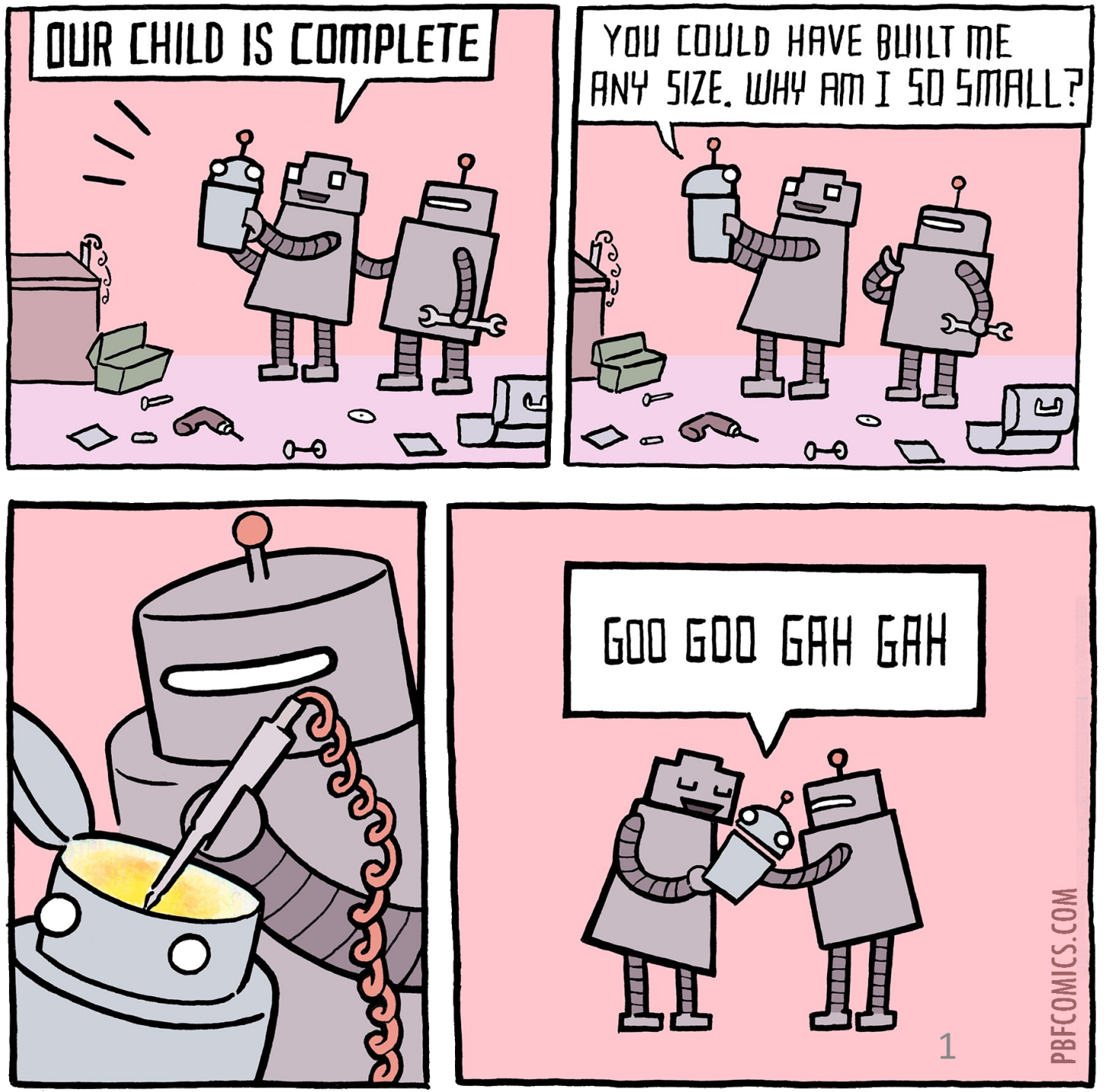
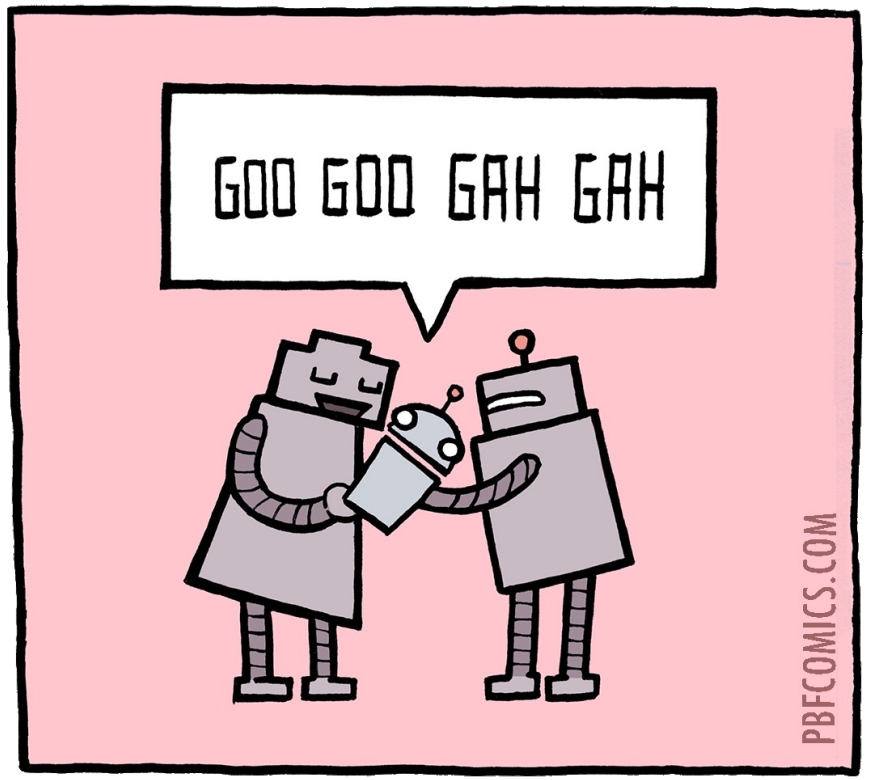
PSYC301: Factors influencing recovery following brain dysfunction

Jay Hosking, PhD

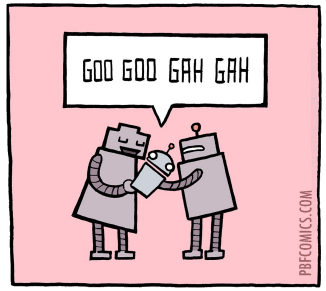




Lecture outline

A. Common misconceptions
B. Anosognosia
C. Effect of age
D. Effect of lesion size and location
E. Chronic vs. acute dysfunction
F. Secondary effects
G. Environmental factors
H. Compensatory strategies
I. Neuroplasticity
J. Therapy dose

Learning objectives



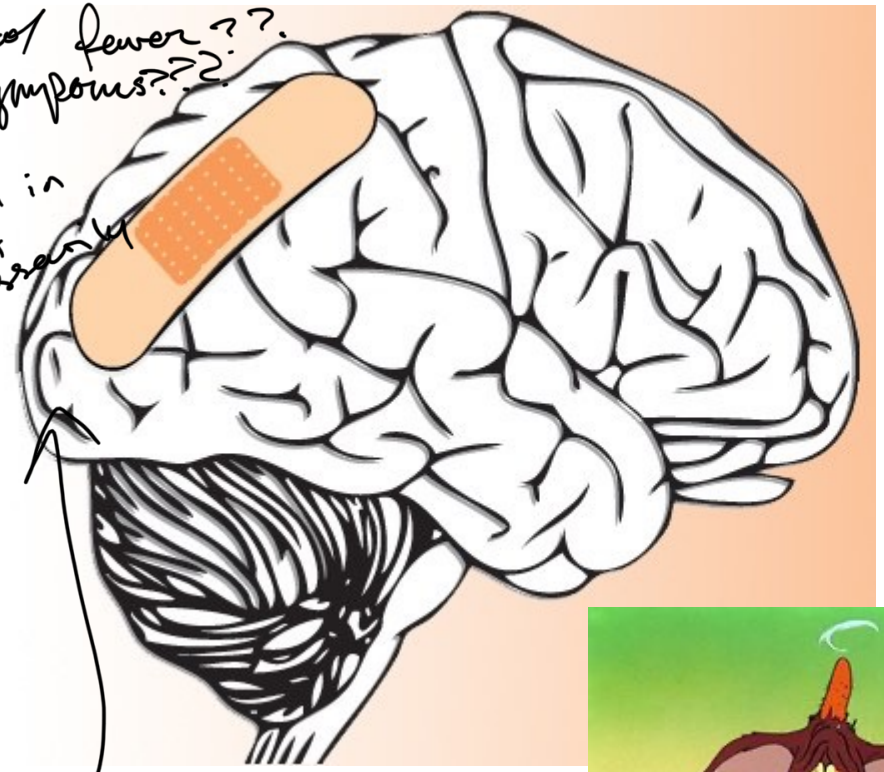
1. To consider some common misconceptions about brain injury and how those misconceptions might affect recovery of function in a brain-injured person.
2. To review and appreciate evidence supporting the notion that self-awareness is an important factor related to successful recovery.
3. To consider how age, the extent of damage, and the secondary effects influence recovery of function across multiple domains.
4. What is the relationship between environment and recovery?
5. What does restitution vs. substitution mean, in the context of recovery? What sort of recovery are we usually seeing?
6. Describe neuroplasticity as related to both recovery and the healthy brain.
7. How could you test whether anosognosia is real or is simply the participant refusing to admit their dysfunction? (Hint: Ramachandran has some ideas.)
8. (Required) Read the paper by Duque *et al*. 2022 on what we know about adult neurogenesis in humans. Based on this information, what role do you think neurogenesis plays in recovery? What do you think about its therapeutic value?

