# Upper extremity stroke rehabilitation

**A framework for implementing task-specific training into clinical practice**

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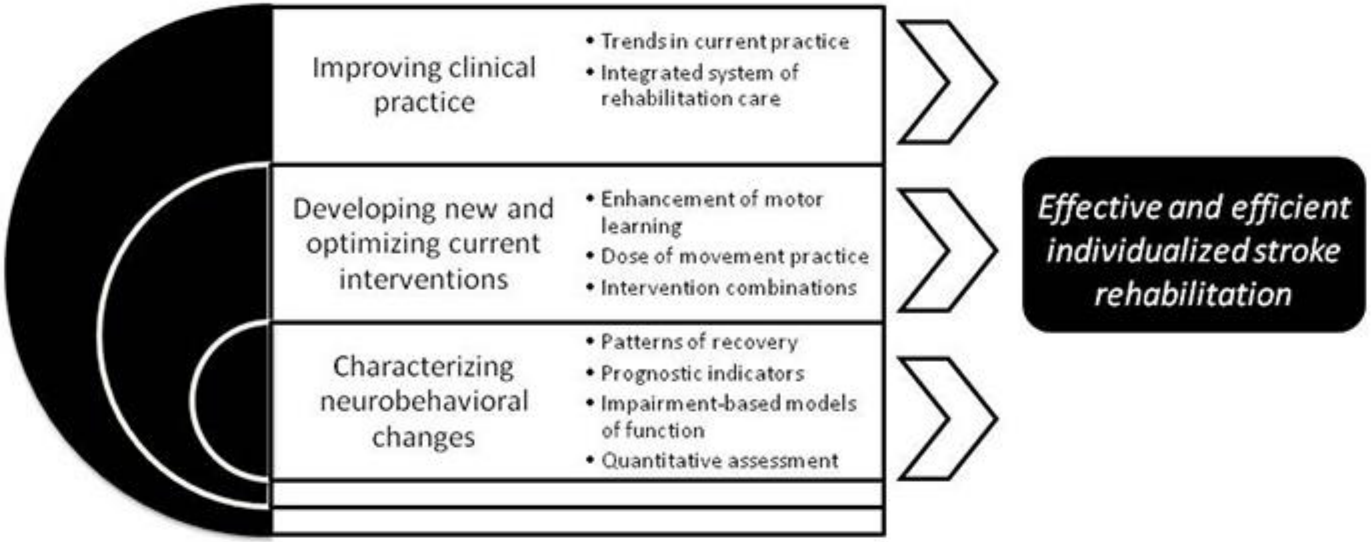
# Neurorehabilitation Research Lab

Principal Investigator: Catherine Lang, PT, PhD




## Current lab members:

Maggie Bland, PT, DPT, NCS, MSCI
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## Former members:

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Ryan Bailey, PhD, MSCI, OTR/L
Michael Urbin, PhD

Slide contributions from CE Lang and members of Neurorehabilitation Research Laboratory

# Upper extremity paresis: clinical significance

- Over 70% of individuals experience hemiparesis after stroke (Harris et al., 2009; Duncan et al., 1994)

- At 6 months:
  - 65% unable to incorporate affected UE into usual activities (Dobkin, 2005)
  - Approx. 50% need assistance with ADLs (Legg et al., 2007)

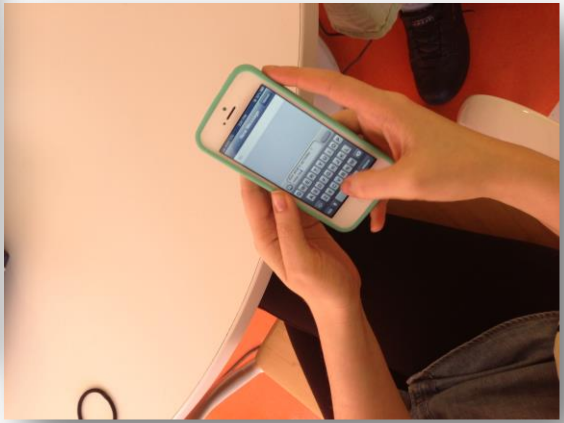
- At 5 years:
  - Nearly two-thirds are limited in performing at least one ADL (Wilkinson et al, 1997)
  - 25-50% have stopped participating in IADL (Wilkinson et al, 1997)

# Course overview

- Introduction to upper extremity (UE) movement
- Relationship of sensorimotor impairment to UE function
  - Prognosis
- Standardized assessments: Clinical importance and implementation
- Principles of task-specific training

# Essential components of UE movements:
## reach, grasp, move and/or manipulate, release



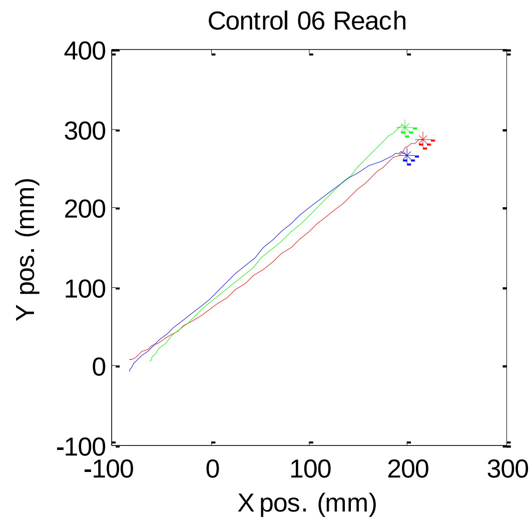


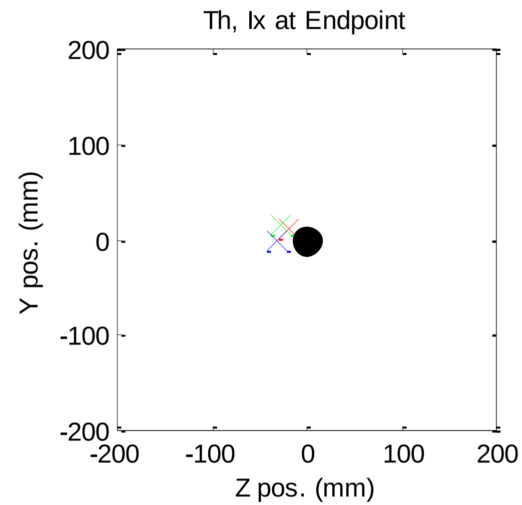

*Components are strung together in an endless number of combinations for daily function*

Lang 2012
Chapter 15
Geriatric Physical Therapy

# There are a few classic, stable characteristics of UE movement control

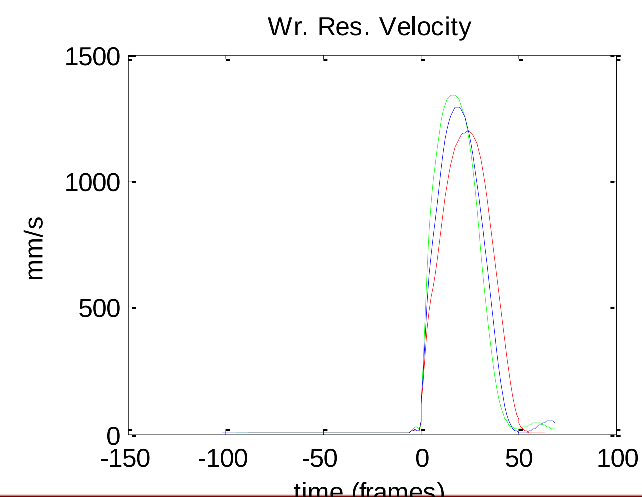
e.g. Reaching



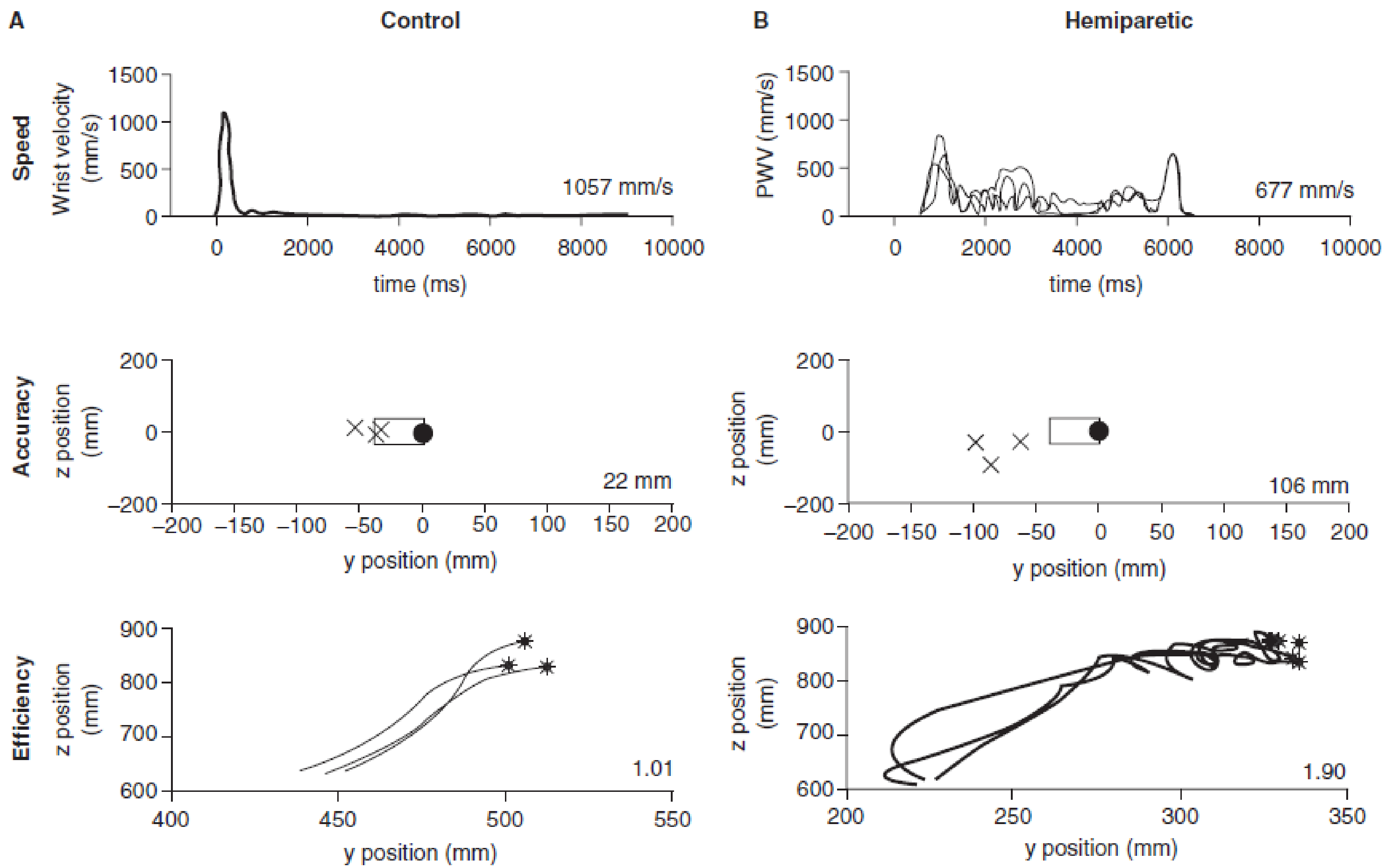




Salient characteristics:

1. Reach is in a straight line, directly to the intended target
2. One large smooth movement
3. Produced by simultaneous rotation at multiple segments
4. Requires anticipatory postural adjustments

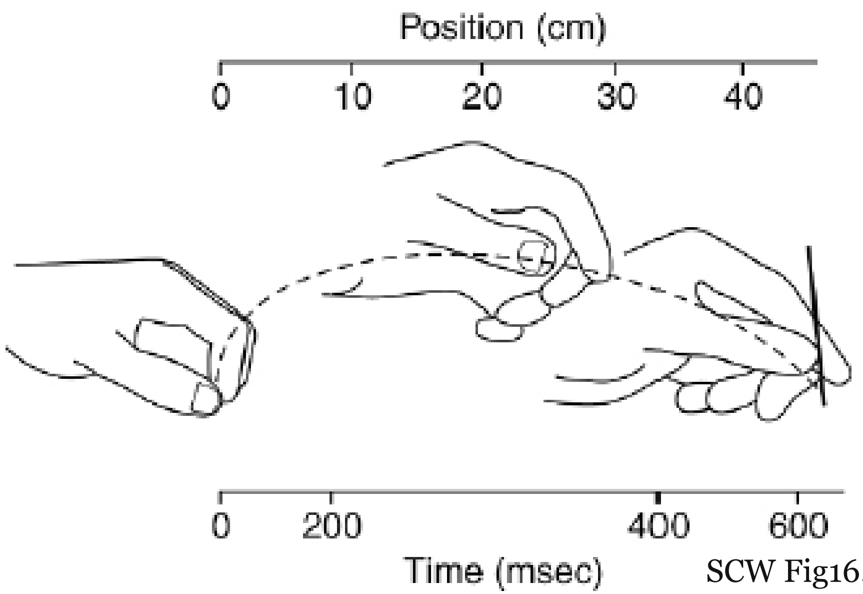


# An example of disrupted reaching post stroke




Wagner et al. 2006

# e.g. Grasping

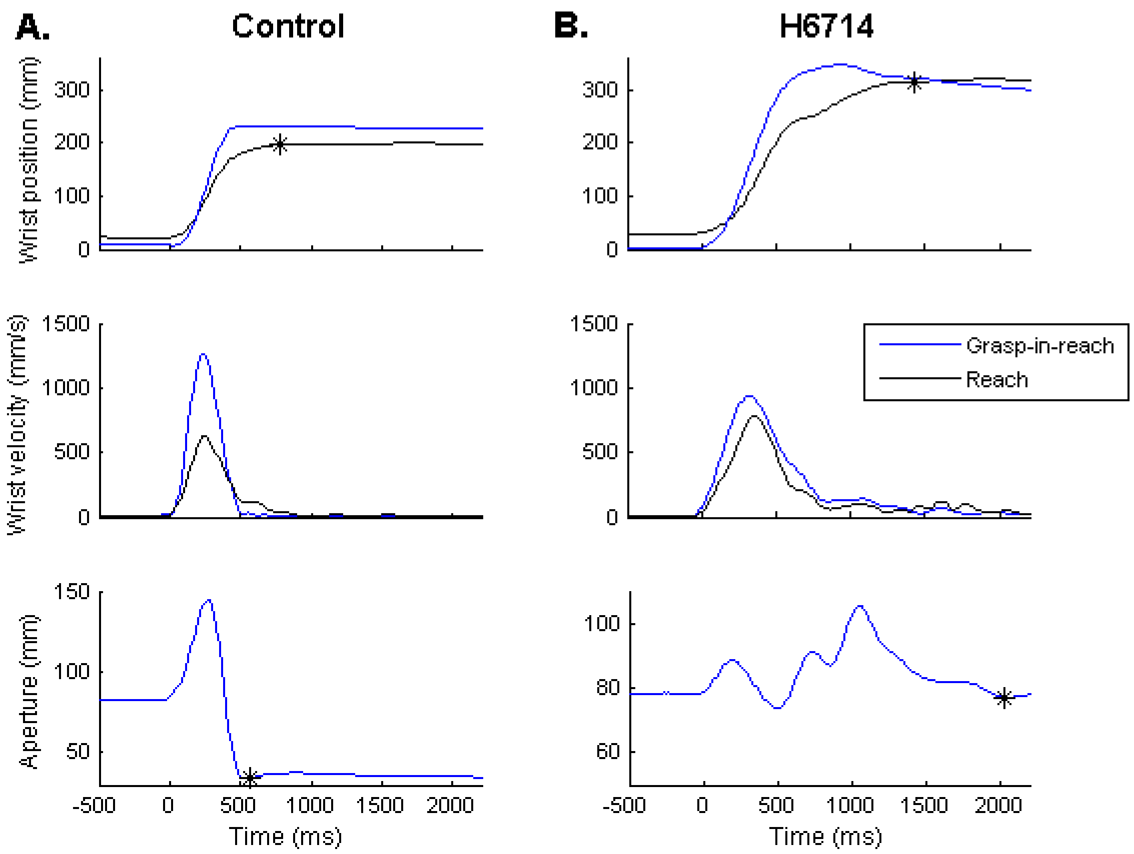


SCW Fig16.6

Salient characteristics:

1. Finger opening starts as the hand begins to move toward the object.
2. Finger aperture is scaled based on object size.
3. Max. aperture is usually slightly bigger then object diameter (open fingers a little wider than absolutely necessary).
4. Fingers open and close in a relatively smooth movement

# An example of disrupted grasping post stroke




Blue line is reach-to-grasp
Lang et al. 2005

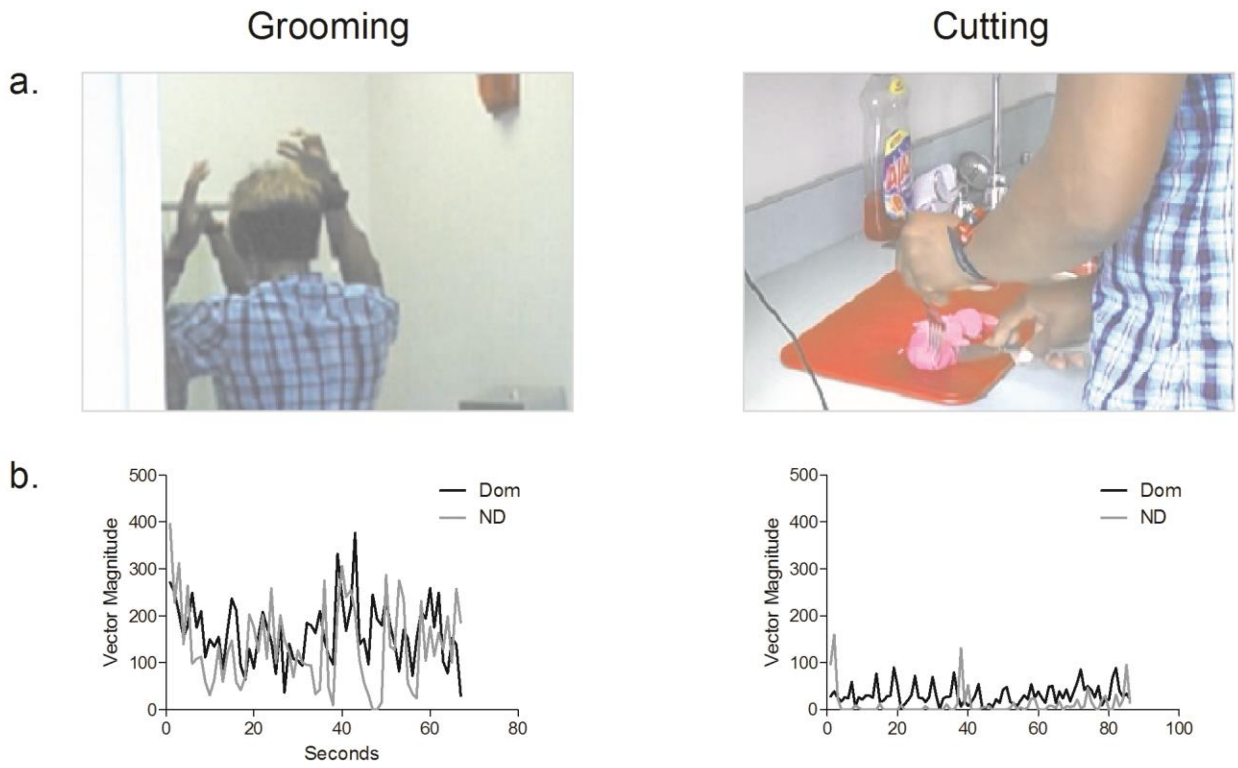
# e.g. Manipulating

Salient characteristics:

