Executive Functions in Traumatic Brain Injury

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Objectives

• Define and describe components of executive functions, how they relate to one another, and what their neural substrates are.

• Describe tests used to assess executive functions.

• Describe treatments for people with executive impairments.

Outline

• Overview and definition of executive functions
• A few words on assessment
• Treatment approaches
  – Awareness
  – Self-regulation
  – Multi-tasking

Functional Consequences of TBI

• TBI can cause a wide range of functional changes affecting:
  – Cognition: e.g., attention, memory, and reasoning
  – Sensation: e.g., touch, taste, and smell
  – Language: e.g., communication and understanding
  – Emotion: e.g., depression, anxiety, aggression, and social inappropriateness

Impairments of executive function are common in people with TBI

Executive Functions

• Mental processes needed to use capacities, knowledge, and skills to engage in purposeful, goal-directed, and future-oriented behavior

• Frees us from over practiced/formulaic responses
**Executive Functions**

- Involved in covert cognitive and overt social behaviors
  - Cognitive Behaviors
    - Rehearsing information
    - Paying attention to an inservice
    - Looking for something
  - Social Behaviors
    - Being “appropriate”
    - Considering other people’s perspectives before acting or making a decision
    - Delayed gratification

**Why the focus on executive functions?**

- Can affect cognition, language, and emotion
- Return to work (Shames 2007)
  - Reasons for termination (Wehman et al., 1989)
    - Insubordination
    - Poor judgment
    - Temper outbursts
- Return to driving (Ortoleva et al., 2012)

**Neural Substrates of Executive Functions**

- Prefrontal Lobes: Dorsolateral, Ventromedial, Orbitofrontal, Superomedial (Anterior Cingulate), Frontal poles

**Executive Function & Frontal Lobes**

- Contusions in the frontal lobes are common.
- Hypoxia leads to cell death in watershed region between ACA and MCA.

**Executive Function and Processing Speed**

- Processing speed affects aspects of EF.
- Diffuse axonal injury & hypoxia affect function of white matter, which leads to slowed speed of processing (e.g., Felmingham et al., 2004)

**What are executive functions?**
Unitary model of executive functions

• Supervisory Attentional System (Norman & Shallice 1986; Shallice 2002)
  • Automatic
    – Routines (driving, brushing your teeth, etc)
  • Controlled
    – Situations that involve planning & decision-making, error correction, novel sequencing of actions, or inhibiting strong habitual responses

Automatic vs. Controlled Behaviors

• Supervisory Attentional System
  – Schemas
  – Tasks & behaviors
  – Biasing mechanism that activates/suppresses schemas
  – Activation determined by:
    • Environmental cues, habits
    • Long term goals, societal norms, etc

Component Models
(Jurado & Rosselli 2007; Sohlberg & Mateer, 2001)

• Attentional Control:
  – Initiation and drive
  – Response Inhibition
• Planning:
  – Organization
• Set Shifting & Cognitive Flexibility:
  – Generative Thinking
• Awareness

Initiation and Drive

• Individuals may have:
  ➢ Adequate knowledge of social rules and expectations
  ➢ Adequate cognitive abilities to complete a task
  ➢ But not use these without prompting
• Laziness?

Inhibition

• Act independently of internal drives and external stimuli
• Impairments:
  – Perseveration
  – Difficulty inhibiting prepotent (habitual) responses
  – Environmental Dependency
    • Actions overly determined by & bound to environment

Planning & Organization

• Organization of Actions => Goal Achievement
  – Identification
  – Planning
  – Time sense
• Impairments in:
  – Identifying and Formulating Goals
  – Including sub-goals
  – Scheduling & Prioritising
  – Problems multi-tasking
  – Problems shifting sets
  – Problems using contingencies
Planning & Organization

- Organization of Thoughts => Covert & Overt Language Use
  - Word Finding
  - Discourse Structure
- Impairments:
  - Organization of Language
  - Word Finding

Generative Thinking

- Creativity, fluency, cognitive flexibility
- Generate novel ideas & perspectives
- Impairments
  - Rigid & concrete thinking
  - Difficulty readjusting plans

Awareness

- Monitoring & Modifying behavior
- Incorporate environmental feedback
- Provides motivation to adopt compensatory strategies

Assessment of Executive Functions

- Mueller & Dollaghan (JSLHR, 2013, p. 1051): “Strong evidence concerning diagnostic accuracy and concurrent validity of EF measures for adults with ABI is lacking. Better specification of the construct of EF as well as research aimed at improving the quality of evidence concerning EF tests are needed.”

