

Usability and the Effects of Interruption in C-TOC: Self-Administered Cognitive Testing on a Computer

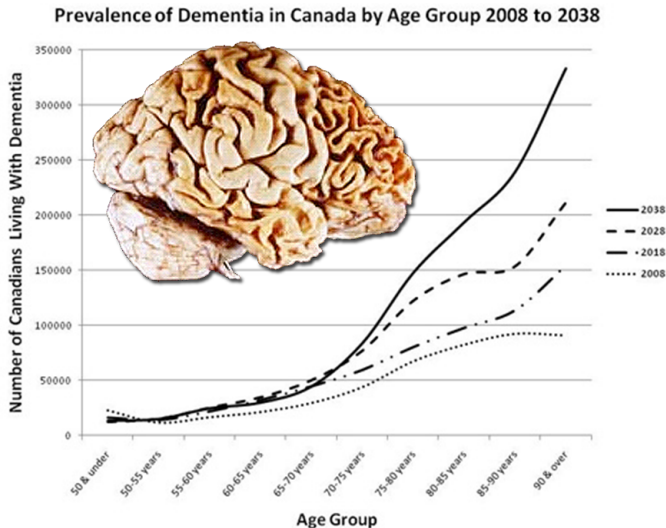
Matthew Michael Brehmer

The Imager Laboratory for Graphics, Visualization, and HCT
Department of Computer Science
University of British Columbia

Motivation: an ageing population



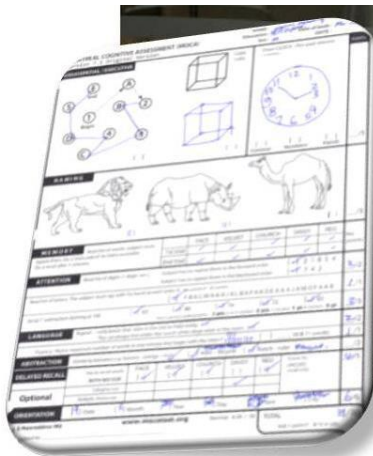
Motivation: increasing awareness of dementia



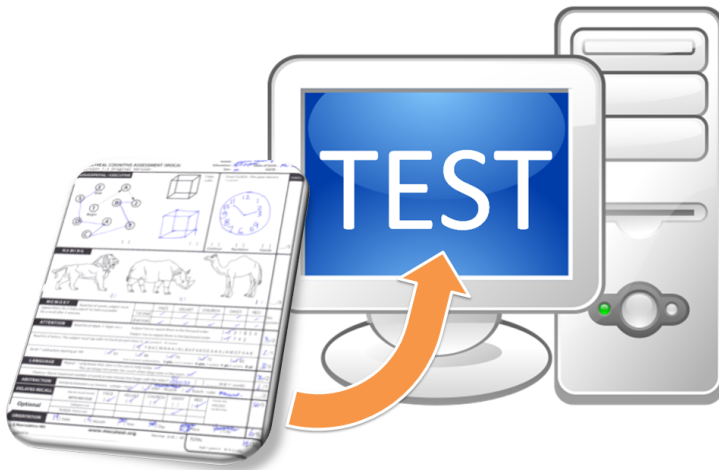
Motivation: long wait times for cognitive assessment



Cognitive assessment tests administered by a clinician



Goal: self-administered computerized cognitive testing




C-TOC: Cognitive Testing On a Computer




Click on the insect

What is the current month?

January	February	March	April
May	June	July	August
September	October	November	December



1 2 3 4 5 6 7 8 9



1 2 3 4 5 6 7 8 9


Response bar

PAPER and PEN

- ☐ A Both are useful in the household
- ☐ B Both are used at school
- ☐ C Both are stationery items


How are the two items above alike?
Choose the answer that best captures their similarity!

target pattern



Reproduce the target pattern here by moving the shapes

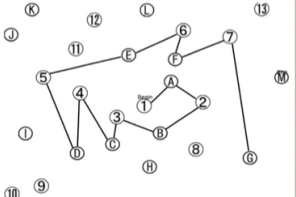
Pattern 2



Shapes

1 2 3 4 5 6 7 8 9

Done



Does *C-TOC* produce valid results?

Is *C-TOC* usable by older adults?

Will *C-TOC* work outside the clinic?

Does *C-TOC* produce valid results?

Is *C-TOC* usable by older adults?

Will *C-TOC* work outside the clinic?

Will *C-TOC* work at home?