1. Movement is fractionated
2. Movements and forces are appropriate for the object in the hand
3. Movement is variable person-to-person and time-to-time

# Movements are variable across tasks

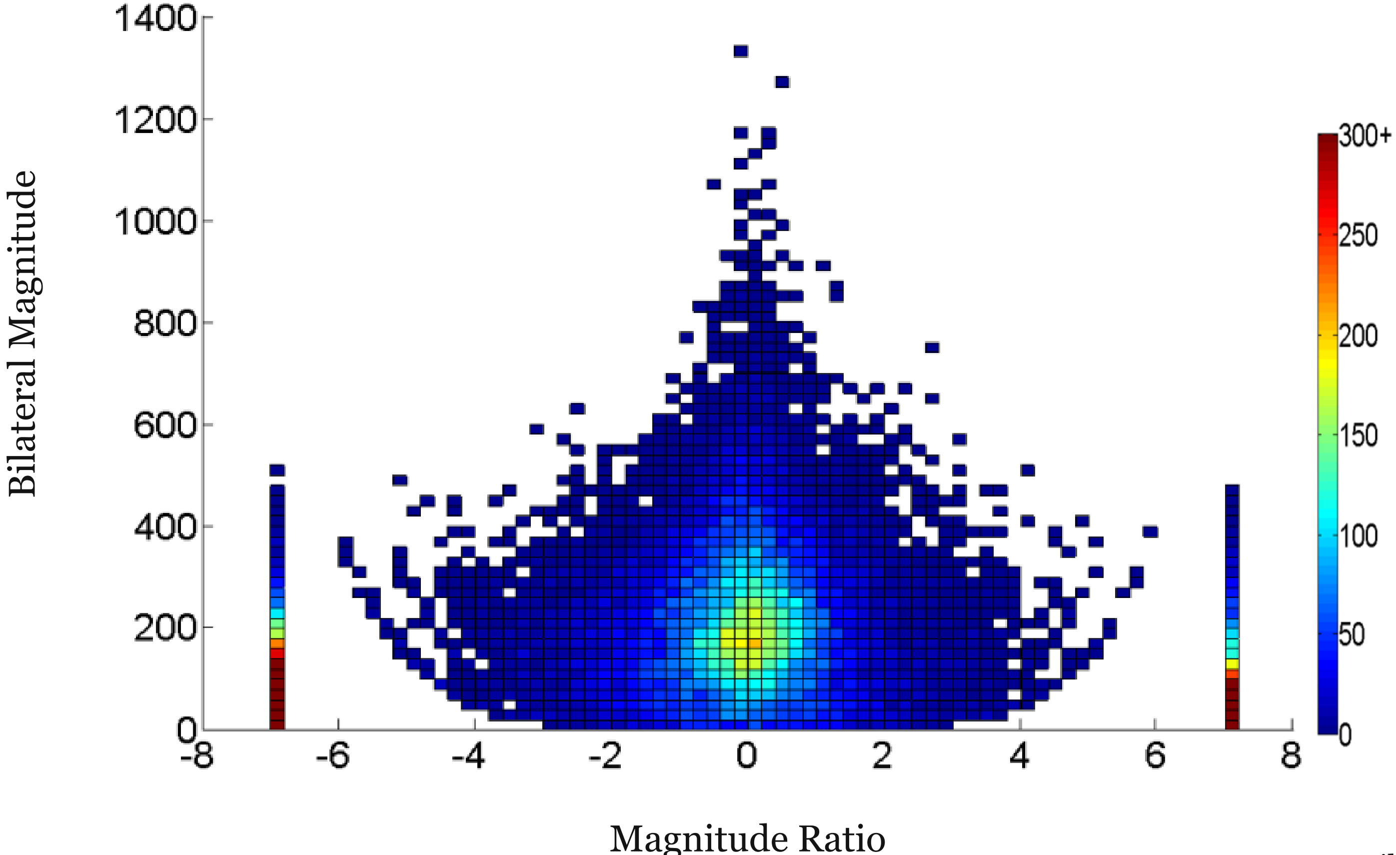
Wrist worn accelerometers




Bailey and Lang, 2013

24 hours of UE use in daily life in a healthy, non-disabled adult

# Movements are bilateral




Bailey, Klaesner, & Lang, 2015

# Course overview

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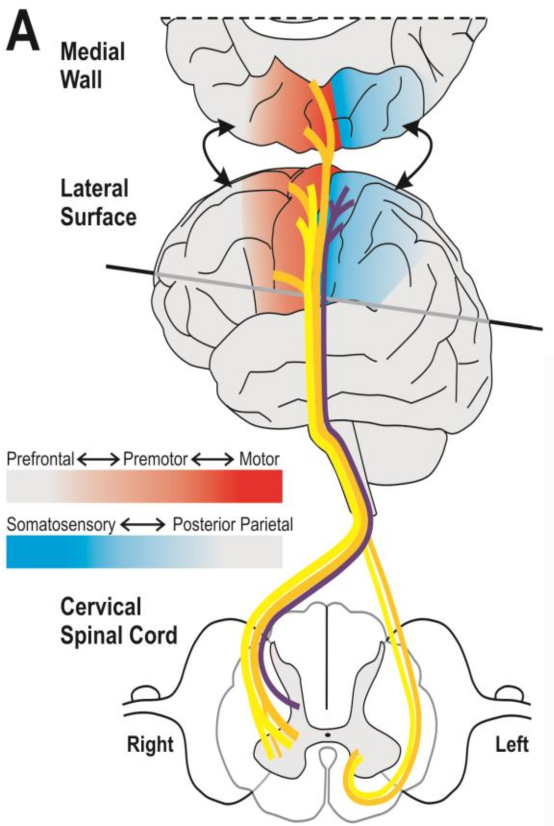
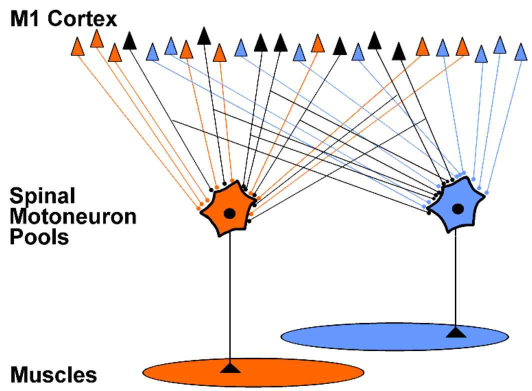
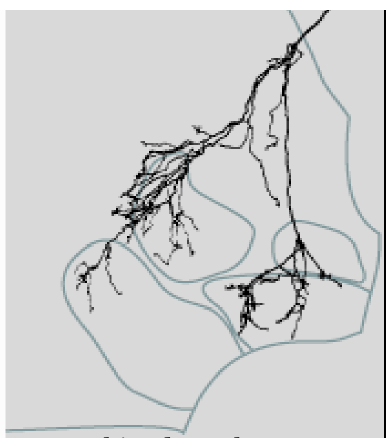
# The corticospinal system is a key neural substrate for skilled UE movement

Movement as music: songs = actions, instruments = muscles
We play many “songs” by activating just the right “instruments”, just the right amount, and at just the right time.

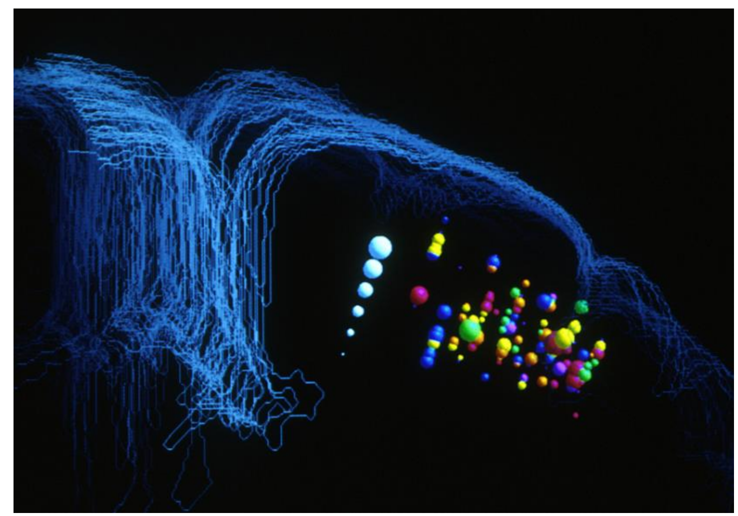



Frey et al. 2011



Shinoda et al. 1981



Schieber & Hibbard 1993

# Stroke affecting the corticospinal system → PARESIS & ↓ FRACTIONATED MOVEMENT

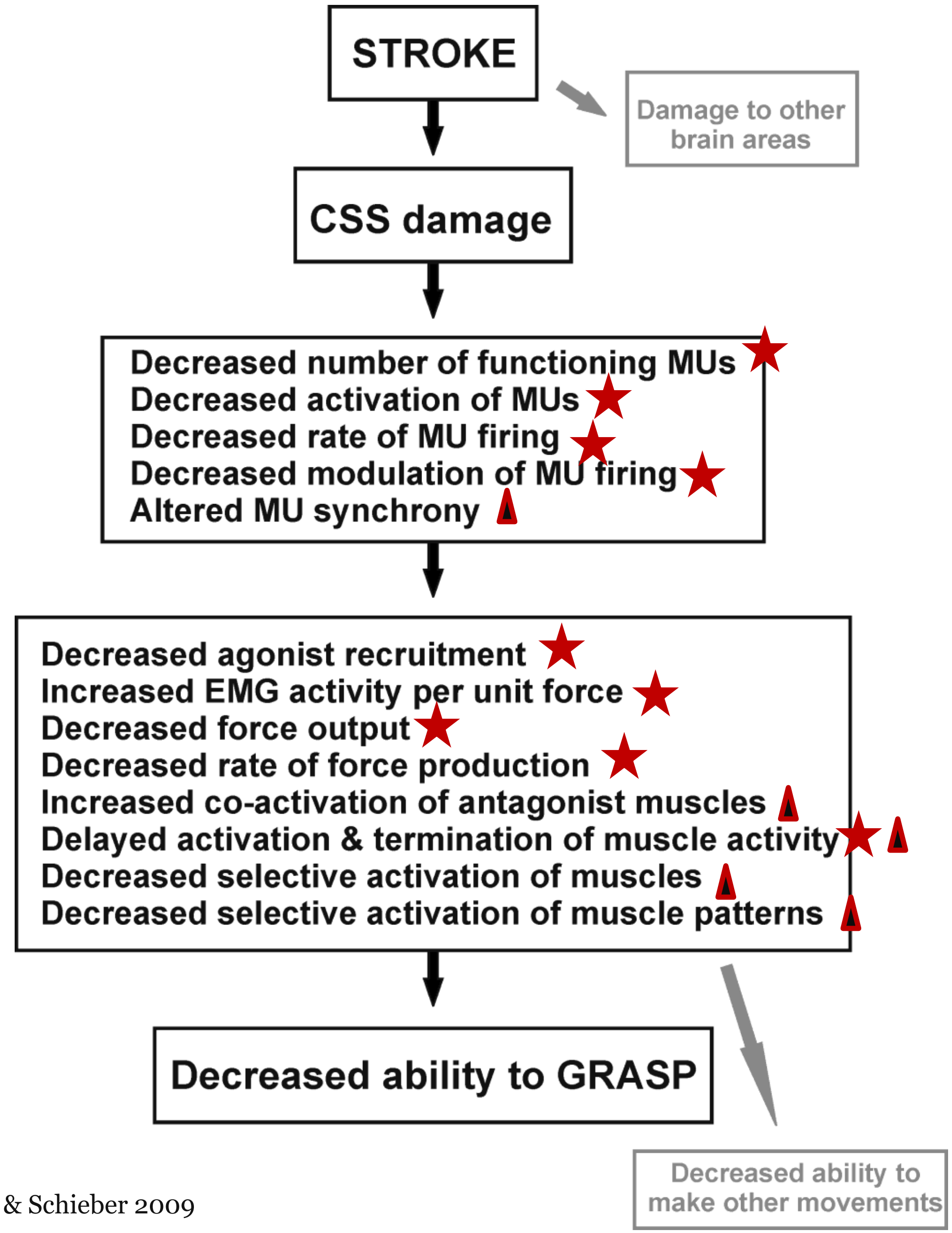
After stroke:

- The conductor has trouble communicating with the instruments
  ↓ ability to voluntarily activate motorneurons (McComas et al. 1973)

- When they get the message, the instruments all play at once
  ↓ ability to selectively activate motoneurons (Lang & Schieber 2004)

- The instruments can still make noise
  Muscles strength is preserved when electrically stimulated
  (Landau & Sahrmann 2002)

- The worse the communication problem, the worse the music
  Extent of CS system damage determines severity of paresis (Pineiro et al. 2000; Carter et al. 2011)



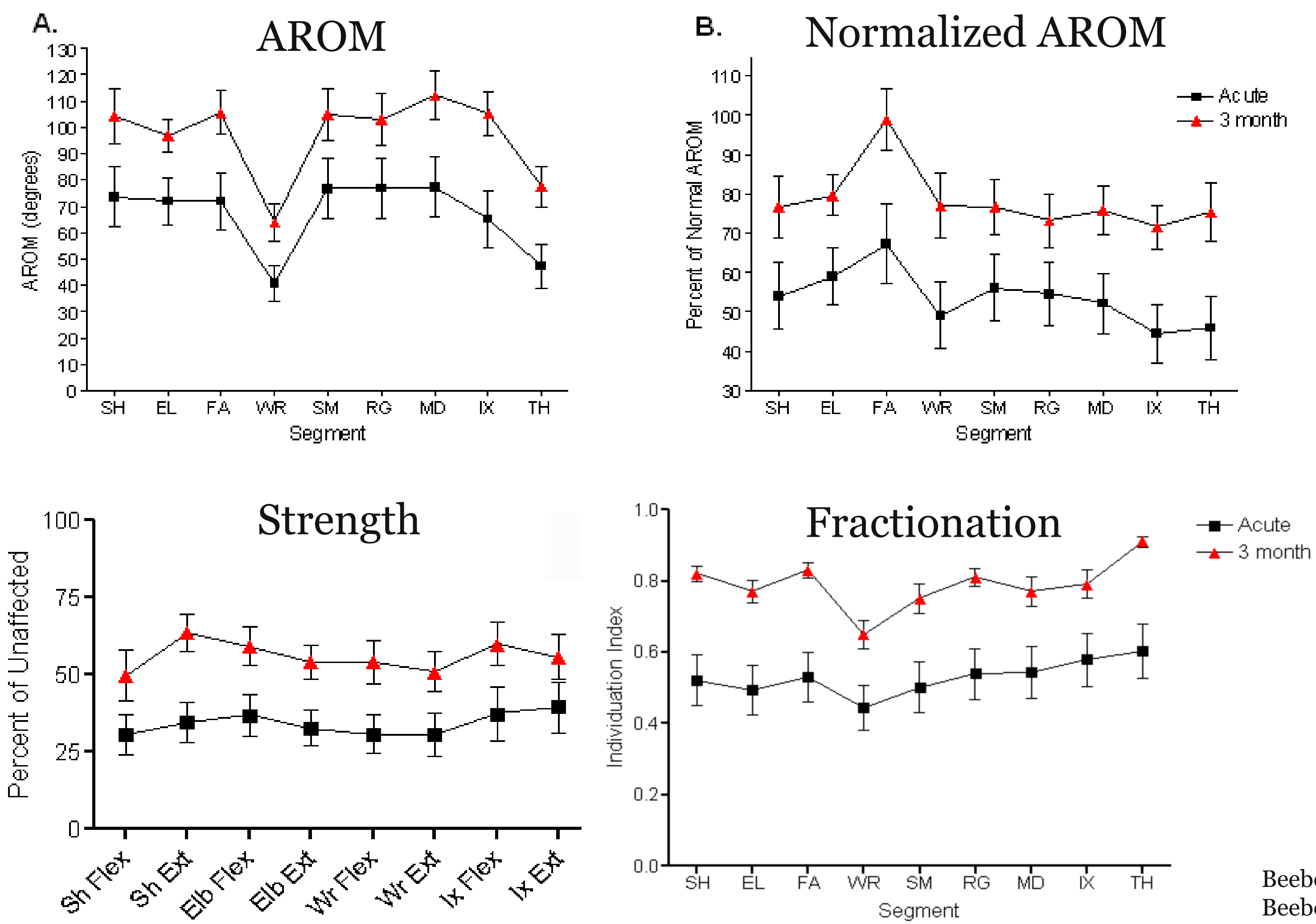

# Cascade of motor deficits following stroke

★ = associated with paresis

▲ = associated with ↓ fractionated mvt.

