Neuroplasticity

Cognitive Communication Disorders
Activity

Therapy
- Be creative
- Try new things
- Be prepared to fail
- Learn from past experiences
- Be flexible

Neuroplasticity
- Participants begin working/communicating → not good
- As they work together more → improvement
- Can change and adapt to the environment
Neural Plasticity

The brain’s ability to change (or adapt) as a result of experience

Plastic from the Greek “plastos” to be molded
  Both structure and function

Differs across the lifespan

Environment

In response to injury – RECOVERY – What happens in the brain?
  Brain injury
  injury to the body/sensory systems
Neural Plasticity

Not a single process

Rather a blanket term for the brain’s ability to change

Different behaviors have different “plastic” properties

Can be studied at different levels
  Molecular (synaptic changes, neurogenesis)
  Cognitive/Systems
Neural Plasticity

Structurally
- New Synapses
- Strengthening of synapses
- Neurogenesis
- Increase cortex size

Functionally
- Development of expertise
- Specialized areas of the brain
“When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth processes or metabolic change takes place in one or both cells such that A’s efficiency, as one of the cells firing B, is increased.” D.O. Hebb, 1949.
Age and Plasticity

“You can’t teach an old dog new tricks.”

The younger the brain, the greater its plasticity.

Kennard Principle
1936 – Young monkeys recover better than older monkeys after motor cortex lesions.

Not this simple, some functions, not others.
Age and Plasticity

Past
Thought the adult brain was “fixed”
Neurons cannot be replaced
Structure and function of the brain could not change (i.e. if damaged)

Why?
Patients with brain damage often made little or no recovery
The brain was viewed as a machine
Our “self” doesn’t change, so how can our brains constantly change
Age and Plasticity

Can be limited to early in life
  Greatest plasticity
  Critical Period – timeframe where stimulus or experience must be present in order for change to occur

Establishment of ocular dominance columns in cats can take place only during an early critical period of a few months.
Age and Plasticity

Can continue into adulthood
  Learning
  Environmental effects
  Usually not to the same extent as developmentally
  May slow with aging
Age and Plasticity

Can occur at the first opportunity
Cats, if raised in the dark, will show plasticity on their first exposure to light
Birdsong learning – typically male learns songs from father early in life. If that is prevented, can still acquire later when presented.
Plasticity and Recovery

Diaschisis
Greek for “shocked throughout”

Sudden loss of function in a portion of the brain connected to but at a distance of a damaged area.

Connected to the damaged areas by neuronal connections

Not damage to the tissue itself but is a dysfunction caused by interruptions in blood supply
Aphasia in Childhood

Recovery is faster and more complete than with adult onset lesions.

Reduced syntactically simplified output is the most common consequence.

Few paraphasias, usually just in acute epoch.

No simple relationship to age of onset within childhood.

Right hemisphere language capacity extends into adolescence.
Experience Expectant

The system requires the refining of the environment however, much of the structure and function is present
- Ocular Dominance columns

Experience Dependent
The system has a greater ability to be shaped by change, no existing structure or function is set
- Learning
- Ylvisaker real world routines
Forms of Plasticity

Lesion induced plasticity
  - Cortical reorganization after injury (central or peripheral)
  - Compensation and repair of functions
    - Homologous area adaptation; cross-modal reassignment

Training/Learning dependent – “use dependent plasticity”
  - changes that accompany the acquisition of perceptual and motor skills

However, lesions can change the pattern of use, so not two entirely separate categories
What happens when a part of the brain is injured?

Silver Spring Monkeys – deafferented
Do they abandon use of the deafferented limbs simply because the monkey is still able to use their good one?
→ Deafferent both arms and they are able to use both arms

Learned Non-use

- Impaired arm function with no hand function
- Repeated failed attempts to use arm
- Discouragement leads to avoidance

Cognitive Communication Disorders
Neuroplasticity

After the Injury

Use it or lose it

When an area of cortex loses input, other adjacent cortical regions will take over

Those processes that are most used will occupy the most cortical space
Constraint Induced Therapy

Constraint – avoid compensation, by constraining the good limb

Forced use – require use of the impaired limb by placing the animals in circumstances where they needed to use it to achieve a meaningful goal

Massed practice – require the constraint and forced use every day and all day long

Shaping – molds behavior in small steps
  Rewards for modest gestures towards target behavior
Constraint Induced Therapy

“The demonstration that motor behavior is modifiable in patients with chronic stroke opens the possibility that another consequence of stroke, language impairment, may be sufficiently plastic to be remedied by an appropriate modification of the CI therapy techniques…”

“Aphasic patients often use the communication channel that is accessible to them with the least amount of effort: they gesticulate or make drawings instead of using spoken language. Such strategies need to be suppressed in CI therapy in favor of verbal communication.”

http://vimeo.com/26164432
Constraint Induced Therapy

Constraint – avoiding the use of compensatory strategies such as gesturing, drawing, writing, etc.

Forced use – communication only by talking

Massed practice – therapy occurring 3-4 hours a day

Pulvermuller et al., 2001 – CI substantial improvement on language scores (token, comprehension, naming)

Meinzer et al., 2005 – CI tx and CI tx +, both groups show similar improvement

Maher et al., 2006 – CI (speech only), PACE (any modality) – Both improve, no difference
Lessons from CI

Rehab
  What’s the goal?

Broad contextualized activities

Functional systems

Dependent on use/time – 10,000, 3.425 years
Can plasticity ever be a bad thing?

- Focal dystonia
- PTSD
- Epilepsy
Neuroplasticity

Summary

The brain is able to adapt and change after damage, and based on experience and learning.

Plasticity is use-dependent
  Those processes that are most used will occupy the most cortical space.

Plasticity is competitive
  When an area of cortex loses input, other adjacent cortical regions will take over.

Neurons that fire together, wire together
  Cortical maps for fingers that move simultaneously become merged.

Plasticity is a normal process – especially for skill learning
  Repetition alone is not enough to cause cortical changes, acquisition of a skill does.