Interruptions and distractions in the home



- An understanding of **how older adults are disrupted** by interruptions

Motivation

- An understanding of **how older adults are disrupted** by interruptions
- The effects of interruption on C-TOC test performance

Motivation

- An understanding of **how older adults are disrupted** by interruptions
- The effects of interruption on C-TOC test performance
- Detection and mitigation of interruptions to **preserve test validity**

The Cost of Interruption (COI)¹

- DVs: task completion time, task resumption time, accuracy,
- Predicting the cost of interruption

¹<http://interruptions.net>

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 - Contextual factors

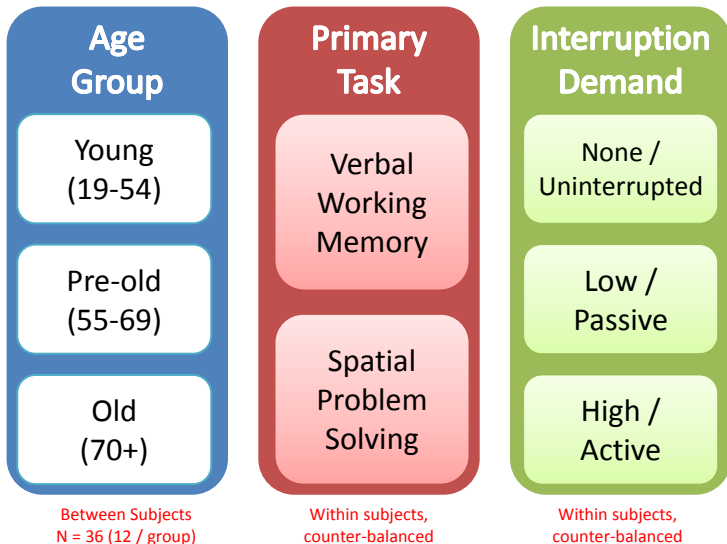
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The COI for Older adults

- Normal cognitive ageing: changes in working memory, processing speed, attention, distractibility, task-switching
- Reported COIs for older adults:
 - Working memory (Clapp 10)
 - Ability to remember intentions (Farrimond 06)

Study Design

3 x 3 x 2 mixed design



Primary Task: VERBAL

**If there is a pink square, move all
the figures to the left.**

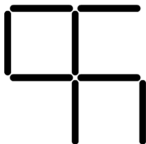
**Otherwise move all the figures to
the right.**



Continue

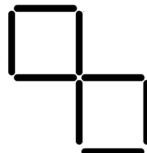
Next

Primary Task: SPATIAL



Move 1 line to make 2 complete squares; don't leave incomplete squares.

Next



Move 1 line to make 2 complete squares; don't leave incomplete squares.

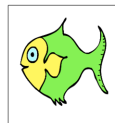
Next

Interrupting Tasks: PASSIVE (left), ACTIVE (right)

WATCH these images.
DO NOT CLICK on them.



CLICK in the box
when the current image repeats
what you saw 2 images ago.



Coordination of Tasks

trial	1	2	3	4	5	6	7	8	9	10
p_1		x_1			x_2				x_3	x_4

Coordination of Tasks

trial	1	2	3	4	5	6	7	8	9	10
P_1		X_1			X_2				X_3	X_4
P_2			X_1		X_2	X_3		X_4		

Coordination of Tasks

trial	1	2	3	4	5	6	7	8	9	10	
P_1		X_1			X_2				X_3	X_4	B
P_2			X_1		X_2	X_3		X_4			C
$P_{n \dots}$		X_1		X_2			X_3			X_4	A

Coordination of Tasks

trial	1	2	3	4	5	6	7	8	9	10	set	
P_1		X_1			X_2				X_3	X_4	B	PASSIVE
P_2			X_1		X_2	X_3		X_4			C	
$P_{n \dots}$		X_1		X_2			X_3			X_4	A	
P_1		X_1			X_2				X_3	X_4	C	ACTIVE
P_2			X_1		X_2	X_3		X_4			A	
$P_{n \dots}$		X_1		X_2			X_3			X_4	B	

Coordination of Tasks

trial	1	2	3	4	5	6	7	8	9	10	%t	
P_1		X_1			X_2				X_3	X_4	A	UNINTERRUPTED
P_2			X_1		X_2	X_3		X_4			B	
$P_{n \dots}$		X_1		X_2			X_3			X_4	C	
P_1		X_1			X_2				X_3	X_4	B	PASSIVE
P_2			X_1		X_2	X_3		X_4			C	
$P_{n \dots}$		X_1		X_2			X_3			X_4	A	
P_1		X_1			X_2				X_3	X_4	C	ACTIVE
P_2			X_1		X_2	X_3		X_4			A	
$P_{n \dots}$		X_1		X_2			X_3			X_4	B	