Lang & Schieber 2009

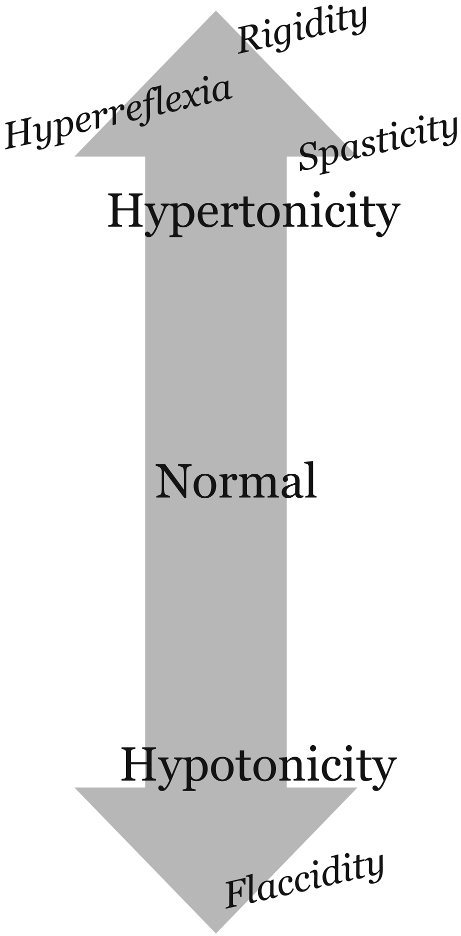
# Surprisingly, neither paresis nor ↓ fractionated movement are distributed in a proximal-to-distal gradient




Beebe & Lang 2008;
Beebe & Lang 2009

# Stroke-related impairments

Abnormal muscle tone




Decreased somatosensation

- Vascular supply is often the same for many motor and somatosensory structures

The tricky thing about trying to measure and manage spasticity is …

Single subject at a single session

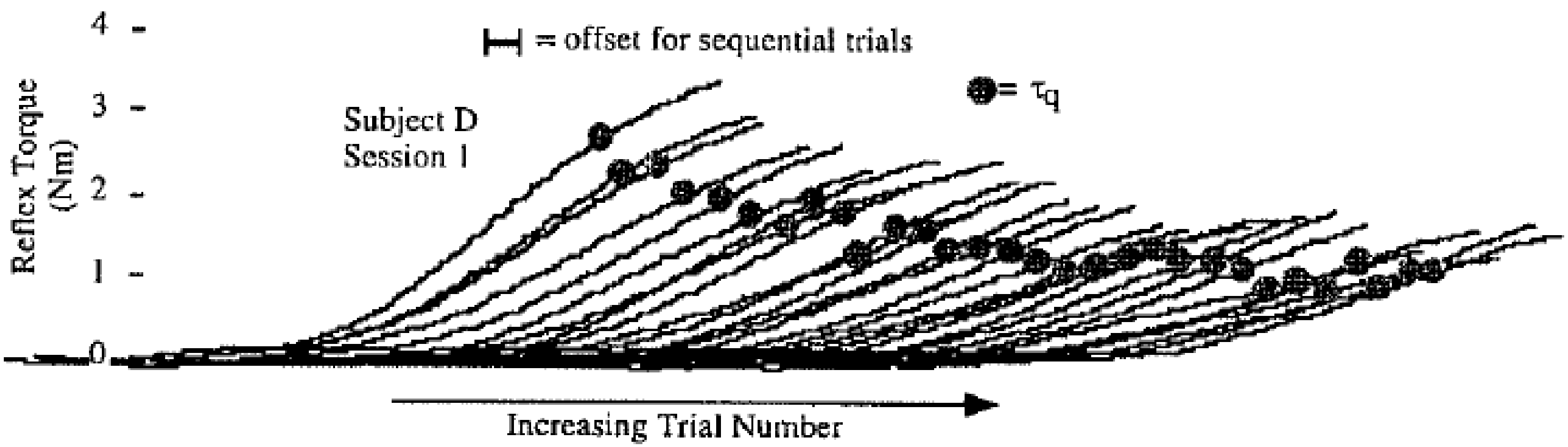
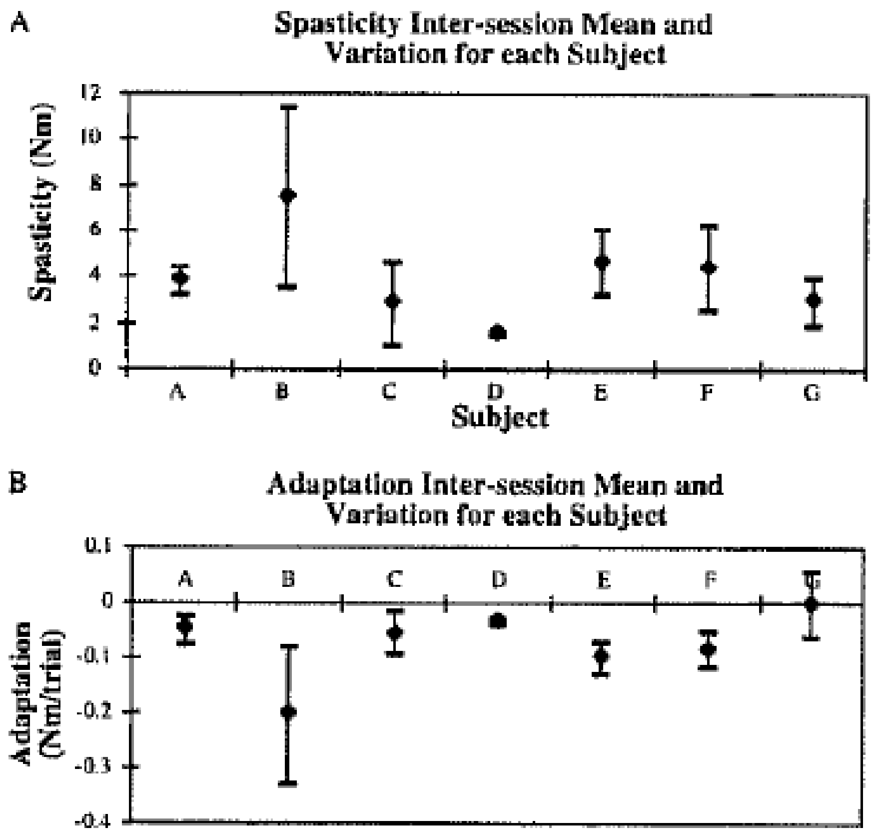



Fig 4. Sequential flexor reflex measurements for subject D show the adaptation of the stretch reflex across the 30 test trials. Reflex torques are offset from left to right as the experiment proceeds. The parameter $\tau_q$ is shown for each trial (gray, solid circles) and declines with increasing trial number.

Schmit et al. 2000

… it fluctuates a great deal within individuals.




Schmit et al. 2000

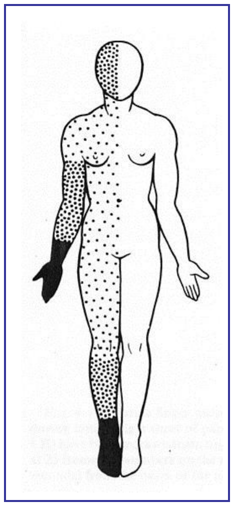
Fig 6. The estimated mean and SD of initial level of spasticity and extent of adaptation for each subject. (A) Spasticity was defined as the intercept parameter of the linear regression analysis. The error bars represent ± 1 SD. Spasticity mean and SD estimates were based on individual analysis of each session (not pooled data). (B) Adaptation was defined as the slope parameter of the regression analysis. Note that subject G did not show significant adaptation.

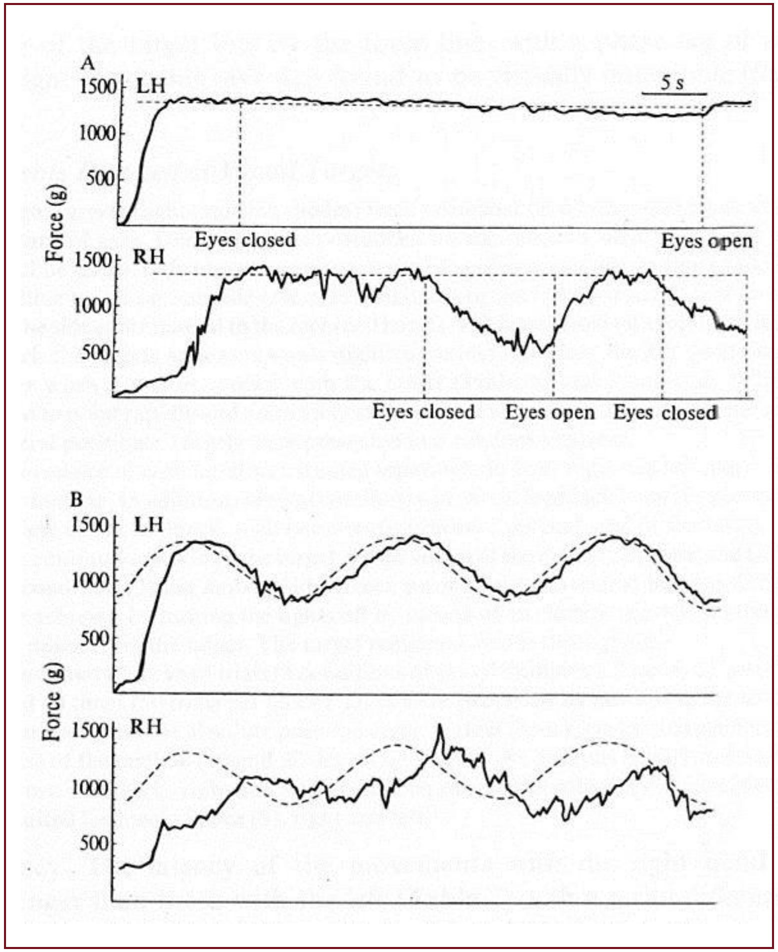
The average amount of spasticity could be highly variable within a given subject.

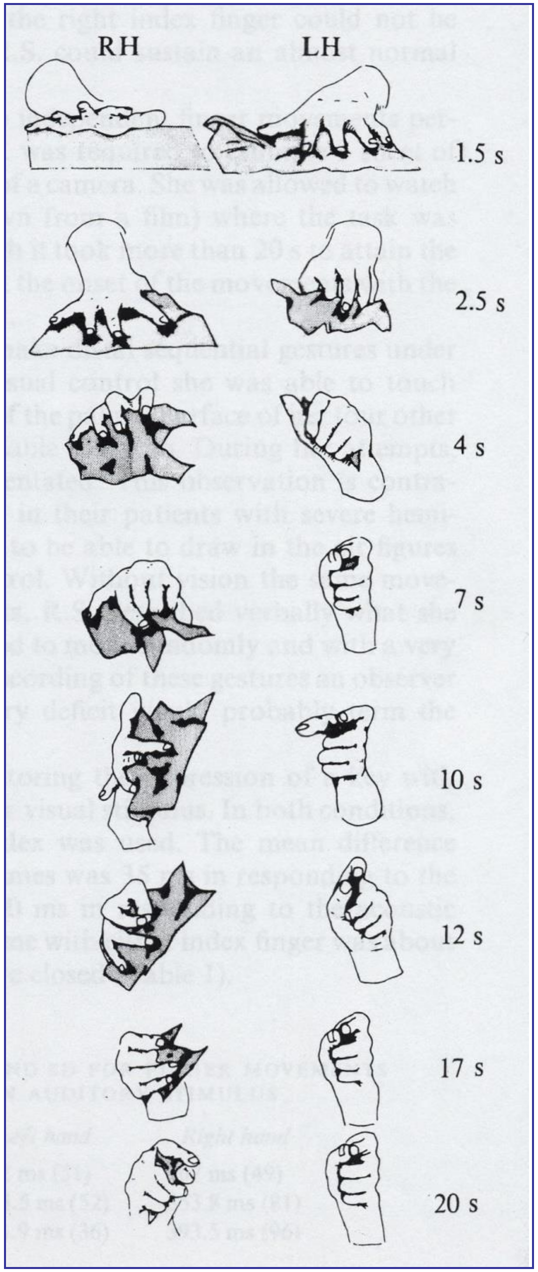
The amount spasticity changed during a single session could be highly variable within a given subject.

… and that fluctuation is not always the same.

# Movement consequences of losing somatosensation in the hand

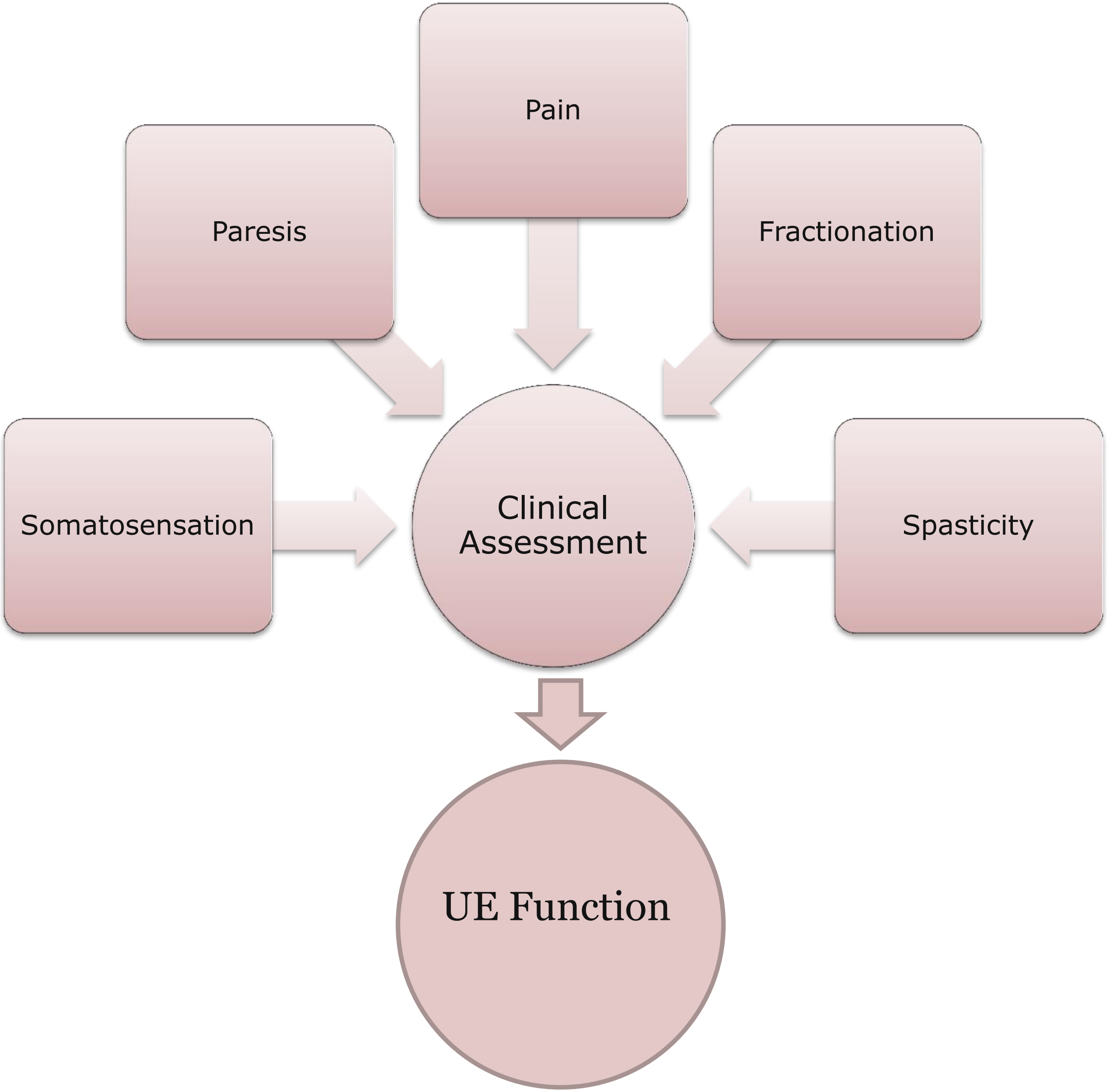




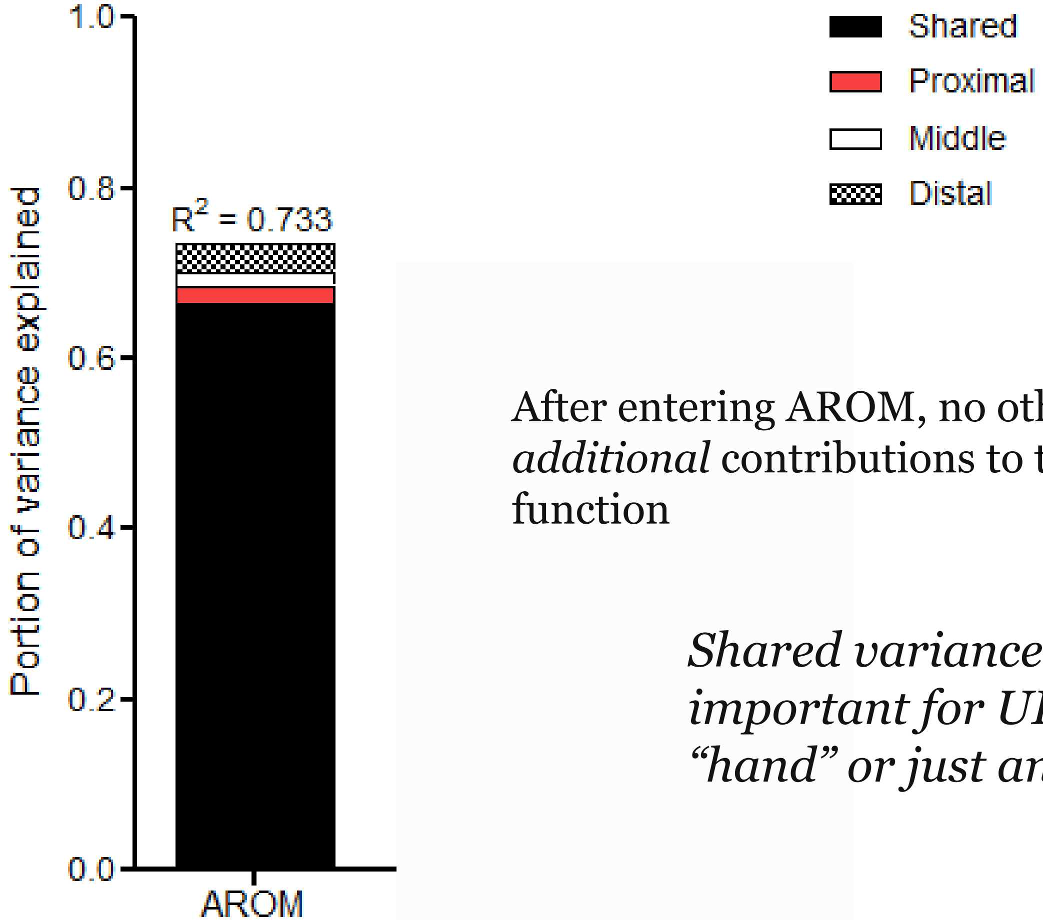




Jeannerod et al. 1984

# How do these impairments influence UE function?


Pain
Paresis
Fractionation
Somatosensation
Clinical Assessment
Spasticity
UE Function

