Working with attention, memory and executive functions in children

Effective Strategies

Presented by
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Why attention, memory and executive functions?

- Commonly disrupted following TBI due to dependence on frontal and temporal systems
- Each can have a major impact on learning and school performance
- Attention and executive functions are also frequently disrupted in developmental disorders
Basic approaches to intervention

- Environmental modifications
- Use of and training in compensatory skills and special teaching techniques
- Direct training of impaired processes
Factors to consider in selecting interventions

- The specific cognitive ability impaired
- Time post injury in acquired disabilities
- Overall pattern of abilities in the child
- Level of support available to the child
- Level of insight and awareness that the child has
Conditions impacting attention and concentration

- Acquired disorders
  - Traumatic brain injury, brain tumors, anoxia, treatment for medical conditions (radiation, chemotherapy, etc...), use of anticonvulsants, toxic exposures

- Developmental disorders
  - ADHD, learning disabilities, depression, anxious disorders, Autism, prenatal alcohol exposure (FAS, FAE), prenatal drug exposure (cocaine, crack), intellectual handicaps
What do we know about the development of attention?

- Capacity or information processing perspective
  - *Suggest that younger children have a more limited attention capacity and as they develop there are changes in internal processing mechanisms which increase this capacity*

- Perceptual learning perspective
  - Attention is defined as perceiving in relation to a goal: from infancy to childhood the exploration and perception become more specific, systematic, economical and task directed. Good attention is defined as efficient perception of information that has utility for a task
How does attention change with development?

- Capacity increases as a function of development
- Capacity increases as a function of changes in speed of processing
- Capacity increases as a function of improvement in other cognitive abilities
  - Language, sub-vocal rehearsal, chunking
- Capacity increases as function of increases in inhibitory control
  - Not processing irrelevant information or improving selection
How do we define ‘attention’

- The amount of information that can be attended and responded to in some finite amount of time

- Concepts include
  - Working memory
  - Vigilance
  - Selectivity
  - Effortful vs. automatic processing
Theories or ‘models’ of attention

Mirsky et al (1991)
- Focus-Execute: ability to select target information from an array - to selectively attend
- Sustain: capacity to maintain and focus alertness over time and demonstrate vigilance
- Shift: ability to change attentive focus in a flexible and adaptive manner
- Encode: ability to maintain information in memory and actively manipulate this information
Theories or ‘models’ of attention

  - Focused attention: ability to respond to a specific stimulus
  - Sustained attention: ability to continuously respond to a specific stimulus
  - Selective attention: ability to respond to a specific stimulus in the presence of distracting stimuli
  - Alternating attention: ability to efficiently shift attention from one stimulus to another
  - Divided attention: ability to attend to more than one simultaneously occurring stimuli
How do we assess attention?

- Direct observation
  - During testing session
  - Classroom observation
  - Tallying ‘on-task’ behavior in a constrained situation

- Parent/Teacher Report
  - Connor’s, ADDES, CBCL

- Psychometric Assessment
  - Hierarchical model of attention
    - Sustained, selective, alternating, and divided attention
Assessment of Sustained Attention

- Can the child maintain attention long enough to accomplish age appropriate tasks
- Psychometric Assessment procedures
  - CPT tasks (Connors, Gordon, TOVA, etc…)
  - Digit span, number letter, finger windows
  - Children’s PASAT
  - Scanning and underlying tasks (D2, Talland, NEPSY Visual Attention, etc…)
  - Auditory Attention measure (NEPSY)
Assessment of Selective Attention

- Can the child attend to selected stimuli and disregard stimuli not relevant to the task?

- Psychometric Assessment procedures
  - GFW Selective Attention task
  - Gordon Diagnostic – Selective attention
  - Stroop tasks
  - Attentional Capacity Test
Assessment of Divided and Alternating Attention

- Can the child divide and shift attention adequately for effective classroom or social functioning?