Trial Completion Time
Task Resumption Time
Trial Accuracy

Trial Completion Time
Task Resumption Time
Trial Accuracy
Questionnaires
Structured Interviews

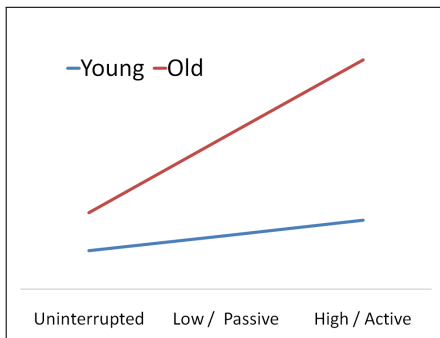
Hypotheses

Hypotheses: Age & Interruption Demand

- 1.1. Overall, *YOUNG adults will perform better than older adults.*

Hypotheses: Age & Interruption Demand

- 1.1. Overall, *YOUNG* adults will perform better than older adults.
- 1.2. Older adults will incur a disproportionately larger COI when interruption demand increases.

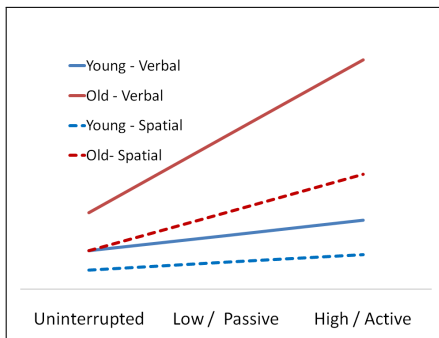


Hypotheses: Age, Task & Interruption Demand

- 2.1. *The VERBAL task places a greater load on working memory. Therefore increased interruption demand will incur a disproportionately greater COI on the VERBAL task than on the SPATIAL task.*

Hypotheses: Age, Task & Interruption Demand

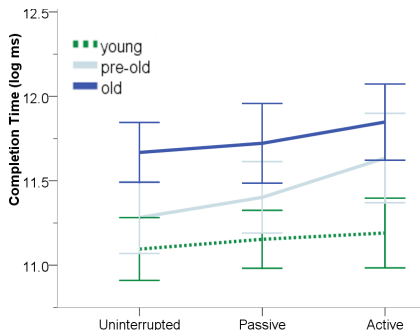
- 2.1. *The VERBAL task places a greater load on working memory. Therefore increased interruption demand will incur a disproportionately greater COI on the VERBAL task than on the SPATIAL task.*
- 2.2. *This difference in COI will be greater for older adults.*



Results

Summary of Results - VERBAL task

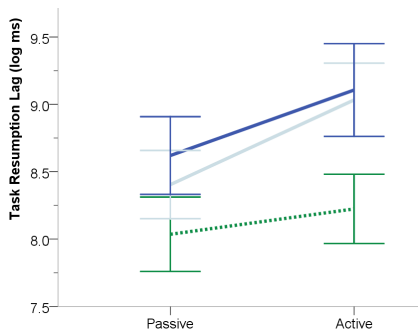
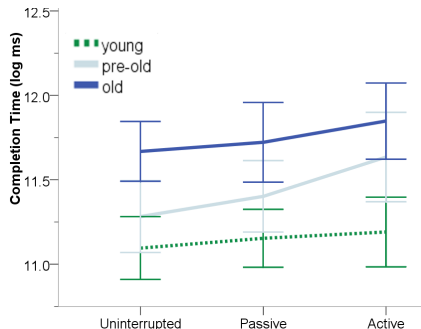
Completion time: All groups slower in ACTIVE cond.



Summary of Results - VERBAL task

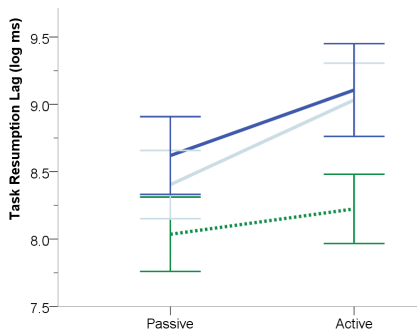
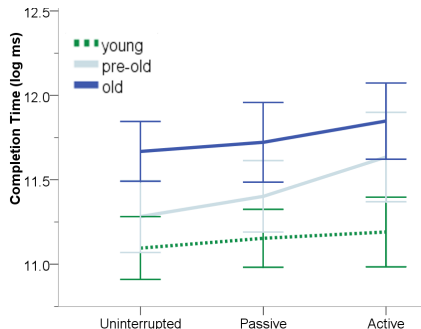
Completion time: All groups slower in ACTIVE cond.

