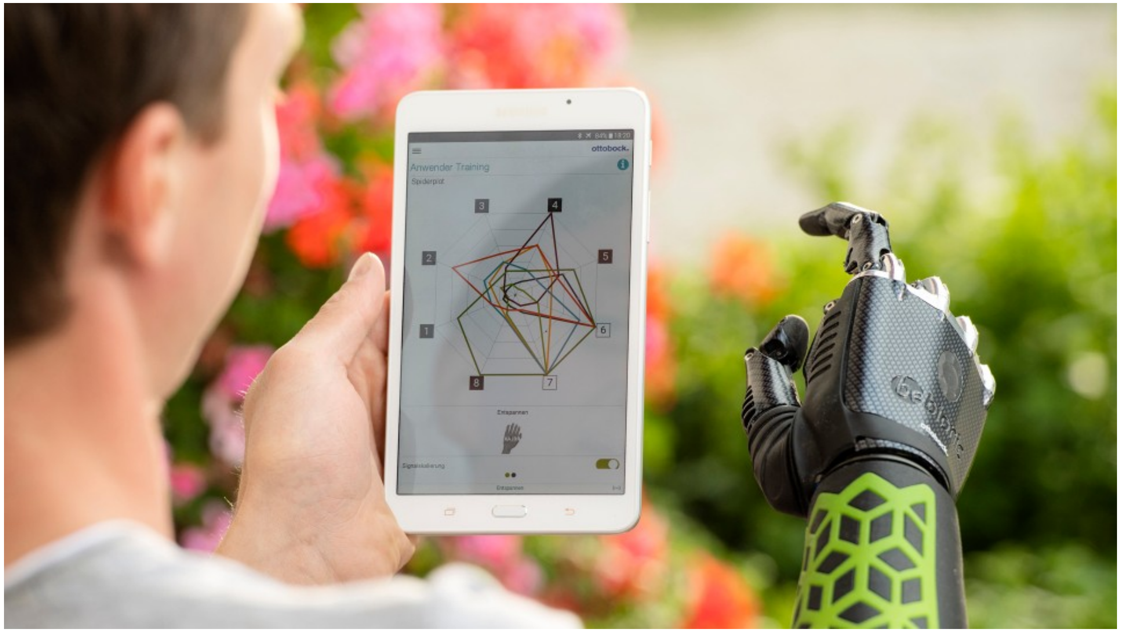




Les prothèses

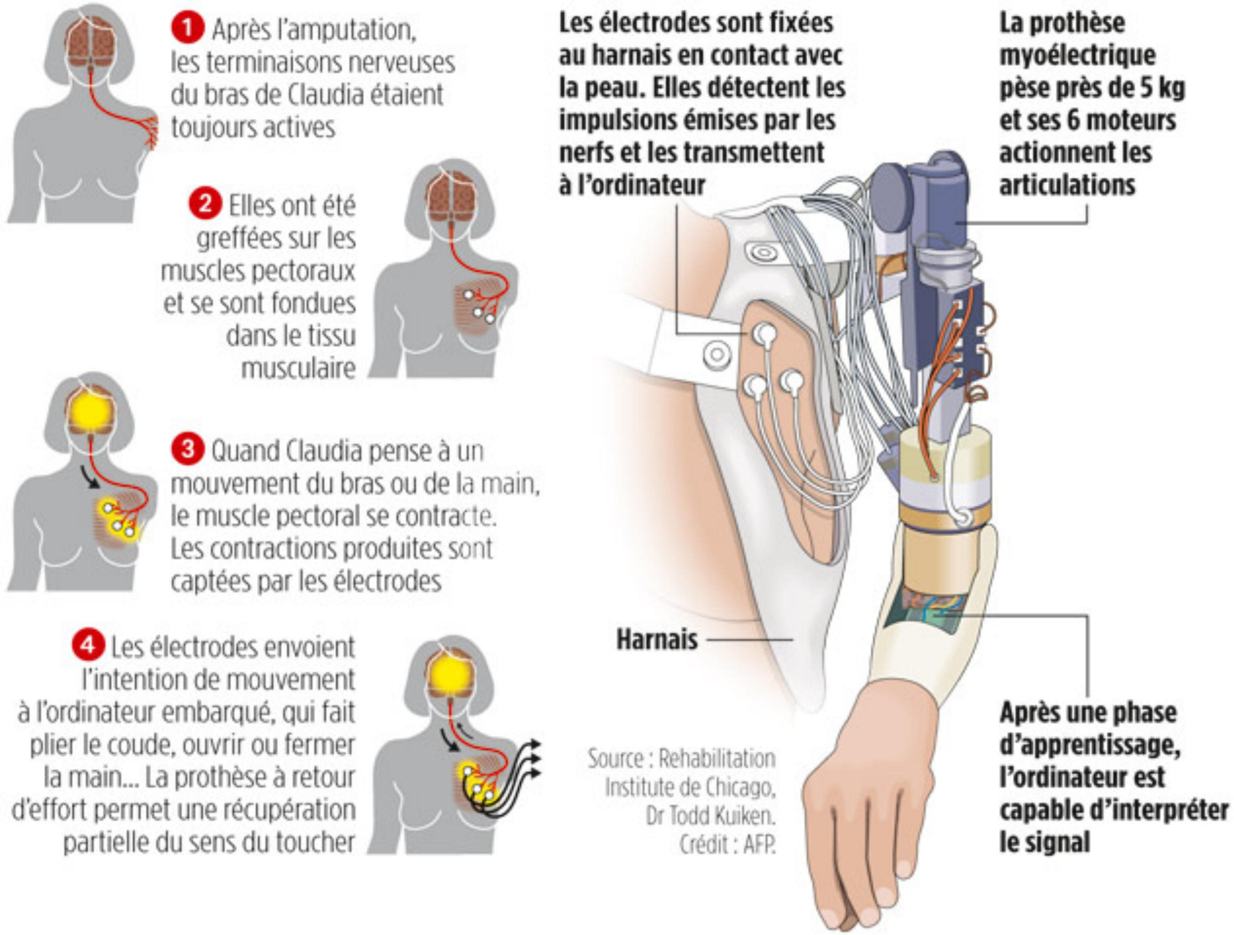
- Prothèse outil

- Prothèse myoélectrique



Actionner la prothèse par la pensée

Claudia Mitchell (ci-contre, à droite) est la première femme équipée d'un bras bionique commandé par la pensée



