Pay Attention to Inattention: Implications for Education

Part 1: Inattentive Behavior
Part 2: Underlying cognitive problems
Part 3: Implications for Education

Wednesday, September 25th 2007:
CHERI: Hippocrates Socrates XI I
Prof Rosemary Tannock
Learning Objectives: Part 1

• To be aware of the range of behaviors classified as “Inattention”

• To recognize observable signs of inattention in the classroom

• To understand that inattentive behavior, but not hyperactivity/impulsivity, in the classroom has a negative impact on academic outcomes
Let’s start with ADHD

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurobiological problem that is generally first noticed in the preschool and early school years.

**Neurobiological disorder:**
An illness of the central nervous system caused by genetic, metabolic, or other biological factors. Many mental health disorders are neurobiological (schizophrenia, depression, Tourette’s, ADHD etc).

**Main Characteristics:**
- Inattention
- Hyperactivity
- Impulsivity
Current medical conceptualization of ADHD (DSM-IV 1994)

Diagnosis based on 6/9 observable behavioral features of Inattention &/or Hyperactivity/Impulsivity

Symptoms are developmentally inappropriate, impairing, onset before age 7, persistent, cross-situational
Attention Problems: at least 6 of 9 symptoms

- Poor attention to details, makes careless mistakes
- Difficulty concentrating
- Doesn’t seem to listen
- Fails to follow through on instructions & finish work
- Difficulty organizing work and self
- Avoids, dislikes lengthy, effortful tasks
- Loses things
- Easily distracted
- Forgetful

Persistent (> 6 months)
Pervasive (> one setting)
Impairing
Behavior problems: at least 6 of 9 symptoms

Hyperactivity

- Fidgets, squirmy
- Leaves seat inappropriately
- Excessive running, climbing
- Difficulty playing quietly
- On the go, driven
- Talks excessively

Impulsiveness

- Blurts out
- Can’t wait turn
- Interrupts, intrudes

Persistent (> 6 months)
Pervasive (> one setting)
Impairing
ADHD consists of two dimensions & three major subtypes

**INATTENTIVE SUBTYPE**
“ADD”

**HYPERACTIVE-IMPULSIVE SUBTYPE**

**COMBINED TYPE**
“Classic ADHD”
Behavior symptoms of ADHD are just the tip of the iceberg!

- Hyperactivity
- Impulsivity
- Observable symptoms of Inattention
- Cognitive aspects of inattention
- Annual Neonatal Health Care Costs Attributable to Maternal Smoking in the U.S. $366,000,000
What is attention?

“Everyone knows what attention is. It is the taking possession of the mind, in clear and vivid form, of one out what several simultaneous objects or trains of thought”.

– William James, 1890

“On attention itself, it is needless to discourse at length; its nature and conditions are familiar to every thoughtful student”.

– Munsell, 1873
Paying attention versus being inattentive: at the surface level

• How do we know that a child is “paying attention?”
  ➢ *What is it that we look for at home or in the classroom?*

• What is it children do or don’t do that lead us to conclude that they are being inattentive?
What do inattention symptoms look like at school?

DVD Program 2: Video Clip

A multi-media Professional Development Program for Teachers, developed by researchers at the Hospital for Sick Children in collaboration with TV-Ontario & University of Saskatchewan (video footage)

with funds from NIMH, CIHR, TV-Ontario, Hospital for Sick Children & an unrestricted educational grant from Shire Biochem Inc.

