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

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Motivation: an ageing population
Motivation: increasing awareness of dementia

Prevalence of Dementia in Canada by Age Group 2008 to 2038

- Number of Canadians Living With Dementia
- Age Group

Graph showing the increase in the number of Canadians living with dementia from 2008 to 2038 by age group.
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?

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<tr>
<th>Month</th>
<th>January</th>
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PAPER and PEN

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

Pattern 2

Reproduce the target pattern here by moving the shapes.

How are the two items above alike? Choose the answer that best captures their similarity!
C-TOC: Research questions

Does C-TOC produce valid results?

Is C-TOC usable by older adults?

Will C-TOC work outside the clinic?
C-TOC: Research questions

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
Motivation

- 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

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\(^1\) http://interruptions.net
The Cost of Interruption (COI)\textsuperscript{1}

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  - Interruption demand (Gillie 89, Monk 08, Oulasvirta 06)

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  - Warning of imminent an interruption (Altmann 04, Hodgetts 06, Trafton 03)
  - Contextual factors

\textsuperscript{1}http://interruptions.net
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

Age Group
- Young (19-54)
- Pre-old (55-69)
- Old (70+)

Primary Task
- Verbal Working Memory
- Spatial Problem Solving

Interruption Demand
- None / Uninterrupted
- Low / Passive
- High / Active

Between Subjects
- N = 36 (12 / group)

Within subjects, counter-balanced

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Primary Task: **VERBAL**

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

Otherwise move all the figures to the right.
Primary Task: **SPATIAL**

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

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

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UNINTERRUPTED

PASSIVE

ACTIVE
Quantitative & Qualitative Measures

Trial Completion Time
Task Resumption Time
Trial Accuracy
Quantitative & Qualitative Measures

- 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
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

[Graph showing completion time and task resumption lag with data for young, pre-old, and old groups across uninterrupted, passive, and active conditions.]
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.

![Graph showing completion time and resumption lag time for young, pre-old, and old participants in different conditions.](image)
1.1. *Overall, young adults will perform better than older adults.*
   - Supported.
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.
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)

---

\(^2\) B. Zeigarnik. Das behalten erledigter und unerledigter handlungen. 

*Psychologische Forschung* (1927).
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.  
*Psychologische Forschung* (1927).
Methodological Implications

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

**WATCH** these images.
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when the current image repeats
what you saw 2 images ago.
Design Implications

- 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?
Detect interruptions by requiring user response. Mitigate interruptions with trial replacement and test restarts.
Detect interruptions by examining variation in task completion rates.
Design Implications

- The user was interrupted. Is their performance invalid?
In general, segment tasks and determine inactivity thresholds.
Future Work
Future Work

- Effect of interruptions on other C-TOC tests
Future Work

- Effect of interruptions on other C-TOC tests
- Determining valid levels of interruption demand
Future Work

- Effect of interruptions on other C-TOC tests
- Determining valid levels of interruption demand
- Examining age differences in task resumption strategy
Future Work

- Effect of interruptions on other C-TOC tests
- Determining valid levels of interruption demand
- Examining age differences in task resumption strategy
- Manipulating other factors of interrupting and primary tasks
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- Effect of interruptions on other C-TOC tests
- 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
Future Work

- Effect of interruptions on other C-TOC tests
- 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
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