LES VOIES DU FUTUR

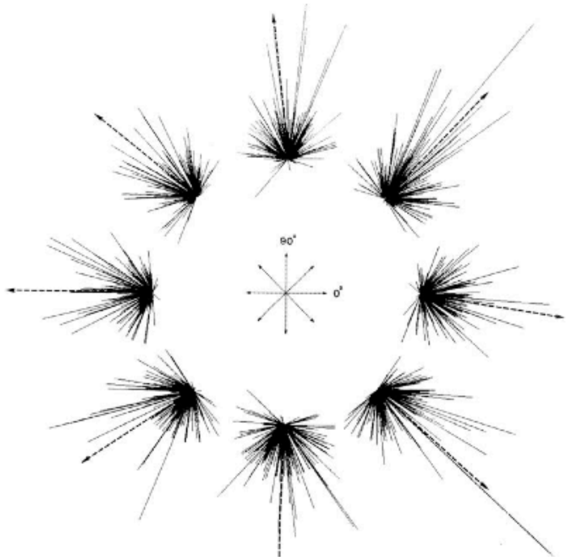
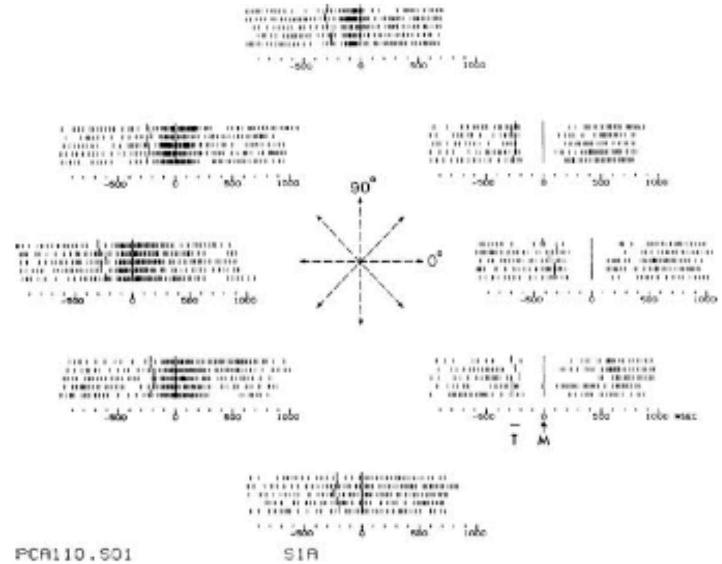
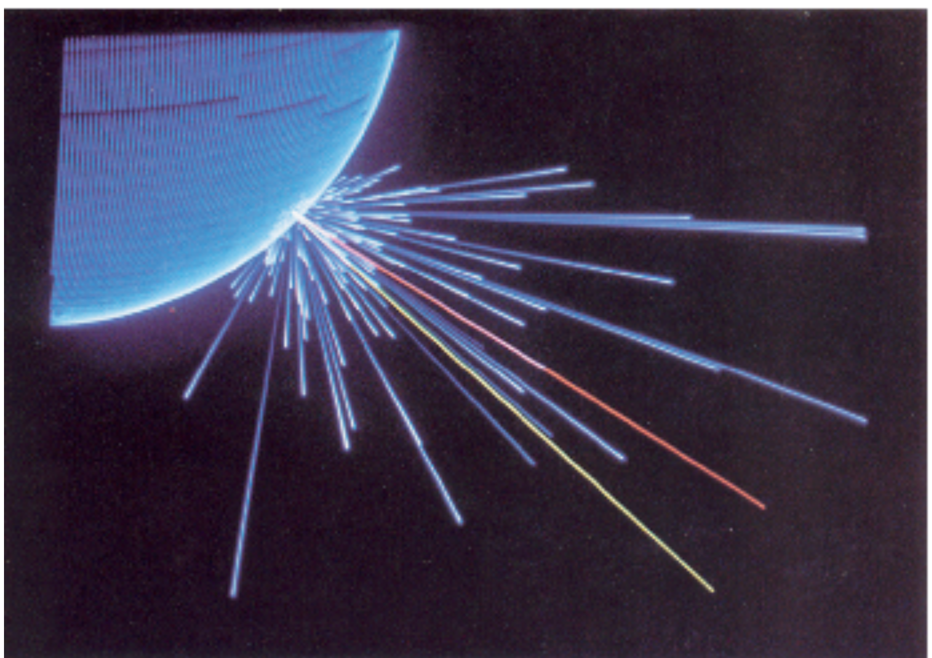
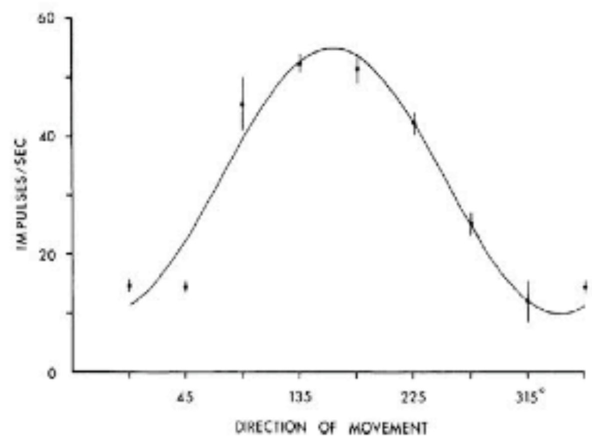


