CLINICAL APPLICATIONS IN NEUROREHABILITATION WITH CHILDREN AND ADULTS:

BUILDING ON PRINCIPLES OF NEUROPLASTICITY

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NEUROREHABILITATION

Neurorehabilitation or ‘cognitive remediation’ typically includes strategies such as:

- Providing direct training to improve specific cognitive processes or skills/abilities,
- Working to maximize emotional and behavioural adjustment (e.g., metacognition, self-regulation),
- Providing compensatory mechanisms or teaching strategies to augment areas of weakness,
- Modifying the environment to eliminate or reduce the need for specific skills or abilities.
10 PRINCIPLES OF PLASTICITY
KLEIM & JONES, 2008

Table 1. Principles of experience-dependent plasticity.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
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<td>1. Use It or Lose It</td>
<td>Failure to drive specific brain functions can lead to functional degradation.</td>
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<td>2. Use It and Improve It</td>
<td>Training that drives a specific brain function can lead to an enhancement of that function.</td>
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<td>3. Specificity</td>
<td>The nature of the training experience dictates the nature of the plasticity.</td>
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<td>5. Intensity Matters</td>
<td>Induction of plasticity requires sufficient training intensity.</td>
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<td>6. Time Matters</td>
<td>Different forms of plasticity occur at different times during training.</td>
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<td>7. Salience Matters</td>
<td>The training experience must be sufficiently salient to induce plasticity.</td>
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<td>8. Age Matters</td>
<td>Training-induced plasticity occurs more readily in younger brains.</td>
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<td>9. Transference</td>
<td>Plasticity in response to one training experience can enhance the acquisition of similar behaviors.</td>
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<td>10. Interference</td>
<td>Plasticity in response to one experience can interfere with the acquisition of other behaviors.</td>
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INTERACTIONS ABOUND

- The principles of neuroplasticity work in concert, not isolation
- Coupling principles (e.g., repetition with saliency) may maximize effects
- Plasticity within one set of neural circuits promotes concurrent or subsequent plasticity (e.g., training fine digit movement increases corticospinal excitability)
- Coupling interventions with peripheral or central stimulation may be necessary to drive transference effects into a functionally beneficial direction (e.g., exercise, arousal)
Goals of
Behavioral & Emotional
Interventions

To develop self-regulatory capacities and increase
insight and awareness (metacognition)

- Metacognitive strategies involve executive regulation
  processes directed at organizing ones behavior to
  complete a task
  - to allocate resources to achieving a goal,
  - to determine the order of steps to be taken to complete the
    goal, and
  - To self-monitor, regulate the intensity or the speed at
    which one should work towards the goal.
- Cognitive self-efficacy, beliefs about ones cognitive
  abilities predicts cognitive engagement and success in
  interventions
INTERVENTIONS TO IMPROVE BEHAVIORAL & EMOTIONAL SELF-REGULATION

Executive control interventions
• Goal management training

Metacognitive interventions
• Cognitive self-efficacy training
• CBT approaches
• Self-Regulation scripts
• ALERT training

Mindfulness meditation approaches
EVIDENCE-BASED TREATMENTS: LINKS TO NEUROPLASTICITY?

Behavioral & Emotional interventions
   Metacognitive approaches
   Mindfulness
   Cognitive Behavioral approaches

Systems/Process oriented interventions
   Motor recovery
   Attention/Working Memory Training

Compensatory interventions
   Instructional strategies
   Technology based compensatory tools
Goals of
Process Specific Approaches

To directly impact specific processes

- Based on the notion that ‘capacity’ can be increased by exercising specific components of abilities

- Interventions are designed and believed to improve the underlying impaired process directly

- The change in underlying capacity is assumed to be secondary to neural plasticity and/or reorganization of neural systems as previously discussed – as such the principles of neural plasticity should guide the intervention
INTERVENTIONS TO INCREASE MOTOR FUNCTION

Constraint induced movement therapy (CIMT)

Background and theory
• Based on primate studies of hemiplegic limb

• Intensive shaping and repeated practice using the affected (hemiplegic) limb

• Incorporates constraining the use of the unaffected limb for most waking hours over the period of treatment

• Associated with improvement in function of affected limb & change in brain activation (e.g. Taub, 2004)
INTERVENTIONS TO INCREASE MOTOR FUNCTION

Constraint induced movement therapy (CIMT)

- Efficacy in adults
- Evidence for neuroplastic changes in adults

- Efficacy in children
- Evidence for neuroplastic changes in children
OTHER MOTOR FUNCTION INTERVENTIONS

Serial assessment of motor function after severe TBI using motor re-learning principles

Exercise approaches in FASD
INTERVENTIONS TO INCREASE ATTENTION & WORKING MEMORY

Background and Theory

- Adopt a treatment model grounded in attention theory
- Use therapy activities that are hierarchically organized
- Provide sufficient repetition to re-establish skills
- Base treatment decisions on performance – adapt the level of difficulty based on success
- Actively facilitate generalization to functional activities from the start
- Incorporate elements to increase cognitive self-efficacy (metacognition)
INTERVENTIONS TO INCREASE ATTENTION & WORKING MEMORY

Attention & working memory training

- Efficacy in adults
- Evidence for neuroplastic changes in adults

- Efficacy in children
- Evidence for neuroplastic changes in children
GOALS OF COMPENSATORY APPROACHES

To remove or reduce the need to rely on an impaired function or process

• Recognizes that some functions will not recover or will only recover partially

• Interventions are designed to increase function and relieve stress and anxiety associated with limitations

• Compensatory interventions may be integrated passively into the individual’s routine or may be used and managed in a very active and interactive way

• Technology advances have dramatically influenced a range of compensatory devices and approaches
COMPENSATORY & TECHNOLOGY APPROACHES

- Compensations for organizational/planning difficulties
- Compensations for memory impairment
- Applications for communication
- Virtual reality interventions for improved movement