Psychometric Assessment procedures

- Coding subtest of the WISC-III
- Consonant Trigrams
- Selective Response – NEPSY
- Trailmaking Test – B, Color Trails
- 6-Element type tasks (Shallice)
- Development of a ‘multi-tasking’ measure
Remediation of Attention Difficulties

- **Direct interventions**
  - Medications
  - Behavior modification programs
  - Cognitive behavioral approaches
  - Attention Process Training – Pay Attention

- **Compensation**
  - Cueing devices – mechanical
  - Breaking tasks down (teachers, parents)
  - Cueing by peer, teacher, parent

- **Restructuring environment**
  - Limiting environmental disruptions
  - Providing simplified tasks
Example of a ‘Pay Attention’ Family
Example of a ‘Pay Attention’ House
Examples of components altered in ‘Pay Attention’ tapes

- Difficulty of target selection
  - Hit the buzzer for things that are round, things you see in the sky, words that begin with the letter ‘B’, numbers ascending, days of the week ascending, numbers descending

- Speed Component
  - Slow/fast

- Distraction level
  - None/heartbeat/story/children playing
Sustained Attention Tasks

- **Visual Tasks - I**
  - Card Sorts into Stacks
    - by single feature (such as card color, hair color, hat/no hat, sex, age group, etc...) or by multiple features
  - House search
    - find single items (such as red things, flowers, things on wall, things on floor, etc...) or find 2 items

- **Visual Tasks - II** (Examiner Paced Tasks)
  - Card Sorts
    - participant has a response button and identifies when the target conditions. Example target conditions:
      - people with brown hair & glasses, blonde followed by a brunette, etc...
Sustained Attention Tasks

- **Auditory Sustained Attention - Tape Set I**
  - Subjects listen for targets and push a response button when they hear them
  - 8 tapes, presented at both a slow and fast pace, tasks start simple and get more difficult
    - Listen for the word red, dog, red or yellow, “B” words, things found in the sky, letters ascending, numbers descending, etc...
Selective Attention Tasks

- **Visual Distractors**
  - Distracting visual overlays are placed over the house stimuli - searches are conducted as in the visual sustained attention tasks.
  - Visual tasks are completed as before, but now distracting noises (such as children playing on a playground are played on tape while participants complete tasks).

- **Auditory Selective Attention**
  - Tapes are played as for auditory sustained attention, but there are distracting auditory stimuli in the background.
  - Tapes increase in complexity as before, distracting auditory stimuli include the sound of a heartbeat, baby crying, someone telling a story, and children playing.
Alternating Attention Tasks

- **Visual Alternating Attention - House Search**
  - The participant has 2 objects which they are searching
  - using one pen color to mark targets, when the examiner
    says switch, change pens and looking for 2nd object

- **Visual Alternating Attention - Cards**
  - Sorting into 2 stacks by identifying features which
    examiner switches; glasses to hats

- **Auditory Alternating Attention**
  - Listening for 2 target words,
  - first word first, then examiner says switch and
    participant listens for the new word, examiner may
    “switch” several times
Divided Attention Tasks

- **Visual Divided Attention - Card Sort**
  - Sorts cards into stacks by some target criteria.
  - An additional rule is used, cards that meet an additional criteria are not only sorted into the correct pile, but placed face down for example.

- **Auditory/Visual Divided Attention - Card Sort or House and Tapes**
  - Participants have two tasks which they do simultaneously.
  - Might sort cards by some criteria while also listening to a tape for a target word. For example, cross out red things in the houses while listening for words that begin with “B”
Improvements following ‘Pay Attention’ in ADHD

<table>
<thead>
<tr>
<th>Treatment Condition</th>
<th>Treatment</th>
<th>Control</th>
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</thead>
<tbody>
<tr>
<td>Mean % Improvement</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td></td>
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</table>

- Day-Night Stroop
- WISC-III Mazes
- Matching Fam. Figs.
- Underline Sustained
- Underline Selective
- Attentional Capacity
- Math Efficiency
Changes on Sustained Attention Task by Subject
Examples of Stimulus Sheets You Could Create
### Examples of ‘Order by Size’ Working Memory Tasks