Figure 13. Population vector algorithm

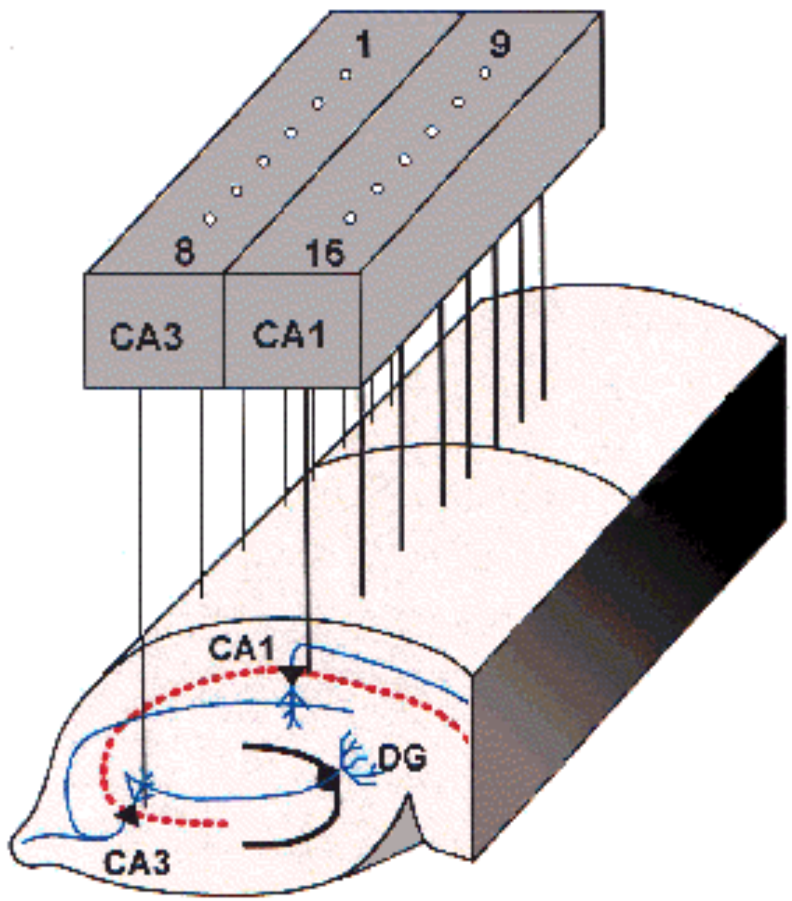


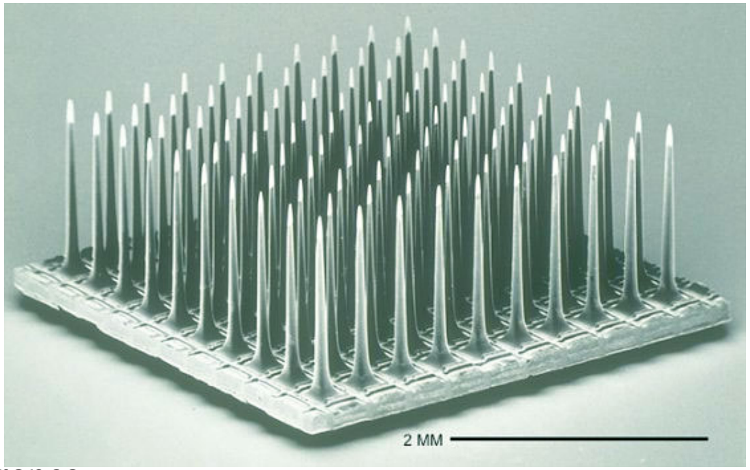




Georgopoulos et al 1982

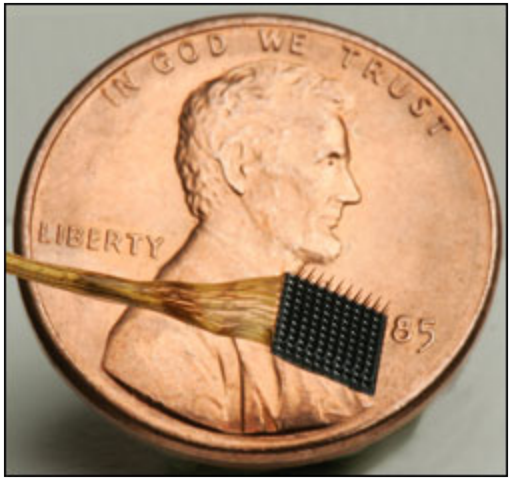