It's true that chronic stress is a risk factor for brain dysfunction, depression, anxiety, cancer malignancy, and autoimmune disorders, BUT that unfortunately leads to quotes like:

"Cancer and ALS and MS and rheumatoid arthritis and all these other conditions, it seems to me, happen to people who have a poor sense of themselves as independent persons… they have a poorly differentiated sense of self. … The people I see with cancers and all these conditions have difficulty saying no and expressing anger."
– Gabor Maté, *When the Body Says No*

It happens in both brain dysfunction and also recovery.
Be careful of these logical fallacies!
Yes, both positivity/attitude and effort/motivation can have mild beneficial effects on recovery,
BUT
If someone has poor recovery/outcome, this does not indicate a failure of positivity/attitude or effort/motivation!

1. Many people falsely believe that recovery from brain dysfunction depends primarily on the injured person's efforts or attitude.
2. Many people falsely believe that a person with even severe brain dysfunction can fully recover.
3. Many people misattribute a behaviour (e.g., fatigue, aggression) that is the result of brain dysfunction to the person's personality or life stage.
4. Many people falsely believe that brain dysfunction must have visible effects on the person.
5. Many people falsely believe that emotional problems after brain injury are usually tangential to the brain dysfunction.
6. Many people falsely believe that a second brain injury can restore lost memories in individuals with amnesia.



Common misconceptions about brain dysfunction

"…a brain dysfunctional patient does not appear to be aware of impaired neurological or neuropsychological functioning which is obvious to the clinician…"

Visible evidence contradicts pt's description → are they in denial or actually unaware?

ie paralyzed arm
pt: arm is fine
dr: move it then
pt: I don't want to
↓
present w/ 1 vs 2 handed task: choose 2 handed → truly unaware

good neuro researcher!

how we experiment

https://www.youtube.com/watch?v=MDHJDKPeB2A

Anosognosia

Links to Anosognosia

These are all v. different disorders! No one thing tied to "self-awareness"

early stages often low-insight

Observed in various forms of brain dysfunction:

Psychiatric disorders (schizophrenia, bipolar)

Movement disorders

Contralateral neglect → failure to pay attn to L/R side of world

Memory disorders

Stroke

Dementia

Dysexecutive syndrome ("frontal lobe syndrome"):

Disinhibition, aggression, impulsiveness, disruptions in planning, working memory

Frontal & parietal lobe often relevant

Executive functions & other "higher" (v/s of cogn. & judgment)

Impairs functional recovery

Prigatano & Wong (1999)

- When prediction of performance improves, the likelihood of achieving rehabilitation goals improves

Cognitive and Affective Improvement in Brain Dysfunctional Patients Who Achieve Inpatient Rehabilitation Goals

George P. Prigatano, PhD, Jane L. Wong, PhD

ABSTRACT. Prigatano GP, Wong JL. Cognitive and affective improvement in brain dysfunctional patients who achieve inpatient rehabilitation goals. Arch Phys Med Rehabil 1999;80: 77-84.

Objective: To evaluate whether improvements in specific cognitive and affective functions are associated with achieving inpatient rehabilitation goals after the acute onset of brain dysfunction.

supervised care facility.[1-3] Priority goals include increased mobility, self-care, bowel and bladder management, and communication.[1] Opinions, however, have differed about the impact of cognitive impairment on neurorehabilitation outcome. Diamond and colleagues[4] reported that improvement on the Functional Independence Measure (FIM) from admission to discharge was unrelated to cognitive status, as measured by the Mini-Mental State Examination (MMSE), in a group of geriatric patients (38% of whom had CVAs). These patients evi-

Impairs functional recovery

Jehkonen et al. (2000)

- Those with initial anosognosia had poorer functional outcomes

10 day – presence of anosognosia @ 10 day = worse outcome 1 yr later EVEN THOUGH none showed anos. @ 3 mo mark

early indicator

Acta Neurologica Scandinavica

Explore this journal >

Unawareness of deficits after right hemisphere stroke: double-dissociationsof anosognosias

M. Jehkonen, J-P. Ahonen, P. Dastidar, P. Laippala, J. Vilkki

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Abstract

Objectives– The aim was to study whether anosognosia for hemiparesis, anosognosia for neglect and general unawareness of illness double-dissociate, indicating that anosognosias are specific and independent impairments of awareness. On the other hand, anosognosias may be associated with one another and with general cognitive dysfunction, which decreases awareness of deficits. The persistence and predictive value of anosognosias was examined during a 1-year follow-up. *Patients and methods*–

Impairs functional recovery

Gialanella et al. (2005) • Rehabilitation progress not as strong when anosognosia is present

even w/ all other symptoms the same

Functional Recovery After Hemiplegia in Patients With Neglect

The Rehabilitative Role of Anosognosia

Bernardo Gialanella, MD; Vittoria Monguzzi, MD; Raffaele Santoro, MD; Silvana Rocchi, PD

Background and Purpose—The aim of this study was to verify whether the presence of anosognosia (A) affects the rehabilitative prognosis of hemiplegic subjects with neglect (N).

Methods—This study was carried out on 30 patients with left hemiplegia: 15 patients had neglect (group N) and 15 had neglect and anosognosia (group N+A). Mean age was 68.2±6.3 in group N (9 men and 6 women) and 72.1±6.4 in group N+A (7 men and 8 women). The average interval from onset of stroke to admission for rehabilitation was 23 and 23.6 days, respectively, in group N and in group N+A. Patients were assessed through the Mesulam test, Bisiach test, Wechsler Adult Intelligence Scale, Fugl-Meyer scale, Functional Independence Measure (FIM), and Rankin scale.

Results—Before rehabilitation, cognitive FIM scores of patients of group N were significantly higher than those of group N+A (P=0.001), whereas motor FIM scores and total FIM scores did not differ between the 2 groups. After rehabilitation, cognitive FIM scores (P=0.000) and even motor (P=0.009) and total FIM scores (P=0.000) were statistically higher in group N than in group N+A. Effectiveness (P=0.005) and efficiency (P=0.012) in the motor FIM scores of group N were significantly greater than those of group N+A. Disability was lower in group N (P=0.040).

Conclusions—Our study shows that the presence of anosognosia worsens the rehabilitation prognosis in hemiplegic subjects who also have neglect. (***Stroke*. 2005;36:2687-2690.**)

Key Words: cerebrovascular disorders ■ neglect ■ stroke ■ rehabilitation

Interventions?