# Paresis (as measured by AROM) explained the most variance in UE function in people with chronic stroke



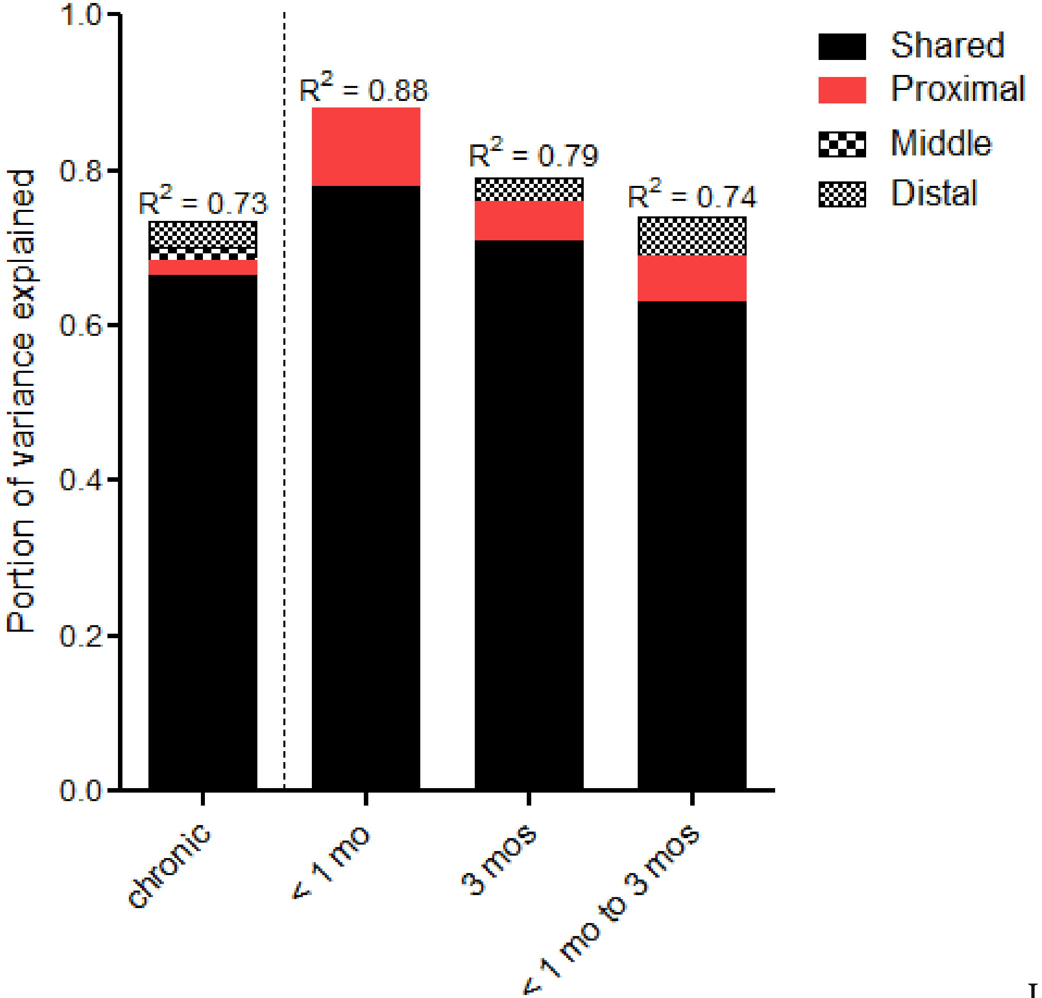

Linear regression, $p < 0.05$

After entering AROM, no other variables made *additional* contributions to the variance in UE function

*Shared variance informs us that all segments are important for UE function, i.e. it is not just a "hand" or just an "arm" problem.*

Lang & Beebe 2007

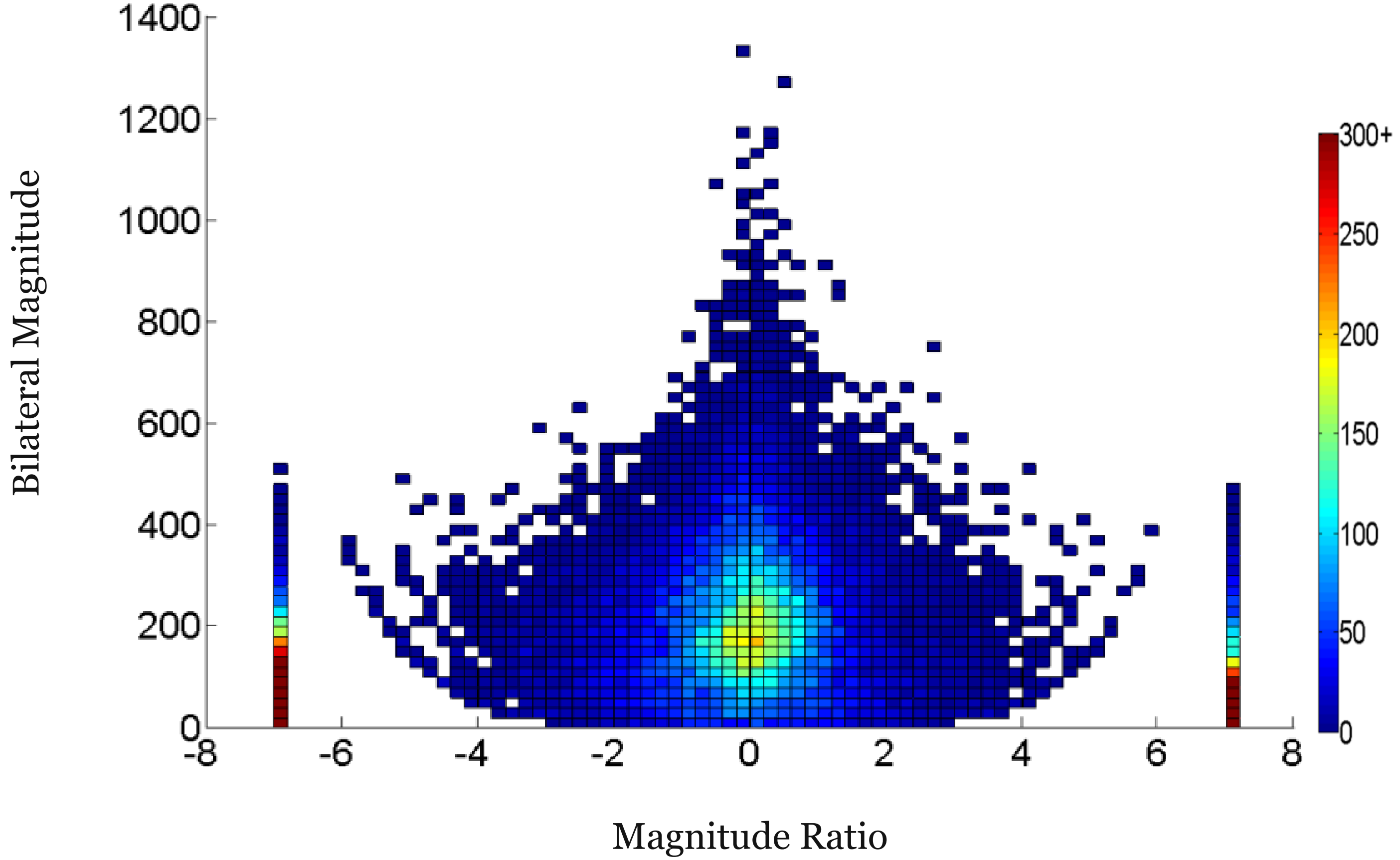
# In a separate sample followed over time, paresis explained similar amounts of the variance in UE function



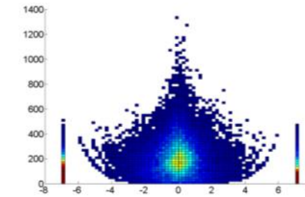

Repeatedly, no other variables made *additional* significant contributions to the variance

Lang & Beebe 2007; Beebe & Lang 2008, 2009

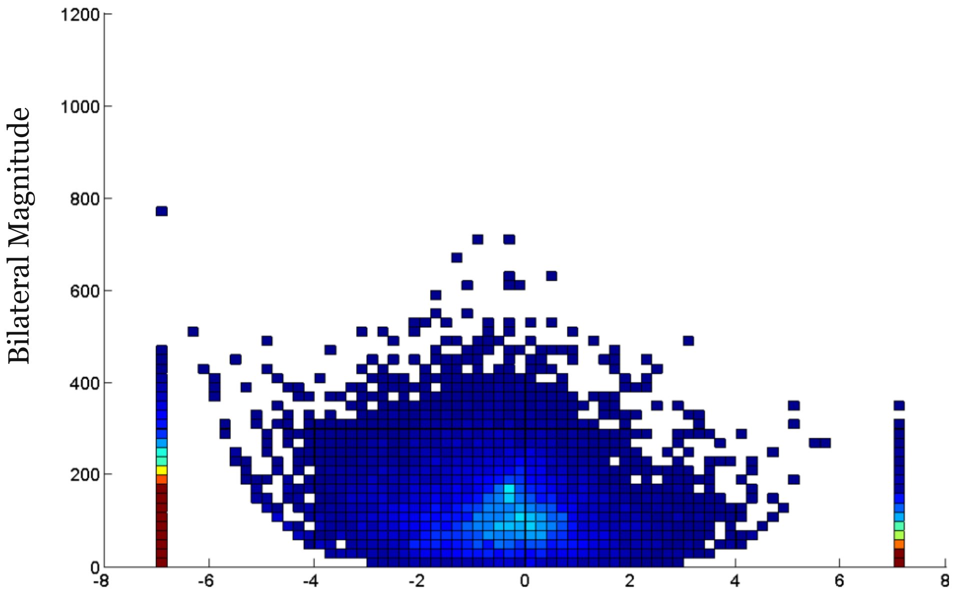
# A clip from the scrapbook…



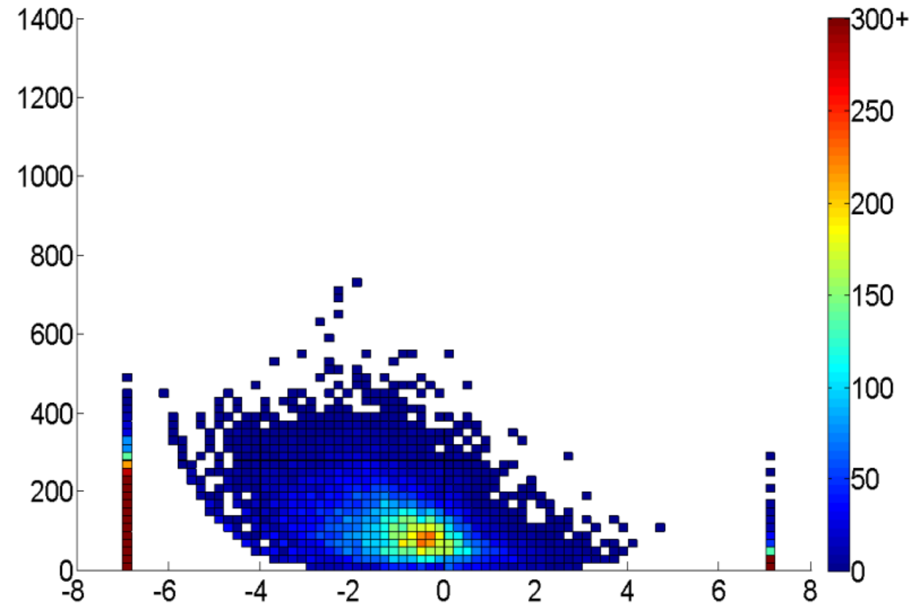
# UE use in daily life after stroke



Moderate paresis 10 days post stroke




Moderate paresis 6 mo after stroke




Magnitude Ratio

Data from Waddell et al., 2014; Bailey et al, 2015

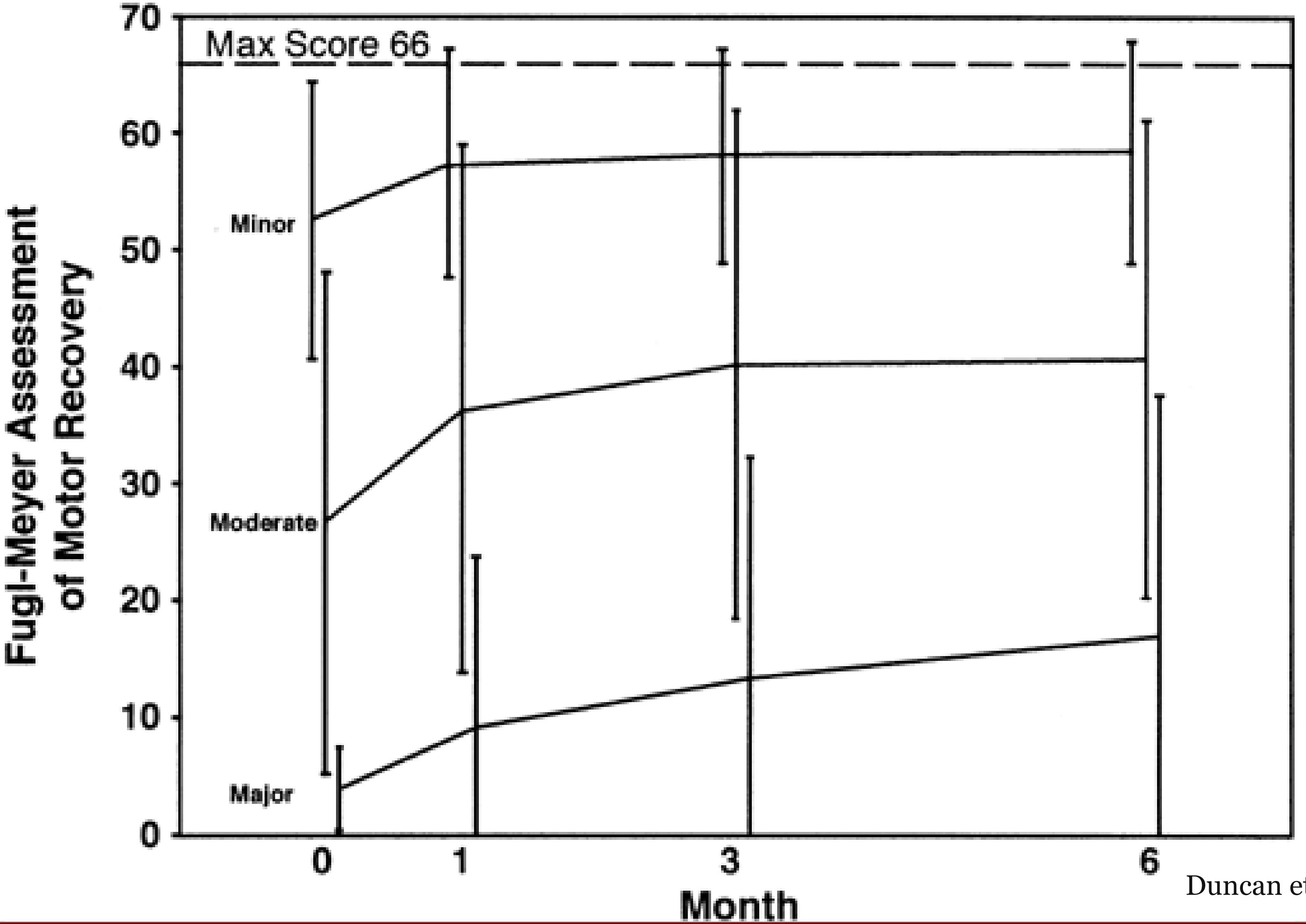
# Prognosis

# Prognosis

- Merriam-Webster Dictionary defines as "*the prospect of recovery as anticipated from the usual course*"

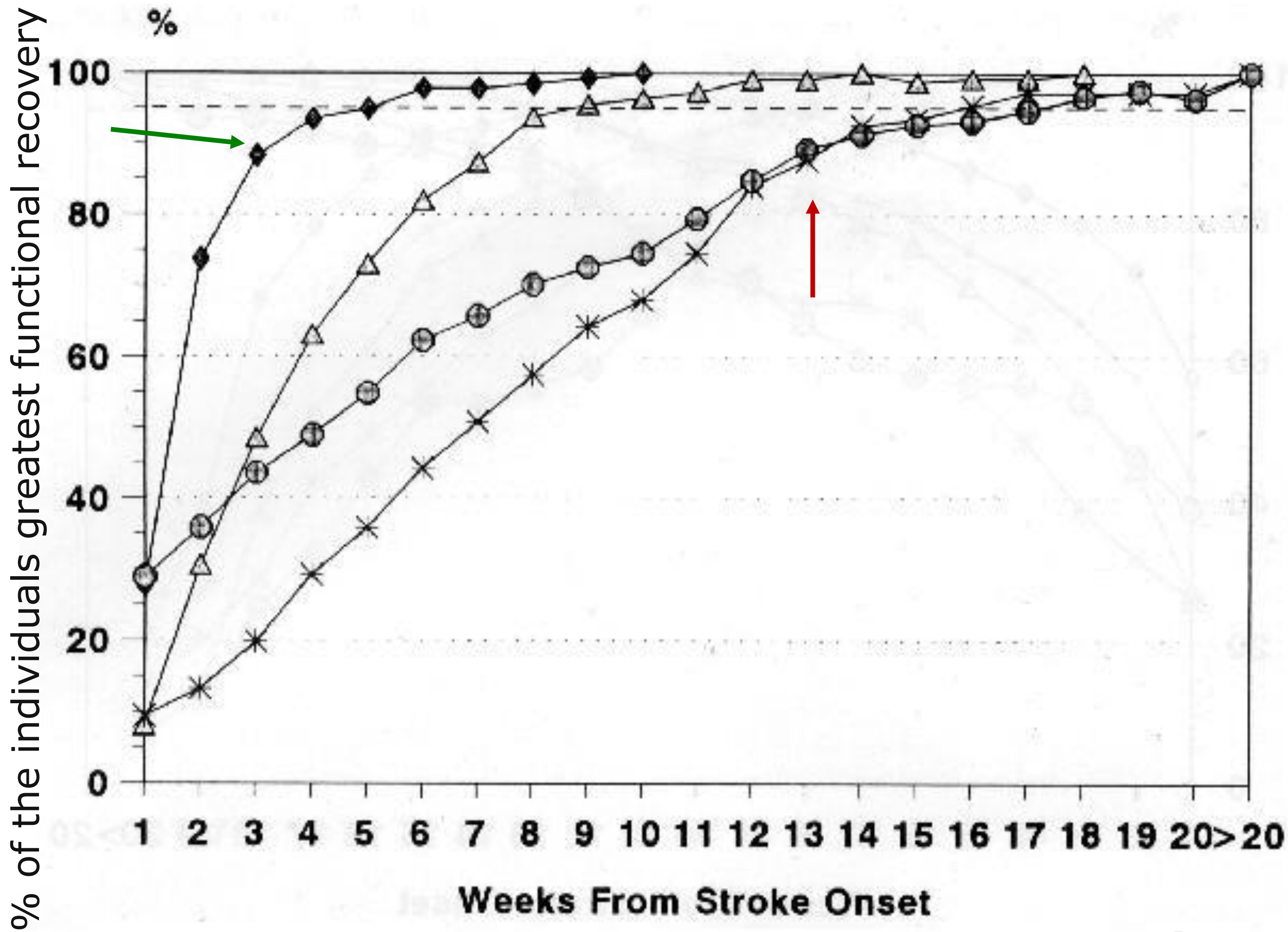
- Why does it matter?
  - Clinical decision making
  - Goal writing
  - Discharge information
  - Patient education