Multi-electrode Neural Recording



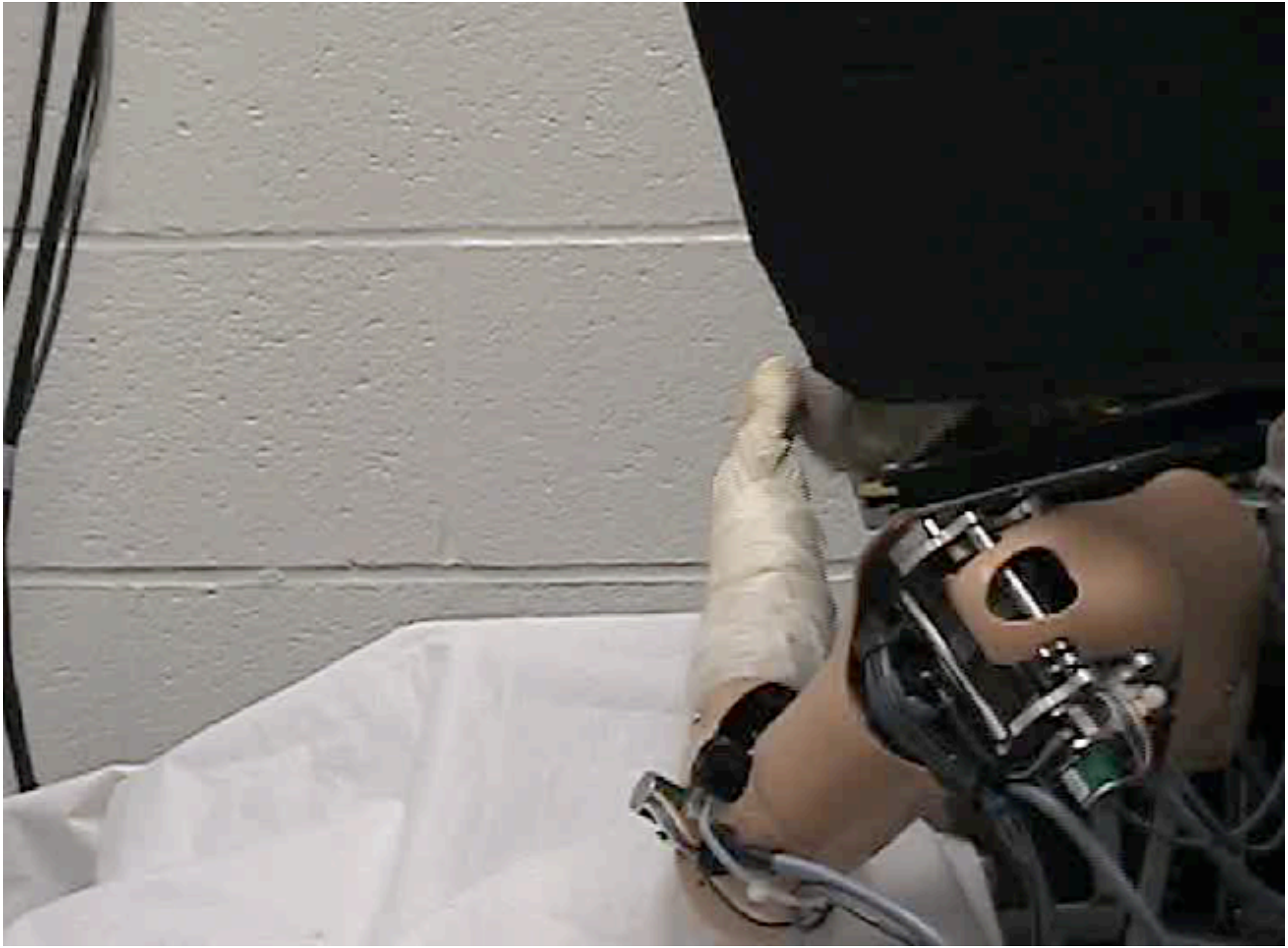


Reference :

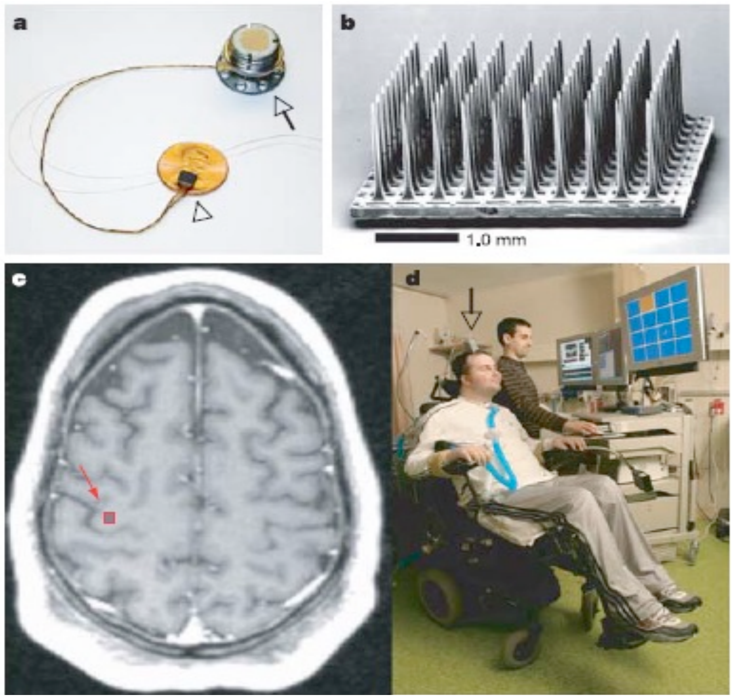
http://www.cyberkineticsinc.com/technology.htm