Cheng & Man (2006)

"Awareness Intervention Program" (AIP)

AIP group showed improved self-awareness but was not associated with improved functional outcome

Can we target anos. to improve recovery?
— Brain injury edu.; show PP what dysf. they were dealing w/.
↓
Decreased anos. faster
BUT
Didn't improve recovery

Original

Management of impaired self-awareness in persons with traumatic brain injury

S. K. W. Cheng & D. W. K. Man

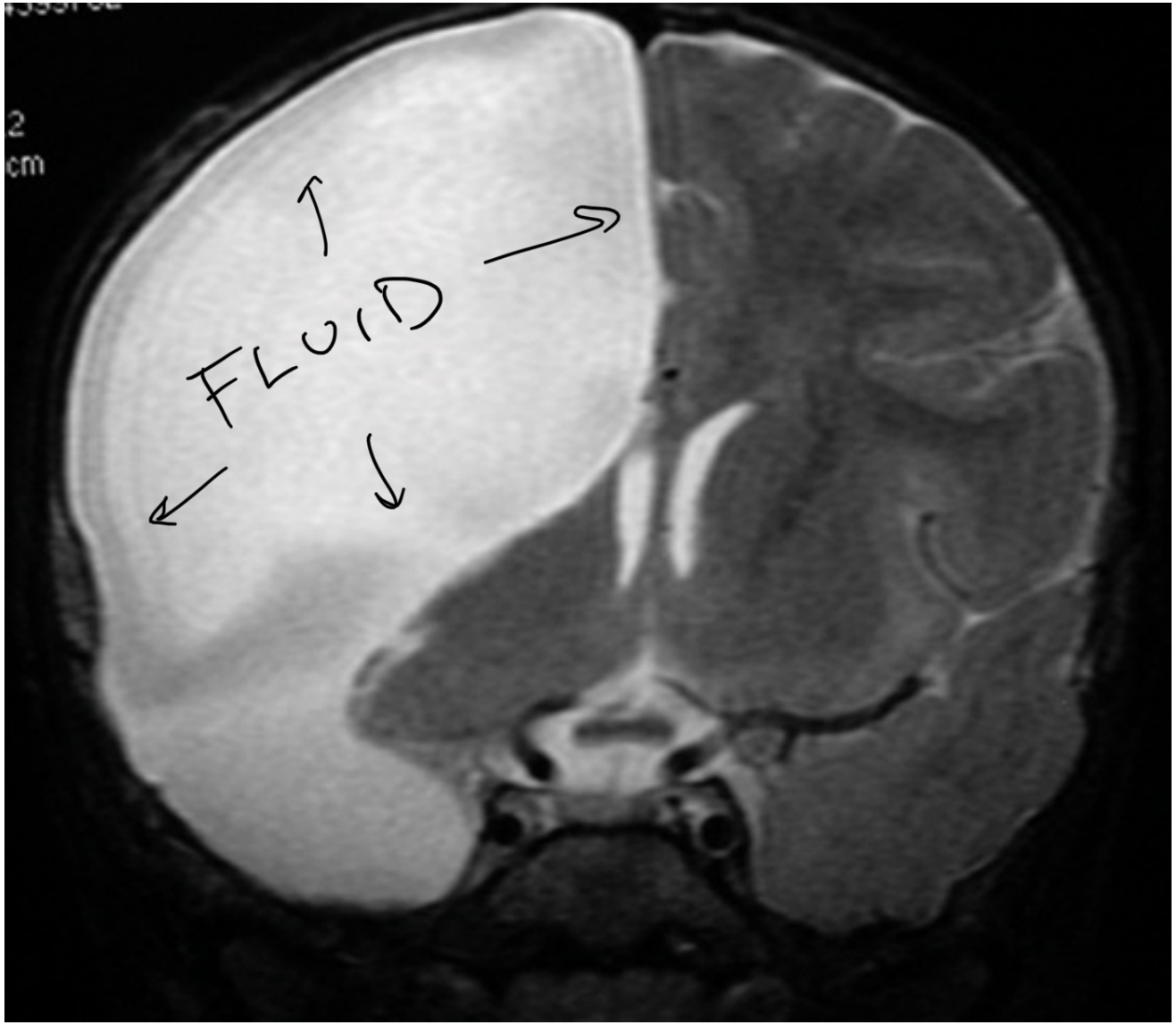
Pages 621-628 | Received 05 Jul 2005, Accepted 02 Mar 2006, Published online: 03 Jul 2009

Abstract

Aim: To develop and evaluate a systematic intervention programme for the management of impaired self-awareness (ISD) in people with traumatic brain injury.

Anosognosia → Anos. is not cause, but indicator

Effect of age



"I only have half a brain"

↓

living relatively normal life

If happens very young: much more flexibility & rewiring

https://www.youtube.com/watch?v=f2fCY_M7Vms

see next slide

↓ age = ↑ outcome

of neuron loss

Effect of age

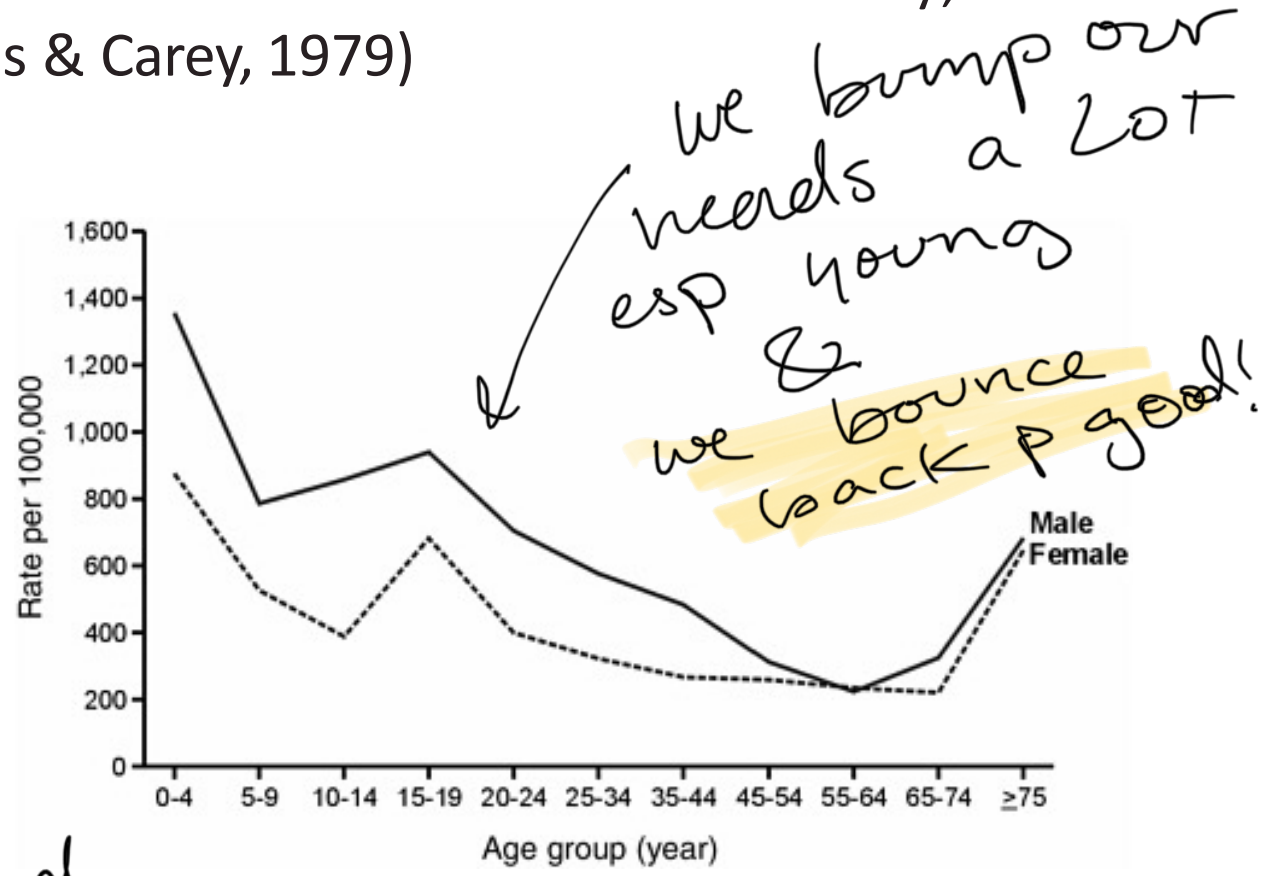
Removal of an infant monkey's primary motor cortex results in a less dramatic impairment than in an adult monkey (Kennard, 1948)

Brain injury resulting in aphasia before age 1 is associated with the best recovery; recovery diminishes as age increases (Woods & Carey, 1979)

BUT:
Prefrontal lesions before 16 months may be associated with an inability to learn social and moral rules later in life (Anderson *et al.*, 1999)