Assessment

- Speed of processing
- Verbal fluency
- Functional Measures
**Speed of Processing**

- Speed of processing in the “Coding” Subtest of the RBANS
  - Rassovsky et al., 2006: Speed of processing significantly predicts outcomes (employability rating scale & FIM) 12 months post-injury

**Tests of Executive Functions**

- Verbal Fluency
  - Convergent: Given 3 items, name the category
    - What are birds, cats, and camels?
    - What are coffee, the sun, and flame?
  - Divergent
    - Semantic: Naming animals, fruits & vegetables, etc
    - Phonemic: Words that start with F, A, S

**Interpreting Verbal Fluency Scores**

- Component scores (Troyer, Moscovitch, Winocur, 1997; Troyer et al., 1998; Zakzanis, McDonald, & Troyer, 2013)
  - Clusters
    - Phonological or semantic subcategories
    - Mediated by temporal lobe
  - Switches
    - Transitions between clusters
    - Frontal lobe

**Interpreting Verbal Fluency Scores**

- People with severe TBI produce fewer words than controls on both tasks
- Semantic fluency differentiates groups better than phonemic fluency in component scores.

**Functional Measures**

- Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES)
  - Four Tasks
    - Planning an event
    - Scheduling
    - Making a decision
    - Building a case
  - Four scores
    - Accuracy, Rationale, Time, Reasoning

**FAVRES**

- Acceptable validity, reliability, sensitivity
- Total accuracy and total rationale correlated with employment outcome (Rietdijk, Simpson, Togher, Power, & Gillett, 2013)
Voicemail Elicitation Task

• Example: William reports to you for a project at work you are in charge of. You notice that he has not been following the dress code recently. The weather outside has warmed up and he started wearing shorts every other day.
• Call your assistant William on his office phone. Remind him of the rule that shorts are not allowed in the workplace and ask him to follow the dress code rules.

Example response (SE Group)
- Hi William. This is (First Name).
- Um, it’s — we need to talk about the dress code here and what’s allowed and what’s not allowed.
- Um, I’m sure you know already that you can’t wear, uh, shorts into work even if it’s warm outside.
- So if you could, uh, just remember to dress in the, uh, dress code.
- If you have any questions feel free to stop by and to see me or give me a call.
- Thank you.

Voicemail Elicitation Task

• Stably employed vs. unemployed groups
  • Differed in:
    Information giving & politeness markers
  • Did not differ in:
    Action requests & content mazes

Data adapted from Meulenbroek et al., 2013

Functional Measures

• Voicemail Elicitation Task (Meulenbroek, Togher, Turkstra, 2013)
  • 4 elicitation scenarios
    • Convey new information
    • Request some form of action
    • Superior, subordinate, friend, colleague
  • Stably employed and unemployed groups of people with TBI

Treating Executive Functions

• Problem solving
• Self-regulation scripts
• Awareness
Goal-Plan-Do-Review

- Can be used with any age group
- Can apply to small-scale or large-scale tasks
- Targets problem solving & awareness

A Guide For Explicitly Teaching Executive Components of Tasks (Ylvisaker, 2001)

**GOAL**
What do I want to accomplish?

**PLAN**
How am I going to accomplish my goal?

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**PREDICT**
How well will I do? How much will I get done?

