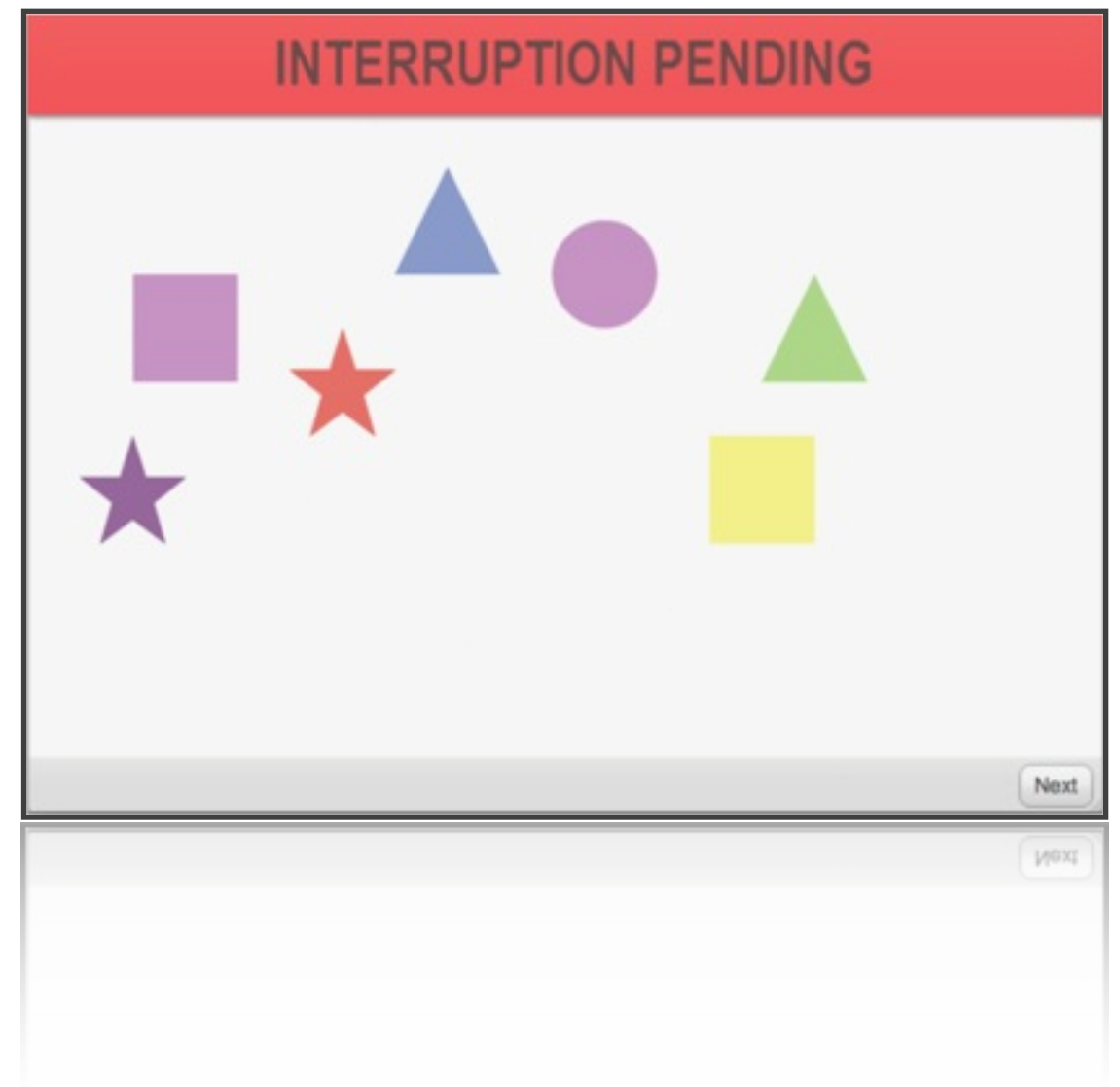
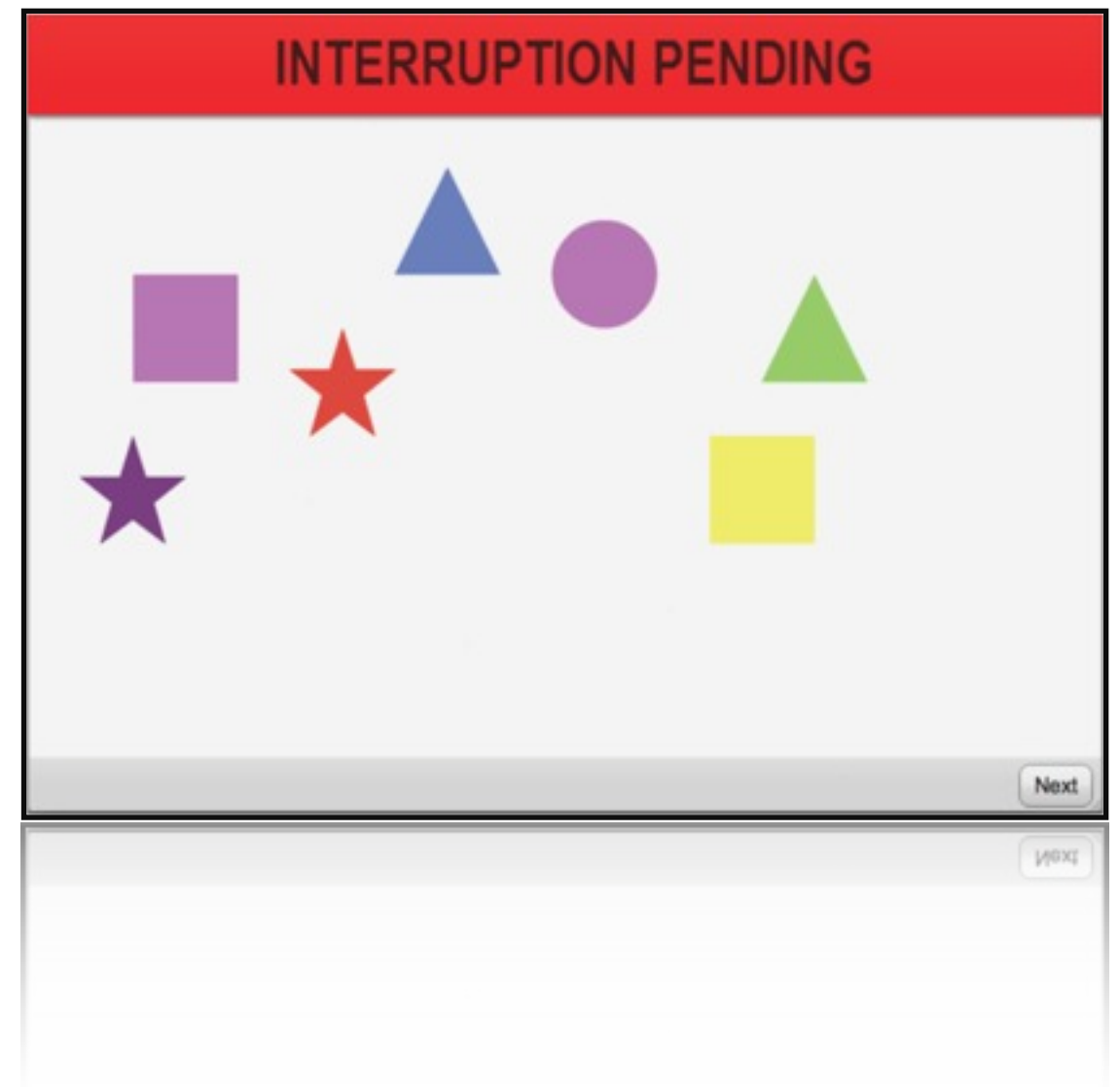
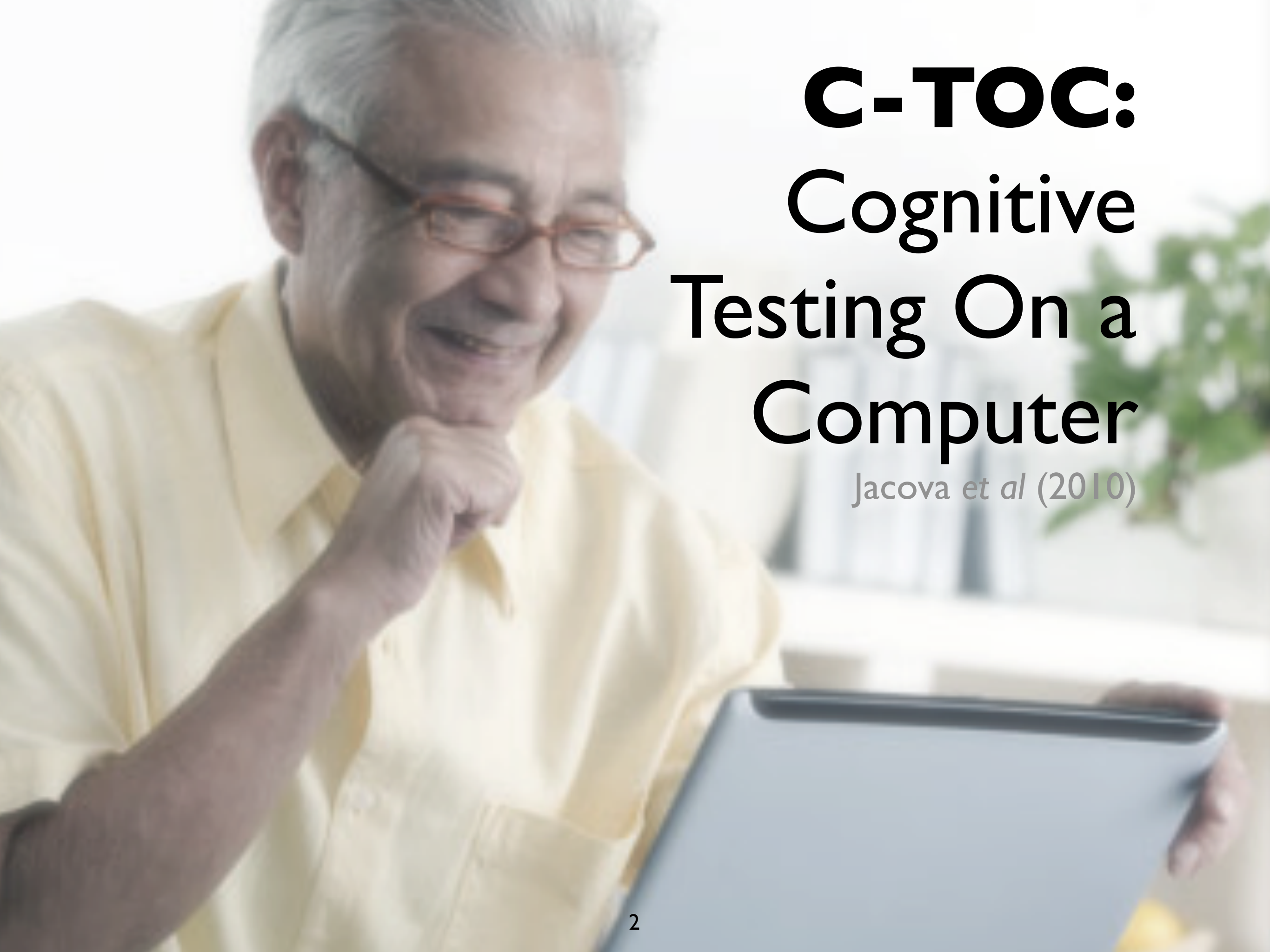