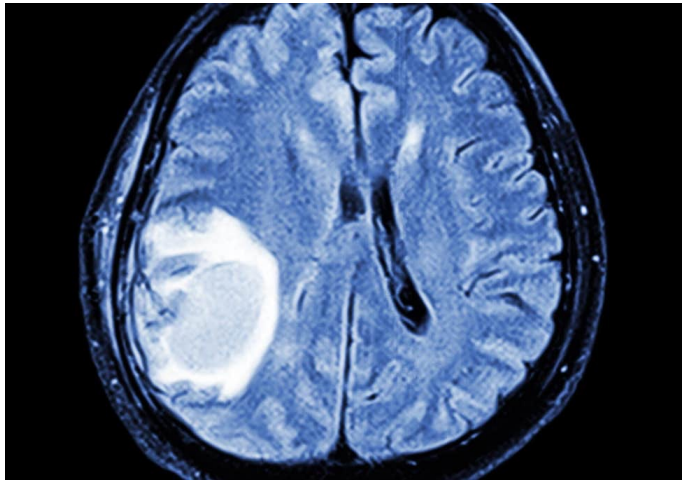
Prefrontal dmg exception: younger brain recovers worse

Dusty requested Ted Cruz dog



Average annual TBI-related rates for emergency department visits, hospitalizations, and deaths, by age group and sex, U.S., 1995–2001. Langlois *et al.* 2004

There is a direct relationship between the size of a brain lesion and the extent of recovery:
Larger lesions generally result in more functional impairments.



unilateral lesion > bilateral

In addition, patients with bilateral lesions show less recovery than patients with unilateral lesions (e.g. hippocampal lesions; Scoville & Milner, 1957; Zola-Morgan, Squire & Amaral, 1986)

Our redundant symmetrical structures

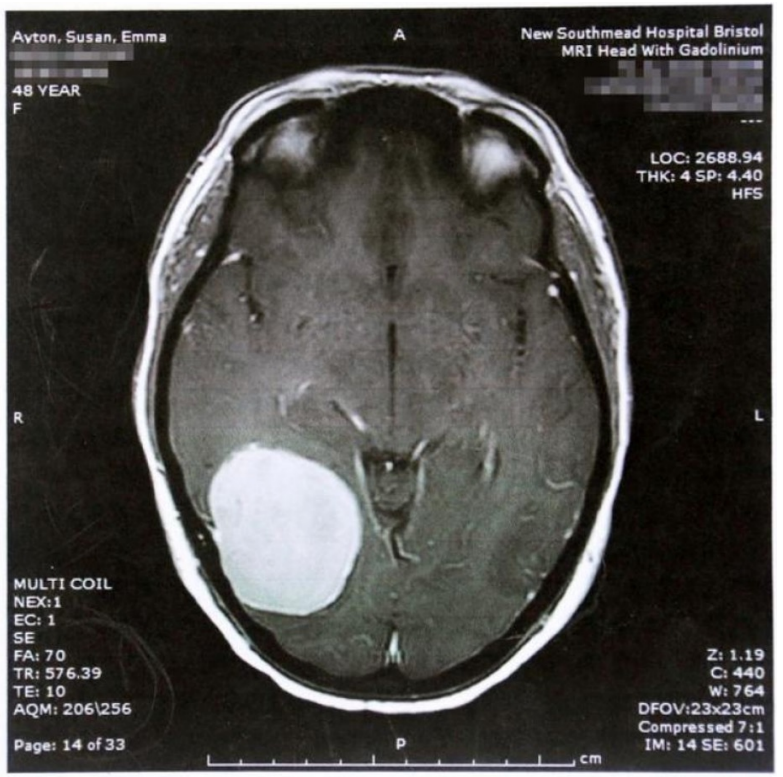
Effect of lesion size and location

Massive tumour, little impairment

vs.

Sudden stroke with associated damage (of a comparable size), functionally devastated

Sudden is far worse than rapid slow



Chronic vs. acute dysfunction

Edema

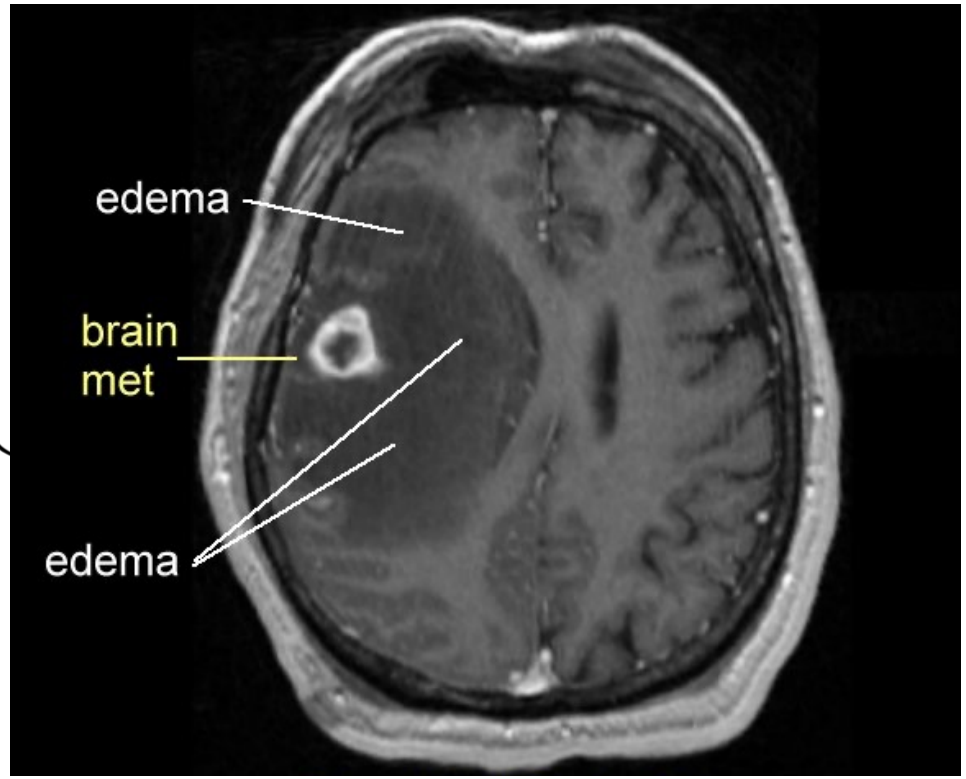
triggered by potassium signalling loop → causes ↑CSF & interstitial fluid

Swelling (edema) after stroke may mask or distort functions in essentially intact regions of the brain

Dissipation of these effects may account for substantial early recovery

doesn't always go away :(

~2 wk after stroke: when swelling ↓, healthy neurons able to function again "bounce back" of function



Secondary effects

Loss of inputs = Diaschisis

A brain lesion can cause dysfunction in an area remote to it because of its strong connections with that area.

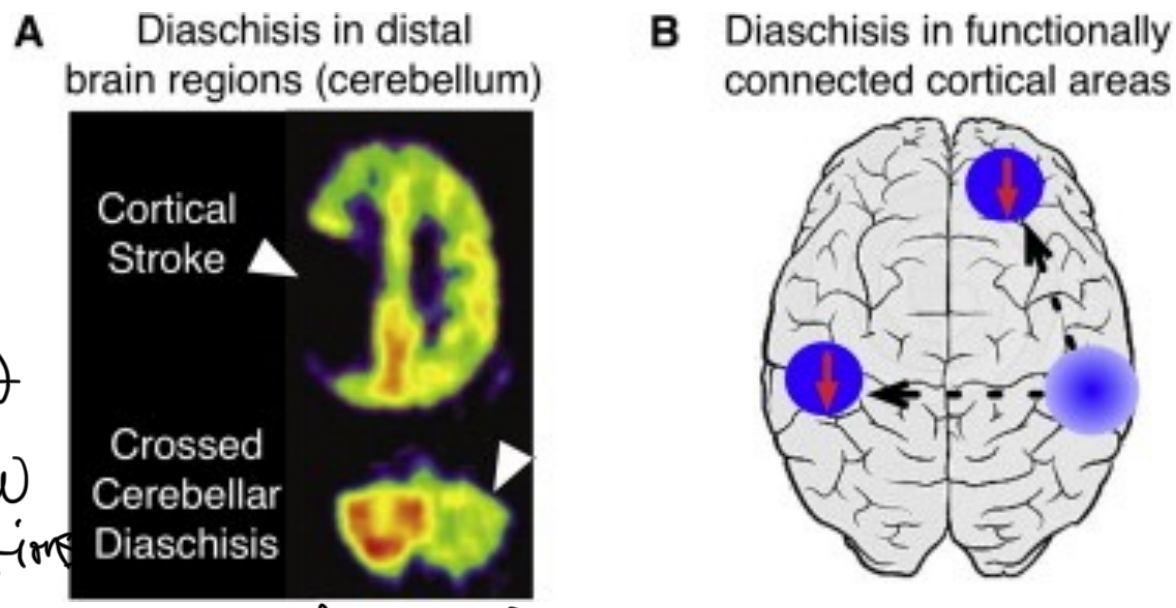
Thus, recovery can occur because of a spontaneous reduction of diaschisis (i.e. reduction in metabolic depression in cerebral areas remote to the lesion).