# Motor recovery is slowest and least for those that are the most severely affected



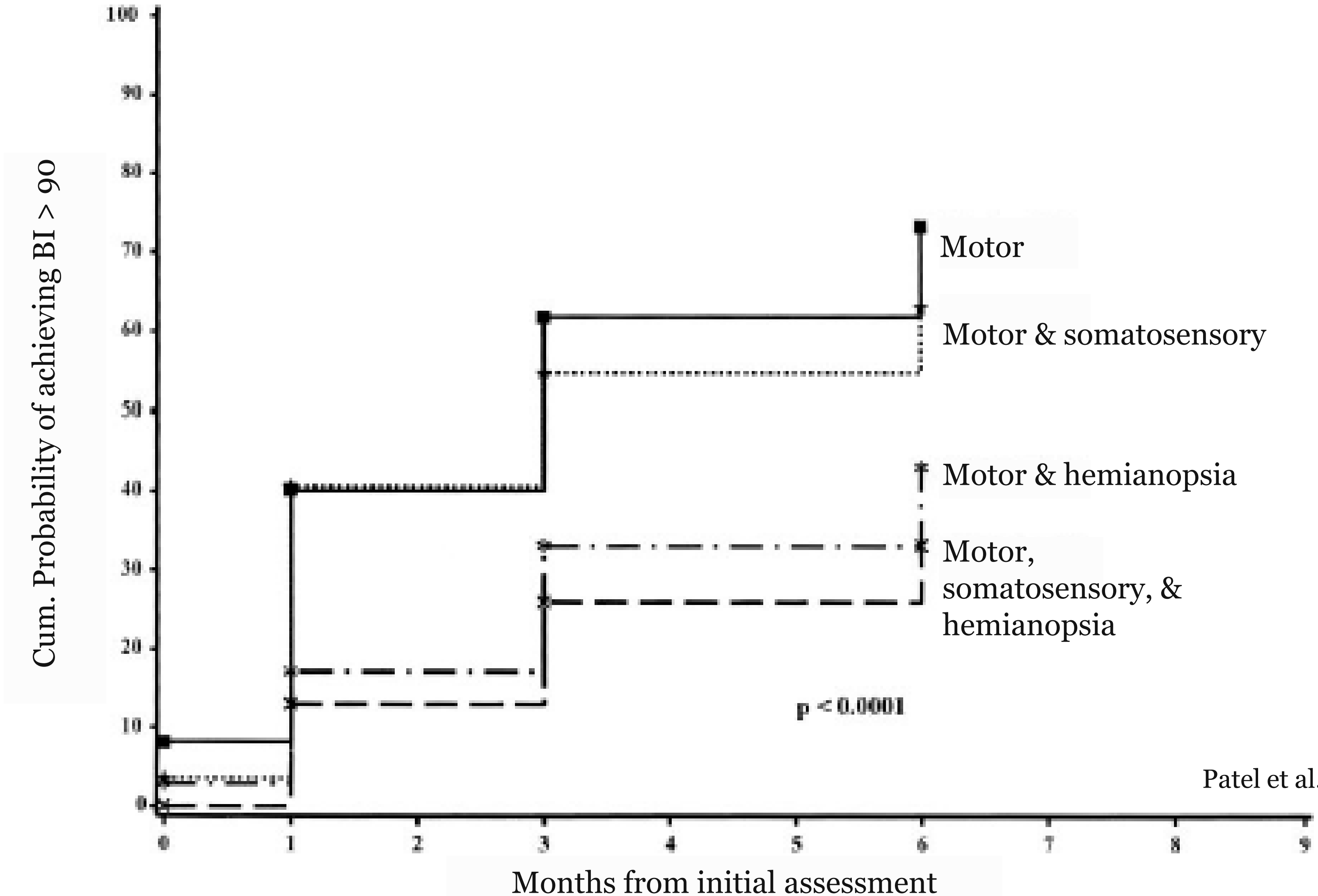

Duncan et al. 2000

# Recovery is fastest for those that are most mildly affected
# Most recovery occurs within 3 months after stroke




Jorgensen et al 1995

# The greater the number of impairments the less the likelihood of functional recovery




Patel et al. 2000

# Prognosis

- Individuals with less severe early impairments (i.e. motor loss) achieve better UE motor function later (Prager & Lang, 2012)

- Active range of motion at 3 weeks post-stroke can predict 71% of the variance in upper extremity function at 3 months (Beebe & Lang, 2008)
  - Shoulder AROM (flexion)
  - Middle finger AROM (flexion)

# Clinical bottom line

- Active Range of Motion may be the best indicator of upper extremity function after a stroke. (Beebe & Lang, 2008, 2009; Prager & Lang, 2012; Hetebrij et al., 2000)

# A helpful website:

http://www.viatherapy.org/

- Created by an expert panel of international researchers
- Answer a series of questions (1-3 minutes)
- Generates evidence-based intervention ideas for that client

# Course overview

- Introduction to upper extremity (UE) movement
- Relationship of sensorimotor impairment to UE function
    - Prognosis
- Standardized assessments: Clinical importance and implementation
- Principles of task-specific training

# Topics

- Ways to assess common impairments following neurological injury
  Paresis, Loss of fractionated movement, Abnormal muscle tone, Loss of somatosensation
- Standardized clinical tests of UE function
- How to choose which test to use with which person
- Using assessments to identify and set goals

# Importance of UE Assessment

- Determines initial level of impairment, function, & activity
- Assessment results compared with goals to see if goals are achievable or need to be changed
- Assessment results help guide the selection of interventions that are client-centered.
- Assessments document improvement throughout rehabilitation services

# Assessments of Sensorimotor Impairments

- Assessment is necessary to select appropriate interventions tailored to each client.

- Assessment should determine the presence and severity of impairments.

- Allows for a more accurate, streamlined communication between therapists

# Four Most Common Sensorimotor Impairments

1. Paresis
   inability to volitionally activate spinal motor neuron pools

2. Loss of fractionated movement
   inability to move a joint or joint segment by itself

3. Abnormal tone
   muscle tone that either is too high (hypertonicity) or too low (hypotonicity)

4. Somatosensory loss
   usually affects multiple sensory modalities (↓ proprioception; ↓ light touch discrimination; ↓ sensory discrimination abilities)

# Other common impairments

- Ataxia

  motor coordination deficit where movements are inaccurate and highly variable.

- Neglect

  attentional deficit resulting in altered perceptions; results from attentional brain networks

- Apraxia

  collection of deficits in motor planning; result of disruption of frontal and parietal lab motor planning networks

(Buxbaum et al, 2004; Corbetta, Kincade, Lewis, Snyder, & Sapir, 2005; Lang et al, 2012; Lang, Bland, Bailey, Schaefer, & Birkenmeier, 2013; Petreska, Adriani, Blanke, & Billard, 2007; Sathian et al, 2011; Wheaton & Hallett, 2007)

# Common clinical terms

Paresis
↓fractionated movement
Somatosensory loss

↓ Fine motor control

Paresis
↓fractionated movement
Somatosensory loss
Ataxia

↓ Coordination

# Measurement of paresis

| Assessment | Time to administer | Description |
|---|---|---|
| Motricity Index | < 5 min | MMT for 3 UE mm groups: shldr abd, elb flex, pinch; Scores converted to total UE score ranging from 0-100. |
| Grip & Pinch strength | < 5 min | Hand-held dynamometer; Measure in kgs or lbs; Normative values available |

# Measurement of fractionated movement

| Assessment | Time to administer | Description |
|---|---|---|
| Observation during paresis assessment | NA | Presence or absence of movement fractionation; Note substitutions or associated reactions |

# Measurement of abnormal tone

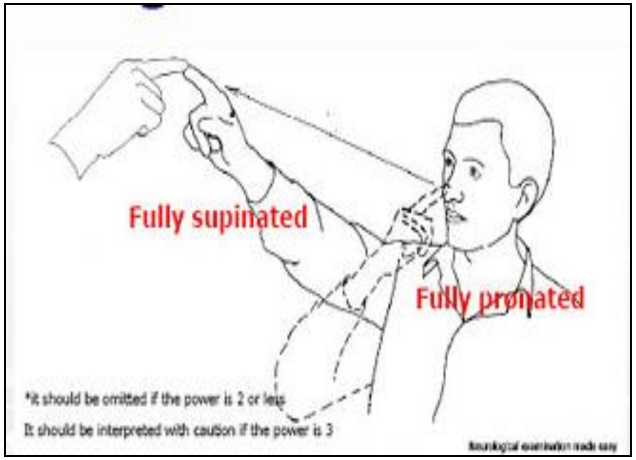
| Assessment | Time to administer | Description |
|---|---|---|
| Modified Ashworth Scale | 2-3 min for 2 mvts | 0 – 4, with 1+ option; tone is similar across UE segments, so could just pick 1-2 mvts, e.g. elb flex, finger flex |

# Measurement of somatosensation

| Assessment | Time to administer | Description |
| --- | --- | --- |
| Light touch | 1-2 min for 1 site | Noted as intact, impaired, absent with light stroke to palm or fingertips; Modalities are similarly affected so LT serves as proxy for others; Distribution loss is similar across the limb, so 1 site serves as proxy for others |

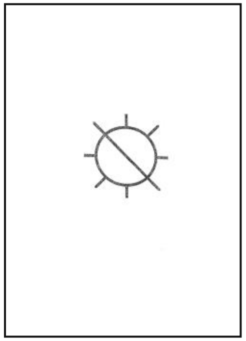
# Measurement of ataxia

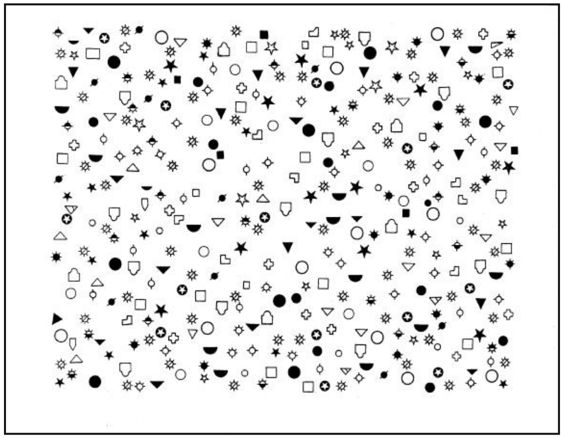
| Assessment | Time to administer | Description |
|---|---|---|
| Finger-Nose-Finger | 1-2 minutes/side | Ct. seated; OT sits across from him/her OT holds out index finger in front of ct.; Client is instructed to touch tip of OT finger, then touch nose |



# Measurement of neglect

| Assessment | Time to administer | Description |
|---|---|---|
| Unstructured Mesulam | < 5 minutes | Ct is instructed to cross out small figures on paper |
| Catherine Bergego Scale | ~30 minutes, throughout session | Checklist of presence of neglect during functional activities |





# Measurement of apraxia

| Assessment | Time to administer | Description |
|---|---|---|
| TULIA | ~5 minutes | Client is asked to perform a variety of gestures with both arms. The client is scored as a 1(Pass) or 0(Fail) |

http://www.youtube.com/watch?v=F5v7-R3mVRM

http://www.youtube.com/watch?v=hx1indPEatU

# Topics

- Ways to assess common impairments following neurological injury
- Standardized clinical tests of UE function
  - Performance tests
- How to choose which test to use with which person
- Using assessments to identify and set goals

# There are lots of choices

## In the clinic

*Performance measures*

- Action Research Arm Test
- Box and Block Test
- Chedoke Arm and Hand Activity Inventory
- Jebsen-Taylor Hand Function Test
- Nine-Hole Peg Test
- Wolf Motor Function Test

*Self-report measures*

- Motor Activity Log
- Stroke Impact Scale – Hand Function, ADL subscales

## Outside the clinic

Accelerometery

# Action Research Arm Test

- Criterion-rated, assesses performance on grasping, moving, and releasing different objects

- 19 items; performance rated 0, 1, 2, 3; max (normal) = 57

- 10 – 20 minutes to administer


http://www.medstarnrh.org/our-services/specialty-services/services/rehabilitation-engineering/#q={}

# Box and Block Test

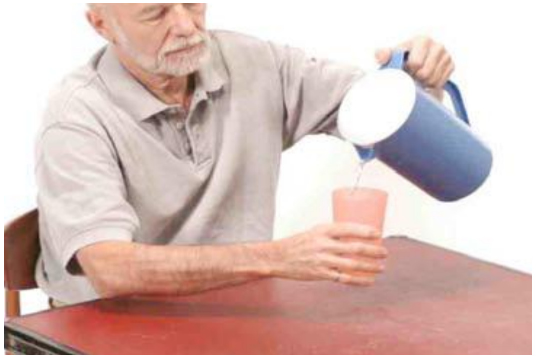
- Assesses ability to grasp, move, and release small cubes
- Score is the number of blocks moved in 1 minute
- Always moving objects of the same shape and size
- Normative values available for comparison
- 5 minutes to administer

# Chedoke Arm and Hand Activity Inventory

- Criterion-rated, assesses performance on a variety of functional UE actions, including bilateral actions
- 13 items with performance on each item rated 1 – 7, total (normal) = 91
- Other versions, CAHAI-7, CAHAI-8, and CAHAI-9 available
- 25-30 minutes to administer 13-item version
- Can use household items, very cost-effective

# CAHAI

8 item version



# Nine-Hole Peg Test

- Assesses ability to place and remove 9 pegs in 9 holes
- Score is the time to place and then remove
- Always moving objects of the same shape and size
- Normative values available for comparison
- 5 minutes to administer

# Measurement outside the clinic: Accelerometry

- Direct Observation
  - Costly & Impractical
- Self-report measures
  - Report Bias
    - Comprehension, Memory, & Motivation
    - Cognitive Impairment
    - Social acceptability
- Improvement on clinical tests of capacity may not translate into increased real-world performance.

# A useful website:

http://accelerometry.wustl.edu

- Anyone can upload accelerometry data and have it processed, free of charge
- Gives you the use ratio, magnitude ratio, and bilateral magnitude values
- Density plot
- What are the implications for this in practice?

# Topics

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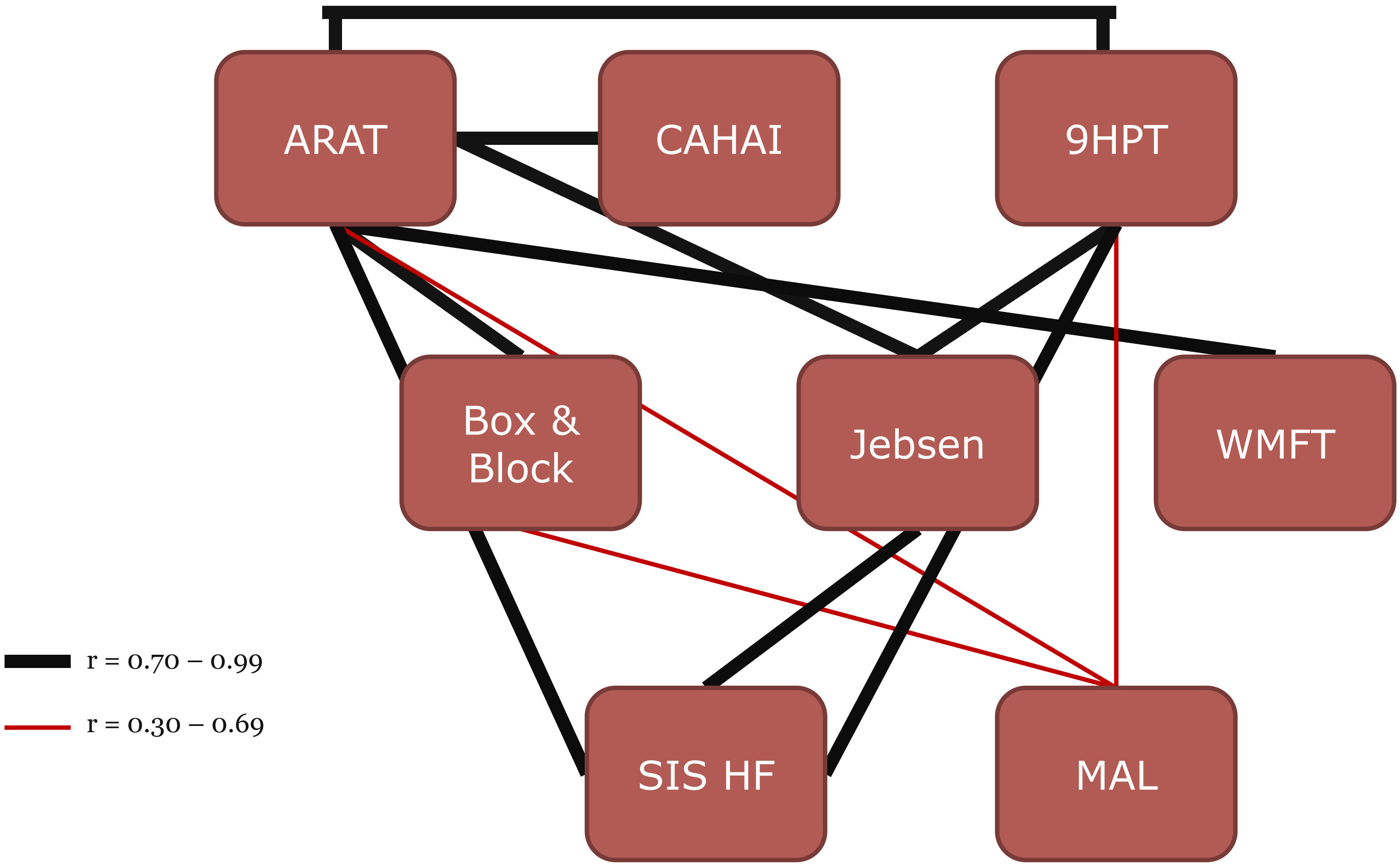
# Scores on these tests are highly interrelated




*… and the relationships are stable across time*

# Choosing a test to use with a specific person

- Strength and consistency of correlations between tests indicates they are measuring the same underlying construct post stroke: UE function

- Pick one or two and use them repeatedly for the same person and across people with stroke

- Questions to ask when selecting a test:
    - Do we have or can I get the necessary equipment?
    - Does it take training, formal or informal, to administer?
    - How much time do I have vs. how much time does it take to administer?
    - Is there additional information from the test, beyond the score, that is useful for treatment selection/planning?

# Topics

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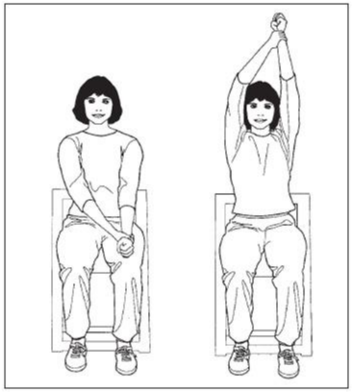
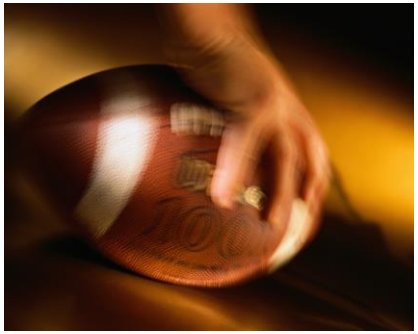
- Using assessments to identify and set goals

# Goal writing



Impairment Vs. Function



# Bilateral goals: The more the merrier!

- Symmetrical & asymmetrical use of the extremities
- Practice tasks that use both arms
- May focus training on the affected hand to be the Supporting hand/stabilizing hand

https://www.northcountryhospital.org/healthy-you/gardening-its-about-more-than-just-digging-in-the-dirt/
http://www.thriftyfun.com/tf/Organizing/Bathroom/Folding-Towels.html

# Take home points…

1. UE assessment is important to determine the initial level of impairments, function, & activity.

2. Use assessment results to determine if goals are achievable or should be altered.

3. Assessment results should guide interventions to achieve the client's functional goals.

# Course overview

- Introduction to upper extremity (UE) movement
- Relationship of sensorimotor impairment to UE function
  - Prognosis
- Standardized assessments: Clinical importance and implementation
- Principles of task-specific training

# Basic Principles of Neuroplasticity

- Use it or lose it
- Use it and improve it
- Specificity Matters
- Repetition Matters
- Intensity Matters
- Time Matters
- Salience Matters
- Age Matters
- Transference
- Interference

Kleim & Jones, 2008

# Principles of neuroplasticity

## Task-specific training

**Graded & Progressed**

- Graded to challenge, but not over or under-whelm motor capabilities (Birkenmeier et al.)
- Intensity?