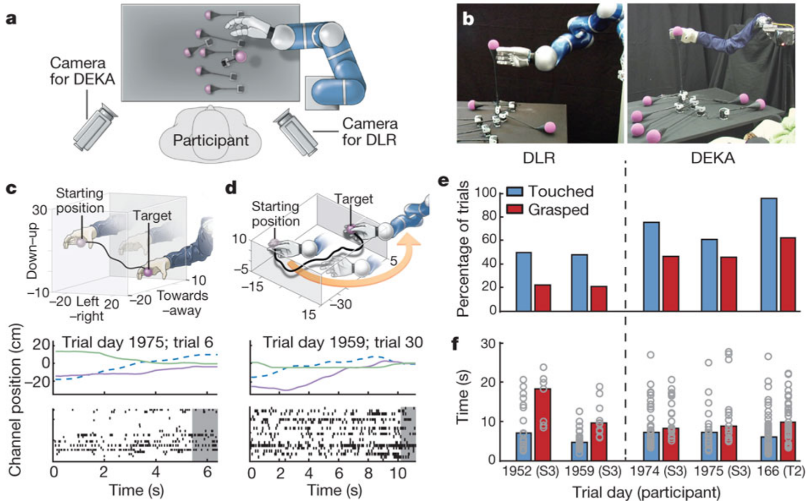
Reference :
http://www.nottingham.ac.uk/neuronal-networks/mmep.htm

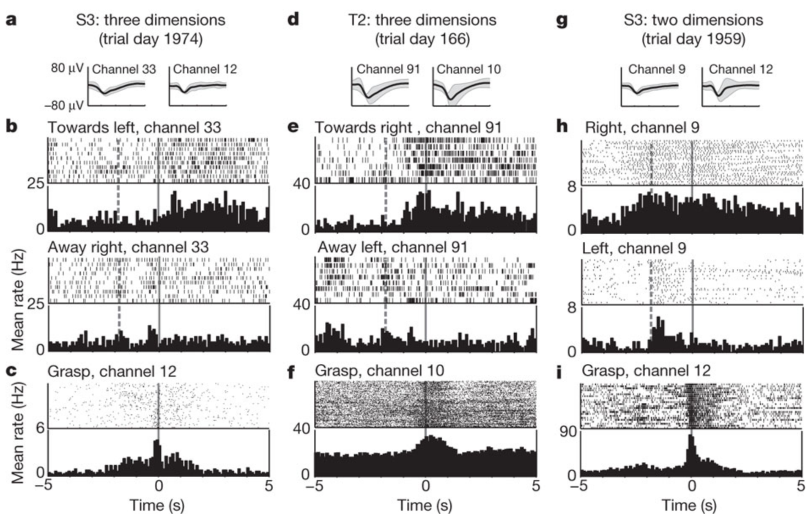


Schwartz et al 2008



Ochberg et al, 2009





BrainGate Pilot Clinical Trial
Drinking From a Bottle Using a Robotic Arm
Participant S3
Trial Day 1959 / 12 April 2011
Hochberg *et al.*, 2012