Cerebellum becomes more metabolically active: find "next best input" when input lost → can make full recovery

↓

True restitution

(altho new connections made, neurons not lost forever?) google



Secondary effects

Environmental factors may affect the amount of functional recovery following brain injury.

Social
Community
&
physical
therapy

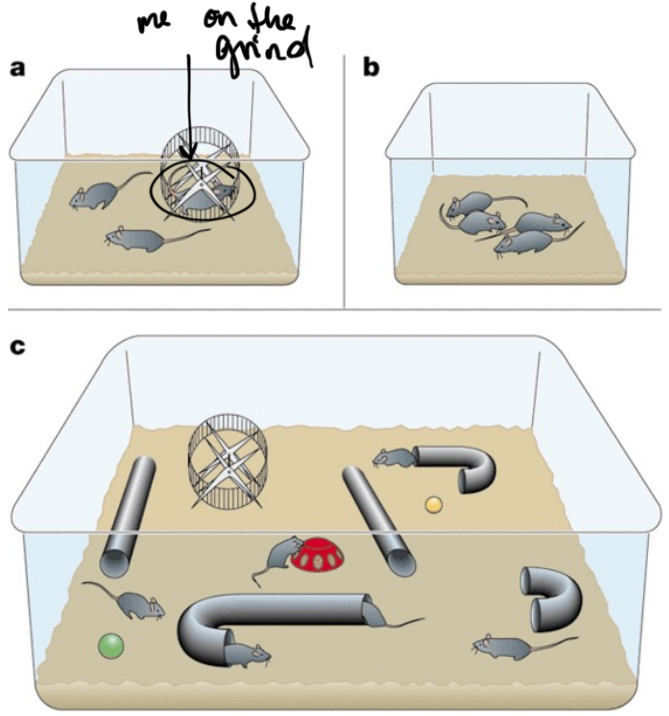
occlude good hand

e.g.

Animals models, enriched environments, **constraint-induced movement therapy**

↳ "rest" can ↓ recovery

use it or lose it



Monkeys with focal strokes to the motor cortex that were retrained in skilled hand use

Compensatory strategies are a mainstay of rehabilitation of patients with brain dysfunction

So recovery may not represent true *restitution* of function, but *substitution* of a new behavior

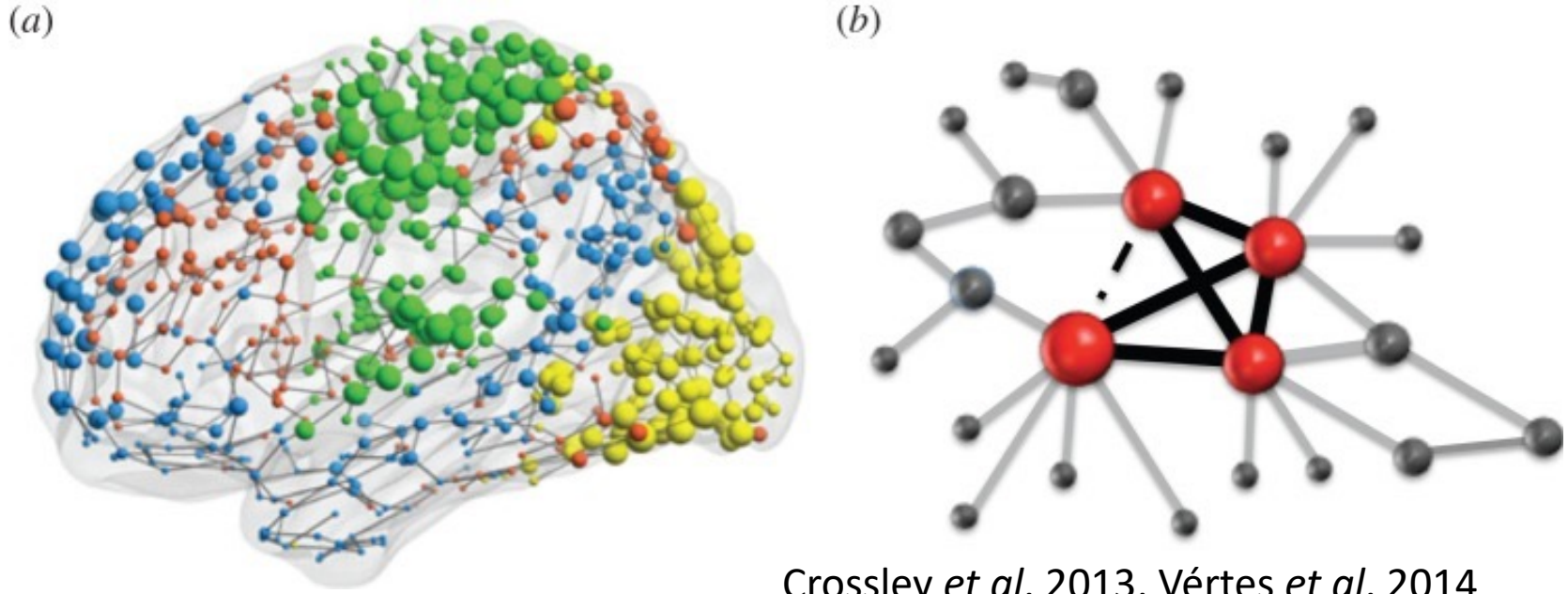
So, a patient learns strategies to adapt to his or her new motor, sensory or cognitive impairments

e.g. Beam-walking of rats with lesions to sensorimotor cortex

It is not a failing if you find a new way to succeed at doing an old thing! e.g. Carrying a notebook, walking with an aid, using notation software, etc.

Compensatory strategies

New wiring for old jobs



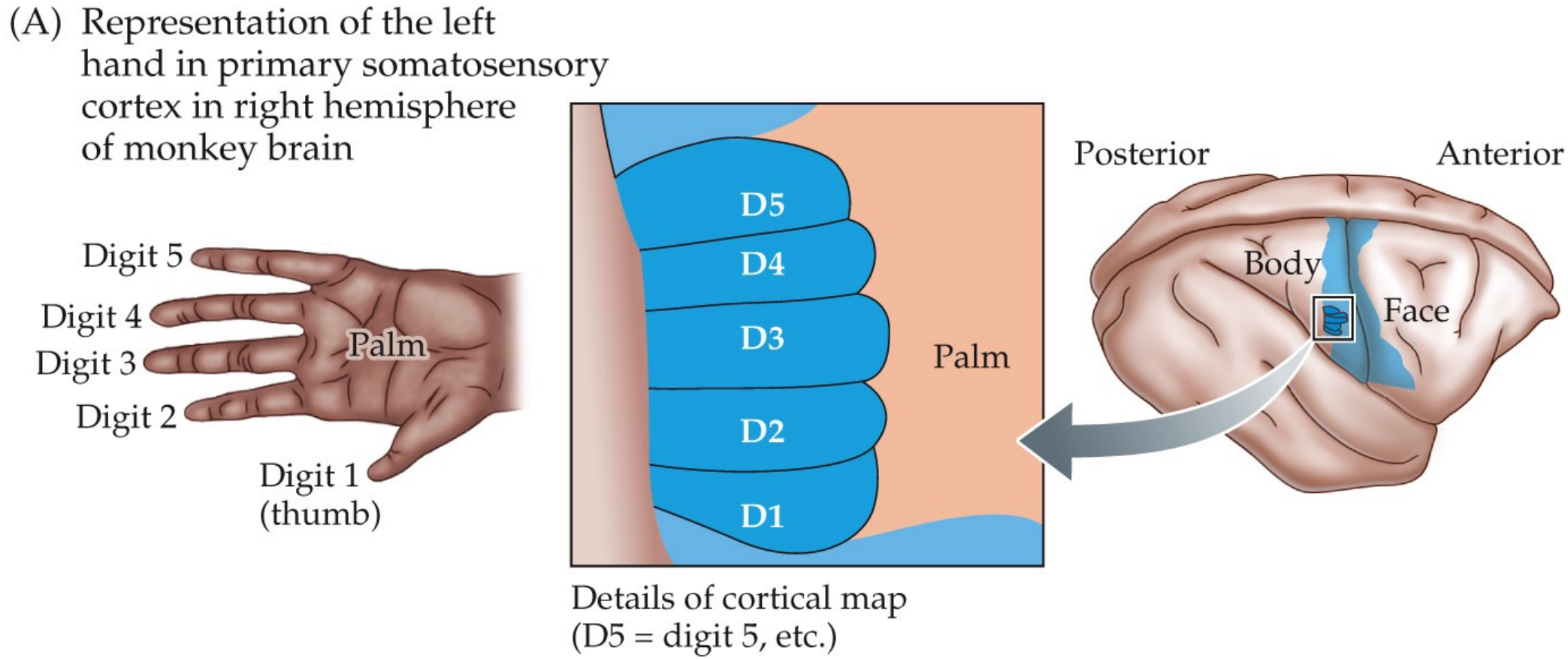
Crossley *et al*. 2013, Vértes *et al*. 2014