**Hundreds of repetitions**

- On average, 300 repetitions is feasible in the outpatient setting (Birkenmeier et al.)
- On average, 289 repetitions is feasible in the inpatient setting (Waddell et al)

**Goal-oriented**

- Functional goals influence movement (van Vliet et al.)

**Specific/Skilled**

- Real objects elicit better performance (Wu et al.)

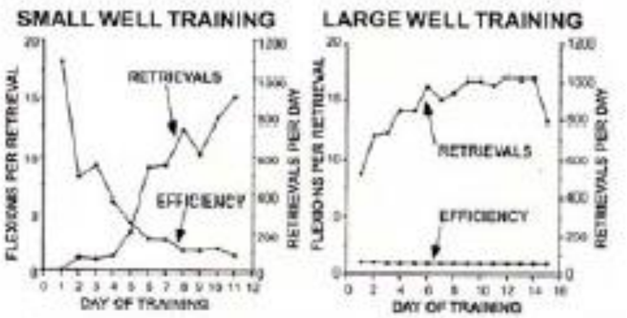
*Task-specific training* is the active, repetitive practice of functional activities in an effort to learn or relearn a motor skill

*Task-specific* implies that the person is participating in behavioral experiences that directly replicate the sensorimotor demands that need to be acted on to execute the motor skill successfully

Bayona et al, 2005; Hubbard et al, 2009

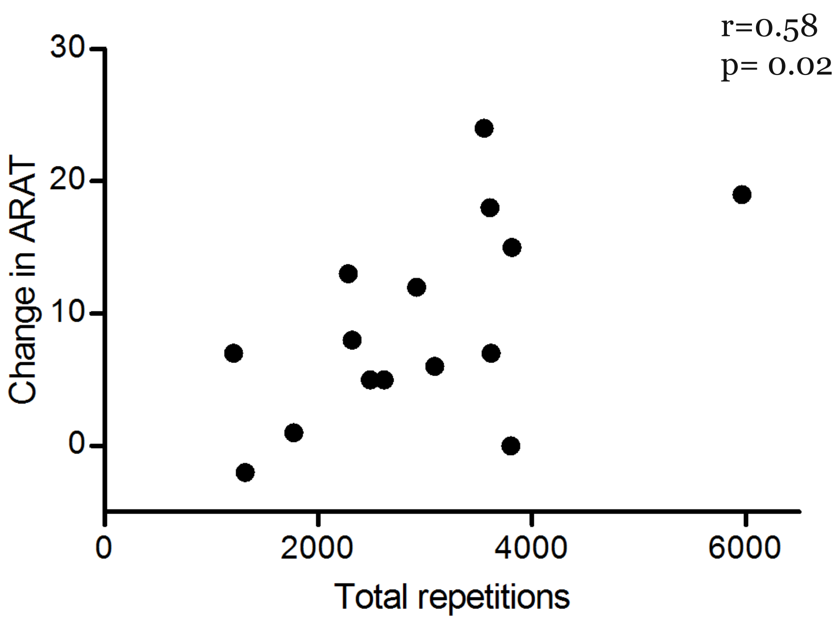
# Graded and progressed

- Shaping = providing an ongoing, gradual challenge to learn a motor skill (Reviewed by Peterson 2004)
- Providing an ongoing challenge via shaping is a critical factor in improving functional outcomes (Taub et al., 2013)
- Animal studies of neuroplasticity always use shaping to train the animals (e.g. Nudo et al. 1996)

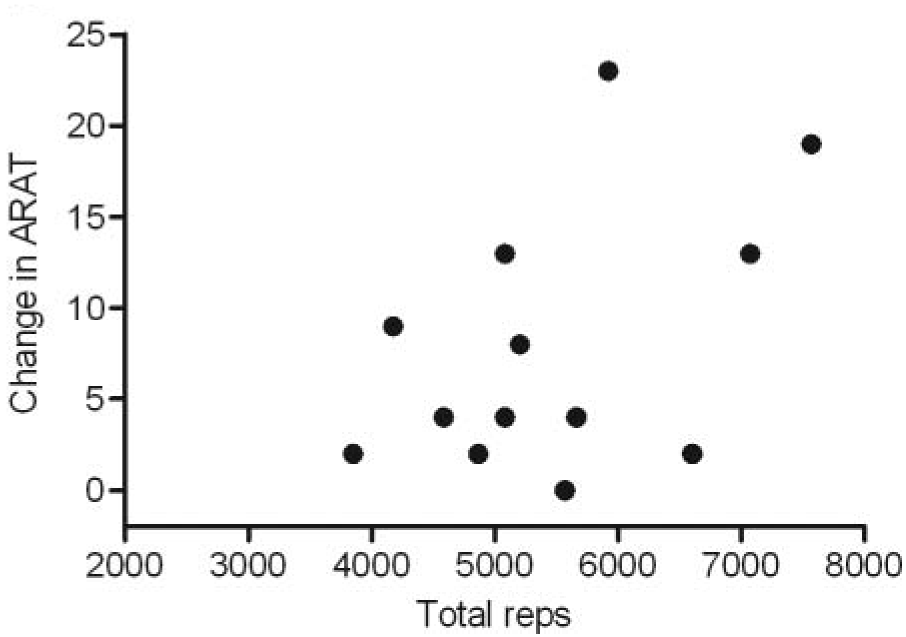



# Repetition

- The higher the dose, the better the outcome (Birkenmeier et al., 2010; Moore et al., 2010; Waddell et al., 2014)




Waddell et al.




Birkenmeier et al.

# Current Trends in Stroke Rehab: Low Doses

## Upper Extremity

- Ave. minutes in OT per day= 47 (Harris et al., 2009)
- 4-11 minutes spent in upper extremity intervention (Harris et al.)
- Ave. reps = 32 (Lang et al., 2009)

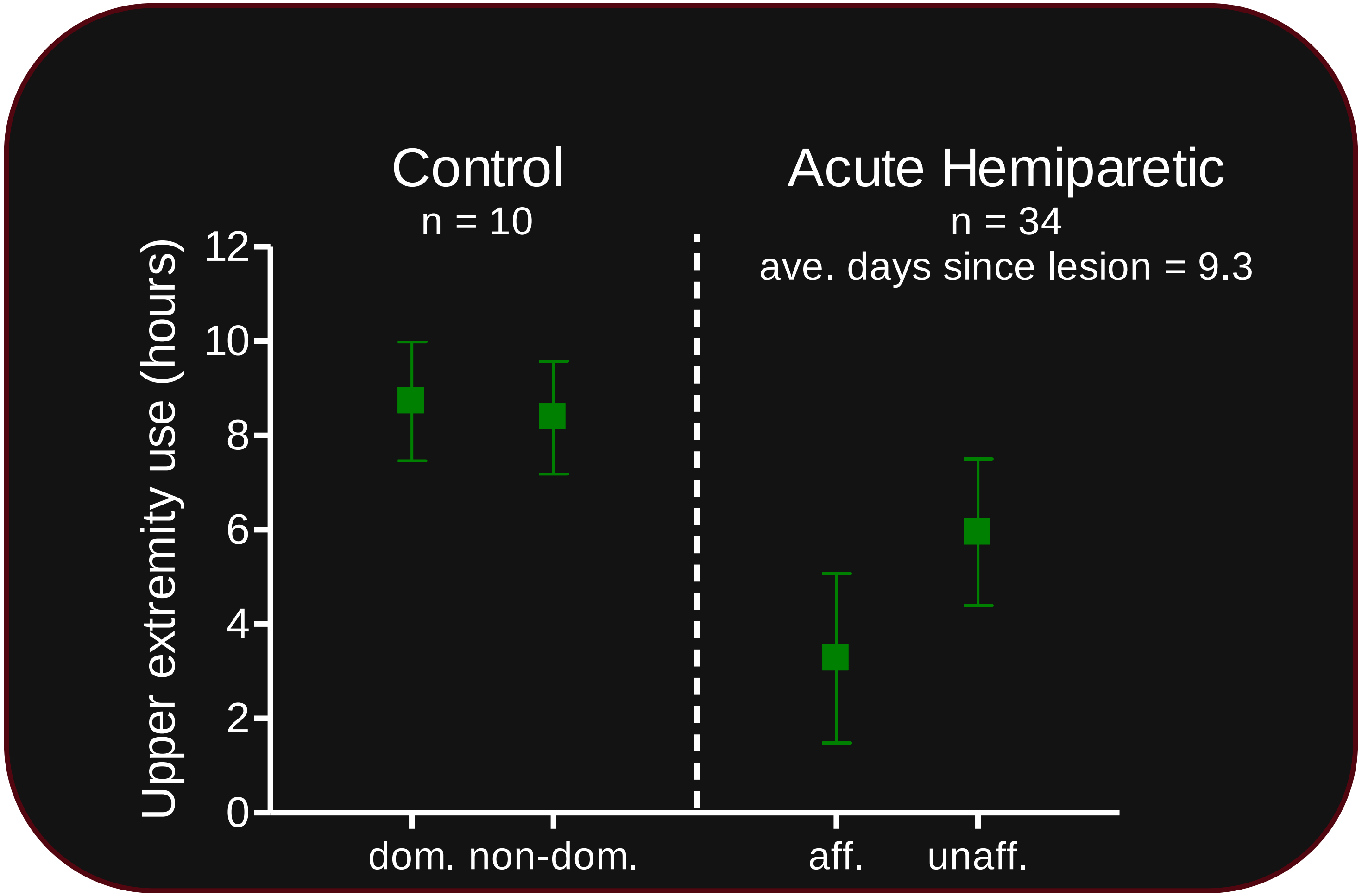
## Walking

- Avg 36±14 minutes in therapy (Lang et al., 2009)
- 28% of the day sitting upright or out of bed in inpatient rehab (Bernhardt)
- Avg of 292 steps taken per session (Lang et al.)

# Repetition in clinical practice

- Animal and human studies of motor learning
  - **Hundreds of reaches** (Barbay et al., 2013; Lang et al., 2007)
  - **Thousands of steps** (Deleon et al 1998; Earhart et al 2001; Lang et al.)
- Not a trivial issue in rehabilitation
  - Difficulty in providing sufficient practice during therapy sessions
    - Limited time, number of assistants/increased effort
    - Variations in education/theoretical frameworks for what should be done in rehabilitation

# Arm use after stroke: Minimal




Lang et al. 2007

UE use measured with wrist accelerometers for 24 hours

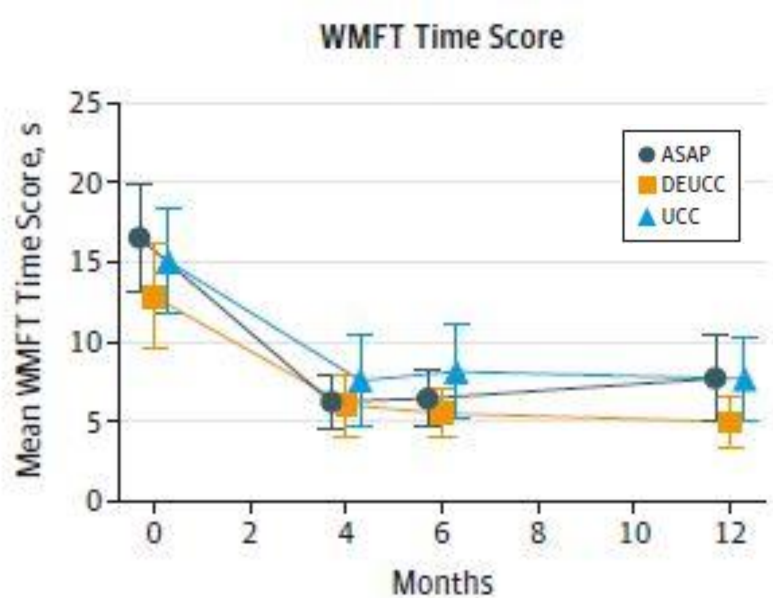
# Is more really better?

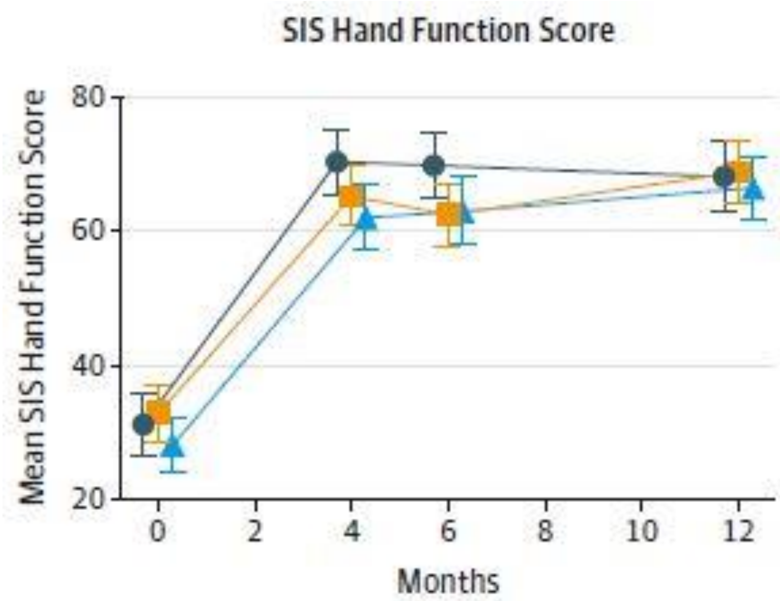
- Recent clinical trial calls this into question

- Individuals with UE paresis randomized into 1 of 3 groups 14 to 106 days after stroke:
  - Accelerated skill acquisition program (ASAP)
    - Task-specific intervention 3x/week, 60 minutes, for 10 weeks
  - Dose equivalent usual and customary care (DEUCC)
    - Completed 30 hours of OP OT
  - Usual and customary care (UCC)
    - No specification of dose

Winstein et al., 2016

# What did they find?



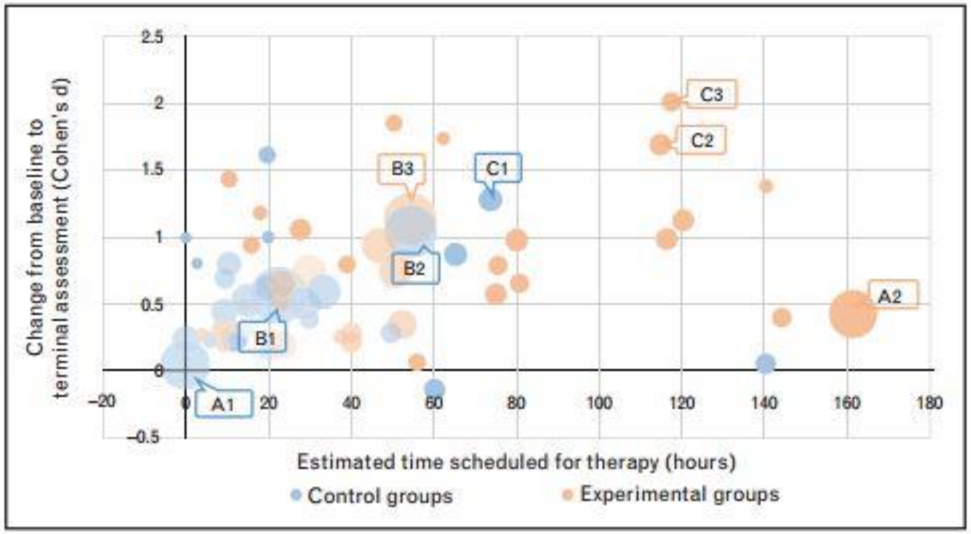

No differences in UE function between the three groups.

Winstein et al., 2016

# More may be better…

- Meta-analysis found a moderate dose-response relationship, regardless of clinical setting.
- More time in therapy has small overall benefit.

- More may be better?
- Earlier may be better?



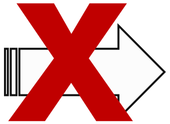

Lohse et al., 2014; Lang et al., 2015

# Specificity

- Specificity is centered around *skill* (Plautz et al., 2000)
- *Learning dependent model of neuroplasticity*
  - Cortico-motor neuron pools organized not just to muscles but more often to specific tasks (Plautz et al.)
- Specificity of motor learning is a key factor of cortical plasticity (Boyd et. al, 2010)
  - Task specific motor learning may be an important stimulant for neuroplasticity (Boyd et. al, 2010)

# Specific and goal-oriented

Generalization of learning hardly occurs in a normal neurological system, why should we expect it to occur in a damaged one?