Order from Smallest size to Largest size

<table>
<thead>
<tr>
<th>Order</th>
<th>Smallest</th>
<th>Largest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant</td>
<td>Mouse</td>
<td>Football</td>
</tr>
<tr>
<td>Desk</td>
<td>Bus</td>
<td>Peanut</td>
</tr>
<tr>
<td>Moose</td>
<td>Pencil</td>
<td>Shirt</td>
</tr>
<tr>
<td>Paperclip</td>
<td>Car</td>
<td>Lunchbox</td>
</tr>
<tr>
<td>Book</td>
<td>Mountain</td>
<td>Tooth</td>
</tr>
<tr>
<td>Nail</td>
<td>Picture</td>
<td>Airplane</td>
</tr>
<tr>
<td>Building</td>
<td>Ring</td>
<td>Shirt</td>
</tr>
<tr>
<td>Wristwatch</td>
<td>Matchbook</td>
<td>Computer</td>
</tr>
<tr>
<td>Magazine</td>
<td>Key</td>
<td>Boat</td>
</tr>
<tr>
<td>Car</td>
<td>Suitcase</td>
<td>Stapler</td>
</tr>
<tr>
<td>Car</td>
<td>Suitcase</td>
<td>Stapler</td>
</tr>
</tbody>
</table>
Temporal Distinctions in Memory

- Duration based distinctions
  - Immediate memory/rote recall/span
  - Working memory
  - Short term memory (up to 30 minutes)
  - Long term memory

- Injury related distinctions
  - Retrograde – loss of memories before the injury
  - Anterograde – loss of ability to store new memories
Other Major Distinctions in Memory

- Semantic versus episodic
  - Semantic – knowledge of facts, meanings
  - Episodic – knowledge of episodes
  - Material specific effects (verbal/nonverbal)

- Procedural versus declarative
  - Procedural – perceptual motor skills, routines (unconscious level)
  - Declarative – episodic and semantic (conscious level)
How do we assess memory in children?

- **Tasks**
  - Immediate recall
  - Delayed recall (e.g. 30 minutes)
  - Recognition (usually easier than recall)
  - Learning with opportunity for repetition

- **Types of materials to be learned**
  - Verbal (word lists, stories, sentences)
  - Nonverbal (designs, faces, locations)

- **Published Tests**
  - WRAML, CMS, TOMAL, C-CVLT, NEPSY subtests
How can acquired brain injury affect memory?

- Impaired concentration can lead to poor input into memory systems
- Impaired processing can lead to poor encoding of information in memory
- Learning can be slow and inefficient
- Difficulty with long term storage and retrieval of information
- Old knowledge often remains intact
Remediation of Memory Difficulties

- Restructuring environment
  - Use of cues, lists, reminders, alarms
  - Modified tests (e.g. recognition format)

- Direct interventions
  - Improving attention
  - Repetition, elaboration
  - Verbal organization (paired-word associations, pegwords, etc)
  - Visualization strategies

- Compensation
  - Modified instruction via error-free learning or direct instruction
  - Memory books, organizers, etc...
  - Cueing by peer, teacher, parent
How might children with memory difficulties learn best?

- Clinical studies have shown that procedural memories are often less impaired
  - Lots of repetition
  - ‘Do’ as opposed to just ‘say’
  - Focus on skills
- Clinical studies have shown implicit memory is often better than explicit
  - Use priming techniques
  - Use of errorless learning
Error-free or errorless learning

- Children with explicit memory impairments may have a difficult time separating correct and incorrect responses.
- Incorrect responses often become ‘primed’ and they are what is remembered next time.
Error-free learning strategies

- Decrease the likelihood of errors through cues, prompts and even providing the correct answer until the knowledge or skill is stabilized.