Reminder: your brain has ~80 billion neurons, and more connections between them than is strictly necessary

"Rich club" vs. "Poor club" of neurons (Buzsaki 2022)

Neuroplasticity

Cortical representation



BEHAVIORAL NEUROSCIENCE 8e, Figure 8.17 (Part 1)

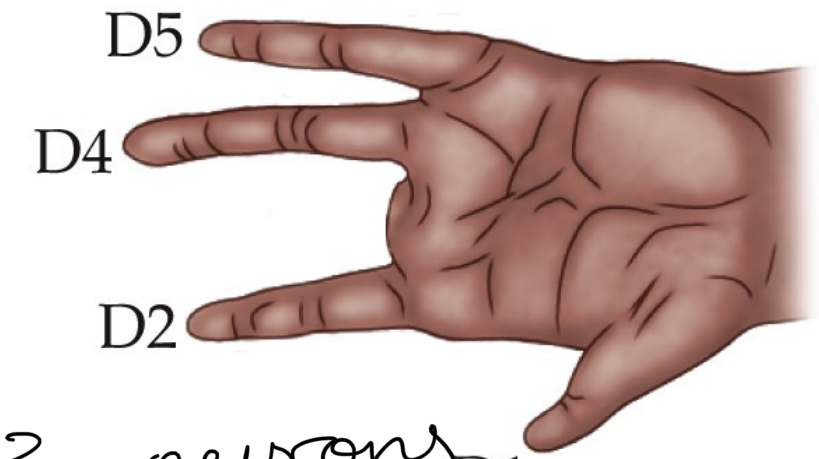
Functional areas are flexible

Representation is based on use

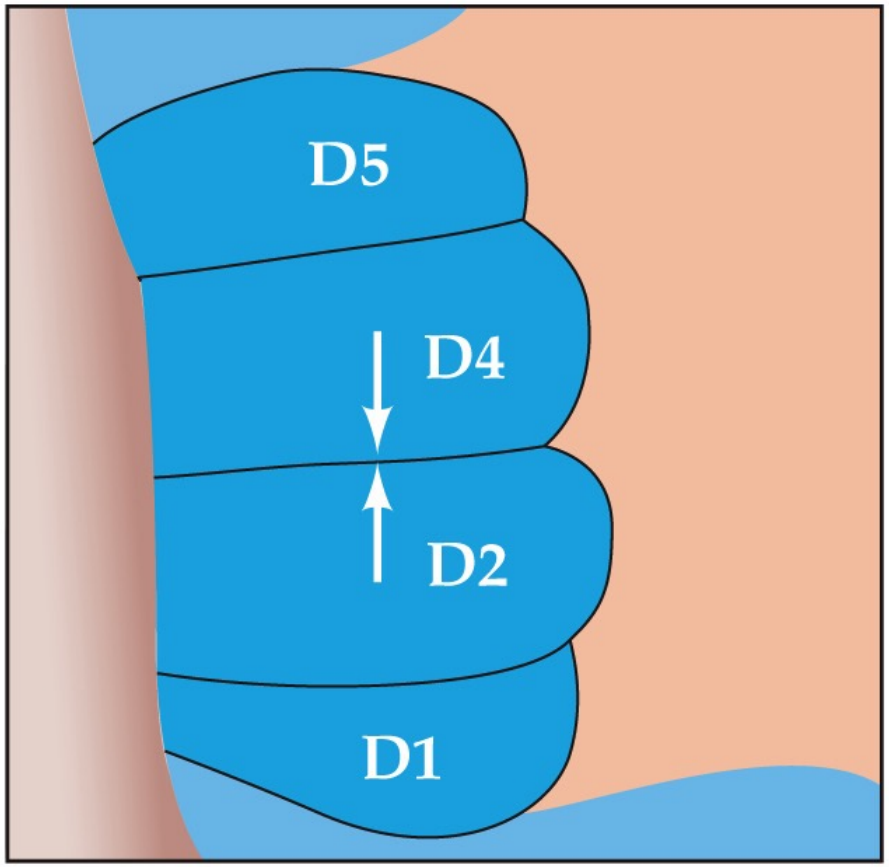
Neuroplasticity due to damage

"The brain abhors an unused neuron."

—Your teacher, last night when he was prepping these slides



D3 neurons revive to next strongest inputs



BEHAVIORAL NEUROSCIENCE 8e, Figure 8.17 (Part 2)

