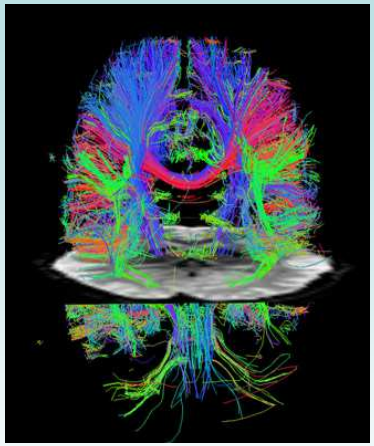


Cerebral Palsy

State of the Science & Current Treatments

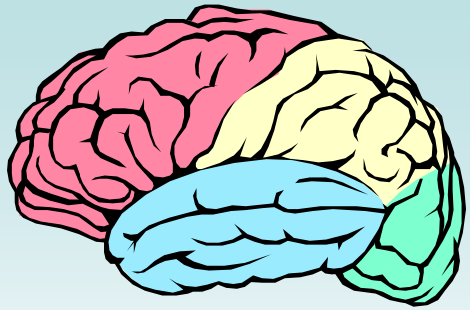
Eileen Fowler PhD, PT

Tarjan Center for Disabilities at UCLA
Director, Research and Education

Peter William Shapiro Chair
Center for Cerebral Palsy at UCLA

University of California at Los Angeles

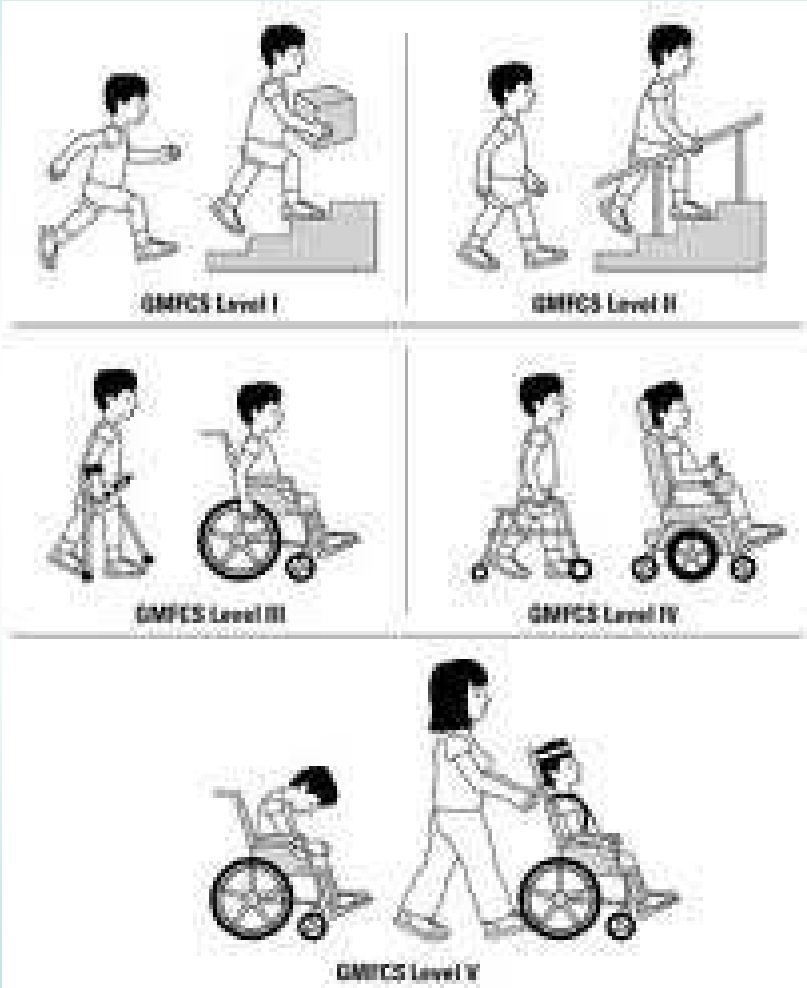
Cerebral palsy



- Cerebral palsy is due to an injury to the developing brain that results in a **motor disability**.
- a group of multiple brain injuries or malformations with variable prognoses
- most common pediatric physical disability (3/1000 live births)
- often associated with cognitive, behavioral and sensory impairments

Cerebral palsy

- Classified by the type and distribution of motor impairment
- Mild or severe motor impairment
- Intellect: normal to severe disability
- Co-morbidities can include visual, hearing disabilities and seizures
- Adaptive equipment: bracing, canes, crutches, walkers, wheelchairs, communication devices



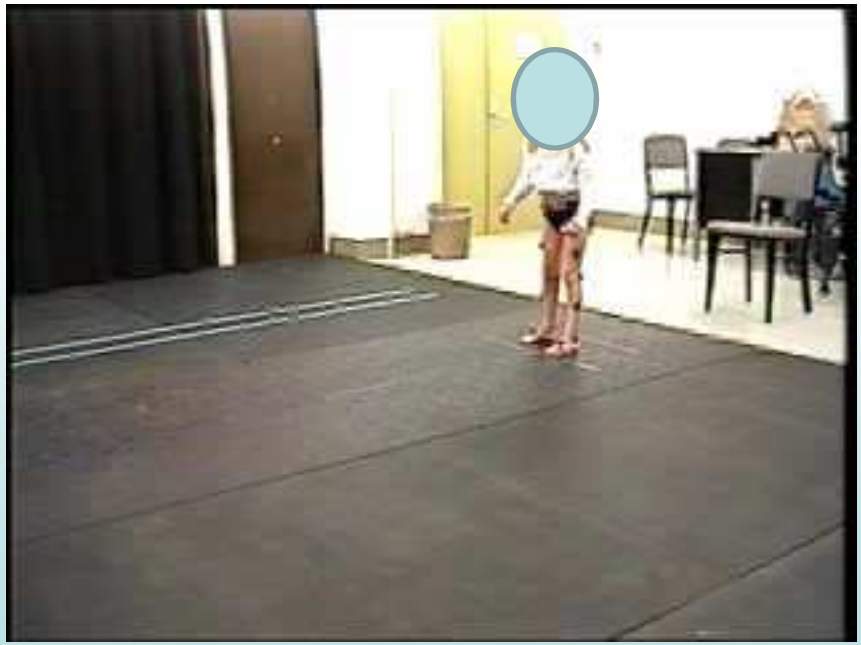
Mobility classification

Spastic Cerebral Palsy
Increased “tone”

Most common subtype

Causes: include premature birth, infection, perinatal stroke

“Velocity-dependent” resistance to motion



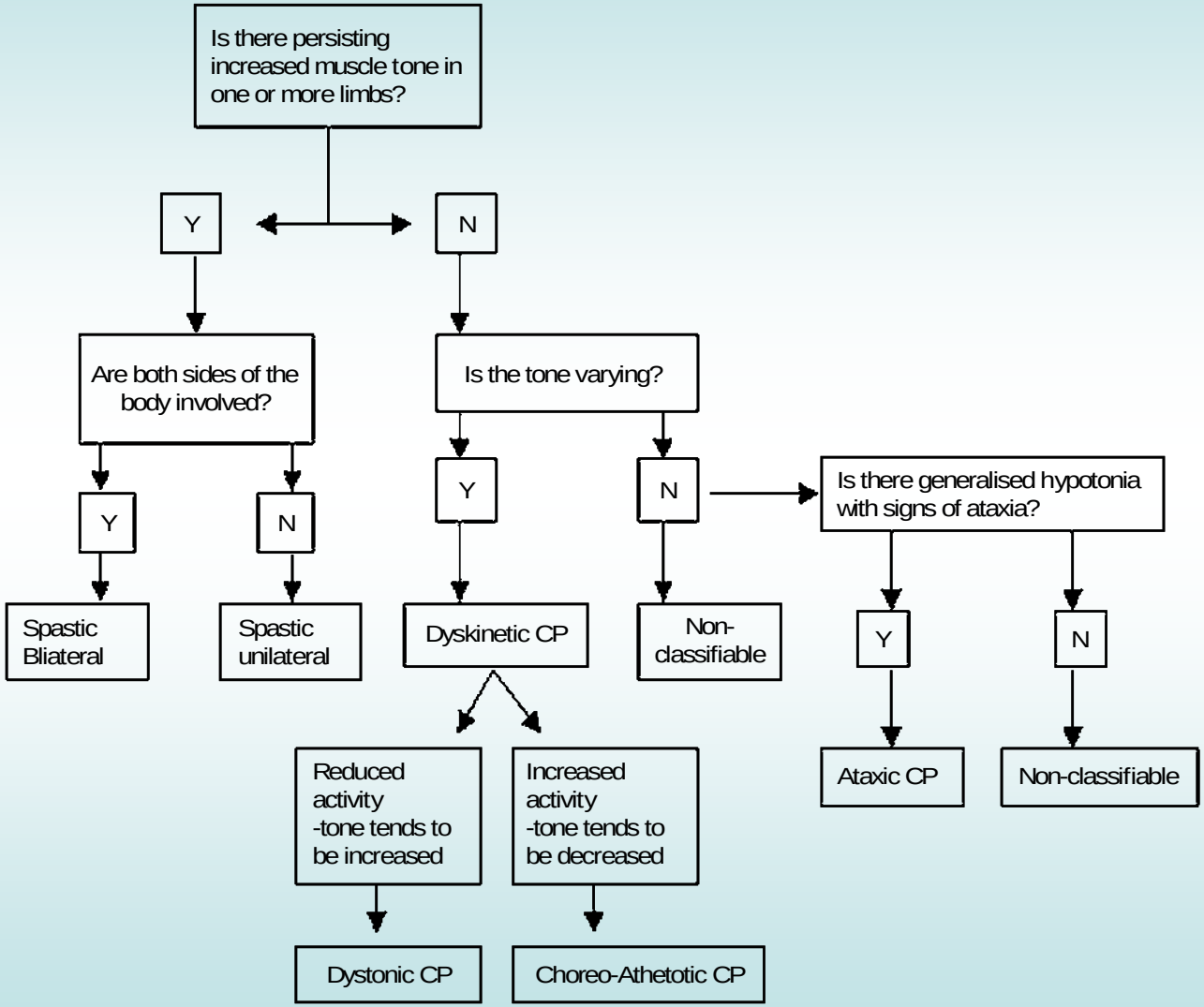
Dyskinetic Cerebral Palsy

variable tone/movement

Causes: jaudice, metabolic problems, trauma, hypo-ischemic encephalopathy

1. choreo-athetosis
    - Writhing component to movement
2. dystonia
    - Sustained postures