# Investigating **interruptions** in the context of **computerised** **cognitive** **testing** for older adults



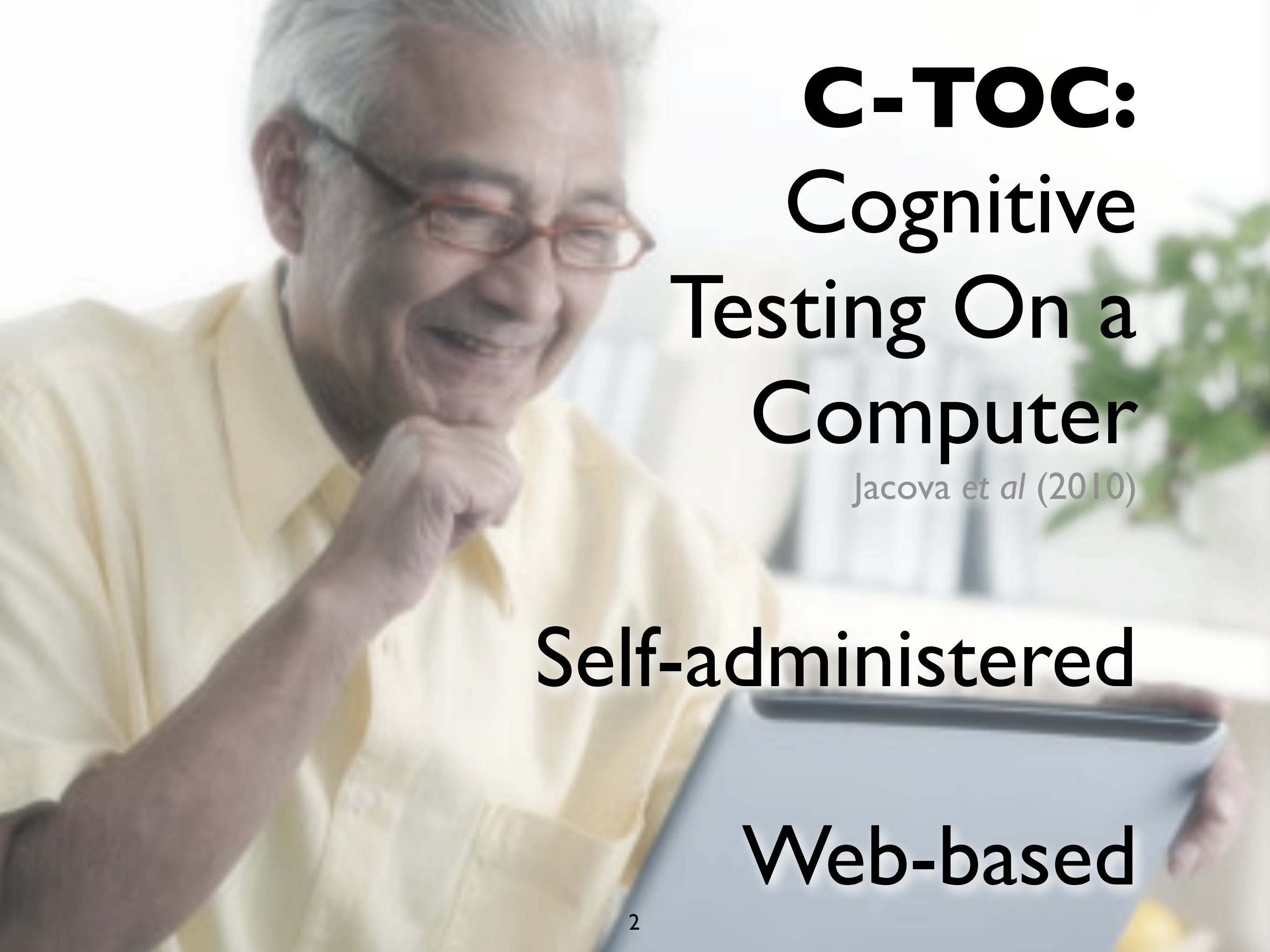
# Investigating **interruptions** in the context of **computerised** **cognitive** **testing** for older adults





# **C-TOC: Cognitive Testing On a Computer**

*Jacova et al (2010)*



# **C-TOC: Cognitive Testing On a Computer**

*Jacova et al (2010)*

**Self-administered**

**Web-based**





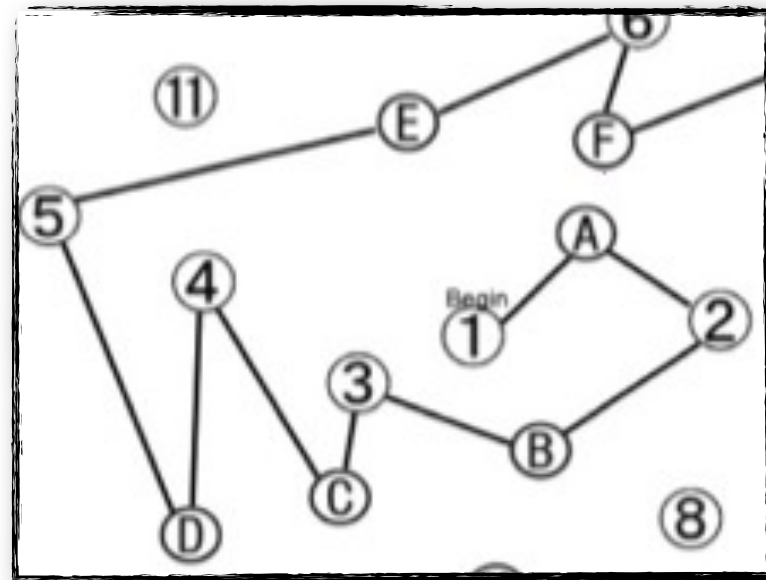
# Long wait times

*Jacova et al (2010)*

# C-TOC:

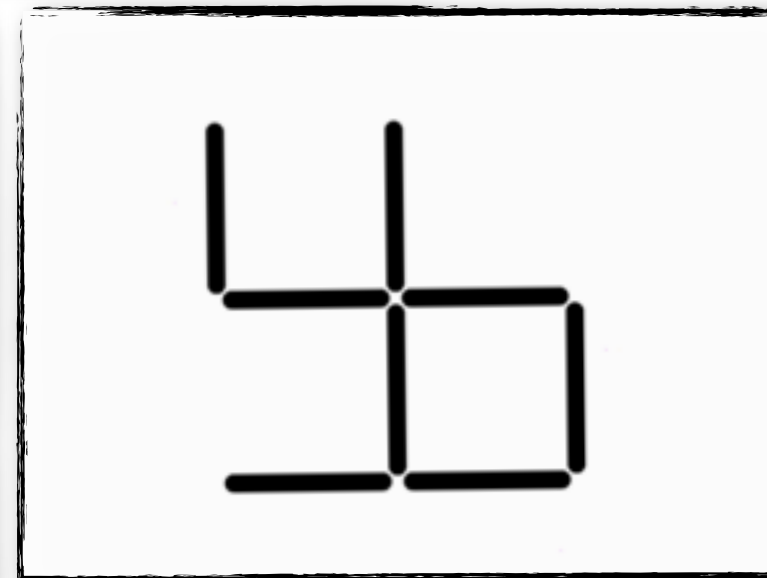
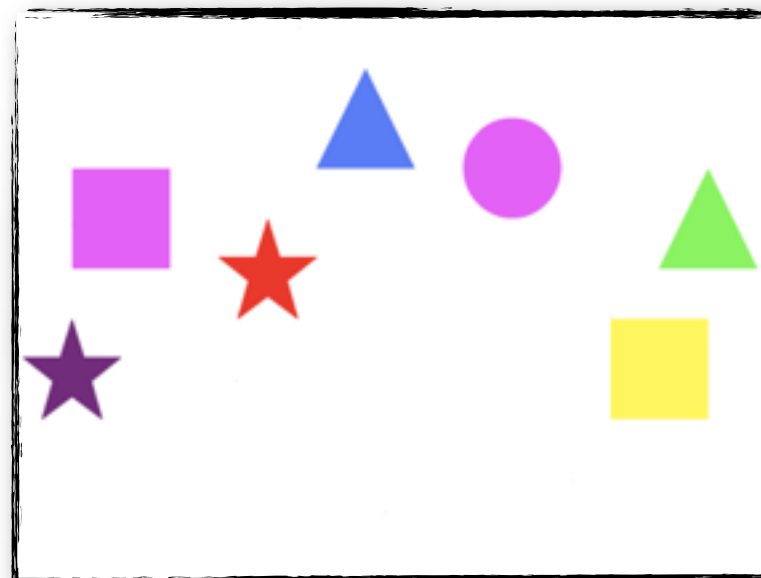
## 15 short tests

Jacova et al (2010)