Resumption lag time: OLD disproportionately slower in ACTIVE cond.



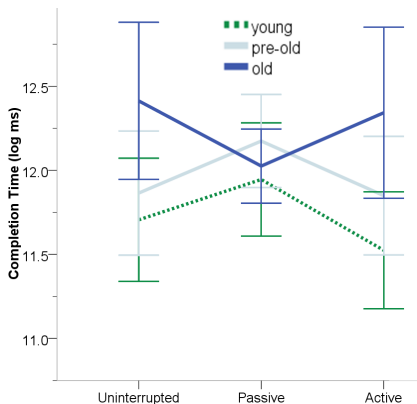
Summary of Results - VERBAL task

Completion time: All groups slower in ACTIVE cond.
Resumption lag time: OLD disproportionately slower in ACTIVE cond.
Accuracy: Old less accurate



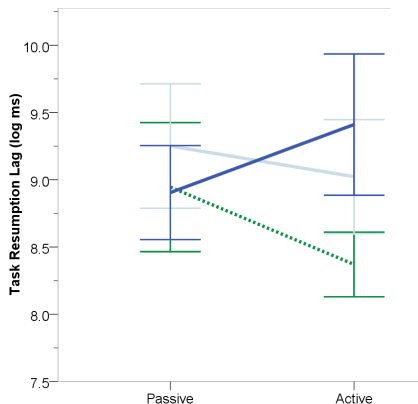
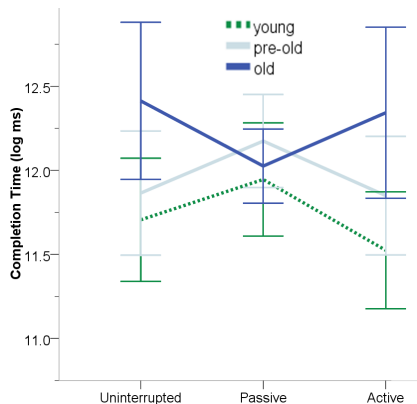
Summary of Results - SPATIAL task

Completion time: No age difference in PASSIVE cond.



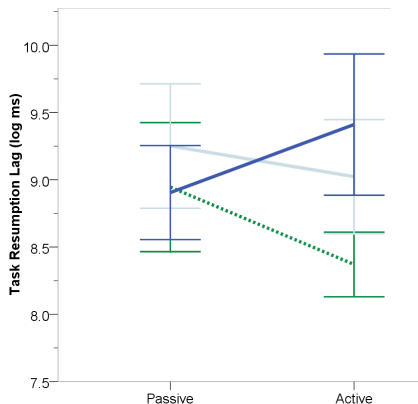
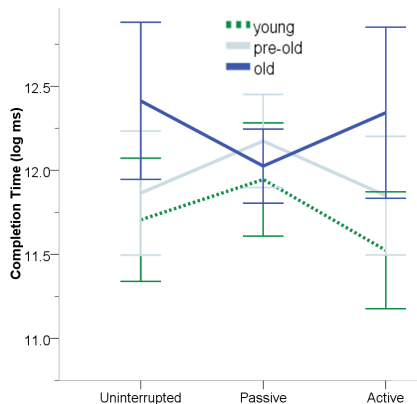
Summary of Results - SPATIAL task

Completion time: No age difference in PASSIVE cond.
Resumption lag time: YOUNG faster in ACTIVE cond.



Summary of Results - SPATIAL task

Completion time: No age difference in PASSIVE cond.
Resumption lag time: YOUNG faster in ACTIVE cond.
Accuracy: Age effect not sig.



Hypotheses Revisited: Age & Interruption Demand

- 1.1. *Overall, YOUNG adults will perform better than older adults.*
 - Supported.

Hypotheses Revisited: Age & Interruption Demand

- 1.1. *Overall, YOUNG adults will perform better than older adults.*
 - Supported.
- 1.2. *Older adults will incur a disproportionately larger COI when interruption demand increases*
 - Partially supported.

Hypotheses Revisited: Age, Task & Interruption Demand

- 2.1. *The VERBAL task places a greater load on memory. Therefore increased interruption demand will incur a disproportionately greater COI on the VERBAL task than on the SPATIAL task.*
 - Partially supported.