1 R. Tannock, B. Ferguson, P. Chaban, R. Martinussen, A. McInnes
What the videoclips show...

- A special class for children with "behavior problems"
  - class designed for research
- 9 children with ADHD: seated at 2 tables
  - None are receiving medication
- 1 special education teacher & 1 educational assistant
  - Both trained in behavior management
Video-clip #1

- Teacher-directed activity: Card matching game
  - Teacher selects which student is to answer
  - Student’s job is to decide which card on the wall chart matches the card in teacher’s hand and then to give the coordinates on the wall chart (e.g., B3)
- Video shows 4 boys seated at a table taking part in the activity
Viewing Videoclips: TeachADHD
Clip # 1 (3:58)

- Write down what you see or hear one of the following students doing (or not doing), which suggests to you that he isn’t paying attention

  ➢ Boy 1
  ➢ Boy 2
  ➢ Boy 3
  ➢ Boy 4
Discussion questions

• Which student was the most inattentive? (Boy 1, Boy 2, Boy 3, Boy 4?)
• What was the most salient inattentive behavior to you?
• What behaviors drew the teacher’s attention?
• Which boy completed the most work?
“Medical” symptoms of inattention

- Difficulty sustaining alertness to tasks that require effort
- Easily distracted by extraneous stimuli
- Difficulty organizing tasks & self

Classroom problems

- Student may complain that task is ‘boring’ or ‘too hard’
- May yawn, look lethargic, put head on desk, daydreams, tunes out
- Constantly turning around – head on a swivel
- Gets sidetracked so may not notice operation signs in math, misses out words in written work
- Papers shoved in backpack; Unable to find materials; Forgets instructions or important steps in assignment;
Pay Attention to Inattention:

Why?

Because it is a risk factor for poor academic outcomes
Pay attention to Inattention

“The presence of even a few inattentive behaviors in early childhood should be viewed as a developmental risk factor”

Large-scale study of school children in England


Inattention in Grade 1-2: associated with

- “below average” academic skills
  - oral language, reading, written language, number concepts and computation
- poor classroom adjustment
  - low confidence, need for repeated instructions
Significance of *Inattention* in early childhood for reading

387 children followed from Kindergarten - Grade 5

Inattention in kindergarten as reported by teachers

even after controlling for IQ, hyperactivity & emotional problems, reading ability in Grade 1

(Rabiner & Coie, 2000; JAACAP 39(7) p.859-867)

Poor reading in Grade 5
Again…Inattention as Risk Factor for Poor Reading Achievement


- Inattentive behaviour in kindergarten students is an *independent predictor* of reading ability in Grade 1 (controlling for K –reading-related skills)

- Inattention also has an *INDIRECT effect* on later reading outcomes via its effect on phonological analysis skills in grade 2

- No effects of hyperactivity-impulsivity on reading

- No increases in behaviour problems as a result of early reading difficulties
Inattention as Risk Factor for Poor Reading Fluency in a sample of school children

71 students (Gr. 1-4) from 4 rural schools in Ontario, Canada
Selected on basis of teacher-perceived attention skills (good/average vs. poor)

*DIBELS Oral Fluency* (number of words in grade-level text read aloud correctly in 1 minute)
Inattention as Risk Factor for Poor Math Achievement

- **Inattentive behavior**, as rated by classroom teachers, is a significant robust predictor of Grade 1 and Grade 3 children’s development of math skills in 3 key areas:1-2
  - Fact fluency/arithmetic
  - Computation
  - Story/word problems

- Inattention predicts poor response to math instruction in Grade 1.3

Significance of Inattention

Inattention

Cognitive Deficits

Poor Academic Achievement

Tannock/CHERI Hippocrates Socrates XII, Sydney, Australia, Sep 5-6, 2007
Part 2:
Underwater explorations of Inattention!
Behavior symptoms of ADHD are just the tip of the iceberg!

- Hyperactivity
- Impulsivity
- Observable symptoms of Inattention

Cognitive aspects of inattention
Learning Objectives: Part 2

- To understand cognitive difficulties underlying inattention & their impact on learning and behavior
- To be aware of the neuroscience of attention
- To understand ‘cognitive load’ and the implications for teaching
Paying attention

- Refers to our brain's ability to take all of the stimuli around us, immediately categorize & organize information as relevant or irrelevant, & focus the mind on one thing, such as the task at hand.

- For a child in a classroom, paying attention to the teacher means filtering out all of the other students, the interactions between them, visual distractions as well as noises inside & outside the classroom.