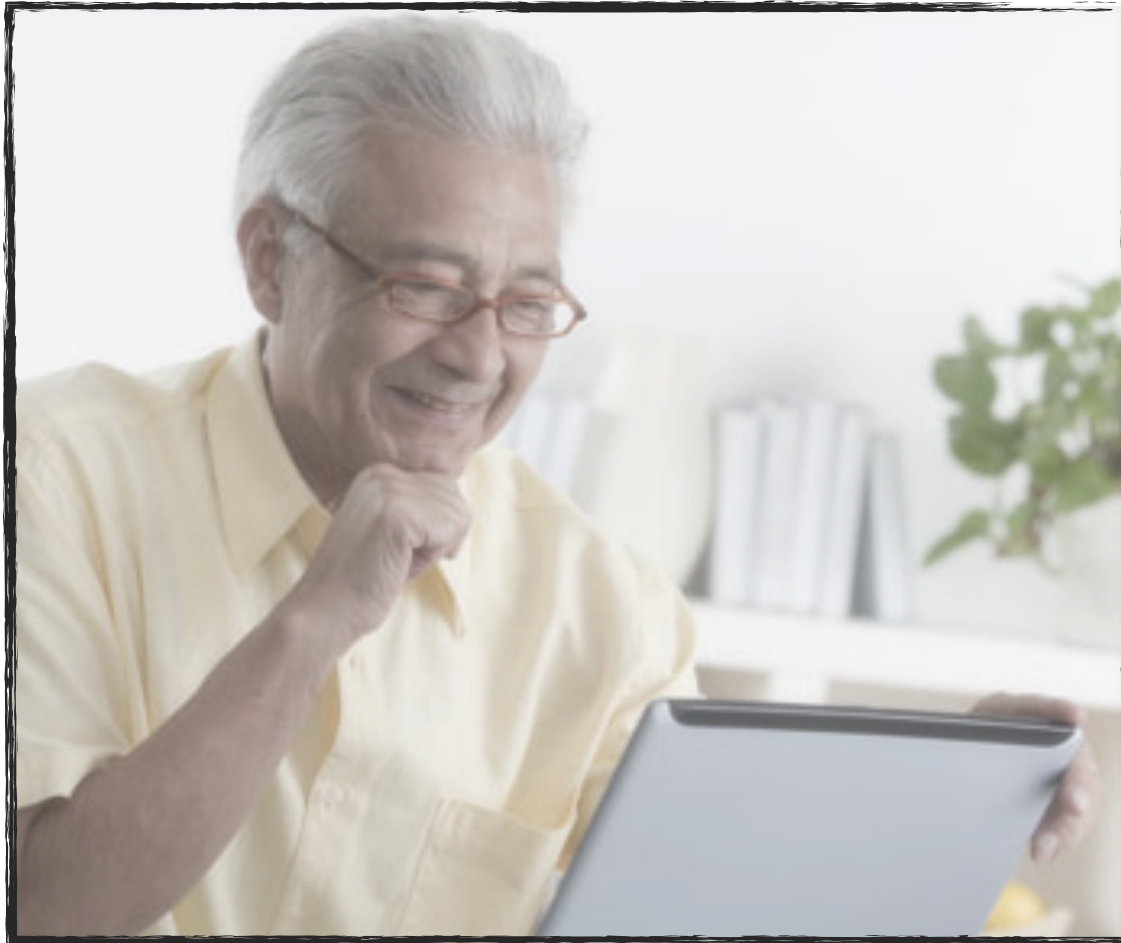


What is the current month?

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

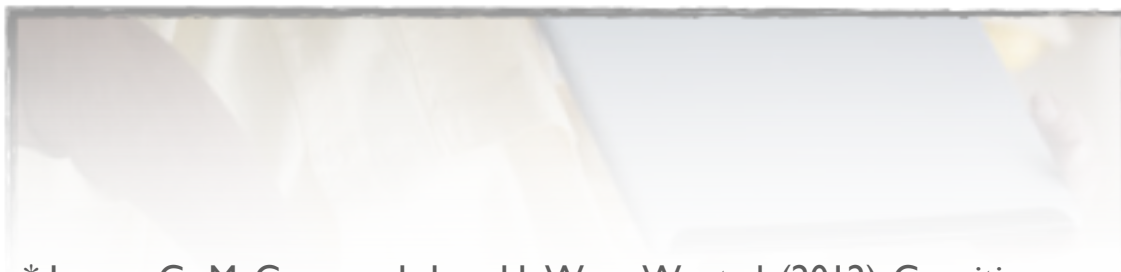


# C-TOC Research Projects



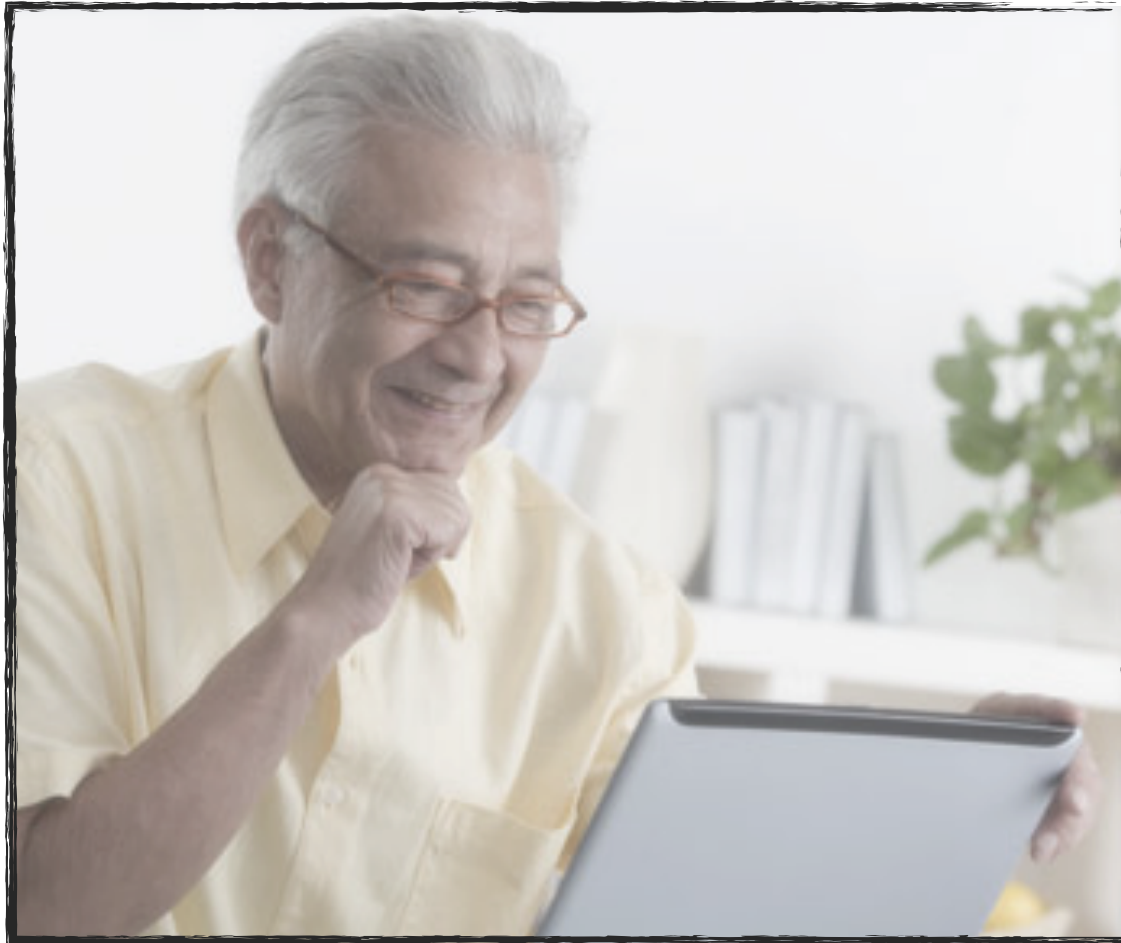
## I. Does C-TOC produce valid results?

Jacova *et al* (2012)\*



\* Jacova, C., McGrenere, J., Lee, H., Wang, W., et al. (2012). Cognitive Testing On Computer (C-TOC): Development and validation of a novel computerized testing tool for office and home administration. Accepted for presentation at *Alzheimer's Association International Conference (AAIC)*.

# C-TOC Research Projects



1. Does C-TOC produce valid results?

*Jacova et al (2012)\**

2. Is C-TOC usable by older adults?

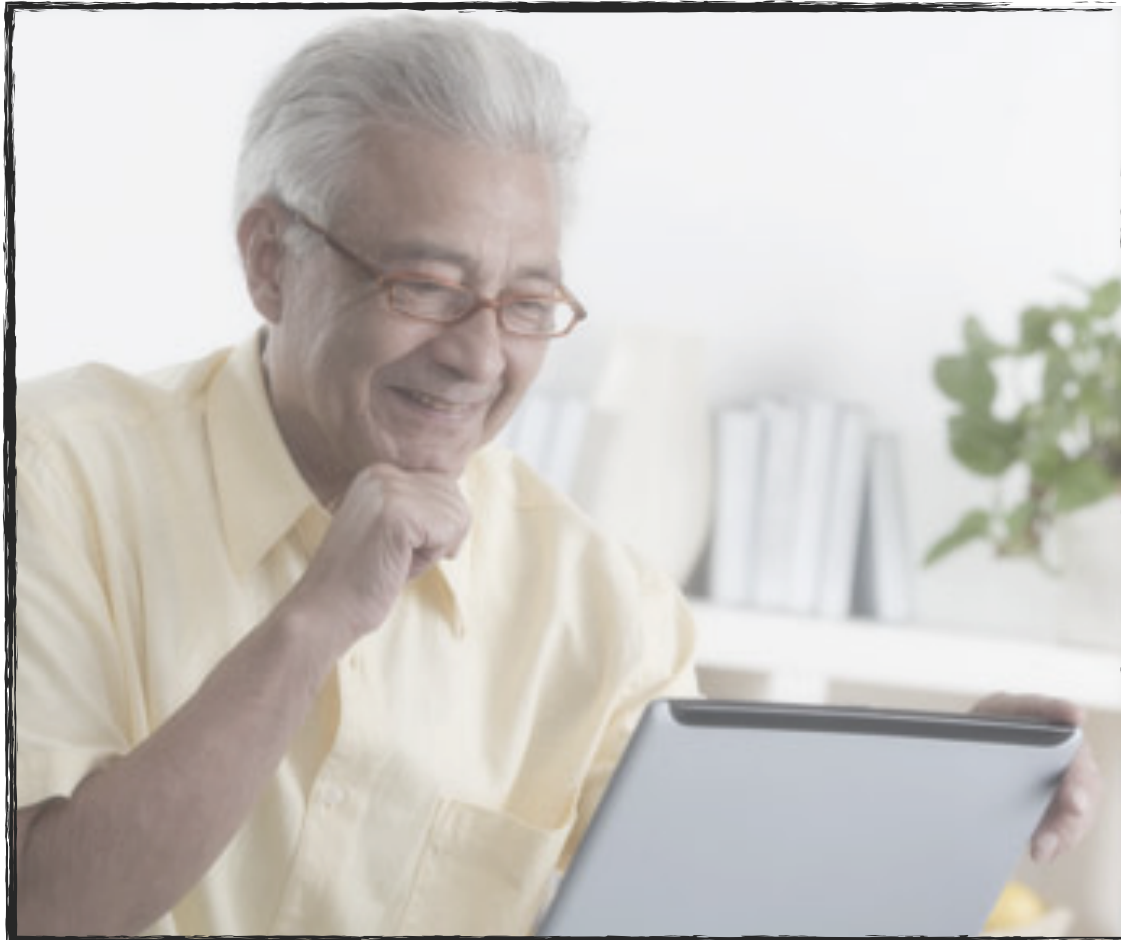
*Brehmer (2011)*



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# C-TOC Research Projects



1. Does C-TOC produce valid results?

*Jacova et al (2012)\**

2. Is C-TOC usable by older adults?

*Brehmer (2011)*

**3. Will C-TOC work in the home?**

\* Jacova, C., McGrenere, J., Lee, H., Wang, W., et al. (2012). Cognitive Testing On Computer (C-TOC): Development and validation of a novel computerized testing tool for office and home administration. Accepted for presentation at *Alzheimer's Association International Conference (AAIC)*.