Decision Tree for CP Subtypes



Cans C. Dev Med Child Neurol. 42:816-24, 2000

Previously? thought that CP could not be prevented, cured, treated

Current State of Science

Prevent

Neuro-Protection

Cure

Neuro-Regeneration

Treat

Neuro-Plasticity

Neuro-Protection

Eliminating Prematurity is the best strategy

1. In Vitro Fertilization (IVF) transfer limits
2. Antenatal steroids – premature labor
3. Magnesium sulphate – premature labor (30% reduction of CP)
4. Caffeine for premature babies
5. Infection prevention
6. Cooling for hypoxic-ischemic encephalopathy (15% reduction in CP)
7. Melatonin for fetus with intrauterine growth restriction
8. Iodine supplements
9. Rubella (german measles) vaccinations
10. Anti-D for RH negative mothers
11. Kernicterus prevention (jaundice)
12. Car seats
13. Education - shaken baby syndrome

Neuro-Regeneration

1. Hypoxic-ischemic encephalopathy (HIE) Cooling Plus
   - Longer deeper
   - Magesium sulphate
   - Zenon
   - Topiramate
   - Erythropoietin

2. Stem Cells
   - Research shows promise
   - Not ready for clinical tx

Neuro-Plasticity

1. Early identification and intervention
    - Active engagement in movement (play)
    - Task specific
    - High dose
    - Promote “skilled” movement

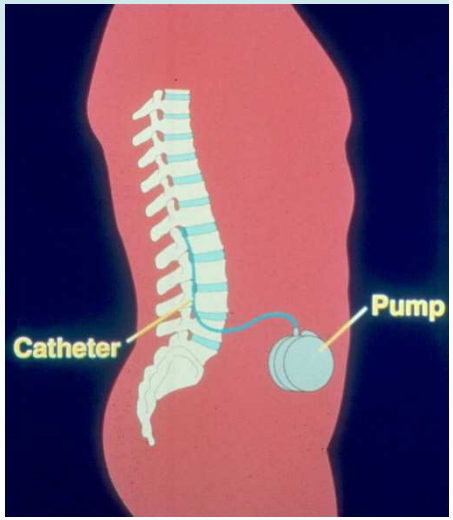
2. Best evidence is constraint-induced and bimanual therapy for the upper limb in children with hemiplegic CP.

3. Promotion of physical activity throughout childhood
    - Decreased mobility level can occur w/o treatment

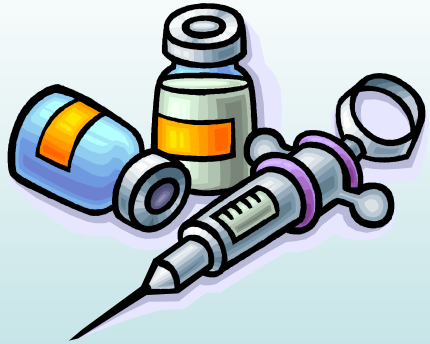
Medical and Surgical Treatments

Selective Dorsal Rhizotomy

Orthopaedic Surgery



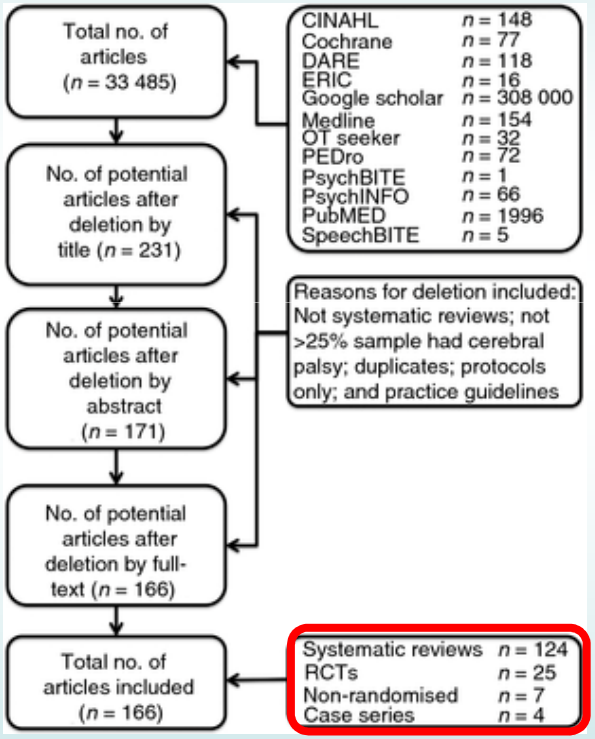
Baclofen Pump



Botulinum Toxin Injections

Cerebral Palsy Treatments

A "Review of the Reviews" of the relatively few intervention studies

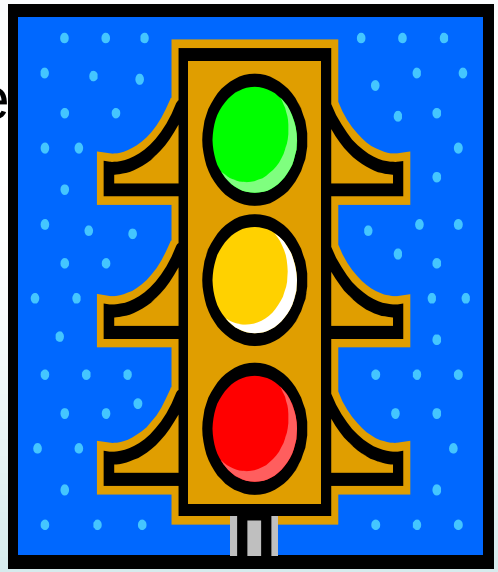


A systematic review of interventions for children with cerebral palsy: state of the evidence
Novak et al. Dev Med Child Neurol 55:885-910, 2013

A systematic review of interventions for children with cerebral palsy: state of the evidence

Novak et al. Dev Med Child Neurol 55:885-910, 2013

- VERY controversial article set off a flurry of editorials.
- Only 16% CP txs were classified as “gre it.”
- Most txs were “yellow.”
  - 58% “probably” do it
  - 20% “probably” don’t do it
- 6% were “red light – do not do it.”
- **The focus for our lab is on exercise interventions**