- “Paying attention” depends on underlying multidimensional cognitive processes.
Definition of Attention

- The regulation of various brain networks by *attention networks*

- What are neural networks?
  - A number of brain regions that when orchestrated carry out a psychological function (e.g., remembering, stopping an impulsive thought or action)
Attention Networks

Attention Networks

- **Alerting** (norepinephrine)
  - Involves a change in one’s internal state in preparation for perceiving stimuli. The alert state is critical for optimal task performance

- **Orienting** (acetylcholine)
  - Selection of information from sensory input. It can be automatic or voluntary; covert or overt
    - e.g., movement automatically grabs our attention- that is why it is easy to be aware of hyperactivity in class!

- **Executive attention**
  - Involves more complex mental operations in monitoring & resolving conflict between computations of different brain regions
    - e.g., planning, decision making, error detection, overcoming habitual actions, feelings, responses
    - WORKING MEMORY (& PROCESSING SPEED)

Atomoxetine [MPH] → Methylphenidate (ATX)
Development of Attention Networks

- Partly specified by genes
- Partly influenced by specific socialization (and educational) experiences
- Early temperamental differences are thought to reflect the maturation of particular networks
  - Individual differences in the efficiency of attention networks have been found to be related to these differences in emotional and behavioral control

<table>
<thead>
<tr>
<th>“Medical” symptoms of inattention</th>
<th>Functional impairments in class</th>
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<td>Difficulty organizing tasks &amp; self</td>
<td>Constantly turning around – head on a swivel – focuses on irrelevant stimuli</td>
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<td>Gets sidetracked so may not notice operation signs in math, misses out words in written work</td>
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<td>Forgets instructions; loses things; papers shoved in backpack; doesn’t complete project on time; reacts</td>
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A Triad of Risk Factors

Inattention

Executive Attention Network

Academic Impairments

Slow processing speed
What Is Executive Function?

Analogies

Company CEO:  
Longer-term  
Overall planning  
(eg, planning a lesson)

Conductor:  
Moment-to-moment  
Context-specific  
(eg, during the lesson)
Role of Executive Function

- Executive control of attention enables us to act in a goal-directed, flexible & intentional manner
  - Represent & identify a problem
  - Develop plans & execute them
  - Organize self & activities
  - Inhibit actions & regulate emotions
  - Resist distraction & control attention
  - Self-monitor & self-evaluate thoughts & actions
Are there different types of executive function?

- Probably, but there is no consensus about the range or number of executive functions.
- Commonly recognized executive functions:
  - Inhibitory control
    - Inhibition of inappropriate action and thought
  - Working memory
    - Momentary storage and use of information
- Speed of processing information is important for efficient executive function.
What is Working Memory?

A limited-capacity cognitive system that allows us to actively **hold & use critical information in mind**, despite ongoing distraction

– for 1 or 2 seconds!

**current focus of the mind**
Engle’s model: executive attention view of working memory capacity

**WM Capacity:** executive control of attention (processing)

**Storage** (scope of attention)

*WM capacity: the ability to control attention in the service of memory.*
Working memory capacity & performance on a test of the Attentional Networks

How’s your working memory?

Star Counting GAME
WORKING MEMORY ACTIVITY

• **Step 1:** You will see a set of letters (e.g., a f k t) on the screen. Remember these items.

• **Step 2:** Next you will see a number followed by a series of stars in rows with addition or plus signs in between the stars.

  ➢ *Beginning with the number, start counting on the number of stars (going across one row then across another row*)

  ➢ *When you come to a “+” sign, count upwards.*

  ➢ *When you see a “-“ sign, count downwards.*

  ➢ *Your job is to get the correct total.*

• Example: 10 + ⭐⭐ ⫾ ⫾ + ⭐⭐⭐⭐⭐

• Your Answer? _________  READY?
What were the letters?