# **Problem:** Impact of interruptions in the home?



# Research goal:

The cost of  
interruptions on  
C-TOC performance



# Research goal:

The cost of  
interruptions on  
C-TOC performance

Preserve test validity:  
prevent, detect, and  
mitigate interruptions





# The cost of interruption and **C-TOC**

How do we **measure** it?

How do we **predict** it?

Factors of **task** and **age**

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How do we **measure** it?

How do we **predict** it?

Factors of **task** and **age**



# Measuring the cost of interruption

Error rate / **accuracy**

Gillie & Broadbent (1989), Oulasvirta & Saariluoma (2006)

Task **completion time**

Zijlstra et al (1999)

Task **resumption time**

Altmann & Trafton (2004), Iqbal & Horvitz (2007)

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Altmann & Trafton (2004), Iqbal & Horvitz (2007)



# Predicting the cost of interruption

## Primary task **demand**

Bailey et al (2000), Speier et al (2003)

## Primary **task structure**

Iqbal & Bailey (2006)

## Interrupting task **demand**

Gillie & Broadbent (1989), Oulasvirta & Saariluoma (2006)

## **Similarity** of primary and interrupting tasks

Gillie & Broadbent (1989), Bailey et al (2000)

## **Duration** of interruptions

Bailey et al (2000), Monk et al (2008)

## **Frequency** of interruptions

Zijlstra et al (1999)

## **Warning** preceding an interruption (interruption lag)

Altmann & Trafton (2004)

## **Contextual** and **social** factors

Iqbal & Horvitz (2007), Storch (1992)

# Age and the cost of interruption

Natural cognitive aging:



Processing speed



Activation of working memory



Suppression and inhibition



Cognitive fatigue

# Age and the cost of interruption

Natural cognitive aging:



Processing speed



Activation of working memory



Suppression and inhibition



Cognitive fatigue

Interruptions more disruptive

Clapp & Gazzaley (2005), Farrimond et al (2006)

# Age and the cost of interruption

Natural cognitive aging:



Processing speed



Activation of working memory



Suppression and inhibition



Cognitive fatigue

Interruptions more disruptive

Clapp & Gazeley (2005), Farrimond et al (2006)

Interruptions and **C-TOC's**  
open-ended puzzle tasks?



# Study Design

## **3 Age Groups**

$N = 3 \times 12$

**YOUNG**

19 – 54

**PRE-OLD**

55 – 69

**OLD**

70 +

# Study Design

## 3 Age Groups

$N = 3 \times 12$

**YOUNG**

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**PRE-OLD**

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## 2 Primary tasks

**VERBAL**  
working memory

**SPATIAL**  
problem solving

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## 3 Age Groups

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## 2 Primary tasks

**VERBAL**  
working memory

**SPATIAL**  
problem solving

## 3 levels of Interruption demand

**NONE**  
no interruptions

**LOW**  
passive interruptions

**HIGH**  
active interruptions

# Study Design

## 3 Age Groups

$N = 3 \times 12$

**YOUNG**

19 – 54

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active interruptions

# Study Design - Primary Tasks

**2 Primary  
tasks**

**VERBAL**

SPATIAL

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

Otherwise move all the figures to  
the right.

Continue

**Step 1:** Instruction

# Study Design - Primary Tasks

**2 Primary tasks**

**VERBAL**

SPATIAL

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

Otherwise move all the figures to the right.

Continue



Next

**Step 1:** Instruction



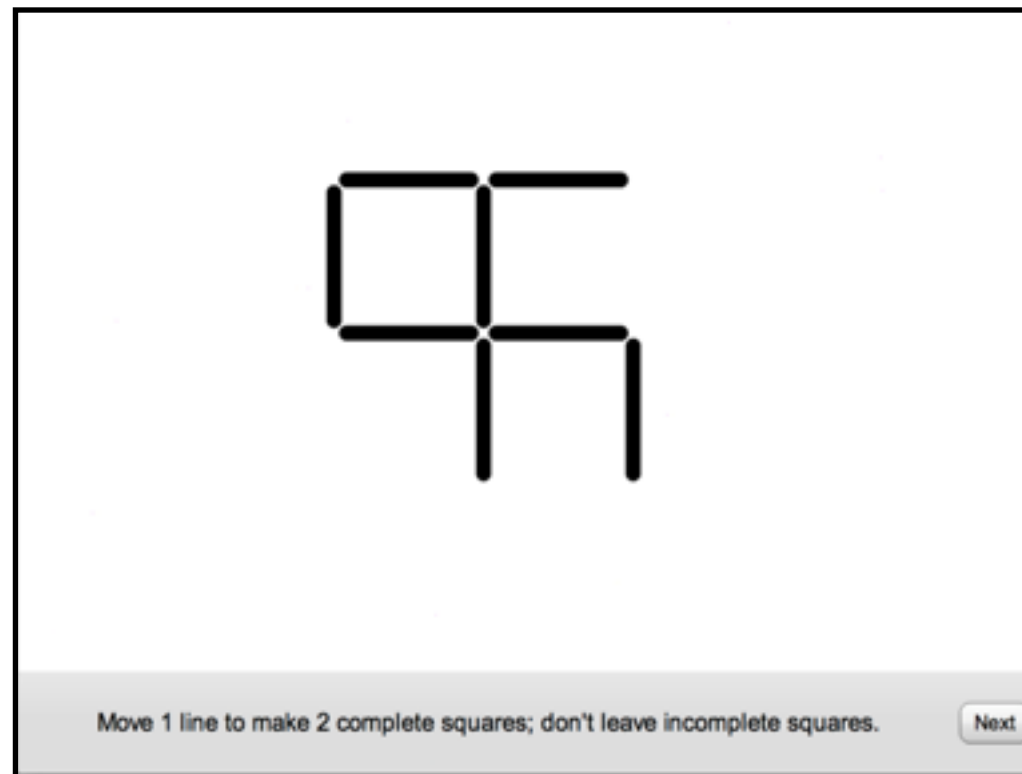
**Step 2:** Execution

# Study Design - Primary Tasks

**2 Primary  
tasks**

**VERBAL**

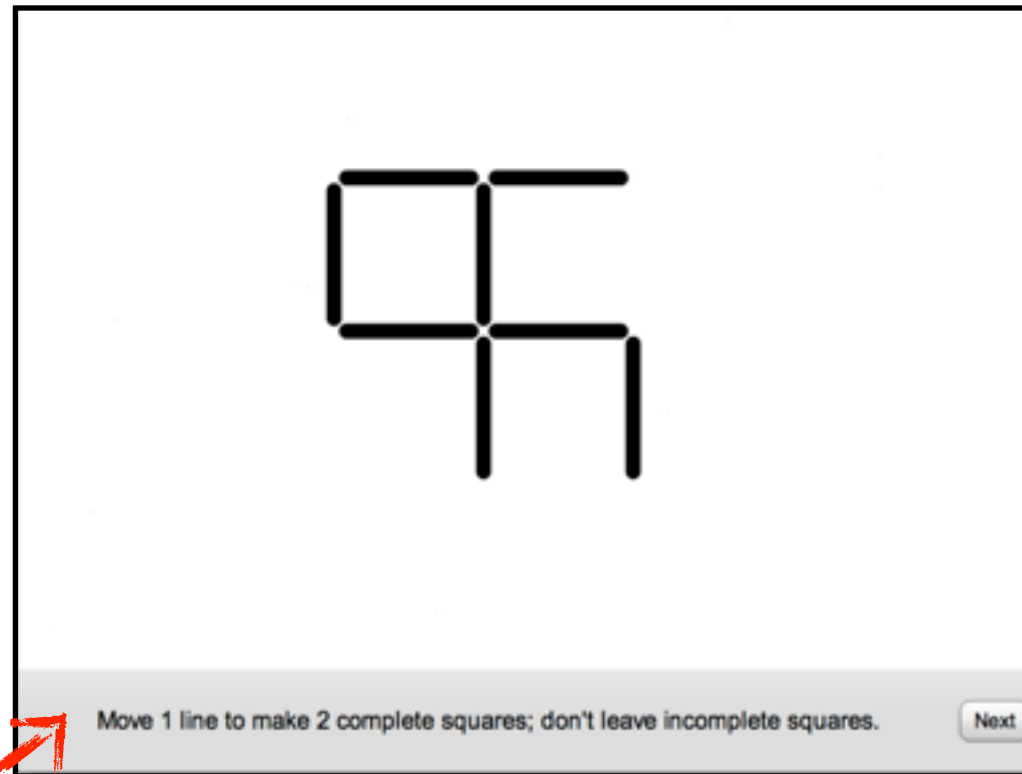
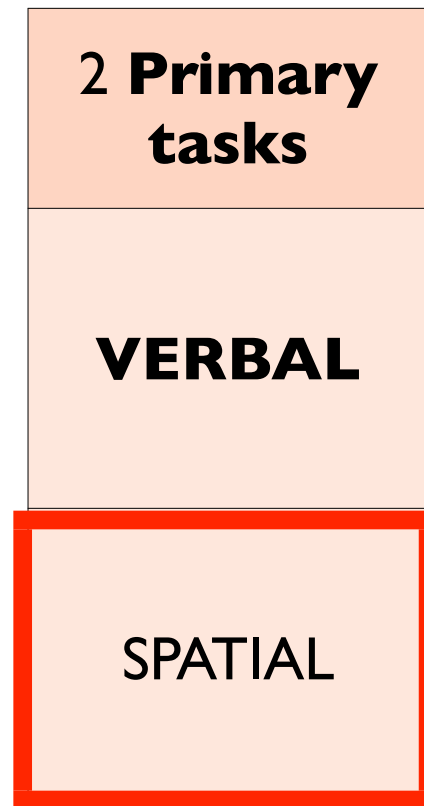
**SPATIAL**