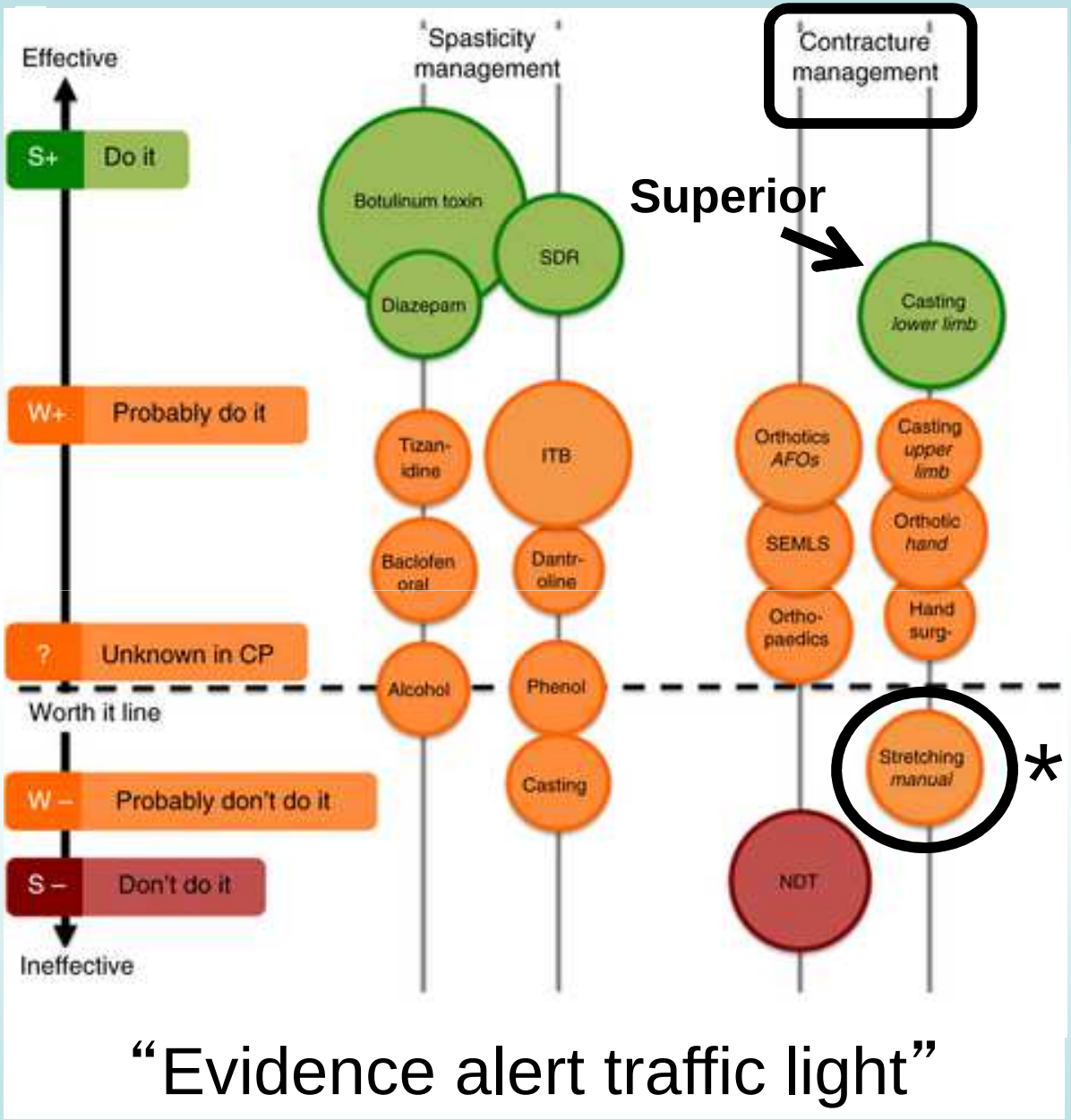


Evidence Alert Traffic Light

Stretching Exercises

2 Review Articles

Low level of evidence does not support PROM ex.



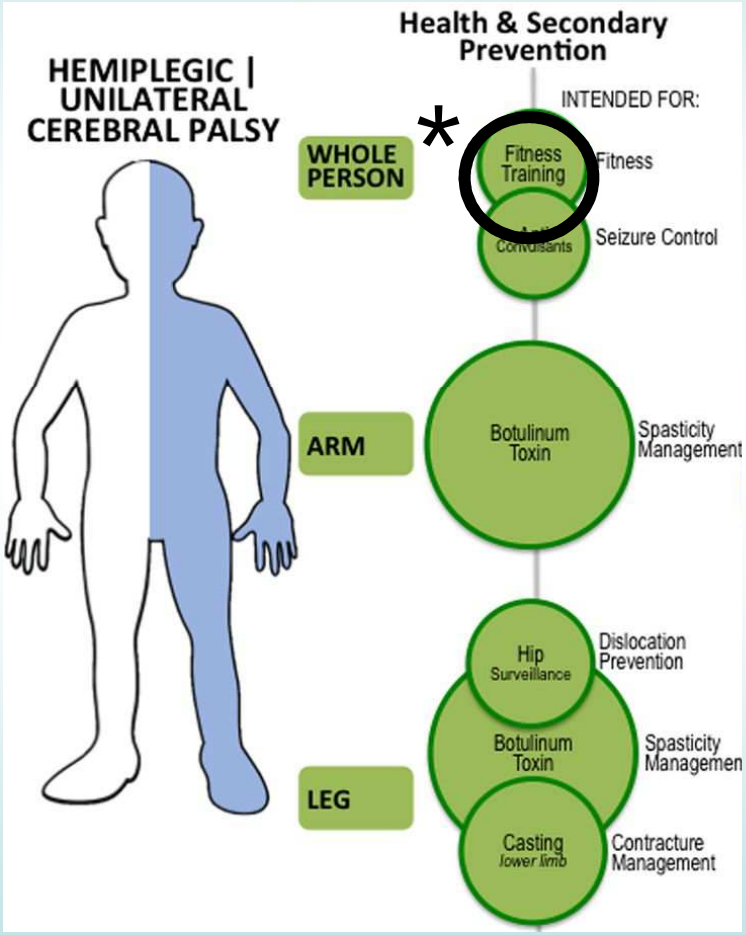
"Evidence alert traffic light"

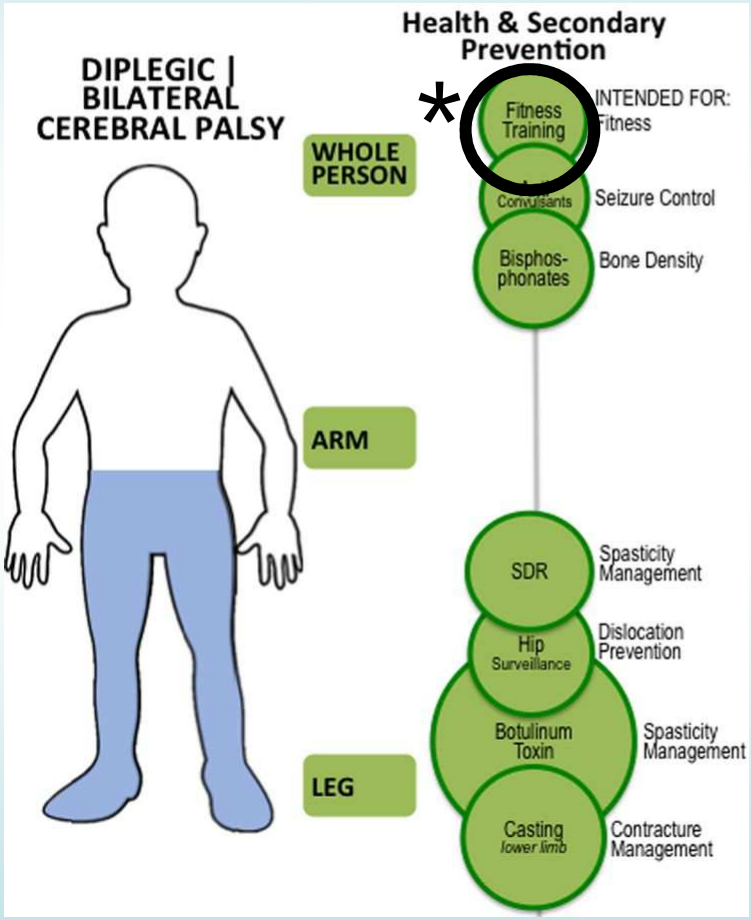
Novak et al. A systematic review of interventions for children with CP: state of the evidence

Dev Med Child Neurol 55:885-910, 2013

Aerobic Exercise Evidence

Green Light – Do it!





Novak I J Child Neurol 2014;29:1141-1156

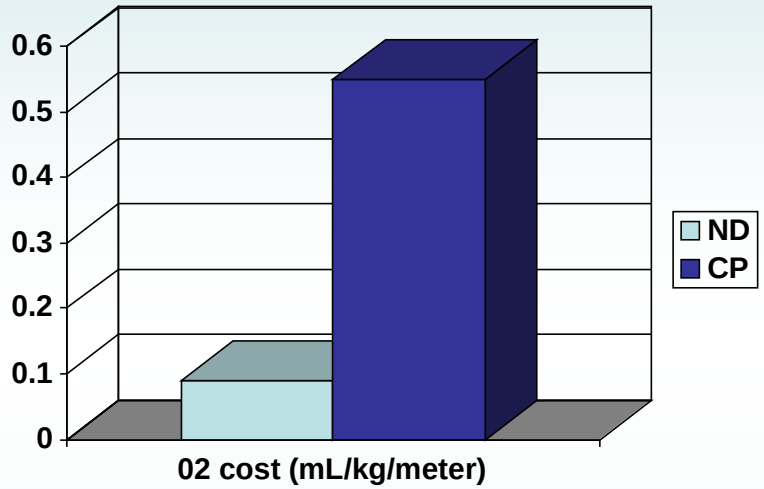
JOURNAL OF CHILD NEUROLOGY

Aerobic Exercise

- CP
  - No primary effect on heart or lung function
- Problem
  - limited ability to play & exercise at levels sufficient to develop and maintain cardiorespiratory fitness
- Decreased Opportunities for exercise
  - accommodations and adaptations may be needed
- Health risks due to sedentary lifestyle
  - diabetes, heart disease, stroke, cancer etc.
  - mental health

Aerobic Exercise
Increase Energy "Reserve"

"I am exhausted just walking and you want me to exercise more?"



Higher $V0_2$ per meter walked

Norman et al. Pediatr Phys Ther 16:206-211, 2004

- Greater energy expenditure during walking but unable to play, walk or run at sufficient intensity to increase $V0_2$ – low "reserve."
- Fatigue commonly expressed by adults with CP.