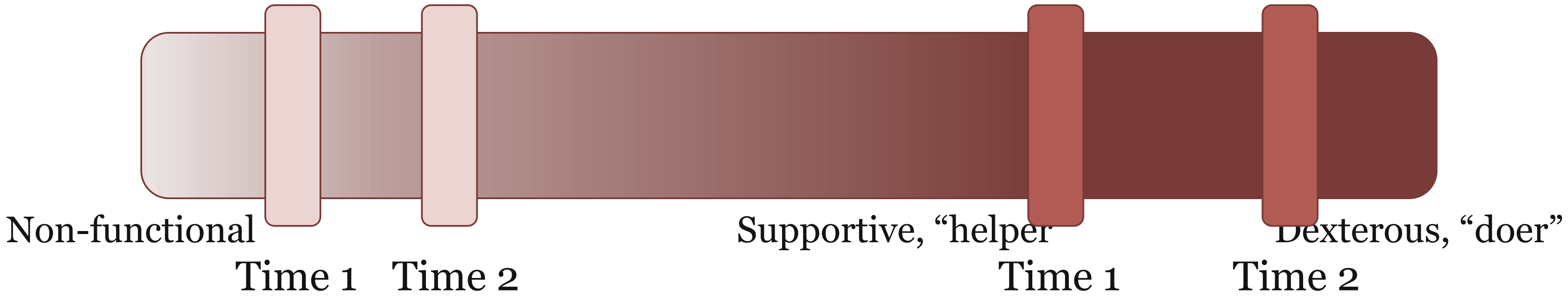
http://resourcecenter.org/health-services/occupational-therapy/
https://en.wikipedia.org/wiki/Golf
http://www.fredbowesmowsngrows.com/landscaping/
http://www.npr.org/sections/health-shots/2012/07/23/157248356
/tie-my-shoes-please-how-persuasion-works

*Task-specific training* is the active, repetitive practice of functional activities in an effort to learn or relearn a motor skill

*Training* implies that the behavioral experiences are not just repetition of the same thing but involve ongoing challenge to an person's capabilities

Bayona et al, 2005; Hubbard et al, 2009

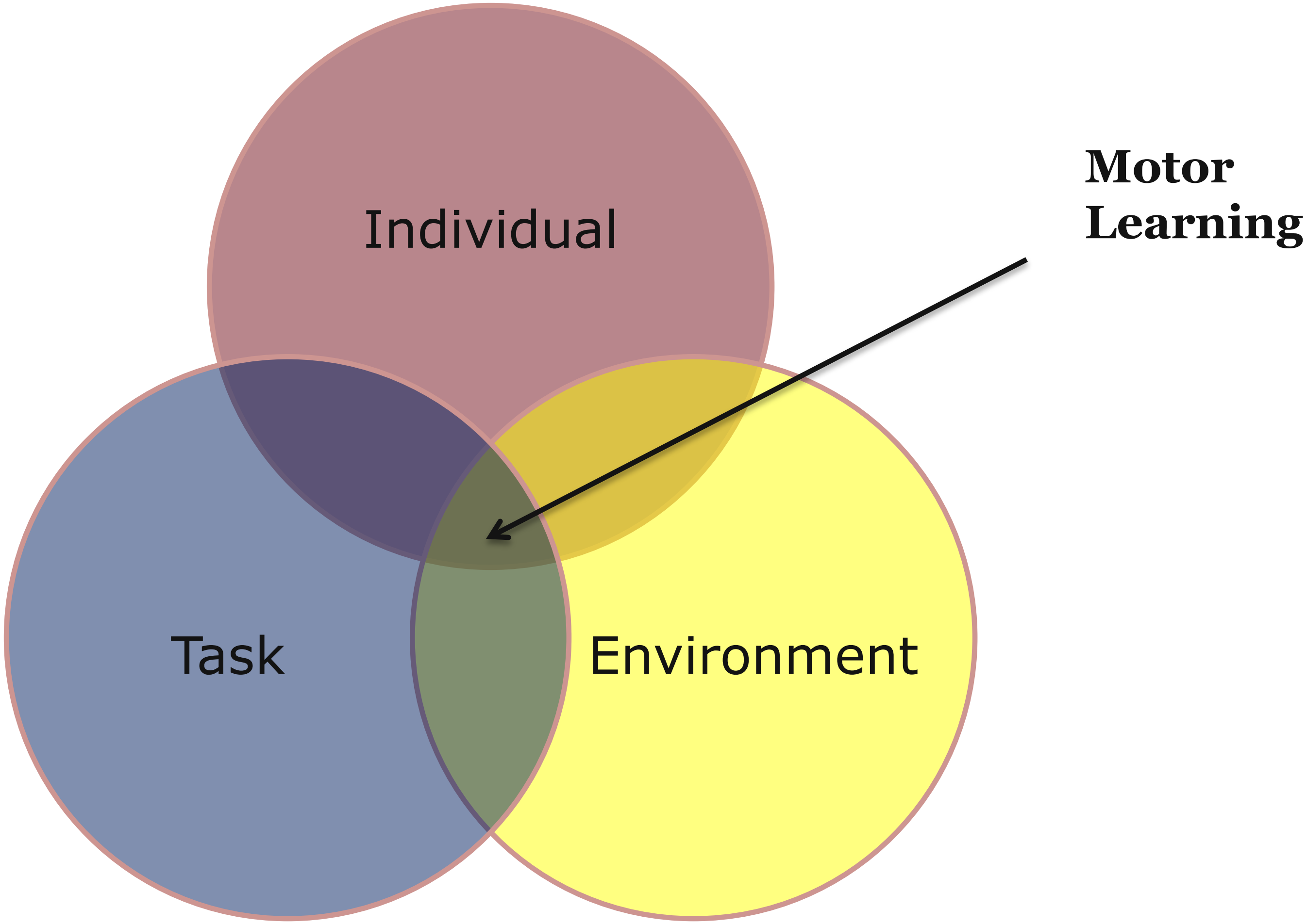
# Assessment and prognosis tell us what kind of UE is anticipated and what types of things to practice




*People need to be able to do things in daily life.*
*To get better at something you need to practice it.*

# A slight detour…

# Motor Learning



# Feedback

- Visual
- Auditory
- Tactile

# Types of feedback: Explicit

- "How to" perform tasks
- Verbal cues
  - "Take a higher step"
  - "Open your hand"
- Tactile cues
  - Facilitation of movement
- Visual cues
  - Mirror

Boyd et al., 2006

# Types of feedback: Implicit

- Inferred from changes in skilled behavior
- Trial and error learning
- Internal strategies
- Accumulate slowly with large amounts of practice

Boyd et al., 2006

# Two types of feedback

- Explicit feedback
  - Mediated by the hippocampus and adjacent temporal lobe structures

- Implicit feedback
  - Highly distributed

- Recent evidence suggests these systems may compete for neural resources during learning

Boyd et al., 2006

# Practice with and without errors

- **Trial and Error** practice is fundamental to motor learning (Schmidt, 1975; Adams et al, 1972; Lee, Swanson, and Hall 1991)
- Errorless learning has less retention than trial and error practice (Prather, 1971; Singer & Pease, 1976; Singer and Gaines, 1975)
- Errorless learning may 'look better' immediately
- Immediate performance ≠ long-term performance (Kantak and Winstein, 2012)

# Level 1A evidence for UE task-specific training

- Recommended intervention choice
  (DOD/VA Guidelines 2009, and guidelines from other countries as well)

- A critical part of efficacious therapies, e.g. CIMT, mCIMT
  (Taub et al. 1999; Wolf et al. 2006; Page et al. 2013; and many more)

- Often used in combination with other treatments, e.g. wrist orthoses, electrical stimulation, brain stimulation, etc.
  (Barry et al. 2012; Knutson et al. 2012; Stinear et al. 2008; and many more)

# Course overview

- Introduction to upper extremity (UE) movement
- Relationship of sensorimotor impairment to UE function
  - Prognosis
- Standardized assessments: Clinical importance and implementation
- Principles of task-specific training

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# Translating principles of task-specific training to clinical practice

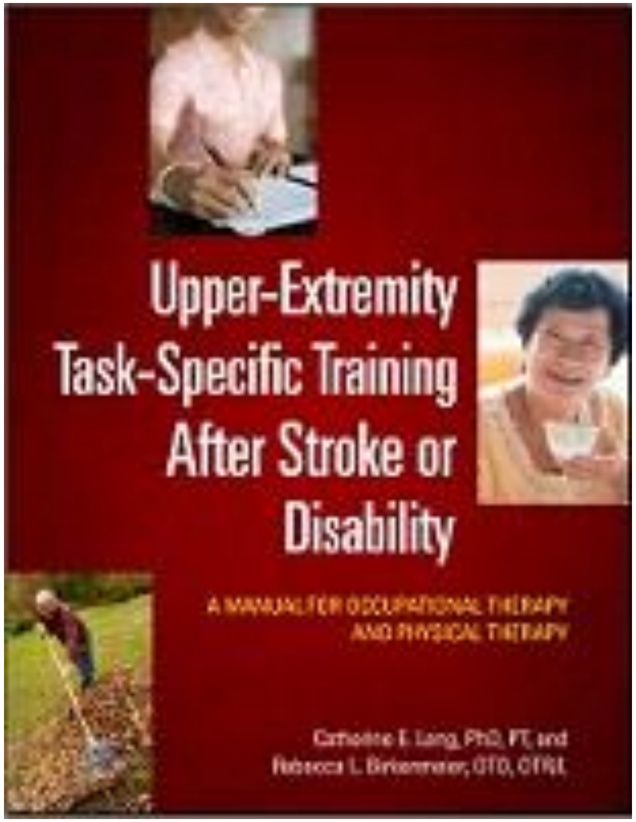
Various slides in presentation contributed by C.E. Lang

Washington University in St. Louis
School of Medicine

# Overview

- Translating principles of task-specific training to clinical practice
  - Session structure
  - Patient population
  - Task selection
  - Grading and changing tasks
  - Feedback and error
  - Goal writing
  - Documentation
- Video case series: Mild, moderate, and severe paresis
- Implementation

# A great resource




http://myaota.aota.org/shop_aota/prodview.aspx?type=d&pid=192364686&sku=900349

# Principles of neuroplasticity

Task-specific training

Graded & Progressed

- Graded to challenge, but not over or under-whelm motor capabilities (Birkenmeier et al.)
- Intensity?

Hundreds of repetitions

- On average, 300 repetitions is feasible in the outpatient setting (Birkenmeier et al.)
- On average, 289 repetitions is feasible in the inpatient setting (Waddell et al)

Goal-oriented

- Functional goals influence movement (van Vliet et al.)

Specific/Skilled

- Real objects elicit better performance (Wu et al.)

# Barriers to service delivery: Inpatient

- Patients not ready/late to session
- Medication pass
- Physician rounding
- Toileting
- Scheduling conflicts
- Outside appointment
- Personal visitors/business

# How to set up practice?

| Principle | Insights & implementation in animal models and motor learning studies | Implementation in clinical practice |
|---|---|---|
| Learning requires solving the motor problem, not rote repetition of over-learned tasks | Brain reorganization occurs with learning, not simply with repetition | Tasks or actions should be graded to challenge the motor capabilities of the individual<br><br>Progression of difficulty level is important as capabilities increase<br><br>Set up the environment for continued practice and discovery learning |

# How to set up practice?

| Principle | Insights & implementation in animal models and motor learning studies | Implementation in clinical practice |
|---|---|---|
| Variable practice conditions are optimal for learning and generalization | Animal models and human studies primarily are interested in a single task, under limited variable conditions – for the purpose of science | Keep the essential movement components the same, but vary the context<br><br>Variation can be accomplished across tasks and within tasks |

# Session structure

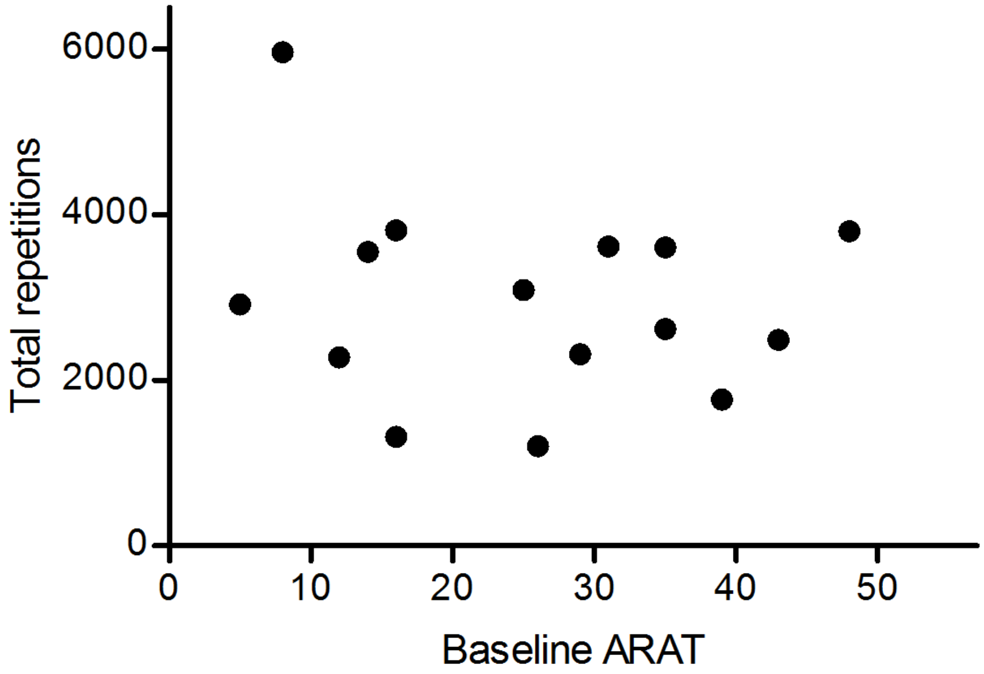
- 60 min session
- Three activities total
  - 100 repetitions per activity

- Activities should be both unilateral and bilateral
- Three activities allows for greater variance
- Addresses a variety of UE deficits

Birkenmeier et al.

# Patient population: Inpatient

Individuals with various levels of UE function can engage in a high-repetition intervention.

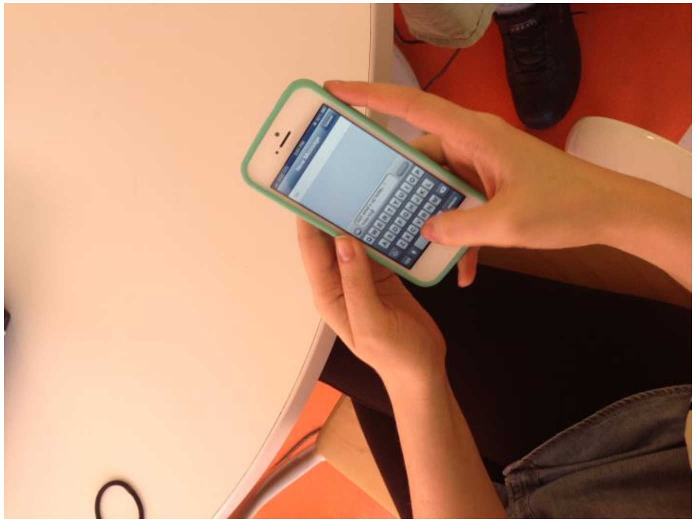



r= 0.19
P= 0.48

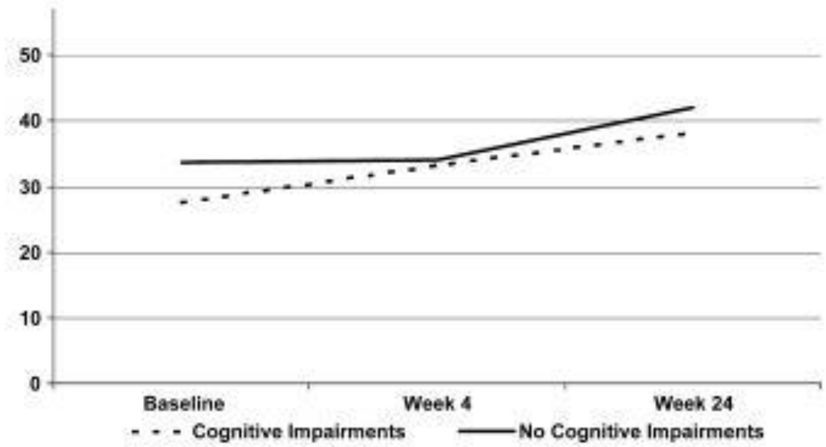
Waddell et al., 2014

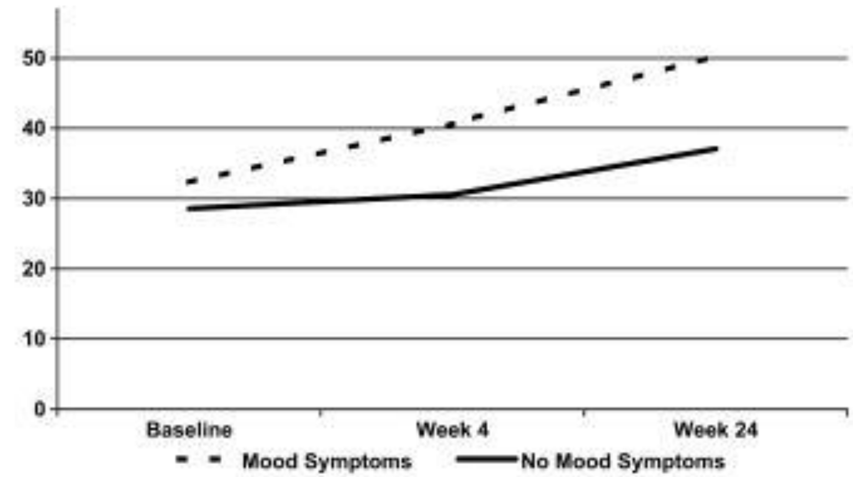
# Patient population: Chronic Stroke

- Slightly narrower population
- Restorative vs. compensation?  Both?
- Action Research Arm Test score of 10 points or greater



# What about other stroke related deficits?




Mild to moderate cognitive impairments did not influence outcomes in UE task-specific intervention

…And depressive symptomatology also did not influence outcomes.

Skidmore et al., 2012

# How to set up practice?

| Principle | Insights & implementation in animal models and motor learning studies | Implementation in clinical practice |
|---|---|---|
| Within-session massed practice promotes learning better than within-session distributed practice | Animal continuously perform their assigned movement task throughout the session | The environment is set-up to allow for continuous practice<br><br>People are encouraged to continue practicing<br><br>Rest breaks are only provided when the person requests it |

# What is a repetition?

- Includes all or a combination of the four movement components:
  - Reaching to
  - Grasping
  - Moving or manipulating
  - And releasing an object

Birkenmeier et al.