- Provide many correct repetitions to enhance procedural learning and implicit memory for the skill or information to be learned.
Examples of error-free learning

- Use in new skill learning
  - Teaching steps to use a memory compensation system (memory organizer)
- Use in acquisition of new knowledge
  - Names of teachers or fellow students
Comparison Error-free vs Errorful Training Effects

% Correct Responses

9 Learning Trials

Step in Process

2 6-step processes for using an electronic organizer
Similarities between errorfree learning and ‘Direct Instruction’

- Both you work with the child at a level that ensures a high rate of success and minimizes errors
- Both provide sufficient repetition
- Both maintain his levels of motivation and feeling of success
- Both emphasize not be afraid to provide a correct answer
- Both use ‘discovery’ techniques very selectively or on a limited basis
External Memory Compensation Systems

- Should be theoretically based
  - Utilize intact procedural memory
  - Training based in learning theory

- Individuals must be properly trained to utilize a system
  - Taught to apply skills in natural environment
  - Need lots of opportunity to practice
  - Don’t expect generalization, plan and effect it
  - Intensive training may be necessary to establish procedural memory routines for system use
External Memory Compensation Systems

- Family members and critical individuals should support and assist in use of system
- Clinician must ensure the system is functional and make necessary modifications
  - Match the system to the individual
  - Assess reasons for failures with system
  - Match memory system to related types of impairment
Memory system functions related to impairment

- Semantic memory difficulties
  - Autobiographical memory, addresses, phonebook, names and faces list, personal goals

- Episodic memory difficulties
  - Diary, journal/logs

- Retrograde memory difficulties
  - Autobiographical information, maps, locker info

- Procedural memory
  - Written routines for school, home, etc…
Three-Phase Training Model

- Knowledge and awareness
  - Child learns names, location and use of memory system sections

- Practice training phase
  - Learn and practice use of memory book
  - Develop procedural learning

- Generalization
  - Learn to use the system in naturalistic and novel contexts
  - Learn to use system spontaneously
Conditions impacting executive function

- **Acquired disorders**
  - Traumatic brain injury, brain tumors, anoxia, treatment for medical conditions (radiation, chemotherapy, etc…), toxic exposures

- **Developmental disorders**
  - ADHD, learning disabilities, Autism, prenatal alcohol exposure (FAS, FAE), prenatal drug exposure (cocaine, crack), intellectual handicaps, OCD/Tourette’s
What are Executive Functions?

- Multidimensional concept
  - Any task requiring both working memory and inhibition (Pennington & Roberts)
  - Barkley’s Model

- Involves integration of information across modalities and is thought to be dependent on higher-order cognitive capacities
Complex behaviors called executive functioning

- Problem Solving
- Planning/Organization
- Prospective memory
- Decision Making/Judgement
- Self-monitoring, correction and evaluating one’s behaviour (awareness)
Executive functions are dependent on frontal lobes

- Regulation of behaviour, abilities, attitudes
- Coordinate input from other parts of brain
- Highly susceptible to damage from trauma
- Mixture of motor, behavioural, emotional and cognitive problems
Development of executive functions

- Studies suggest that executive function develops throughout childhood with some aspects developing as late as adolescence.

- We know relatively little about the development of awareness.
  - Older preschoolers can identify which of 2 students can pay better attention.
  - By 8 children recognize when it is harder to pay, recognize lack of interest decreases attention, think that the mind controls paying attention.
Developmental Study of Executive Function

- 84 children recruited from Greater Victoria School Districts
- Ages 7 - 12 (M=10.08, SD=1.72)
- 34 Males & 50 Females
- Average IQ (KBIT FSIQ M=109.7, SD=10.76)
  - excluded for neurological, psychiatric, developmental or learning difficulties
FOLLOWING DATA FROM:

Measures of Inhibition

![Graph showing measures of inhibition across different ages with Z scores and performance metrics such as Go No Go Commission, Sun-Moon Stroop, Fruit Stroop, and Golden Stroop Performance.]
Measures of Working Memory