Initial



# Study Design - Primary Tasks



Initial

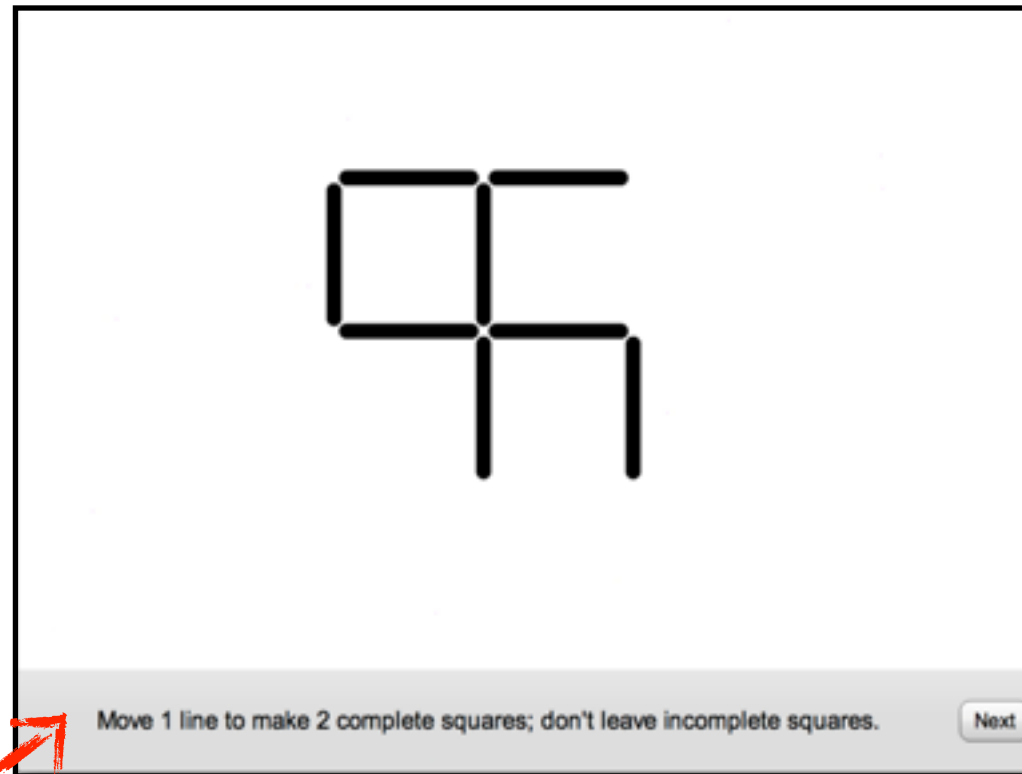
*“Move **X** line(s) to  
make **Y** complete  
squares;  
  
don't leave  
incomplete squares.”*

# Study Design - Primary Tasks

2 Primary  
tasks

VERBAL

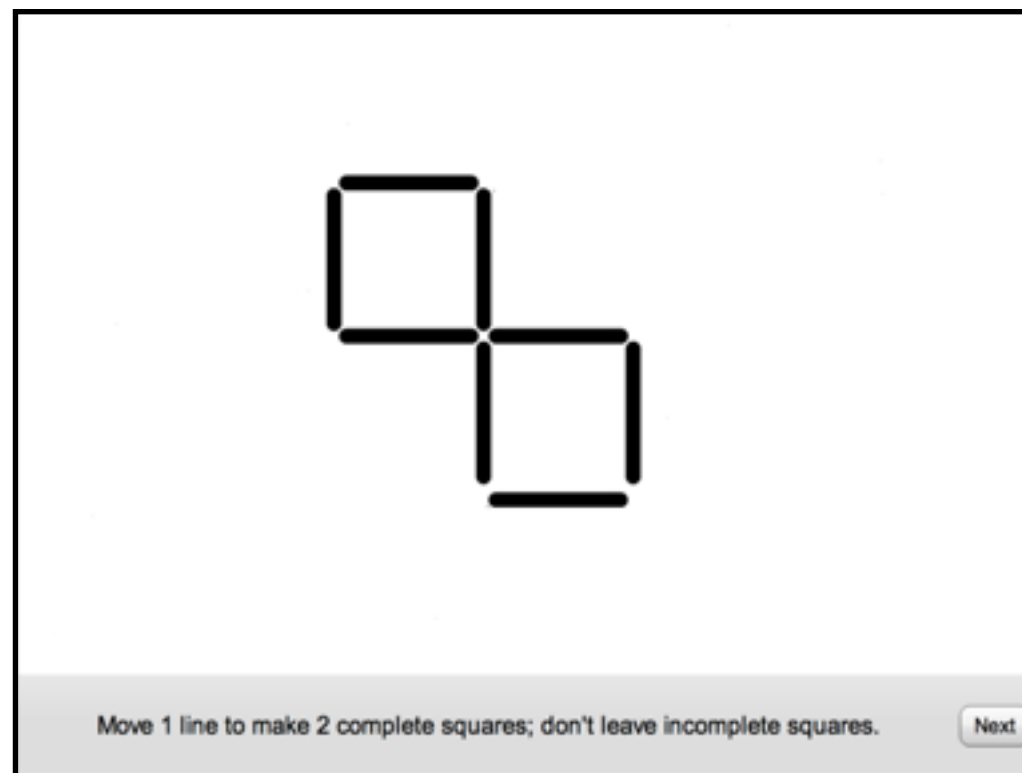
SPATIAL



Initial



Completed



*“Move **X** line(s) to  
make **Y** complete  
squares;  
don't leave  
incomplete squares.”*

# Study Design

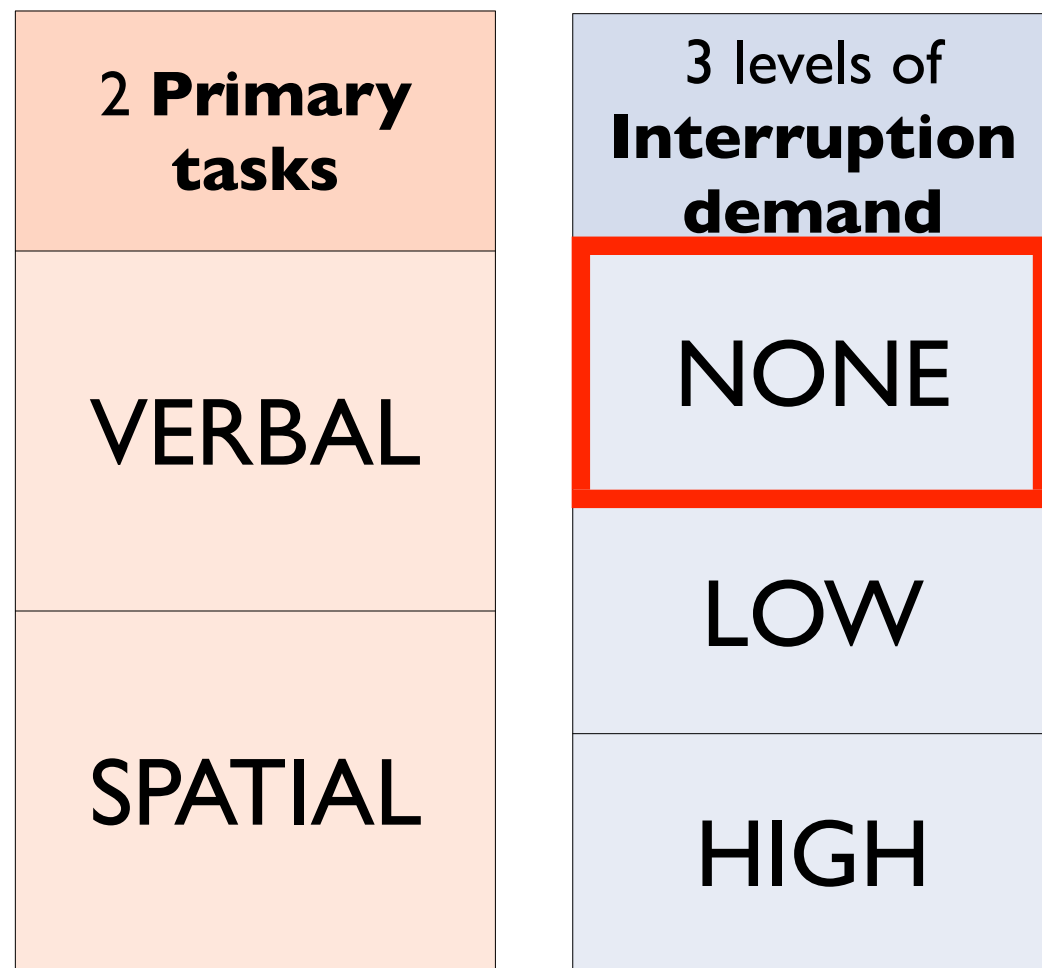
2 Primary tasks	3 levels of Interruption demand
VERBAL	NONE
	LOW
SPATIAL	HIGH