Aerobic Exercise Interventions

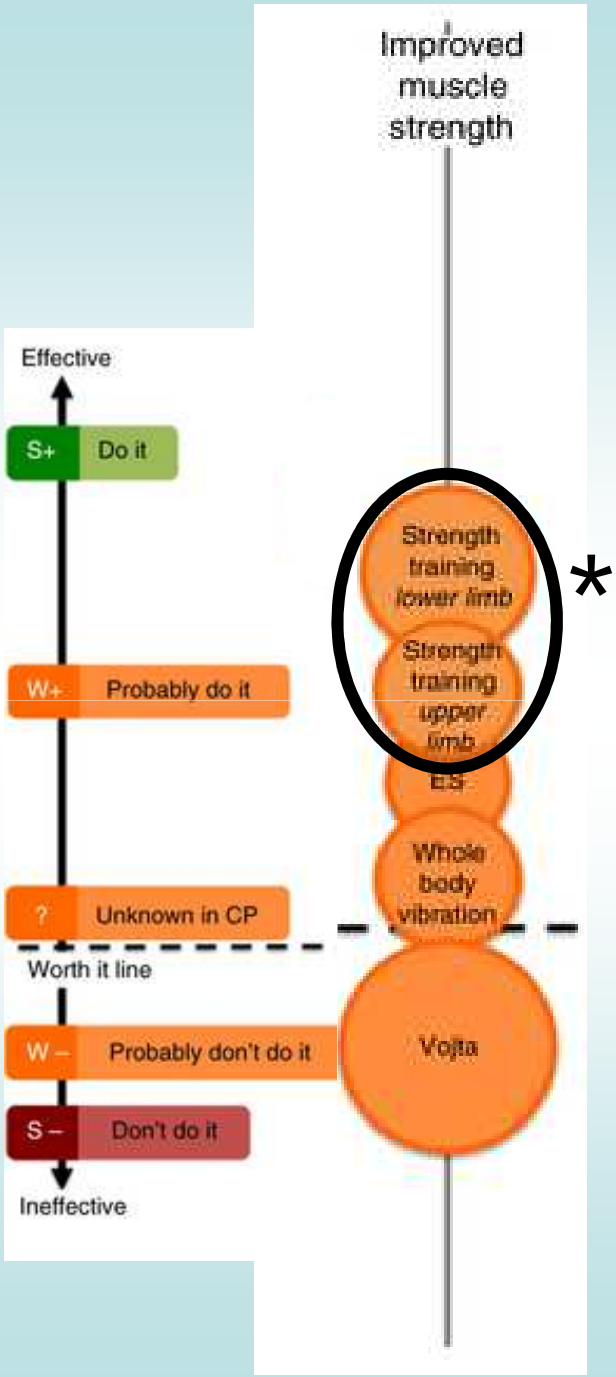
Types of Exercise

- Running/walking fast
- Aerobic dance
- Treadmill: may need body weight support
- Underwater, reduced gravity treadmills
- Robotic walking with active participation
- Lower or upper extremity cycling
- Rowing
- Swimming or vigorous pool exercises
- Mat exercises

Strengthening Exercises

Yellow light – probably do it

Weak translation to activity and participation levels of ICF

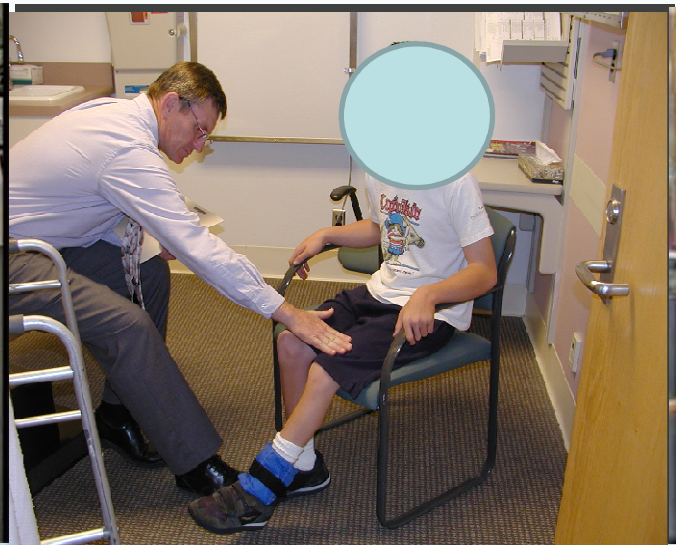


Novak et al. A systematic review of interventions for children with CP: state of the evidence

Dev Med Child Neurol 55:885-910, 2013

Strengthening Exercises

- Contra-indicated until 1990s
- Isometric, isotonic, isokinetic exercise
- Optimally 3x/week – 48 hours for recovery



PEDALS

Pediatric Endurance Development & Limb Strengthening for Children with Cerebral Palsy

PARTNER IN RESEARCH

Foundation for Physical Therapy

CPRIF

Eileen Fowler, PT, PhD — **University of California, Los Angeles**
Sharon DeMuth, PT, DPT — **University of Southern California**
Loretta Knutson, PT, PhD, PCS — **Missouri State University**
Roksana Karim, MD, PhD — **University of Southern California**

Study Design

Randomized controlled trial (RCT)

Spastic diplegic CP

- 62 participants
- 7–18 years
- GMFCS I, II, and III

Cycling group, n=31

- 30 sessions over 10-12 week period

Control (no cycling) group, n=31

Pre-post assessments (12 weeks)

Evaluators blinded to subject assignment

PEDALS OUTCOMES

WHO - ICF Framework

Body function & structures

Activity

Participation

Biodex
Knee joint torque

Gross Motor Function
600 yard walk-run
Preferred walking speed

Overground cycling

Health Related Quality of Life: PedsQL, PODCI

Stationary Cycling Intervention

Each cord = 10 lbs resistance

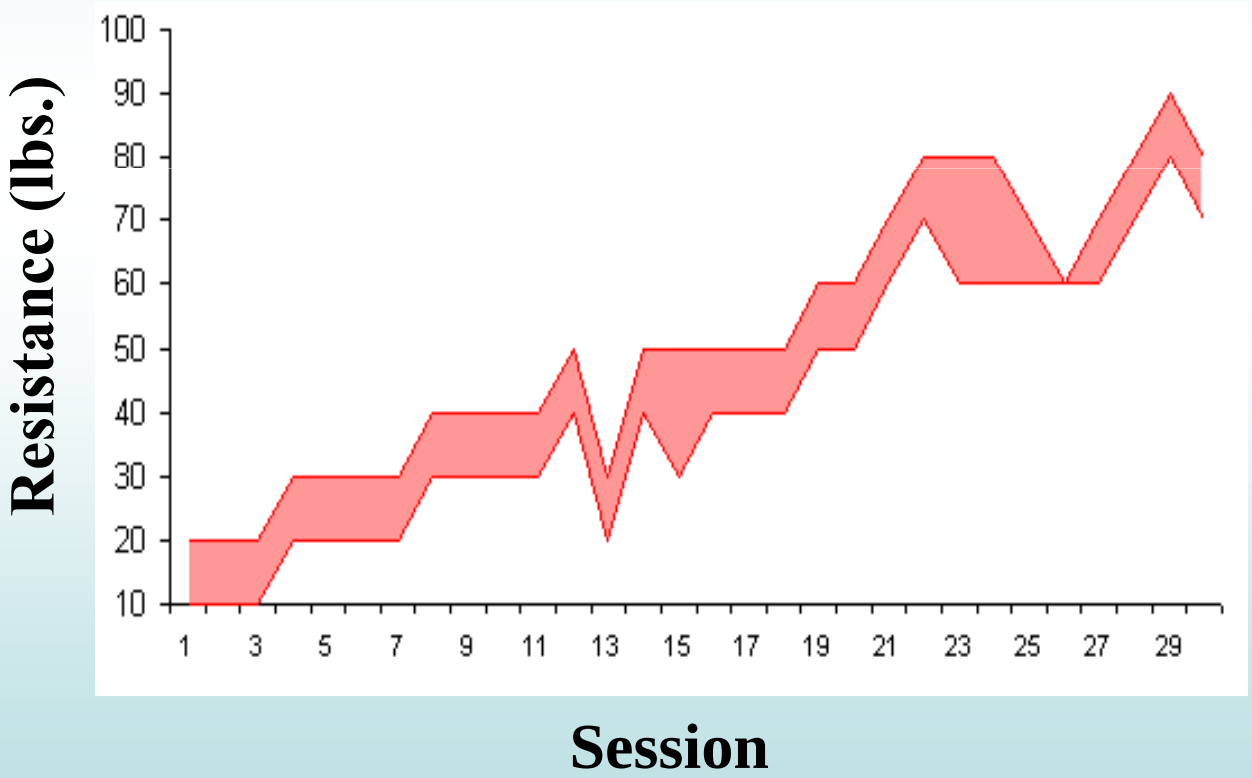
Phase 1 = PRE strengthening component (20 min)

Phase 2 = aerobic exercise, monitored heart rate (30 min)