Hypotheses Revisited: Age, Task & Interruption Demand

- 2.1. *The VERBAL task places a greater load on memory. Therefore increased interruption demand will incur a disproportionately greater COI on the VERBAL task than on the SPATIAL task.*
 - Partially supported.
- 2.2. *This difference in COI will be greater for older adults.*
 - Partially supported.

Discussion

Discussion: The Results

- OLD adults compensate for slower task resumption.
A *Zeigarnik* effect? ² (improved performance on interrupted tasks)

²B. Zeigarnik. Das behalten erledigter und unerledigter handlungen.

Discussion: The Results

- OLD adults compensate for slower task resumption.
A *Zeigarnik* effect? ² (improved performance on interrupted tasks)
- Primary task accuracy was not affected by interruptions.

²B. Zeigarnik. Das behalten erledigter und unerledigter handlungen.

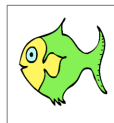
Methodological Implications

- Low-demand interruptions need not be passive.
- High-demand interruptions may not have been difficult enough for young adults.


WATCH these images.
DO NOT CLICK on them.



CLICK in the box
when the current image repeats
what you saw 2 images ago.



- Prevent interruptions with prompts tailored to each test.

WHAT DO I NEED TO GET READY? 

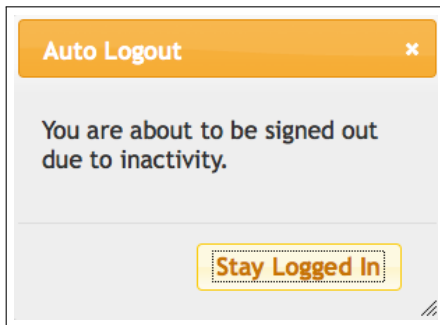
Please check all items that apply as you go through the list.

- ☐ If you need your glasses, please wear them now.
- ☐ Check if the computer and mouse are working.
- ☐ Remove aids and distractions, e.g. TV, cell phone, calendar, computer-activated features.
- ☐ If you want a family member to be present, that is okay, however, they must NOT offer assistance.
- ☐ Are you seated comfortably?
- ☐ Are you prepared to spend about 30 minutes at the computer now?

Back4Next

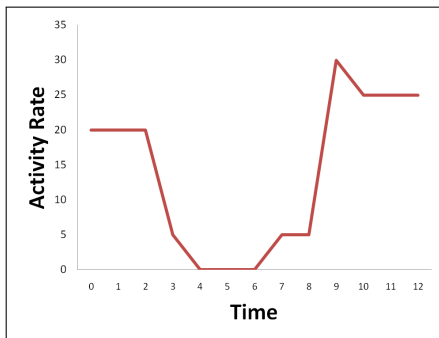
Design Implications

- Detect interruptions by requiring user response. Mitigate interruptions with trial replacement and test restarts.



Design Implications

- Detect interruptions by examining variation in task completion rates.



Design Implications

- The user was interrupted. Is their performance invalid?



Design Implications

- In general, segment tasks and determine inactivity thresholds.

Flights

Flight Pass

Hotels

Cars

Vacations

Travel [Multi-city](#)

Leaving from

Going to [Map search](#)

Departure date


Return date


Adult (16+) [Children?](#) [More than 9 passengers](#)

Country of residence

Promotion Code (optional)

[Executive Class](#) | [Online booking FAQs](#)

 **Check-in**

 **Flight Status**






Send Money Now

I'm paying someone in:

Amount: Currency:

My payment is for: [About Our Fees](#)
☐ Friends and Family
☐ Buying Something

Step 1 of 3

Send money with:     

Future Work

- Effect of interruptions on other C-TOC tests

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- Determining valid levels of interruption demand

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- Determining valid levels of interruption demand
- Examining age differences in task resumption strategy
- Manipulating other factors of interrupting and primary tasks
- Investigating the effects of interruptions on individuals with cognitive impairment
- Evaluating designs for preventing, detecting, and mitigating effects of interruptions in C-TOC

Acknowledgements

Thanks:

*Joanna McGrenere, Claudia Jacova, Charlotte Tang, Peter Graf
Carmen Li, Hyunsoo Lee, William Wang*



Ministry of
Health Services



Vancouver
Coastal Health
Research Institute



- Interactions of age, task, and interruption demand: additional insights?
- Are older research subjects more conscientious?
- Externally valid interruptions for older adults?
- Tips on recruiting older adults