For each primary task,  
**3 sets of 10 trials**

**Subset of 4 trials**  
interrupted in LOW and  
HIGH demand conditions

Fixed interruption  
**onset** and **duration**

# Study Design

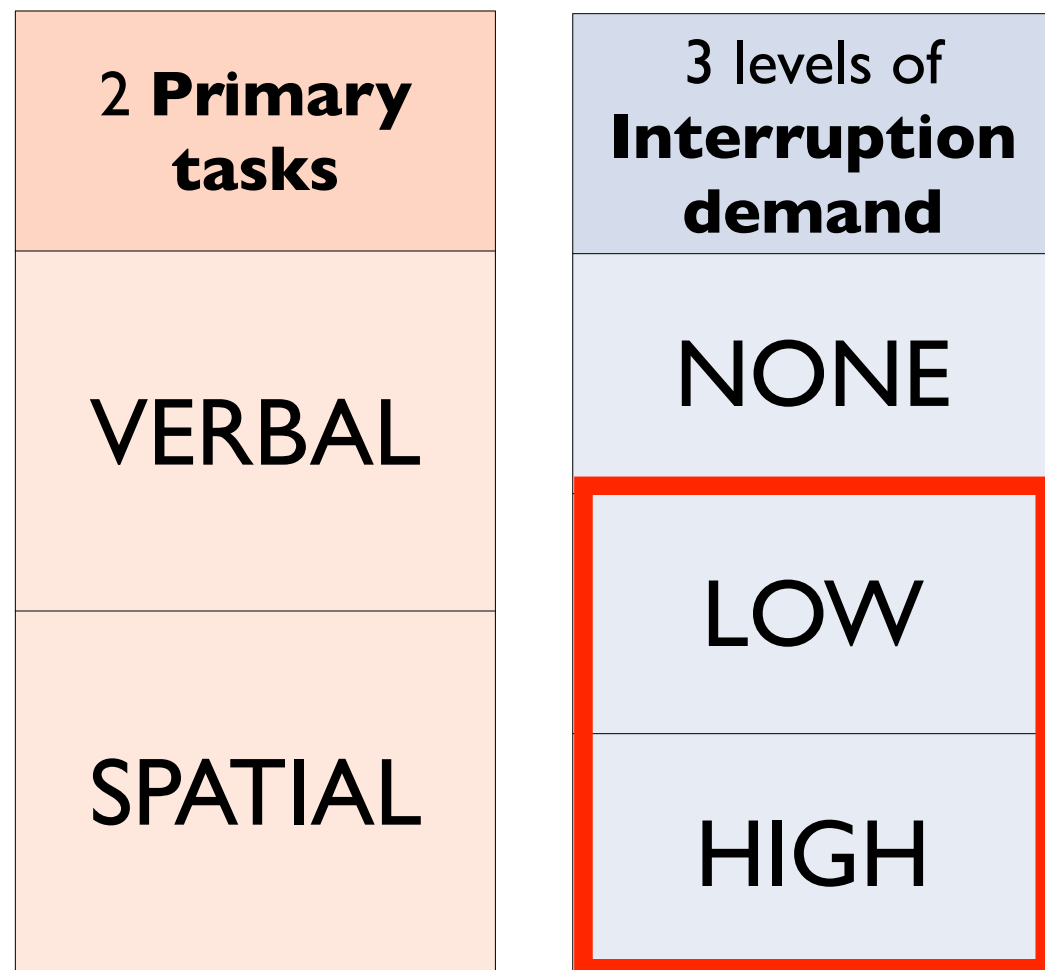


For each primary task,  
**3 sets of 10 trials**

**Subset of 4 trials**  
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Fixed interruption  
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# Study Design



For each primary task,  
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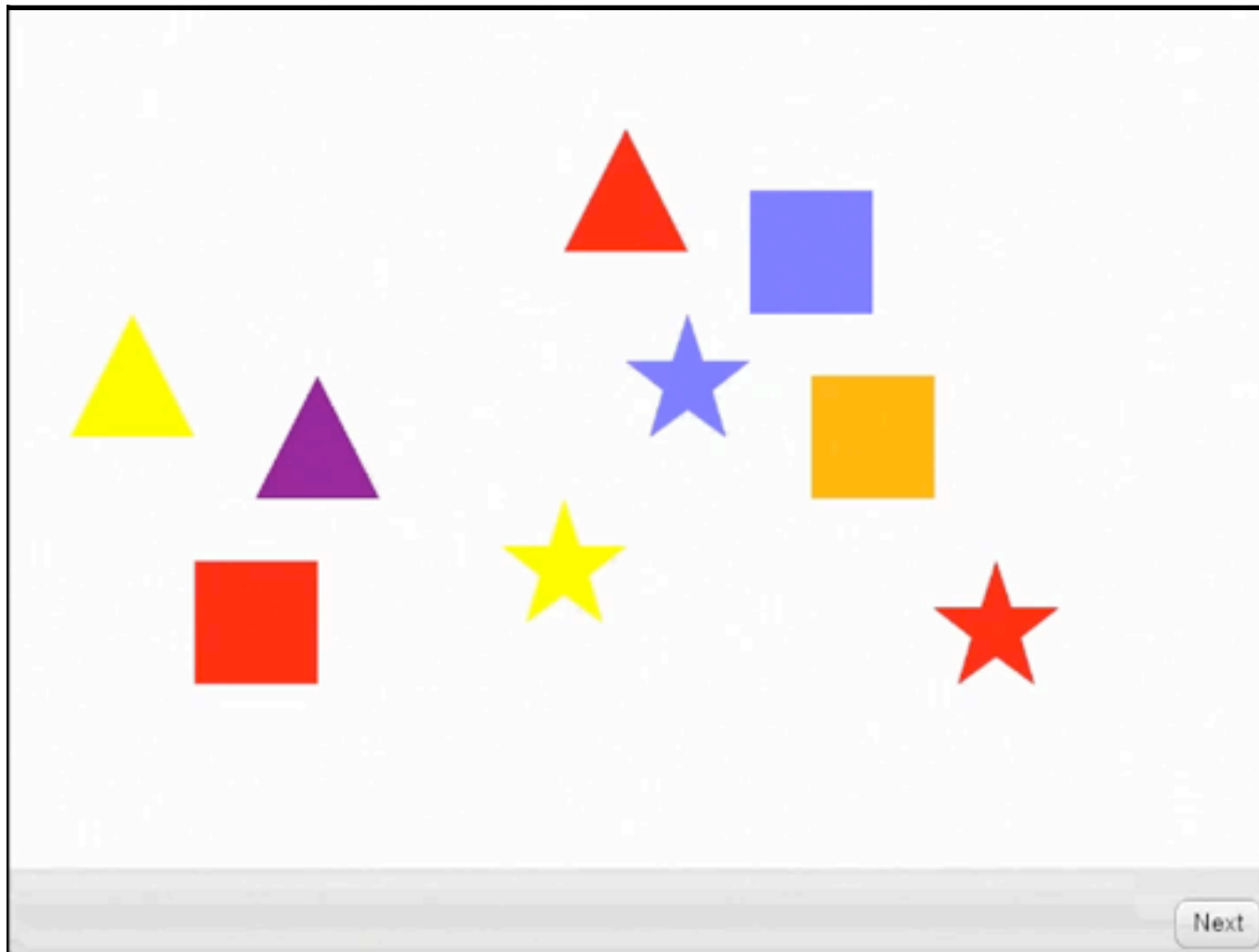
**Subset of 4 trials**  
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Fixed interruption  
**onset** and **duration**