How many stars?
Working memory & the cocktail party phenomenon (Conway, Cowan, Bunting, 2001)

Humans exhibit the ability to attend to only part of a noisy environment, yet a highly pertinent stimulus, can suddenly capture one’s attention.

In approx 33% individuals... Those with low working memory capacity
Whose mind wanders most?
(Kane et al., Psychol Science, 18(7): 614-621, 2007)

- 124 undergrads
- Mind-wandering in daily life:
  - Palm Pilot PDA signaled participants to complete questionnaires 8 times daily for 7 days
  - Classified as high vs low working memory capacity (WMC) on complex span measures
- Students with low WMC were less able to maintain on-task thoughts, & more likely to mind-wander than participants with high WMC
Working memory is required in social interactions, in games & sports

• Keeping track of a conversation
  ➢ Who said what..to whom
  ➢ who asked what…

• Keeping track of a game
  ➢ Whose turn is next…
  ➢ What cards have already gone…
  ➢ What stage the game is at…

Working memory is impaired in ADHD (Meta-analysis: Martinussen et al., JAACAP 2005)

- A substantial proportion of students with ADHD exhibit working memory problems
  - Particularly those with many behavioral symptoms of inattention
  - Particularly for visual-spatial information
  - Impairments evident in preschoolers, children, teens, adults
  - Problems evident on standardized tests of working memory (e.g., WISC-IV, CANTAB)
ANOTHER LOOK AT WORKING MEMORY

Working memory & classroom instructions
Simulation: DVD #3: start 11.01
Importance of working memory in Education

- Working memory processes are known to be important predictors of performance on national curriculum achievement tests:
  - **Auditory/Verbal:**
    - literacy, reading comprehension, written expression, vocabulary,
  - **Visual/spatial:**
    - math, science

*(Gathercole & Pickering, 2000; Jarvis & Gathercole, 2003)*
ADHD & its cognitive impairments impede school functioning

- Children with ADHD and poor executive function (EF) perform more poorly academically than children with ADHD alone (1)

- ADHD symptoms predict poor social and school functioning; EF predicts poor school functioning (2)

- Children with poor EF (irrespective of ADHD) show poor social functioning (3)

- EF impairments in ADHD are stable & persist into adulthood, particularly poor working memory (4)

# ADHD impedes Academic Attainment

<table>
<thead>
<tr>
<th>Educational Outcome</th>
<th>ADHD vs Peer Group</th>
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<tbody>
<tr>
<td>Low achievement at school</td>
<td>2-fold risk</td>
</tr>
<tr>
<td>Grade repetition(^1,2)</td>
<td>2- to 4-fold risk</td>
</tr>
<tr>
<td>Low academic grades (C’s/D’s)(^3)</td>
<td>8%-10% lower</td>
</tr>
<tr>
<td>Achievement scores (reading, mathematics)(^1-3,)</td>
<td>23(^{rd}) percentile (low average)</td>
</tr>
<tr>
<td>Early school leaving(^4)</td>
<td>1 year lower</td>
</tr>
<tr>
<td>Highest level completed</td>
<td></td>
</tr>
<tr>
<td>Tertiary level attainment (college)(^5)</td>
<td>lower GPA</td>
</tr>
</tbody>
</table>

Working memory problems are not unique to ADHD:

Working memory impairments may also occur in students with specific LD, language impairments, autism, & other types of behavior problems

Problems with anxiety/depression may also affect working memory
Significance of Inattention

Inattention

Cognitive Deficits

Poor Academic Achievement
Thus, students with poor working memory are at risk for:

1. Being easily distracted
2. Frequent mind-wandering
3. Poor academic outcomes
Recap of Main Points

- Human attention is a complex construct & involves multiple components at both brain/networks and behavioural/functional levels.

- Behavioral symptoms of inattention are associated with poor working memory abilities, which gives rise to academic problems.