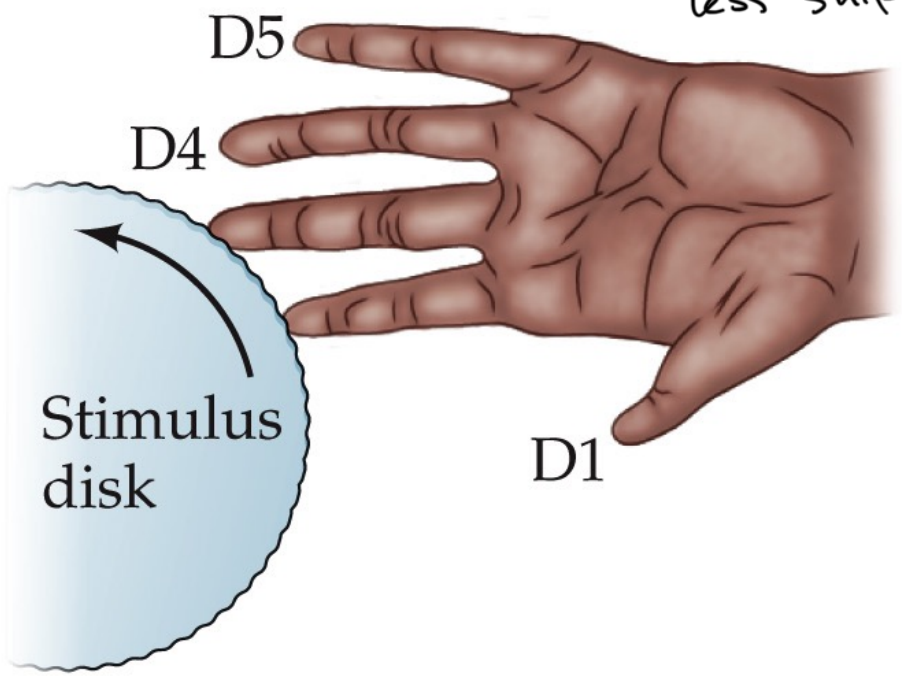
Neuroplasticity due to use

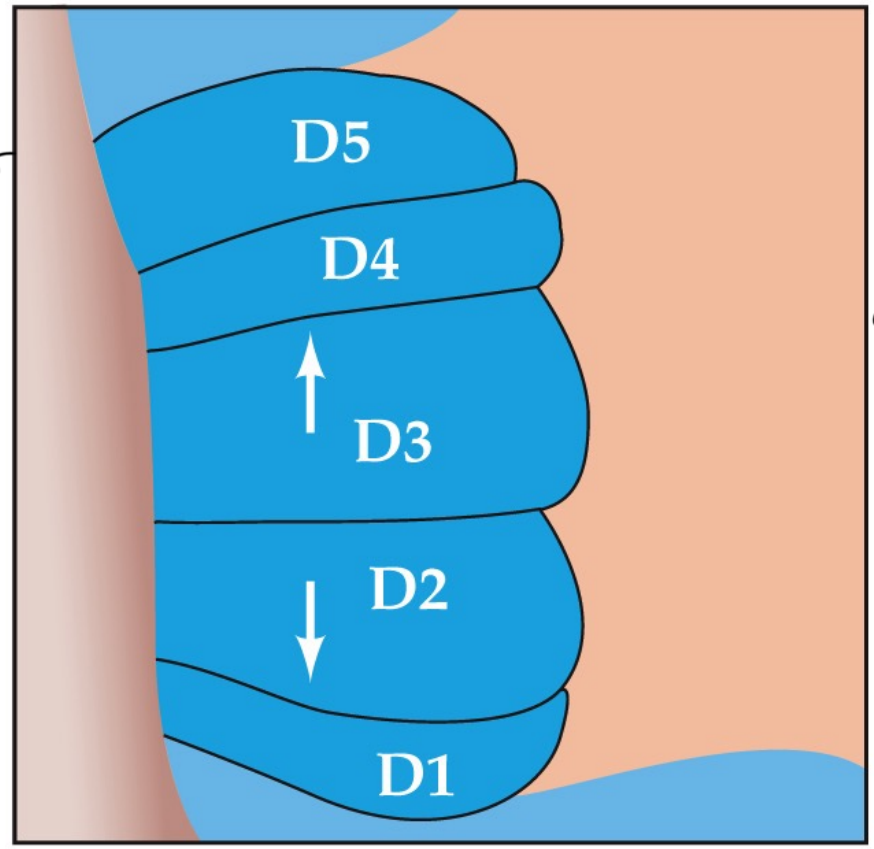
The more you use neurons, the more the region expands

Implications for your life?

closing kitten eye vs adult eye

less shifting



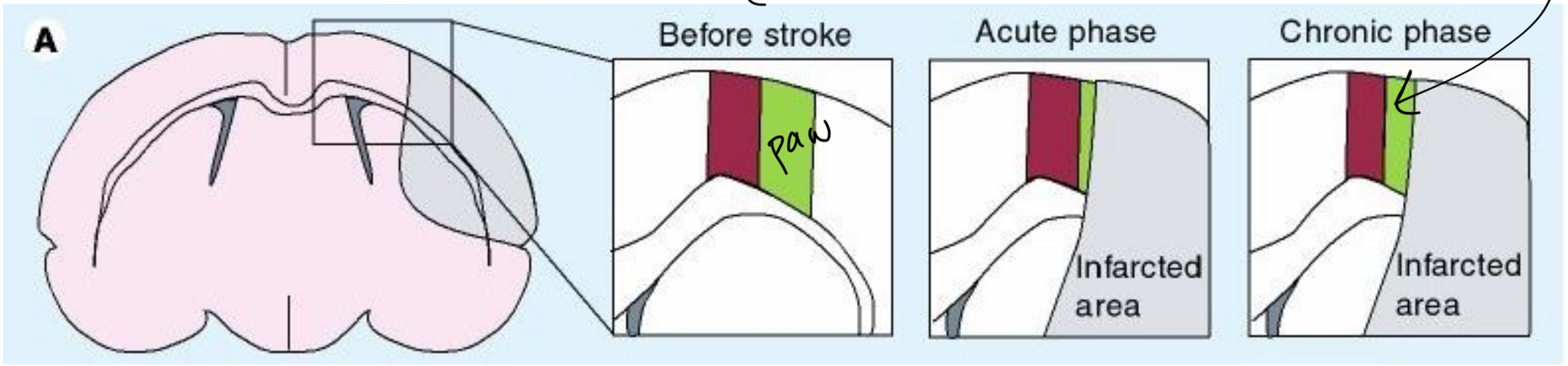


neurons shift roles

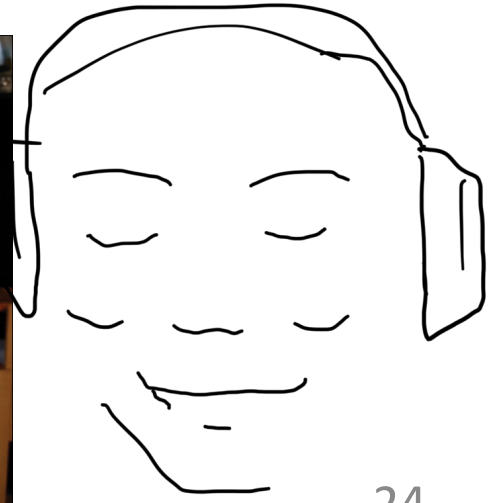
neurons that are poor are ones that change

BEHAVIORAL NEUROSCIENCE 8e, Figure 8.17 (Part 3)