# Study Design - Interruptions

3 levels of <b>Interruption demand</b>
<b>NONE</b>
<b>LOW</b>
<b>HIGH</b>

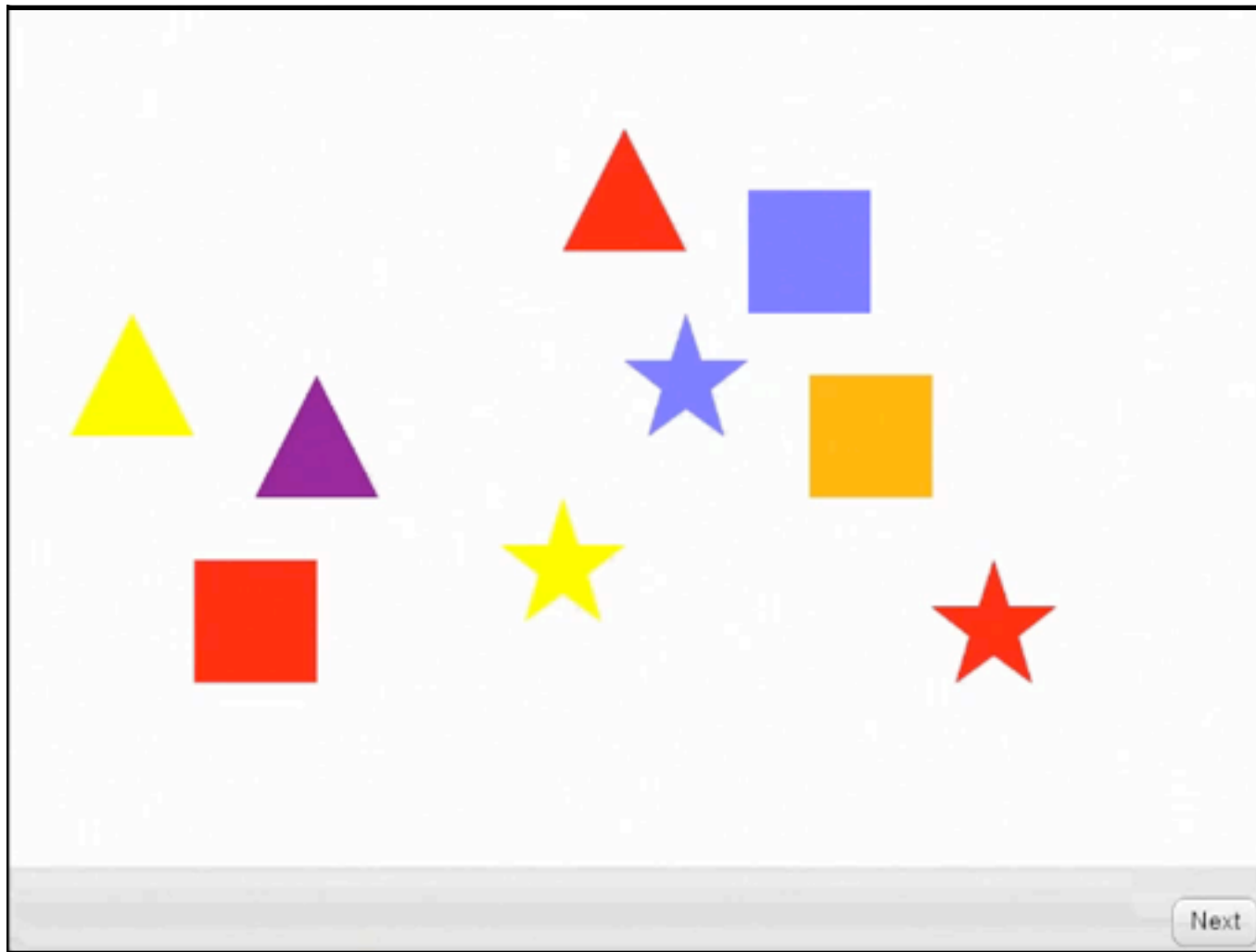
# Study Design - Interruptions



3 levels of Interruption demand
NONE
<b>LOW</b>
HIGH



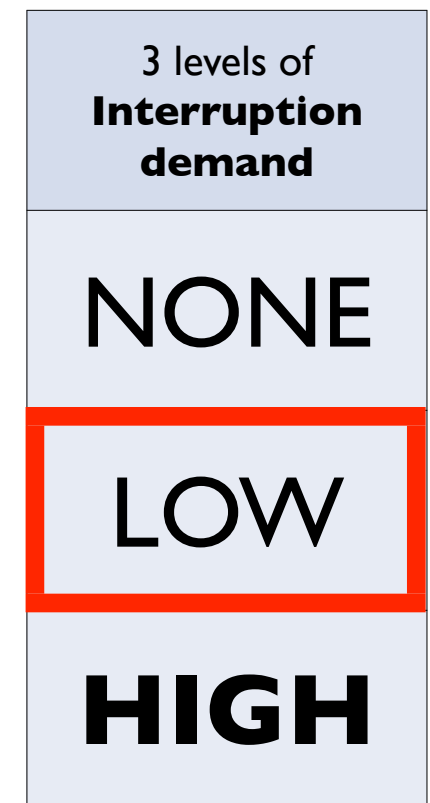
# Study Design - Interruptions



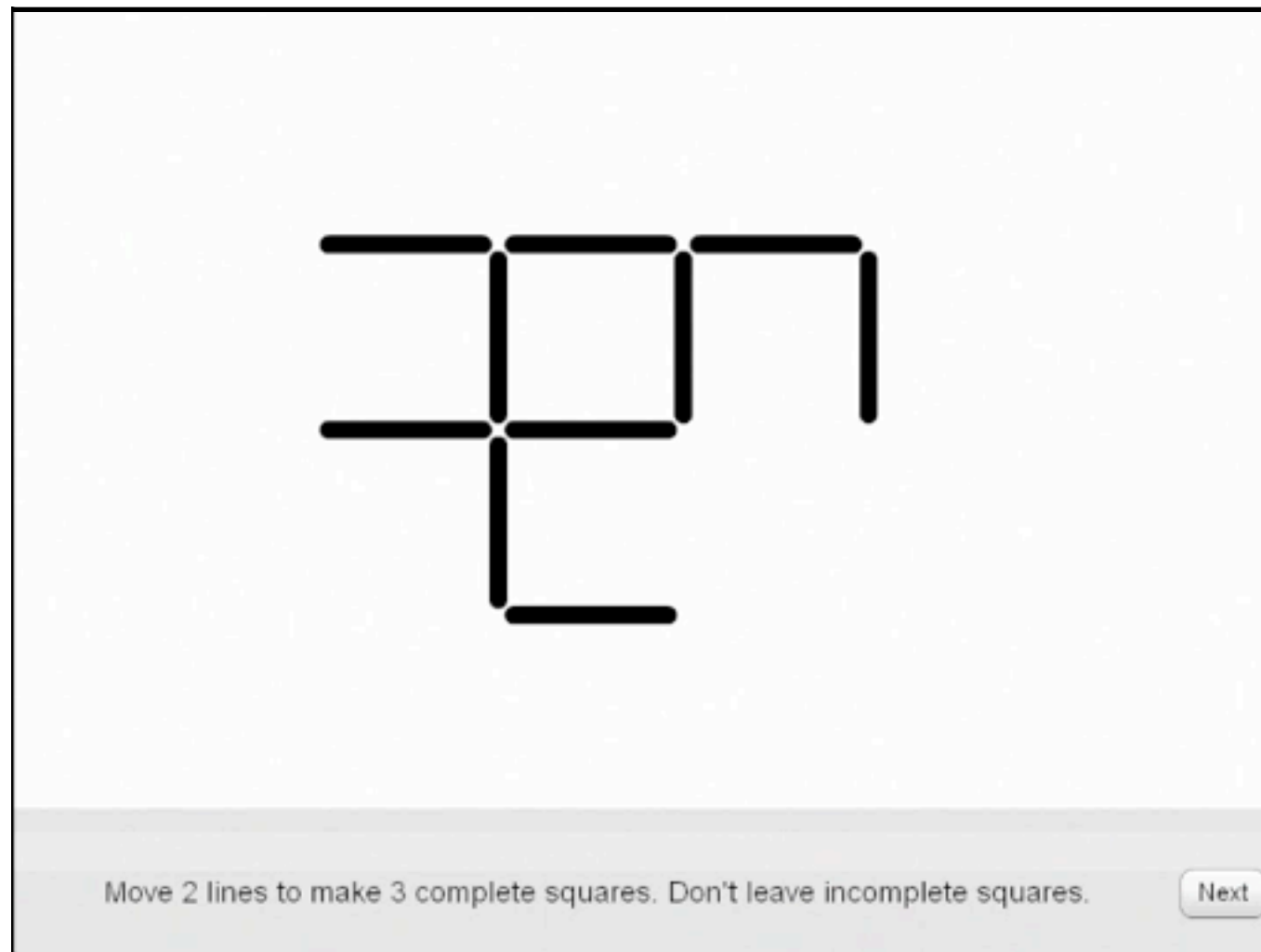
3 levels of Interruption demand
NONE
<b>LOW</b>
HIGH

**Note:** video playback speed is doubled

# Study Design - Interruptions

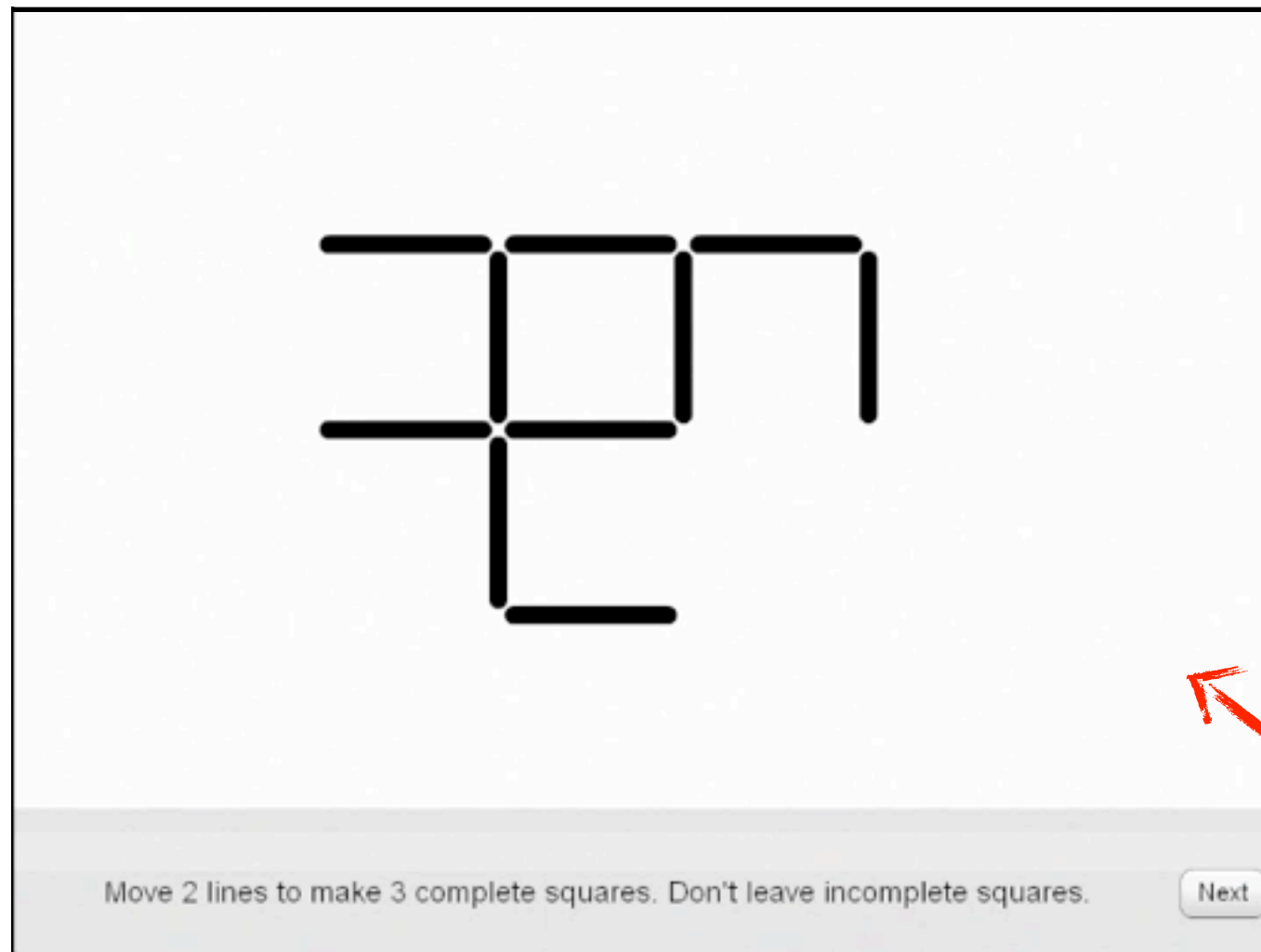


# Study Design - Interruptions



3 levels of Interruption demand
NONE
LOW
<b>HIGH</b>

# Study Design - Interruptions



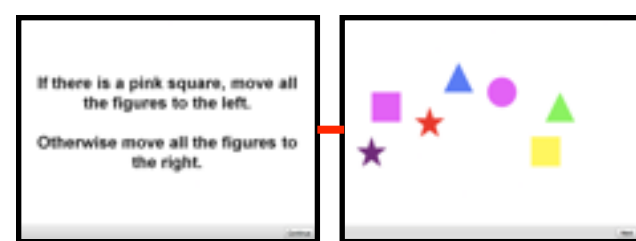
3 levels of Interruption demand
NONE
LOW
<b>HIGH</b>

*The **n-back**  
working  
memory task*  
[Owen et al (2005)]