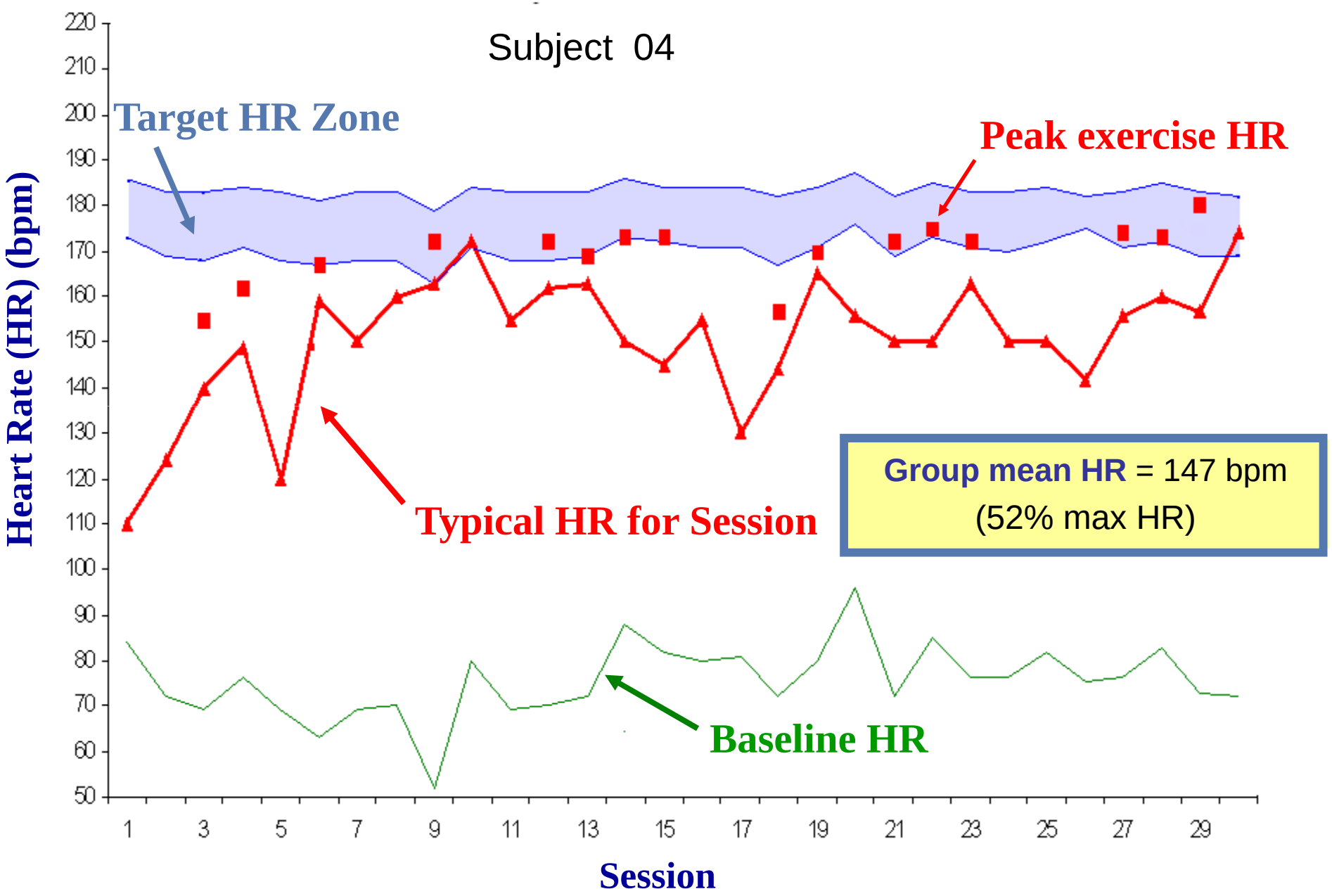
Phase 1: Strengthening Component

Subject 4

Group mean ↑ = 66 lbs
(↑ from 30 - 74% BW)



Phase 2: Cardiorespiratory Training



PEDALS Summary

Within the Cycling group

- Participants developed the ability to cycle independently
- ↑ in walking/running endurance
- ↑ in knee joint power/strength
  - 120 deg/s for knee extensors, 30 deg/s for knee flexors
- ↑ in gross motor function
- No change in preferred walking speed

PEDALS Summary

Between group dif. for Psychosocial health

- ↑ emotional health in cycling as compared to control group
- ↑ parent satisfaction with child's condition in the cycling group

No sign. b/w group differences for other measures

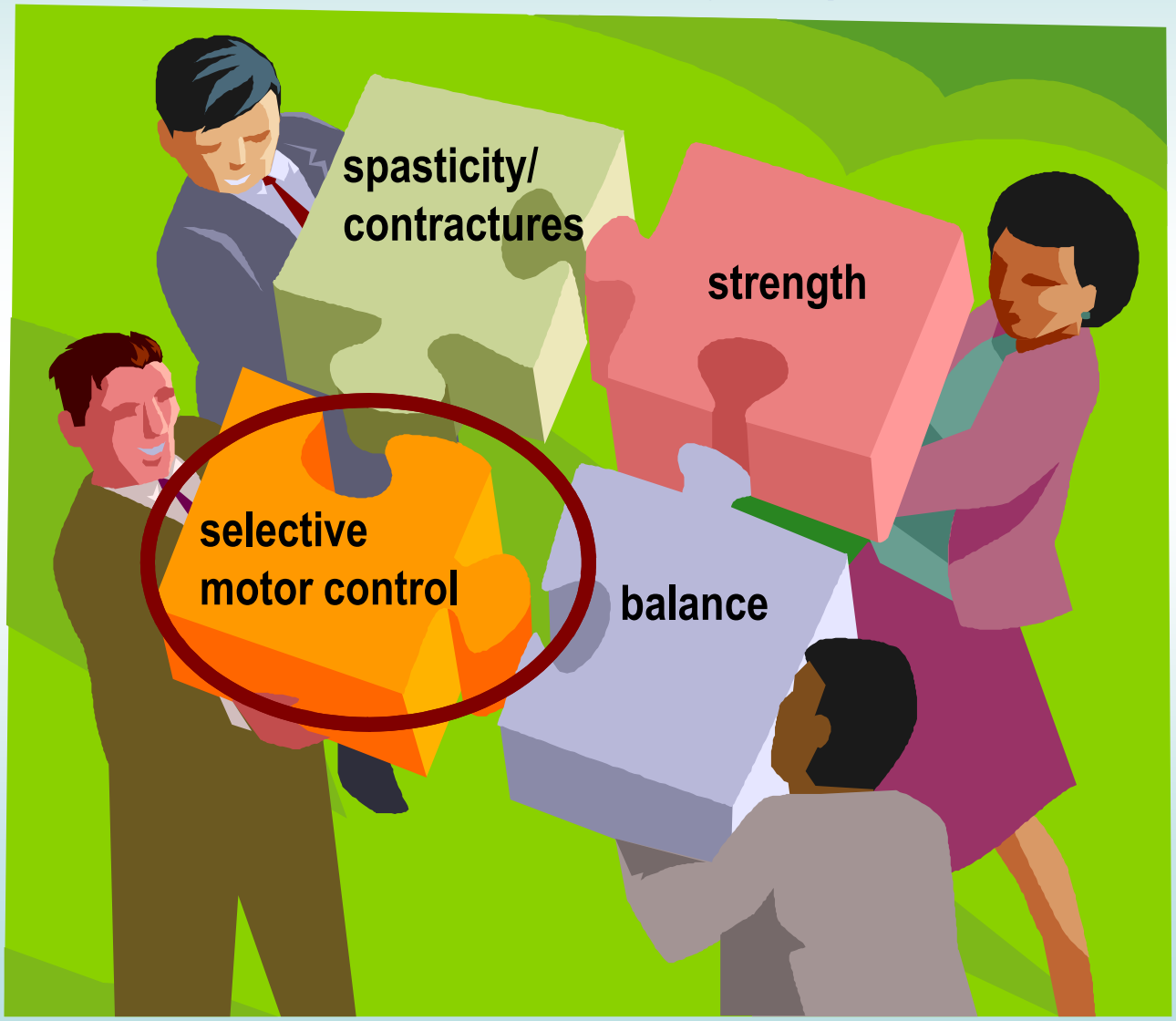
- consistent with other RCTs
- large SDs both groups– reflects heterogenity/co-morbidities
- control group: mean ↑ for most measures
- cycling group: motivation and capacity varied
- n=130 required for b/w group dif

Free Adapted Tricycle for all PEDALS Participants

Participation level of ICF:
86% respondents were using their bikes min. 1x / week
2 – 3 years after the program, no between group difference

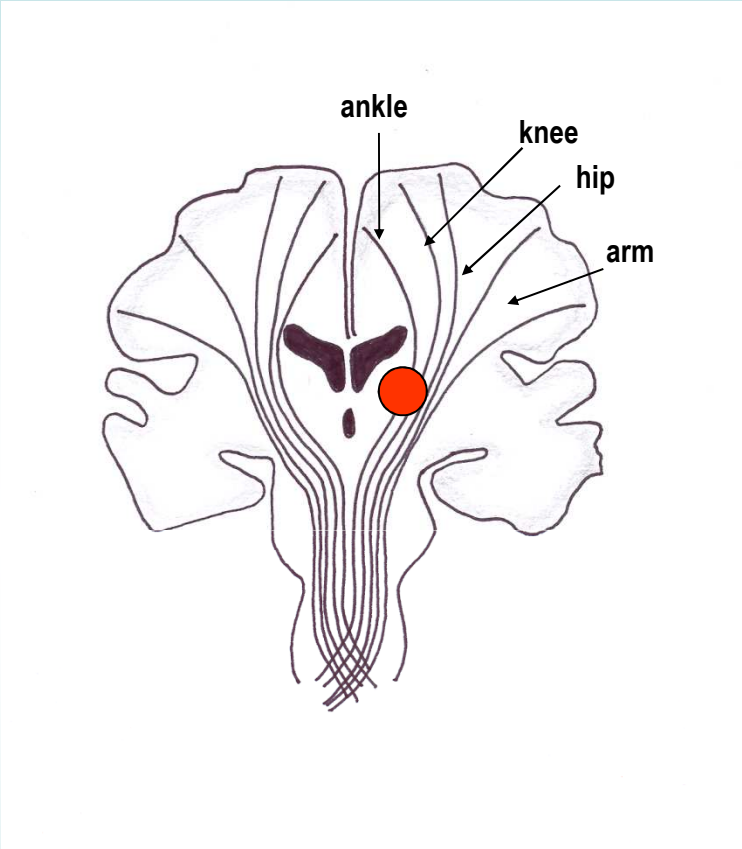
Why do some children improve and others do not?