- Working memory is a key factor to consider in designing classroom instruction for inattentive children.
Pay Attention to Inattention: Implication for Education

Part 3: Implications for Education
Curriculum and Cognitive Demands

- The curriculum and evaluation are increasingly focused on higher level thinking and application skills
  - Make significant daily demands on
    - executive functions
    - working memory
    - language and communicative competency
    - well-developed literacy and numeracy skills, and media literacy

  a high potential "cognitive load"
Cognitive Load Theory
(Sweller, 1986; 1994)

Cognitive load: the total amount of mental activity imposed on working memory at any point in time
- number of elements that need to be attended to
- whether it is necessary to understand connections between concepts

e.g., in an explanation or instruction: length + complexity
Intrinsic and Extraneous Cognitive load

**Intrinsic** - the complexity of the material itself

**Extraneous** - the complexity due to how it is presented or what the output demands are

Total cognitive load of a learning activity

**can be modified in teaching**

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Classroom tasks carry a high cognitive load

- **Input demands**
  - processing longer instructions, new vocabulary, explanations, class discussions
  - comprehending and using information from textbooks & web

- **Output demands**
  - explaining and reasoning, using new vocabulary
  - written assignments

_in a differentiated instructional approach, input and output demands should be balanced with the child’s current abilities_
What it should look like......
**But**, when working memory deficits are present, and cognitive load is high……

Inattentive students are likely to:

- Lose concentration, cannot maintain focus
- Go off-task - daydream instead of listen
- Forget multi-step instructions
- Be unable to start the assigned work or carry it to completion
- Read, but fail to comprehend what they have just read
- Unable to plan the steps to do the task
- Fail to organize their thinking to solve a problem

*(just some of the possible breakdown points)*
Cognitive Overload!

Input Load

Output Load

STUDENT

WM Capacity

Knowledge

Skills

TASK DEMANDS

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Big Ideas: matching cognitive load to student’s capacity

- Explicitness
  - Structure tasks, provide clear goals, teach steps, provide checklists, organizers

- Engagement
  - Increased opportunities to respond, vary group size

- Emotional support
  - Encouragement, feedback – specific and clear

- Evaluation
  - Is the child making gains? Under what situations/contexts is improvement observed?
Educational Interventions for Inattention &/ or WM

**Child-Focused**
- General Attention-Training
- Specific Attention-Training
- Working Memory Training

**Teacher-Focused**
- Knowledge, Awareness, Identification
- Instructional Strategies
- Hybrid
Teacher Professional Development about Inattention/ADHD is effective

  *J Learn Disabil* 35(6):546-562
  - RCT: Positive
    - teacher knowledge
    - parent & teacher ratings of child ADHD symptoms
    - child academic performance

- Rowe, Rowe, Pollard (2004)
  - RCT: Positive
    - children’s attention
    - reading & math scores

- Tymms & Merrell (2006)
  - RCT: Positive
    - Teachers’ knowledge & stress
    - Children’s attitudes to school
    - Children’s reading
Teacher Professional Development about Inattention/ADHD is effective

• Barbaresi & Olsen (1998)
  *J Dev Behav Pediatr* 19(2):94-100

• Miranda et al (2006)
  *Psicothema* 18(3):335-341

• Sayal et al 2006
  *Soc Psychiatry Psychiatr Epidemiol* 41:806-813

• UNCONTROLLED
  ➢ Positive effects on teacher knowledge & stress

• CONTROLLED: Quasi-Experimental 3 groups
  ➢ Positive effects of psychoeducation on parent & teachers rating of children’s ADHD symptoms

• UNCONTROLLED
  ➢ Positive Effects: teachers more accurate in recognizing children ‘at risk for ‘and ‘probable’ ADHD
MAI N POI NT S

1. INATTENTION PREDICTS POOR ACADEMIC OUTCOMES (despite average or above IQ)

2. SURFACE BEHAVIOURS (symptoms) REFLECT PROBLEMS IN COGNITIVE PROCESSES (WORKING MEMORY)

3. SUCCESSFUL INTERVENTIONS MUST ADDRESS COGNITIVE PROCESS