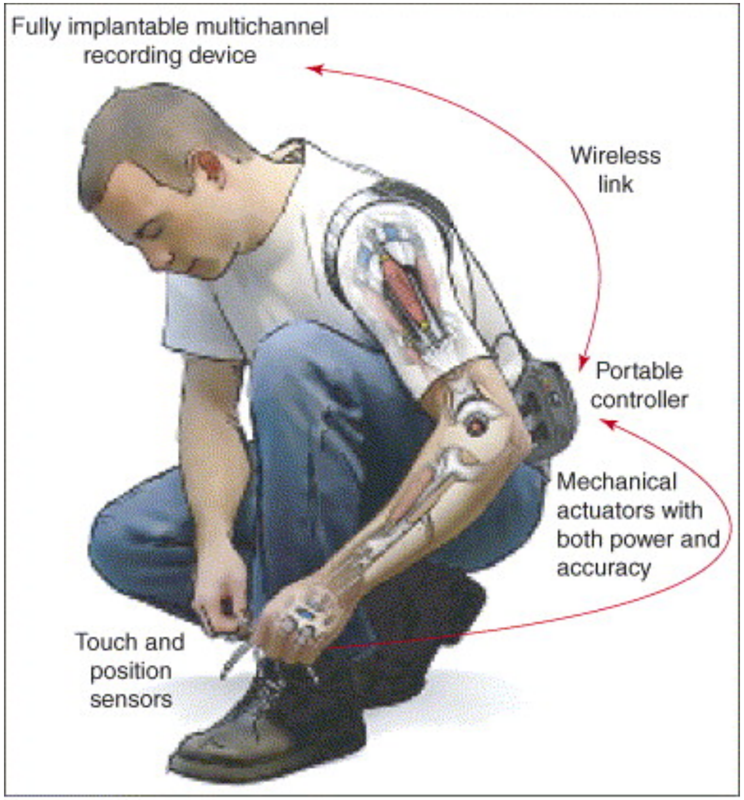
Caution: Investigational Device. Limited by Federal Law to Investigational Use.

LR Hochberg *et al. Nature* **485**, 372-375 (2012) doi:10.1038/nature11076

nature

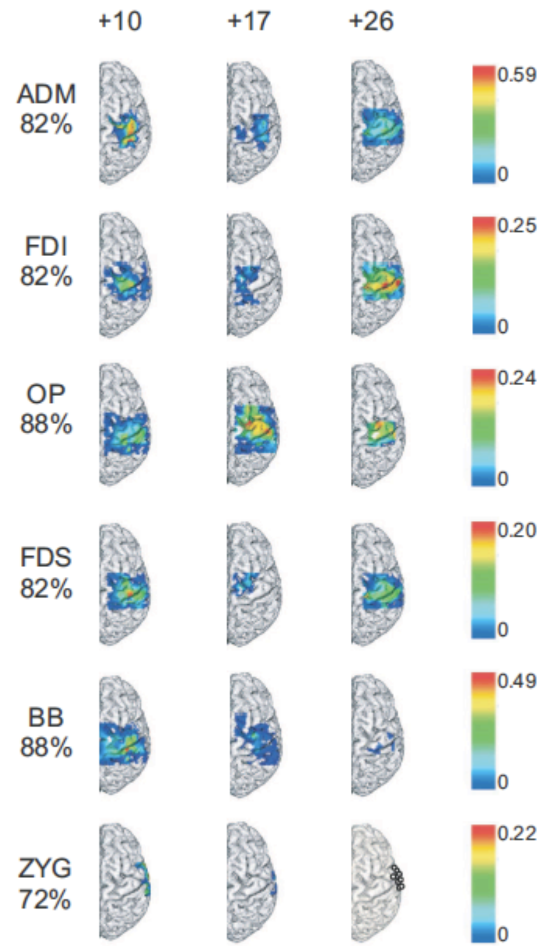
Electrodes implantées

- Pas d'apprentissage
- Pas de moyennage
- Echantillonnage élevé



Les greffes

- Peu de cas
- Problème des immunosuppresseurs



Re-emergence of hand-muscle representations in human motor cortex after hand allograft

Claudia D. Vargas[a,1], Antoine Aballéa[a], Érika C. Rodrigues[a,1], Karen T. Reilly[a], Catherine Mercier[a,2], Palmina Petruzzo[b], Jean M. Dubernard[b], and Angela Sirigu[a,3]

Conclusion

- La main et le mouvement sont intimement liés
- Une vision anatomique qui change
- Des données EBM de plus en plus robustes
- Le champ du possible est de plus en plus large dans le domaine de la compensation