Note: Higher scores mean superior performance
Inhibition & Working Memory

Factor 1: Inhibition
Factor 2: Working Memory

Note: Higher scores mean better performance
Executive Functions

- Perplexing paradox
  - Often see intact IQ, language skills

- Disrupt ability to function in daily activities

- Determine extent of social and vocational recovery
3 Steps to Assessment of Executive Functions

- **Standardized tests**
  - Tower tasks, Self-ordered pointing, Wisconsin, Go-No-Go, 6-Element like tasks, Delayed Alteration/Non-alternation, Cybercruiser

- **Functional assessment**
  - Parent reports, observations

- **Determine current age appropriate behaviors and pre-morbid functioning difficulties**
Measuring Prospective Memory in Children

- No standardized measures/tasks
- Most tasks or time-based PM involve the use of a clock and ability to “read time”
- Restricted range of outcome - low variability
- Difficult to assess in laboratory settings
Development of “CyberCruiser”

- Engaging to children
- Minimal age-related motor and cognitive demands
- Multiple trials of prospective task
- Enhanced timing capacity
FOLLOWING DATA FROM:

## Correlation Coefficients in Normative Study Sample

<table>
<thead>
<tr>
<th>Test</th>
<th>STROOP</th>
<th>DANA</th>
<th>SOP</th>
<th>PIQ</th>
<th>VIQ</th>
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</thead>
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<tr>
<td>Out of</td>
<td>-.4315</td>
<td>.3238</td>
<td>.3722</td>
<td>-.1111</td>
<td>-.1637</td>
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<tr>
<td>Gas</td>
<td>P= .000**</td>
<td>P= .004**</td>
<td>P= .001**</td>
<td>P= .326</td>
<td>P= .147</td>
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<tr>
<td>Checks</td>
<td>.0823</td>
<td>.1402</td>
<td>.1208</td>
<td>-.0049</td>
<td>-.0331</td>
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<tr>
<td></td>
<td>P= .465</td>
<td>P= .227</td>
<td>P= .283</td>
<td>P= .966</td>
<td>P= .771</td>
</tr>
</tbody>
</table>
Results of Prospective Memory Times “Out of Gas”

- Study 1:
  - ADHD: 3
  - Controls: 1

- Study 2:
  - ADHD: 3
  - Controls: 1
Prospective Memory Task
Number of Checks

<table>
<thead>
<tr>
<th>Study</th>
<th>ADHD</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study 1</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Study 2</td>
<td>35</td>
<td>30</td>
</tr>
</tbody>
</table>

Legend:
- Red: ADHD
- Blue: Controls
Difficulties with Current Interventions

- No available overall approaches agreed upon
- Lack of empirical support for most interventions
- Differences in efficacy depending on disorder and individual characteristics
Remediation of Executive Function Difficulties

- Restructuring environment
  - Task modification
  - External supports (e.g., prompts, written instructions, signs)

- Direct interventions
  - Problem solving strategies
  - Education/awareness training
  - Metacognitive skills (study skills, self-regulation training)

- Compensation
  - Task specific routines
  - External devices
    - Written/Electronic Memory or Organizational System/Tape recorder/watch
  - Providing external structure and support
Basic Decisions for Intervention

- Identify which functions are deficient
- Younger children and early stage TBI
  - Environmental modifications
  - Cues, prompts, checklists
  - Teach task specific routines
- Older children/adolescent
  - Train active versus passive interventions
  - Train self-monitoring and self-regulatory techniques
  - Increase awareness regarding nature of difficulty
  - Provide emotional support as awareness increases
Environmental Supports

- Establish routine and consistency
- Advance planners – assist with prospective memory
- Photo assists
- Written/visual cues
- Provide choices when possible
Compensatory Systems

- Task specific instructions
- External devices
  - Memory system
Direct Interventions

- Training in awareness
- Prospective memory training
- Metacognitive strategies
That’s all –
Thanks for your time!