Another approach to problem solving

- Goal Management Training
  - What it is
    - Develop a mental checking routine
    - Clearly define goals
    - Learn the steps to accomplish the goal
    - Check progress

Programs that incorporate GMT

- Attention and Problem Solving Training (Miotto, Evans, Souza de Lucia, & Scaff, 2009)
  - Adopt a systematic approach to identifying ways to solve a problem
  - Self-monitor progress

Goal Management Training

- Levine et al. (2000)
  - GMT group made fewer errors and responded more slowly on outcome measures
  - Case study found improvements when a “real-life” task was used
Attention and Problem Solving Training (Miotto et al. 2009)

- Goal #1: Increase insight
  - Problem awareness, monitoring, and evaluation:
    - Self-monitoring sheets
    - Education about brain injury
    - Drills to target attention (sustained, selective, etc)

- Goal #2: Learn to develop a plan
  - STOP: THINK!
  - Hypothetical and real-life situations

- Goal #3: Initiate & implement plan
  - Electronic reminders (pagers, watch alarms, etc)
  - External memory aids

Format of Group Training: 10 weeks
- Weeks 1-4: Focus on Attention
  - Education
  - Tasks used to demonstrate various types of attention
  - Discuss internal and external strategies
- Week 5-10: Focus on problem solving.
  - Given problem solving framework
**Attention and Problem Solving Training (Miotto et al. 2009)**

- Improvement in some measures of executive function immediately after treatment and 6 months later.

**Problem solving & Self-regulation Scripts**

- In general, scripts should involve (e.g., Feeney, 2010)
  - Discrimination
  - Explanation
  - Strategy

**Self-regulation and Scripts**

- Example: Script for staying on task (Sohlberg & Turkstra, 2011)
  - Set cell phone alarm for 15 minutes
  - When hear alarm, “Am I doing what I am supposed to be doing?”
  - Reset alarm, and keep going.

**Use of Scripts**

- Example: Ready/ Not ready script for impulsivity (Feeney, 2010)
  - Do you have what you need to do your homework?
    - Hierarchy of cues
      - I am not sure you are ready because you don’t have your books. Maybe get them and then will be ready.
      - Are you ready for X?
      - Is it time for X now?

**Use of Scripts**

- Other Scripts
  - Flexibility/Changing your play
  - Hard/Easy (Awareness)
  - Choice/No choice

**Awareness**

- In general, studies report an immediate increase in awareness for similar tasks (e.g., Cheng & Man 2006; Goverover et al. 2007; Toglia et al. 2010)

- Typically, studies use some form of problem solving treatment, sometimes with an education component
Awareness Treatment: An Example
(Goverover et al., 2007, also cf. Toglia et al., 2010)

• Participants performed tasks in treatment sessions (e.g., prepare a lunch box)
• Before the task, the experimental group:
  (1) Defined goals
  (2) Predicted how hard the task would be
  (3) Anticipated and planned for errors/obstacles
  (4) Choose a strategy to circumvent such difficulties
  (5) How much assistance will be needed?

Awareness Treatment: An Example
(Goverover et al., 2007)

• After the task, the experimental group:
  (1) Self-assessed their performance
  (2) Complete a structured self-evaluation of the task
  (3) Discuss participants’ responses and the researcher described observations and answers to the same questions.
  (4) Participants wrote in a journal about their experiences in performing the task

Awareness Treatment: An Example
(Goverover et al., 2007)

• Results
  – Experimental group improved in measures of self-regulation and organization for ADLS and IADLS
  – Little evidence of improvement on ecological measures (measures of general awareness and community integration)

Awareness Treatment: Example 2
(Cheng & Man, 2006)

• Experimental group
  – Concrete feedback
  – Education about TBI and resultant deficits
  – Goal-plan-do-review
• Control group received “conventional treatment”
• Both groups showed improvements on standardized measures (FIM, IADLS) but experimental group showed greater improvements in self-awareness scores.

Extras (Depending on time)

• Teaching problem solving strategies
• Computerized training programs
• Multi-tasking

EF Training: Some generalities

• Strategies for compensation
• Slower might be better
• Treating Awareness: Two Take Homes
  – Education
  – Some version of problem solving treatment
References