Spastic Cerebral Palsy Impairments



Spastic CP

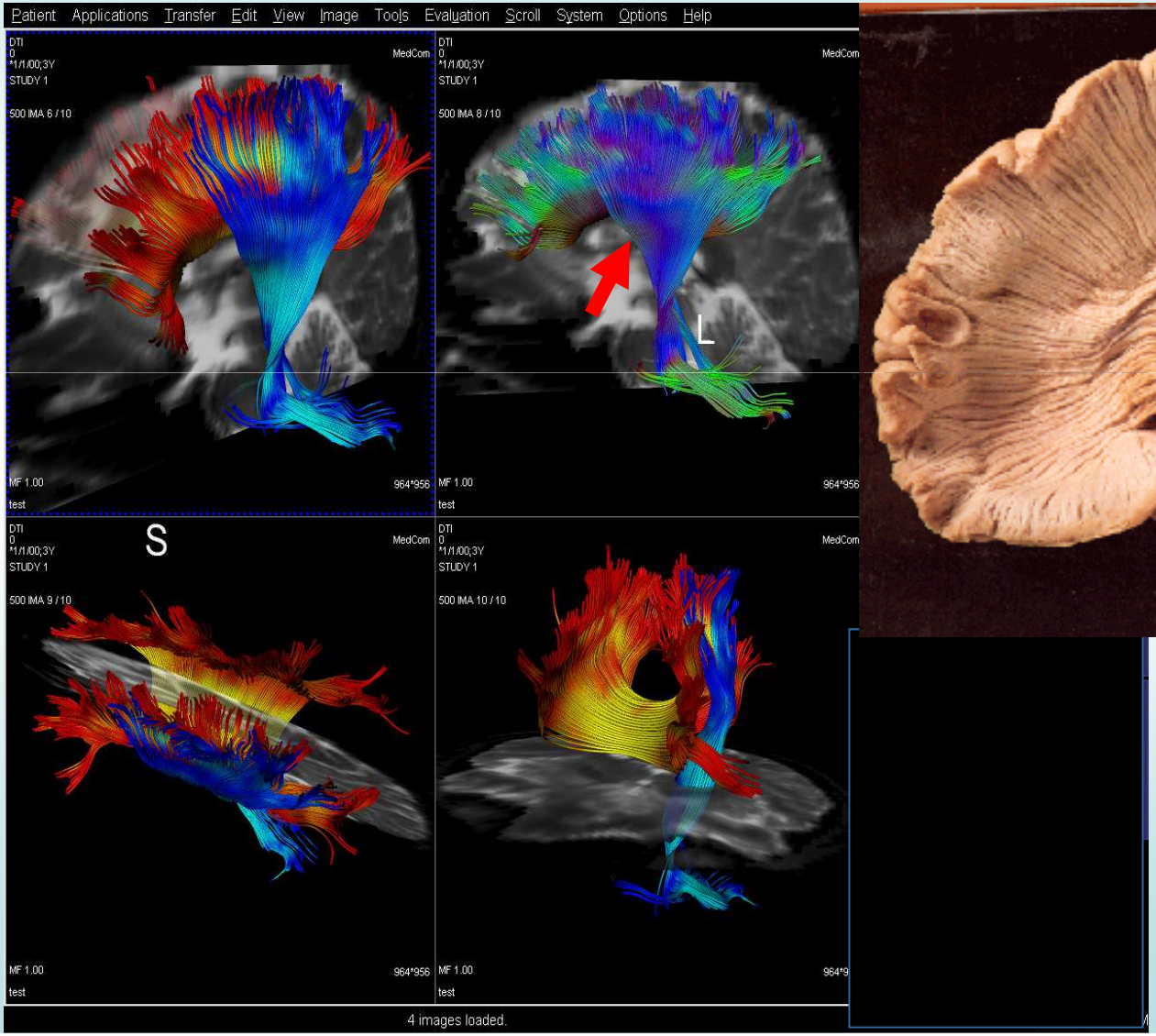
- damage voluntary movement pathways
- loss of **Selective Motor Control**
- mass limb flexion and extension
- mirror movements
  - preservation ipsilateral tracts
  - maladaptive plasticity

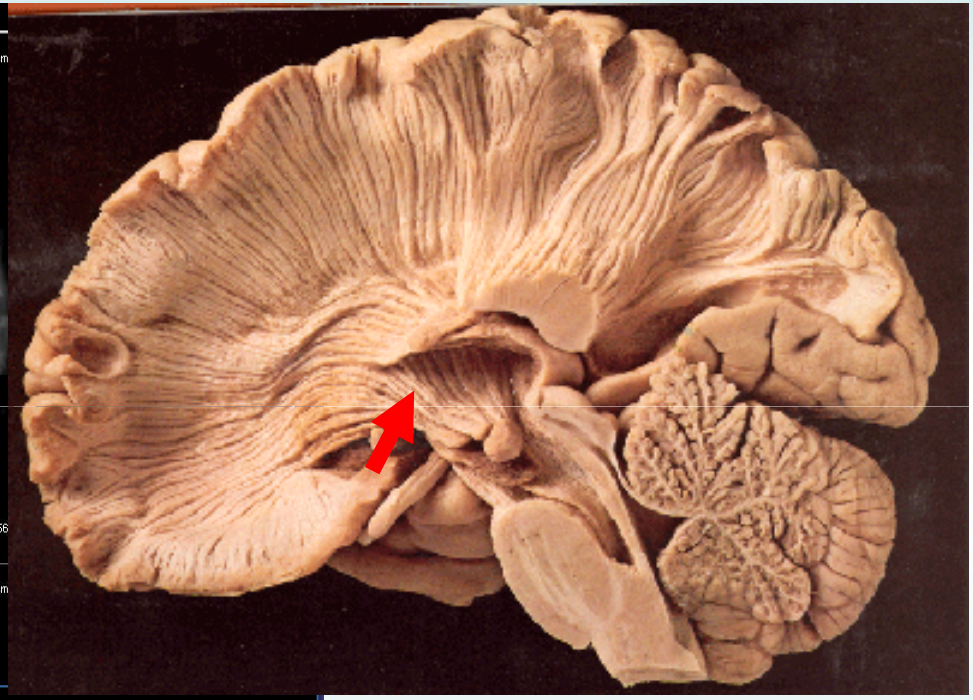


Periventricular leukomalcia

Does the extent of corticospinal tract damage predict functional outcomes?

Corticospinal tracts
Diffusion Tensor Imaging





FA=Fractional anisotrophy
“directionality” of fibers

Development of a Clinical Test for Selective Control of the Lower Extremity (SCALE)

			Left				Right				
Grade		Hip	Knee	Ankle	STJ	Toes	Hip	Knee	Ankle	STJ	Toes
Normal (2 points)		√					√	√			
Impaired (1 point)			√						√	√	
Unable (0 points)				√	√	√					√
Total Limb Score	L= 3	R= 6									