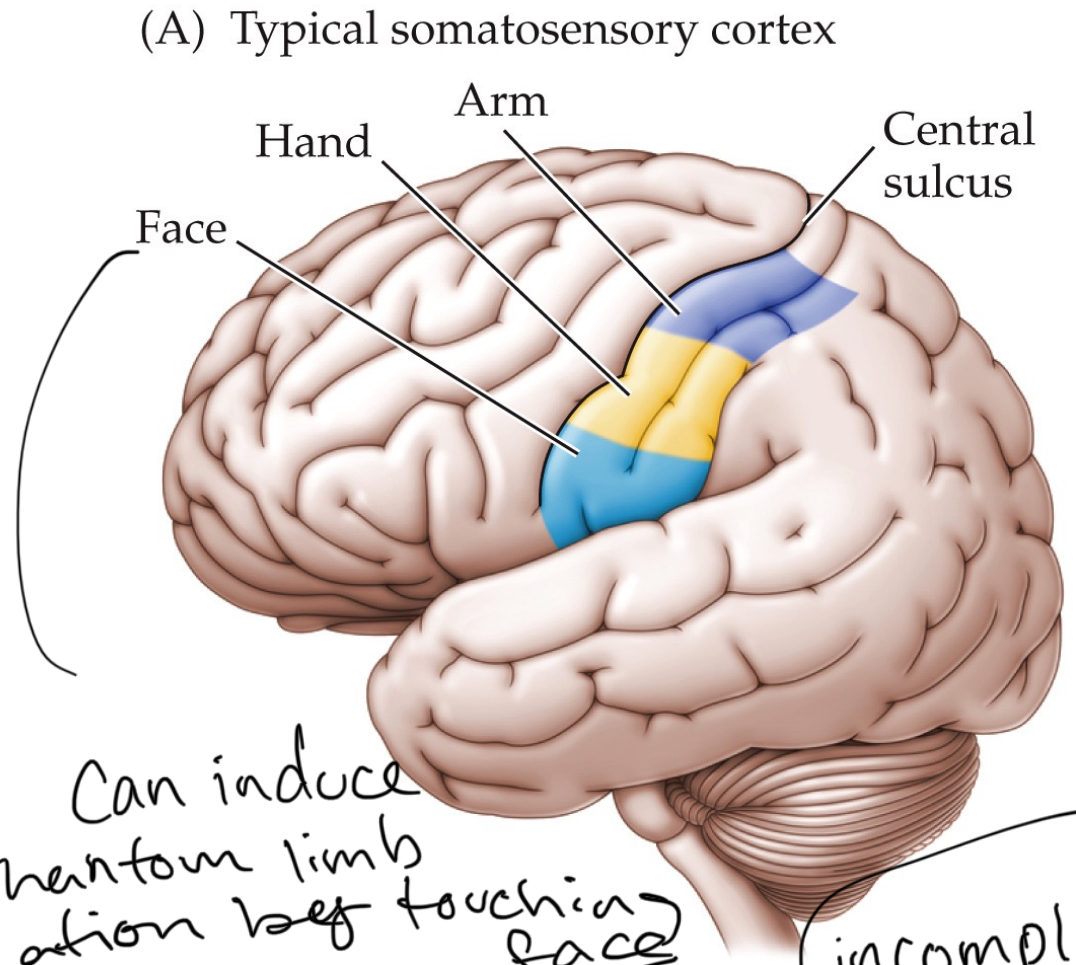
Neuroplasticity due to cortical damage



Constraint-induced therapy



Phantom limbs: a case of large-scale plasticity



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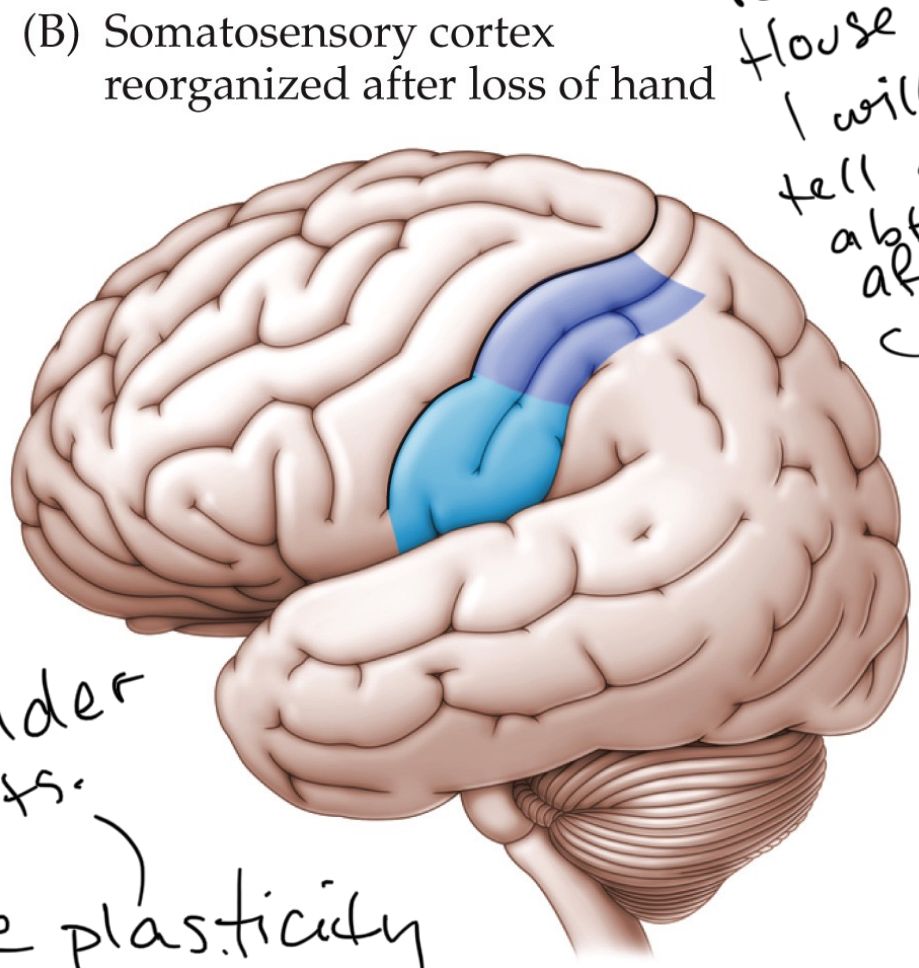

BEHAVIORAL NEUROSCIENCE 8e, Figure 8.18 (Part 2)
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relevant House ep I will tell u abt after class

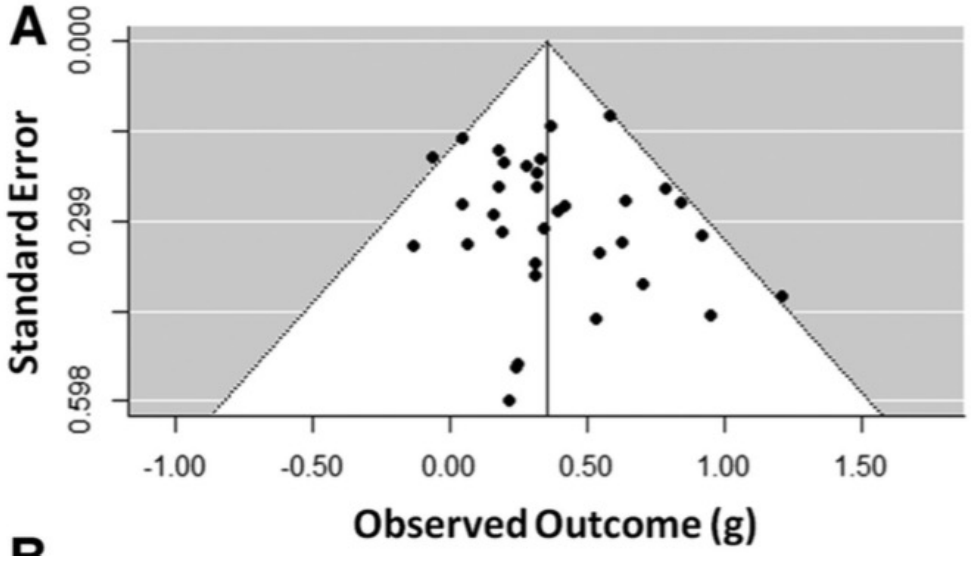
after I pee

Can induce phantom limb sensation by touching face

older pts.

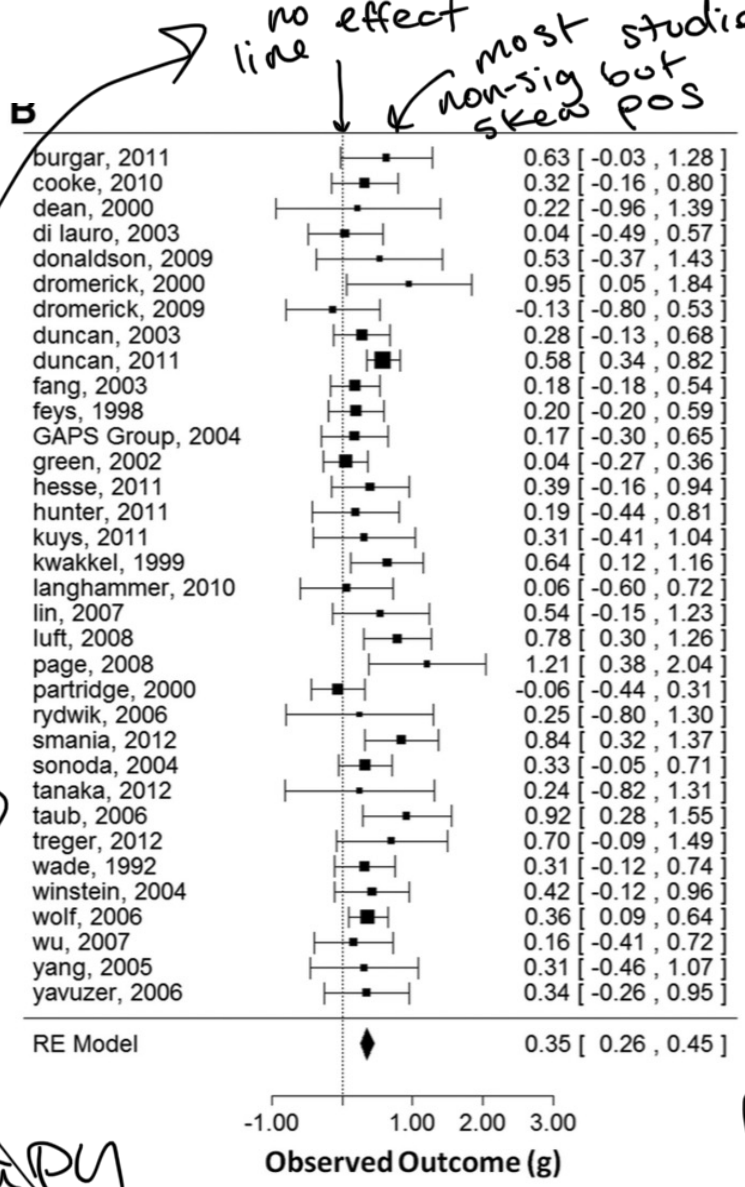
incomplete plasticity

mixed signal



Intro to meta-analysis methods

Lohse meta-analysis: to understand effect of therapy, while controlling for time



from Lohse et al. (2014)

no effect line

most studies non-sig but skew pos

How much therapy?

Recovery "plateau" after ~1 yr

What if you continue?

Hard to tell if results due to therapy or time

more therapy is actually better!

Therapy dose