# Repetition

# How to keep someone interested?

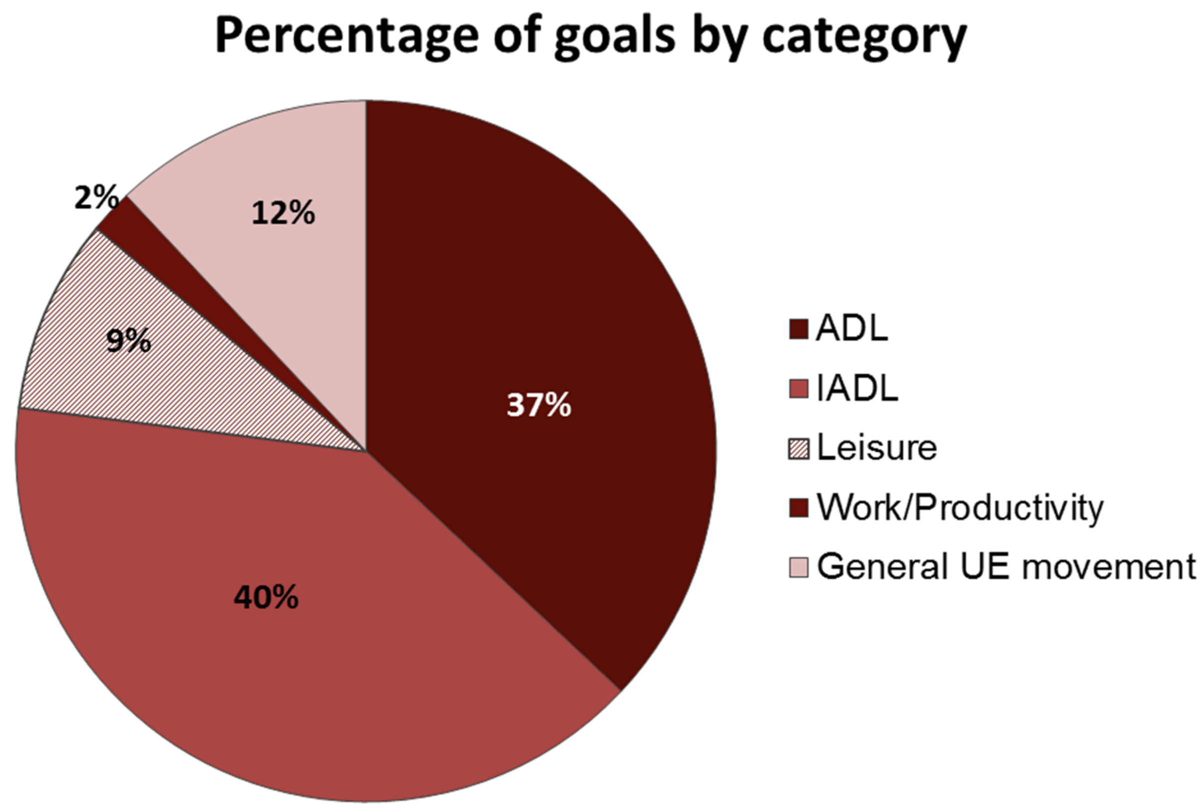
| **Principle** | **Insights & implementation in animal models and motor learning studies** | **Implementation in clinical practice** |
|---|---|---|
| Optimal learning occurs with high levels of motivation and engagement | Animals are food-deprived, and the task is to retrieve food, creating very high levels of motivation and engagement | Individuals help select rehabilitation goals and tasks to practice<br><br>Remind the individual how practice of the action or task relates to their goals<br><br>Practice more than one task in a session<br><br>Change tasks to increase variability and reduce boredom |

# Selecting tasks

- Activities selected from occupational profile
  - Can be through formally administering COPM
  - Informal discussion
- Individualized, graded, and progressed according to established criteria

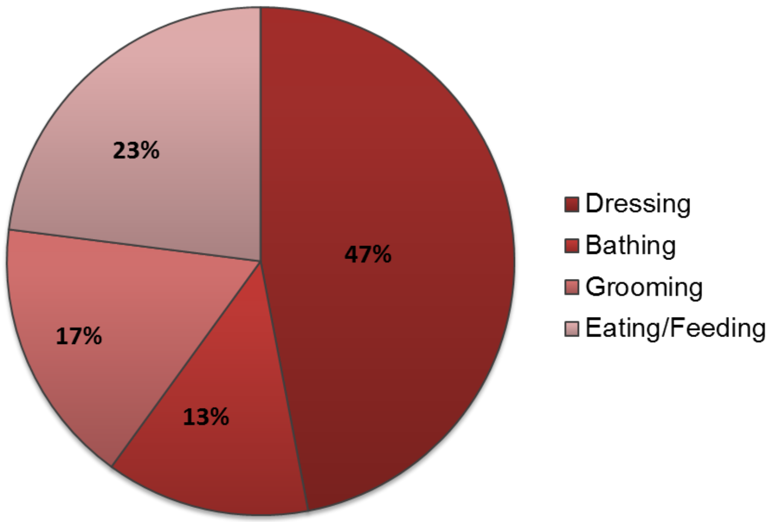
# Self-reported goals on COPM

- Goals analysis of 65 participants in task-specific training study with UE paresis post-stroke.

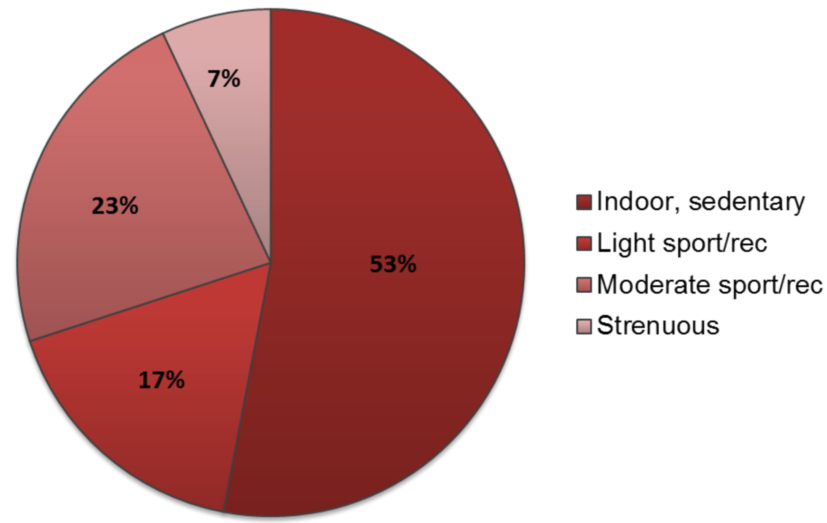



Waddell et al., 2016

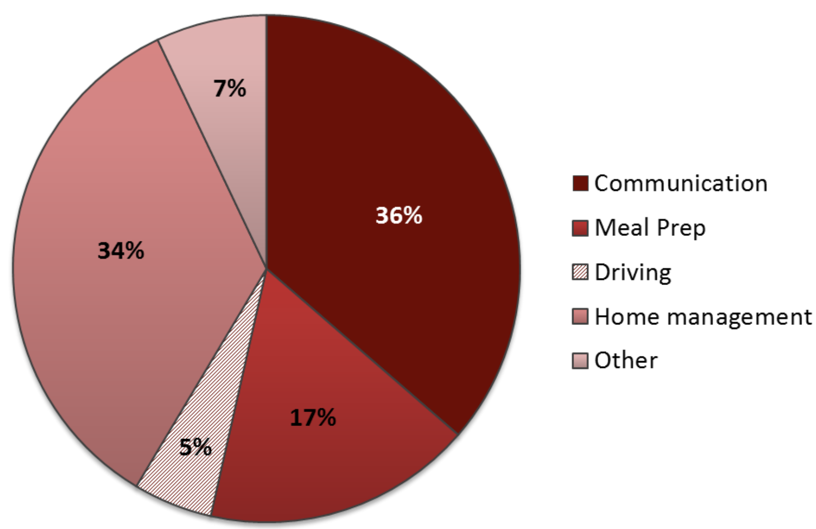
# ADL




# Leisure




# IADL



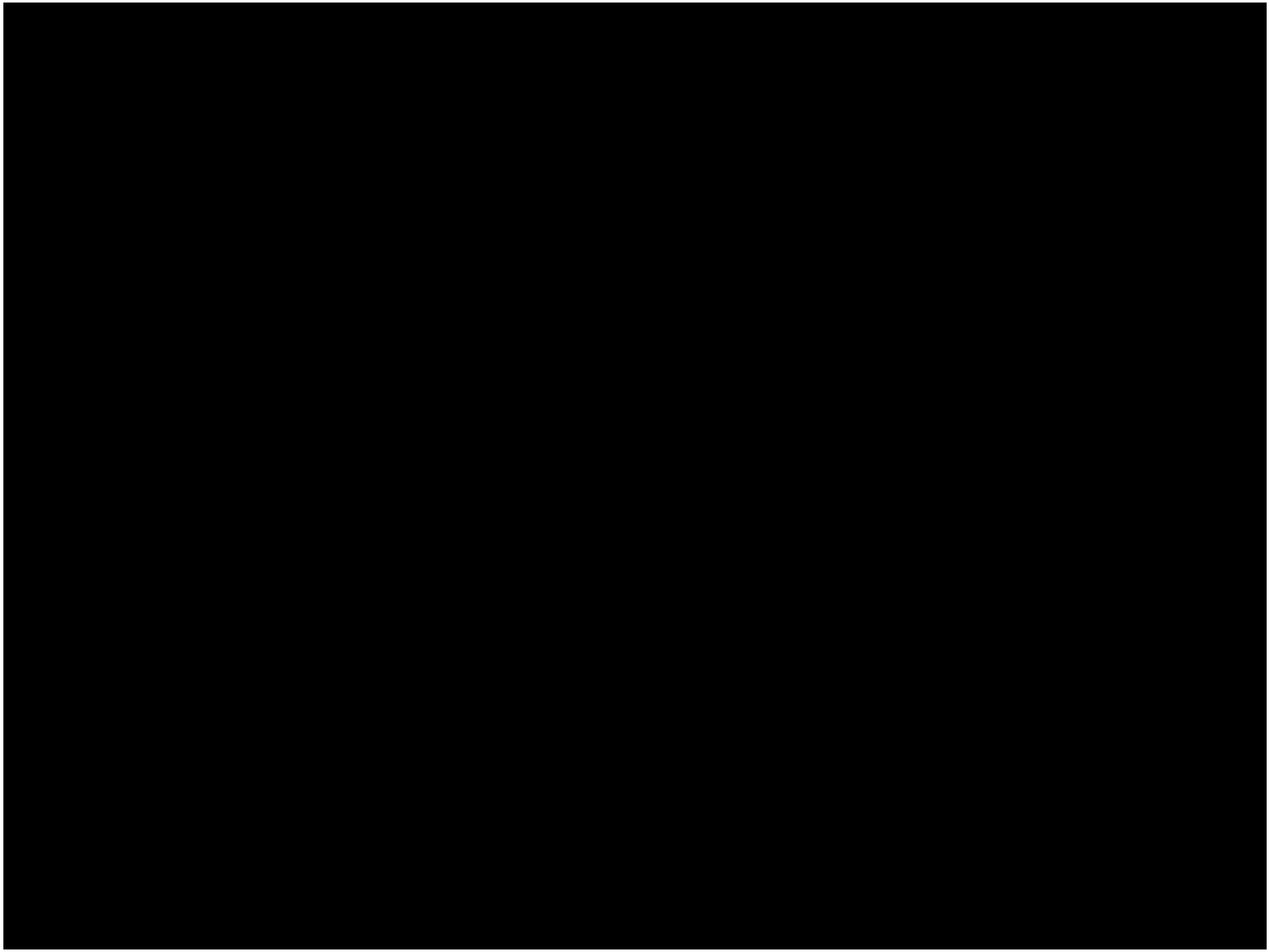

Waddell et al., 2016

# Examples of tasks

| ADL | IADL | Cont. |
|---|---|---|
| Brushing teeth | Placing containers on shelf | Answering cell phone |
| Don/Doff shirt | Unloading grocery bag | Hanging clothes on hangers |
| Pull pants up/down | Typing | Watering plants |
| Washing face | Handwriting | Hunting |
| Combing hair | Money management | Sorting tools |
| Bathing | Drying pots/pans | Pouring liquid into cup |
| Clothing fasteners | Folding towels | Painting |
| Tying shoes | Golfing | Taking picture |
| Applying make-up | Playing cards | Opening bottles |
| | | |

Lang & Birkenmeier, 2013

# Oh, the possibilities!



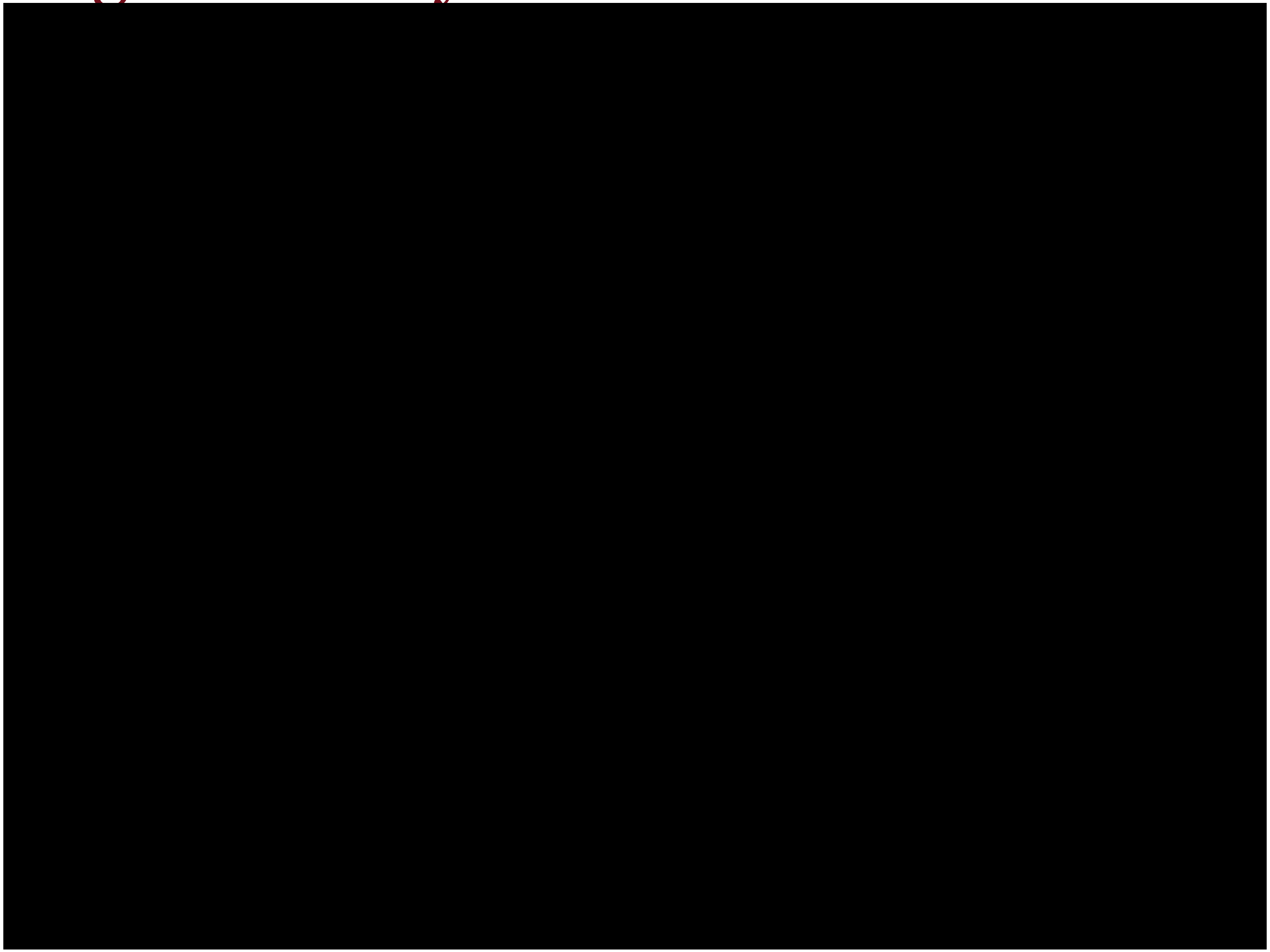
# Progressing Tasks

- Parameters for grading difficulty level up:
  - Successfully achieves 100 repetitions in less than 15 minutes on 2 occasions

- Parameters for grading difficulty level down:
  - Unable to achieve 50 repetitions of task within 15 minutes
  - Extreme fatigue and/or pain
  - Increase in error

(Birkenmeier et al., 2010)

# Grading an activity



# Changing to Different Tasks

- Stated mastery
- Cannot increase difficulty level
- Performs the whole activity without difficulty (100+ reps in <15 minutes on 2 occasions)
- Every 4th session: check in with patient on activity selection

(Birkenmeier et al., 2010)

# How to provide feedback?

| **Principle** | **Insights & implementation in animal models and motor learning studies** | **Implementation in clinical practice** |
|---|---|---|
| Learning does not occur in the absence of feedback<br><br>Intrinsic feedback is optimal for promoting self-learning and generalization | Animals have clear intrinsic feedback on each trial<br>(e.g. did or didn't eat the pellet) | Actions or tasks have clear goals so it is easy for the individual to determine success<br><br>Individuals can be given summary feedback about results or performance at the end of practicing a task |

# Goal writing

- Task-specific training should be included as a goal.
  - Example: P will tolerate 4 units of task-specific training with no more than 2 rest breaks 3 sessions/interim.
  - Example: P will complete 300 repetitions of task-specific practice with the RUE 4 sessions/interim for increased functional use of the RUE.

# Merging self-reported goals and goal writing

- Individuals after stroke experience little control over their rehab goals.
- Involvement is often passive

- Involving patients in goal setting process is empowering
- Generates a personal sense of ownership
- Increases motivation

Rosewilliam et al., 2011
Laver et al., 2010
Maclean et al., 2000

# Documentation

- Documented under therapeutic activity

- Consider the occupation
  - Meal preparation?
  - Medication management?
  - Dressing?
  - Grooming?

- Include items used and set-up details so task is reproducible

- Record time & repetitions in comment section of note

# Counting repetitions

- Hand held counter

- Group setting
  - Have a pre-set number of items (e.g. 10 towels or 5 containers)
  - "Rotating stations"
  - As much as possible, match groups by UE capacity
  - Use of rehab aide

# Inpatient Rehab Barriers: Revisited

| Barrier | Solution |
| --- | --- |
| Not ready; Toileting | •Use of rehab aide<br>•Nursing assist |
| Schedule conflicts; Medical complexity | •Scheduled outside MD rounding<br>•Scheduled outside med pass |
| Medical complexity; Multiple goal areas | •Addressed ADL in session<br>•Spatial deficits addressed<br>•Interdisciplinary team |

# Overview

- Translating principles of task-specific training to clinical practice
  - Session structure
  - Patient population
  - Task selection
  - Grading and changing tasks
  - Feedback and error
  - Goal writing
  - Documentation

- Video case series: Mild, moderate, and severe paresis

- Implementation

# CLINICAL CASE #1

# CLINICAL CASE #2

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# Clinical Case 1

- Joe is a 45-year-old male, 2-weeks post a right parietal stroke with resulting left upper extremity paresis. He was just admitted to inpatient rehabilitation. He is single and travels 2-3 times a month for work as a CPA. His stroke was very unexpected as Joe is an active guy and keeps a fairly busy social calendar. Naturally, he is very upset and confused over all of this.
- After his initial evaluation, his assessments showed the following deficits:
    - LUE paresis (score of 22 on the ARAT: can pick up smaller items and able to lift 1-2 onto a close shelf, very limited fine motor control but does show emerging finger flexion/extension, gross motor control is also present, as measured by ability to bring hand to mouth and almost reach behind head)
    - Mild neglect
- Some of his favorite activities include: cooking, riding his bicycle, traveling, and fishing. Since he lives alone, he is responsible for all his ADLs and has verbalized a strong desire to be independent with his self-care again. He is also responsible for all household IADL tasks as well.
- What treatment activities could you do to address his UE paresis?
- How would you set up 3 of the tasks based off his current presentation?
- How could you grade the difficulty up? Down?
- What barriers, both at the physical hospital site and also from Joe's deficits do you anticipate? How would you address them?

## Clinical Case 2

- Sharon is 71 years old, previously healthy with some osteoarthritis in her bilateral knees and shoulders, although Sharon reports this doesn't really limit her with daily activities. Sharon is married, has 3 grown children and 6 grandchildren, who she loves to spend time with.
- Sharon and her husband are avid golfers. She enjoys scrapbooking, cooking, meeting her friends for coffee every Thursday morning, and doing water aerobics. Sharon also babysits her grandchildren 1 day a week and gloats over her award winning garden she cares for with her husband.
- Sharon is one-year post-stroke and is living at home. She arrives in outpatient for a "tune-up" to try and help her right arm improve. She had a left sided stroke (exact location unknown). At initial eval, she scored 40 points on the Action Research Arm Test.
    - To score a 40, she can pick up small blocks and tubes and place on shelf. She also has sufficient fine motor skills to pick up both a marble and a ball bearing and place in a small dish on the same shelf.
    - She has complained of difficulty sequencing tasks or sustaining attention to a task for a long period of time.
- What treatment activities could you do to address her goal of improving her UE function?
- How would you set up 3 of the tasks based off her current presentation?
- How could you grade the difficulty up? Down?
- What barriers, both at the physical hospital site and also from Sharon's deficits do you anticipate? How would you address them?