Example of scores for a child with spastic diplegic CP

Maximum score per each lower limb = 10

Fowler et al. Dev Med Child Neurol 2010

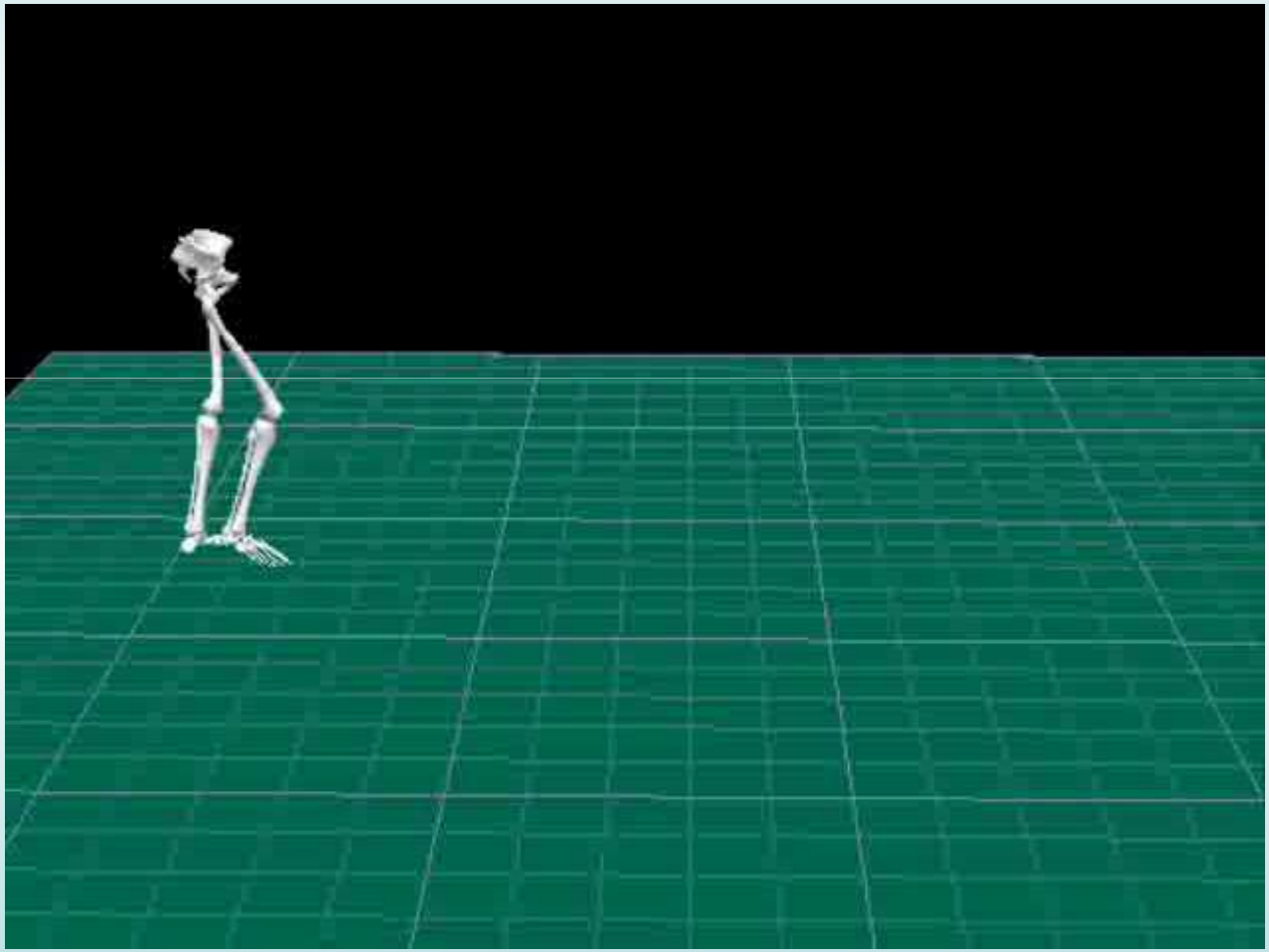
Spastic CP
Knee Motor Control = “Normal”

Spastic CP
Knee Motor Control = “Impaired”

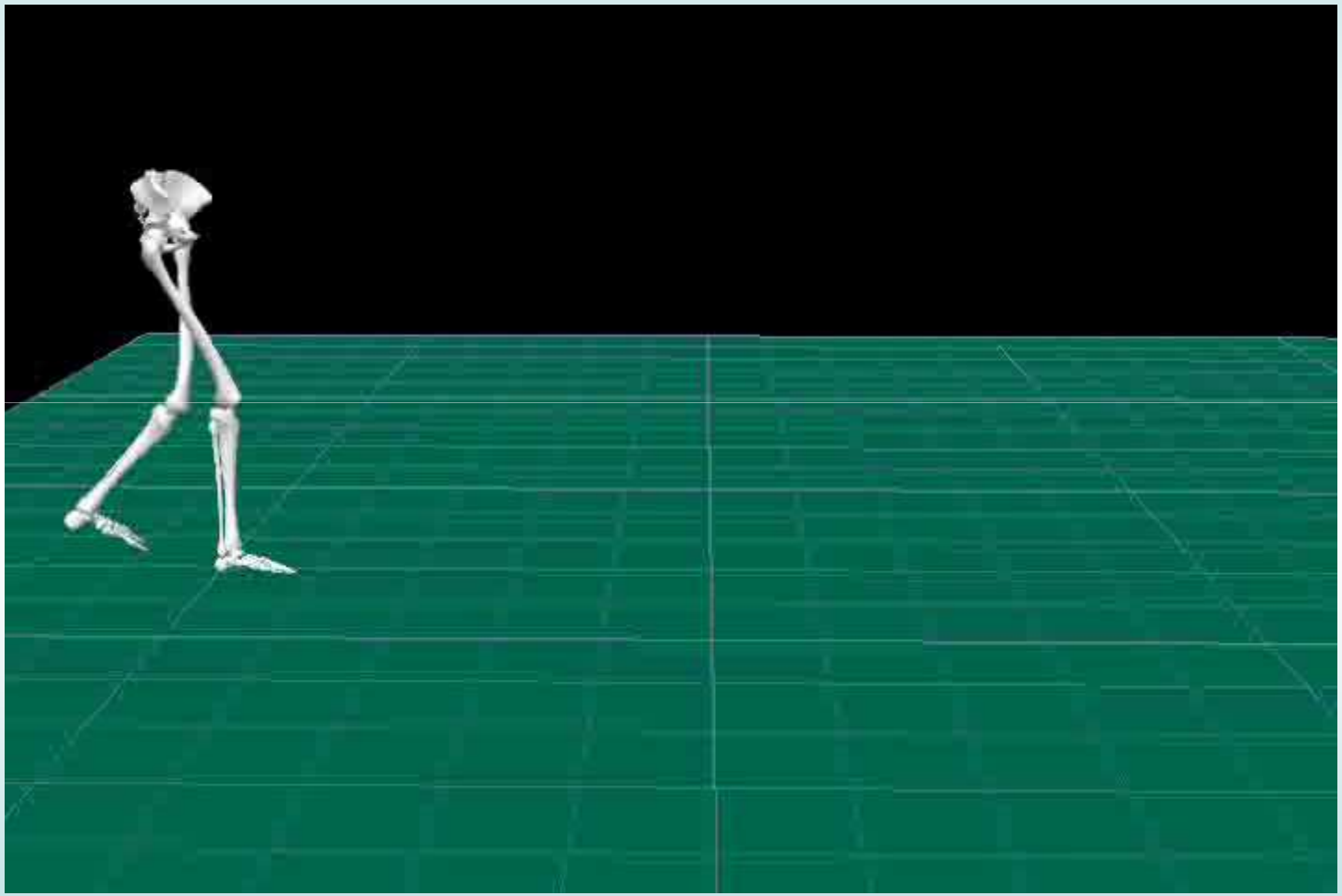
Spastic CP
Knee Motor Control = “Unable”

Challenging to perform knee joint strengthening exercises for this child !

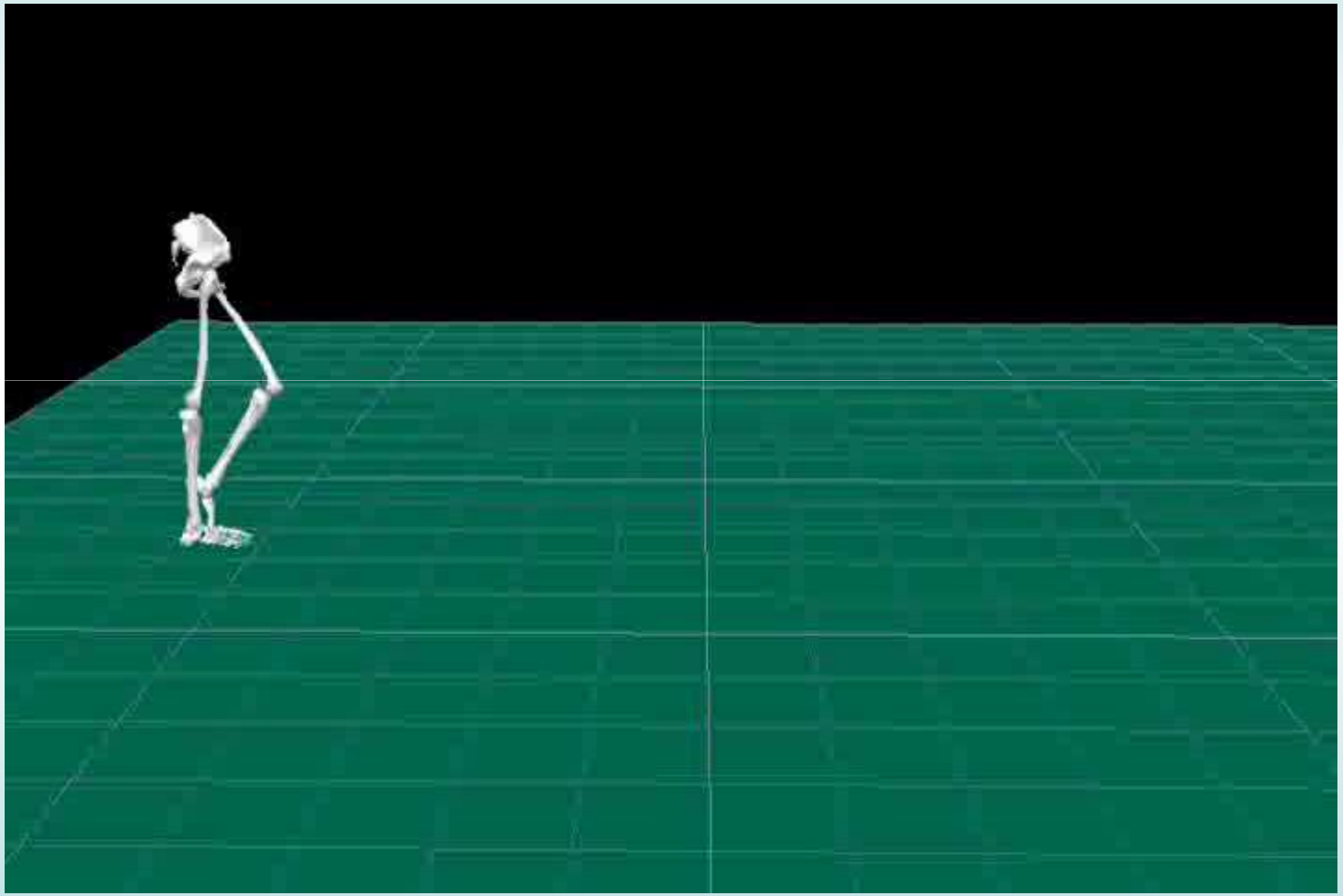
Gait: Normal SVMC
Step length - hip and knee coordination



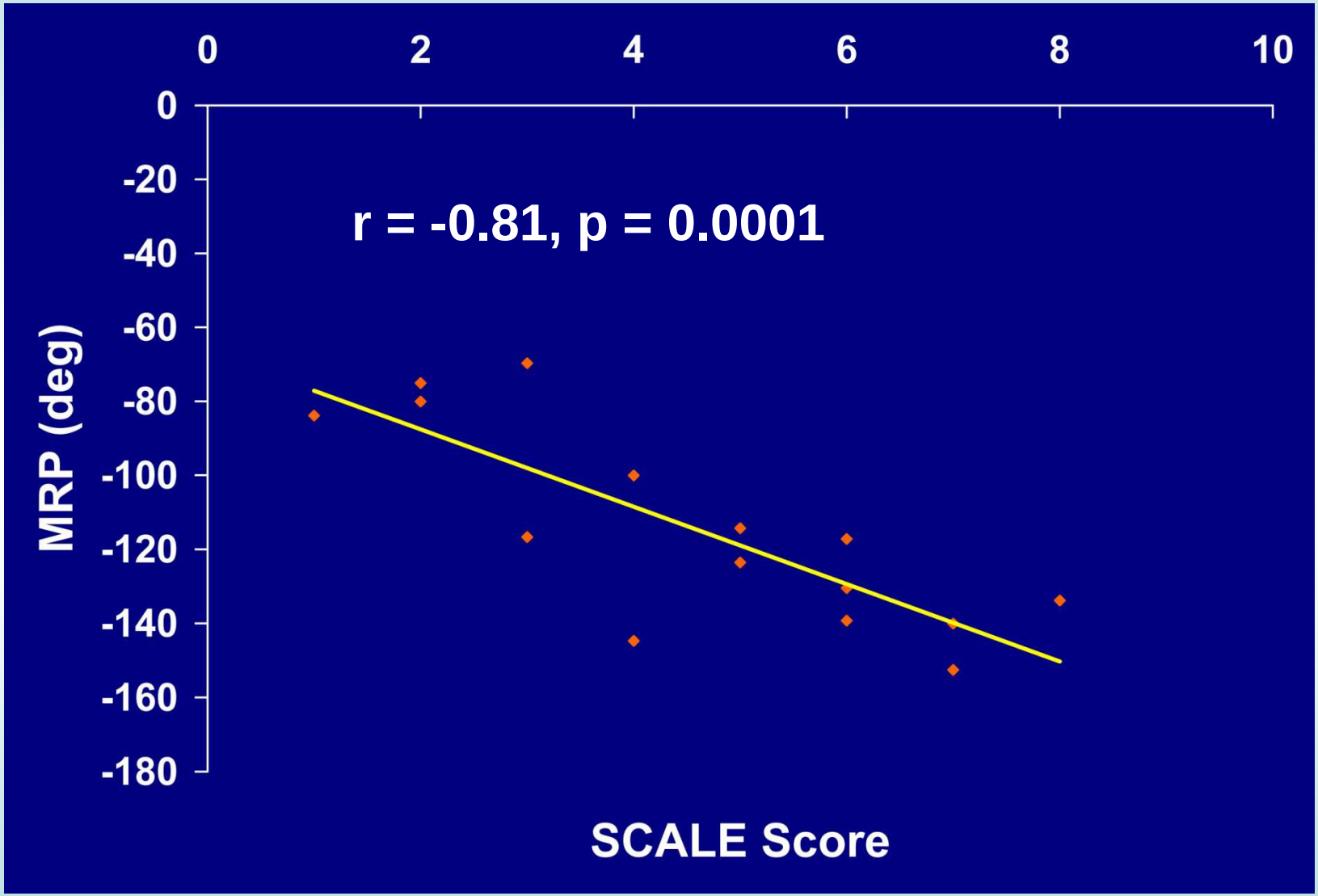
Gait CP: Impaired SVMC
reduced step length



Gait CP: “Unable” SVMC markedly reduced step length

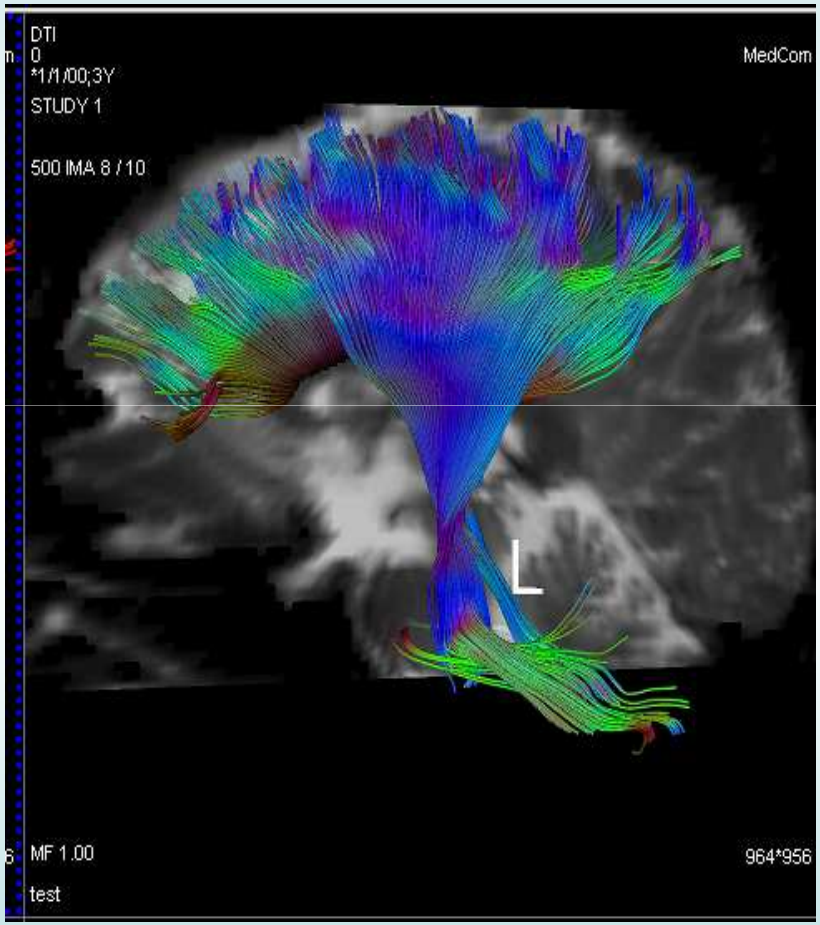


Does the clinical exam predict hip/knee coordination during walking? YES



SCALE - MRP Correlation (right limb)

Does the clinical evaluation correlate with Corticospinal tract MRI – DTIs parameters?



Data currently being analyzed

Can we improve selective motor control in children with spastic CP?

- July 2014: 15 sessions of intensive therapy, 3 hours/day
- UCLA undergraduate counselors
- Exercises aimed at improving **selective motor control**
- Outcomes: Brain MRI-DTIs, gait and function

Outdoor play

Isolated knee extension

Step length

Individual Laboratory Sessions

Isolated knee Strength/Power

Isolated ankle motion

Currently analyzing the results!

SUMMARY

Exercise Recommendations

- Assess capacity
  - single joint strengthening? adaptations needed?
- “Active” motor learning, need motivation
- Specificity of training
  - Goal: ↑ walking speed ⟹ practice walking fast
  - evidence for translation across the ICF is weak
- Sufficient intensity
- Lifelong exercise programs
  - “Use it or lose it”
  - school, recreation, community programs

Transforming Healthcare for Women with Disabilities

- Funded by the Cerebral Palsy International Research Foundation
- Partnership with Tarjan Center and UCLA OB/GYN
- Focus on reproductive health
- Addressing attitudinal and physical barriers

Psychological Health

- Major problem and understudied area
- Very few lifespan CP clinics
- Depression and anxiety are common problems of adults that attend our CP clinic
- Psychologists are rarely team members

Selective Motor Control Research

Research Team

Marcia Greenberg MS, PT
Evan Goldberg, PhD
Eileen Fowler, PhD, PT
Kent Heberer, MS
Loretta Staudt, MS, PT
Shantanu Joshi, PhD
Carolyn Kelly, DPT
Christy Skura, DPT

CAMP LEG POWER

Thanks for your attention!

NEW FRONTIERS

69th ANNUAL MEETING

AACPDM

2015

JW MARRIOTT AUSTIN, TEXAS OCTOBER 21-24

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