**Note:** video playback speed is doubled

# **Study Design - Interruption timeline**

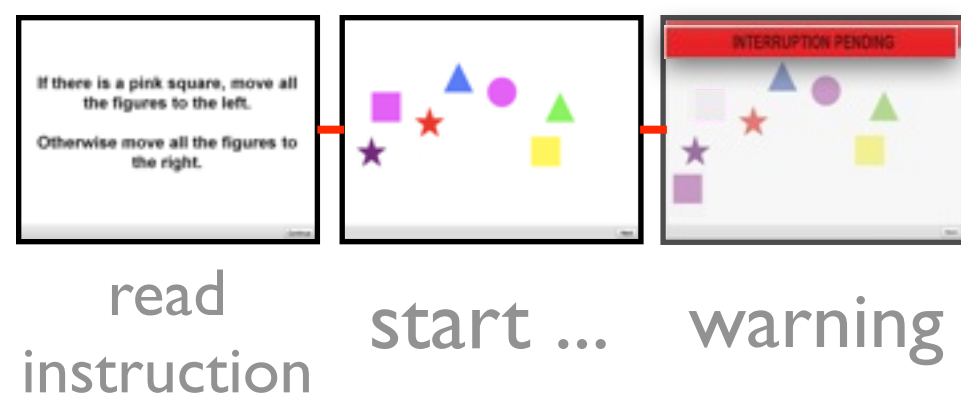
# Study Design - Interruption timeline



read  
instruction

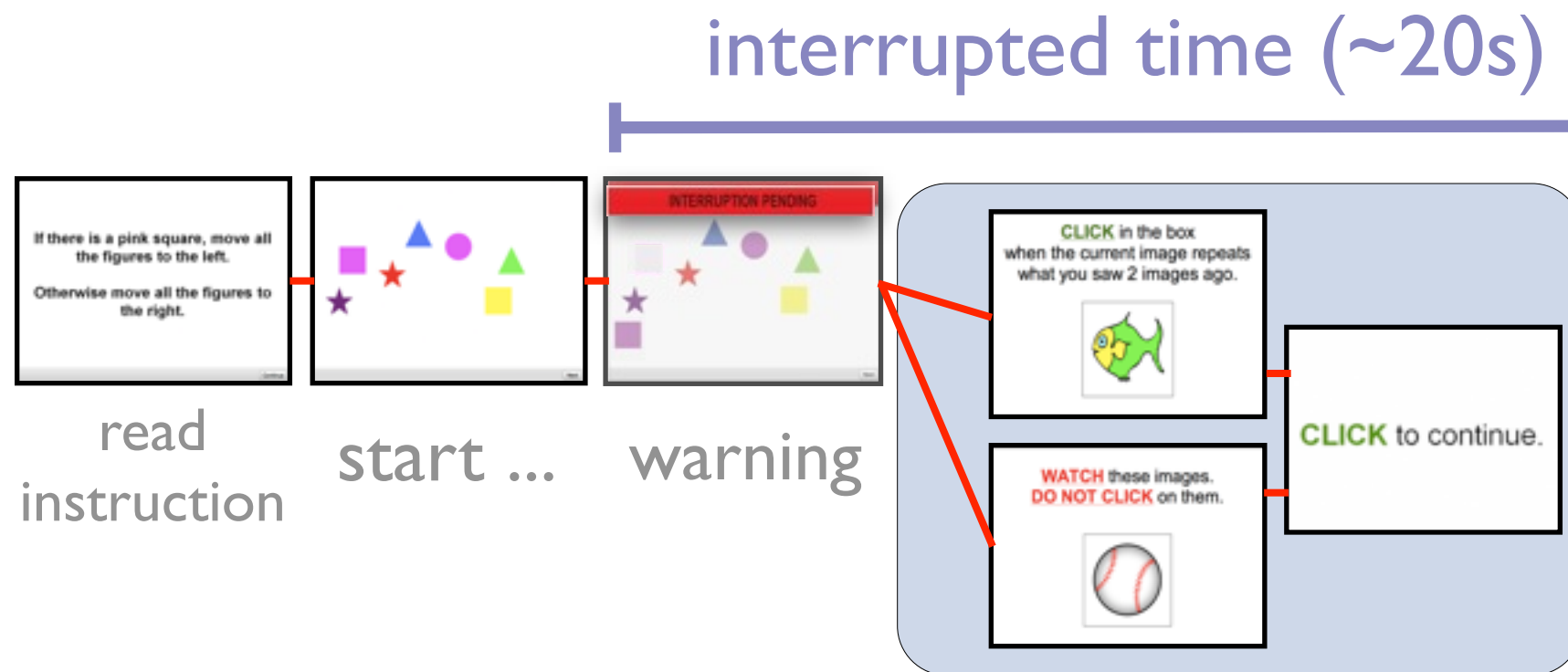
start ...

# Study Design - Interruption timeline

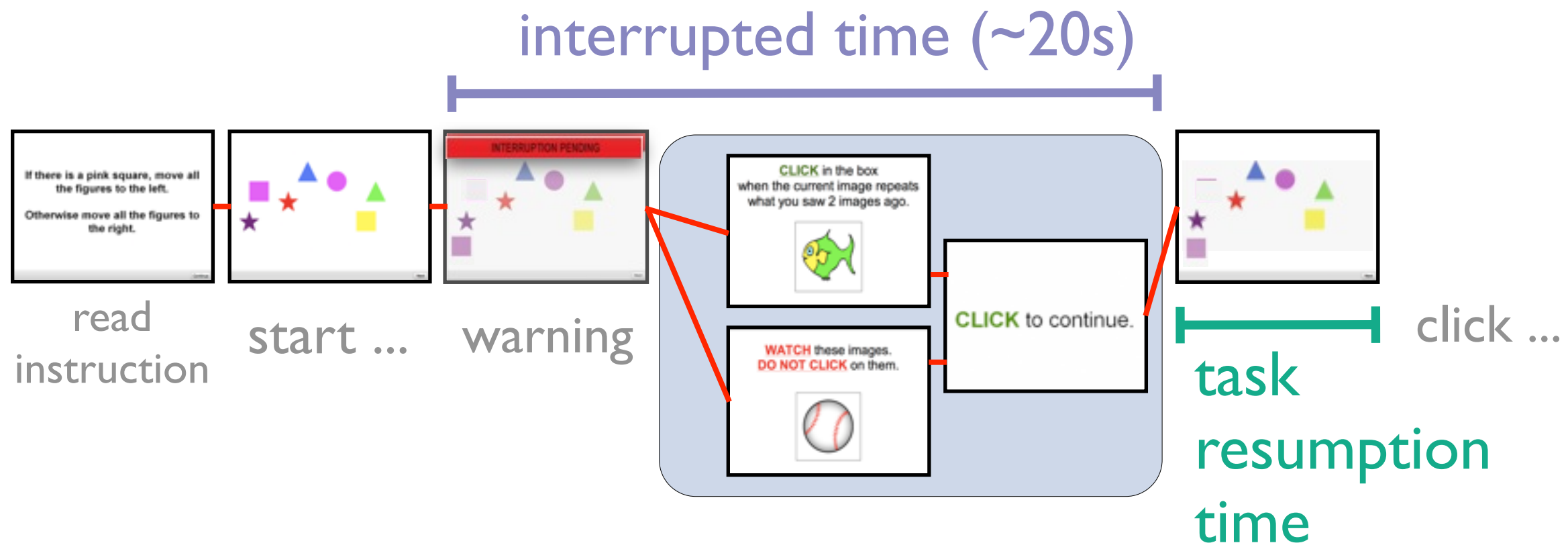




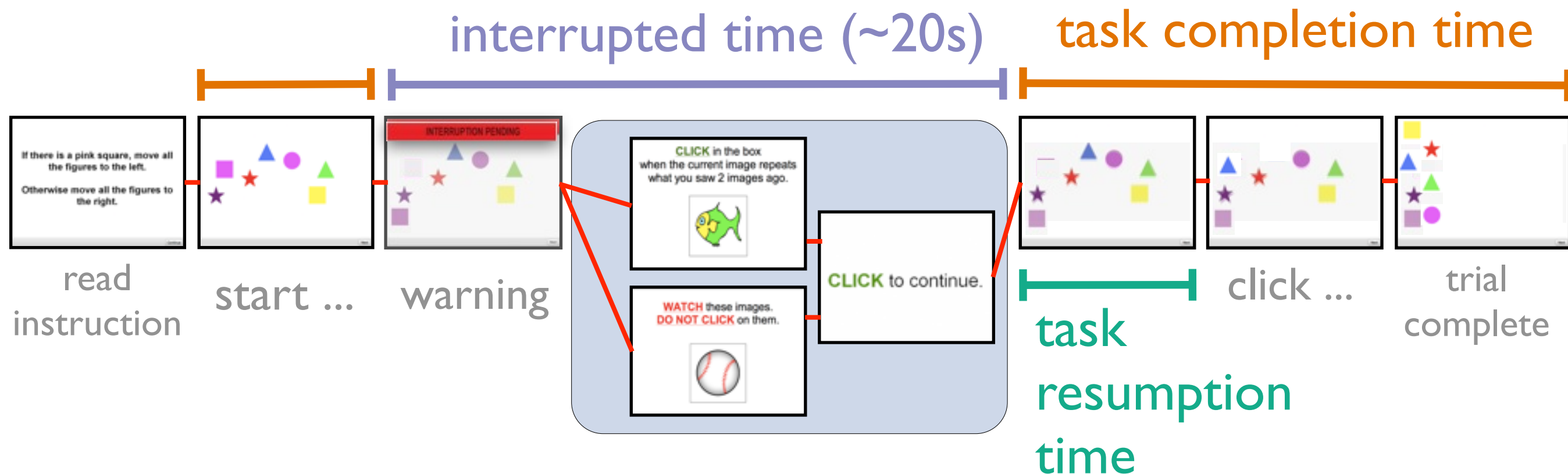
# Study Design - Interruption timeline



# Study Design - Interruption timeline



# Study Design - Interruption timeline



# Hypotheses

H1. Overall, **YOUNG** adults will perform better than **OLD** adults.

## Hypotheses

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H3. **H1 + H2** will be more pronounced in the VERBAL task



**Supported**

H1. Overall, **YOUNG** adults will perform better than **OLD** adults.

Partially  
Supported

H2. **OLD** adults will incur a disproportionately greater cost of interruption

Partially  
Supported

H3. **H1 + H2** will be more pronounced in the VERBAL task

# **Key Results:** **YOUNG** and **OLD**

## **Dependent measures:**

- accuracy
- task resumption time
- task completion time

# Key Results:

**YOUNG** and  
**OLD**

## Dependent measures:

- accuracy
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- task completion time

**OLD** less accurate than **YOUNG**

# Key Results:

**YOUNG** and  
**OLD**

## Dependent measures:

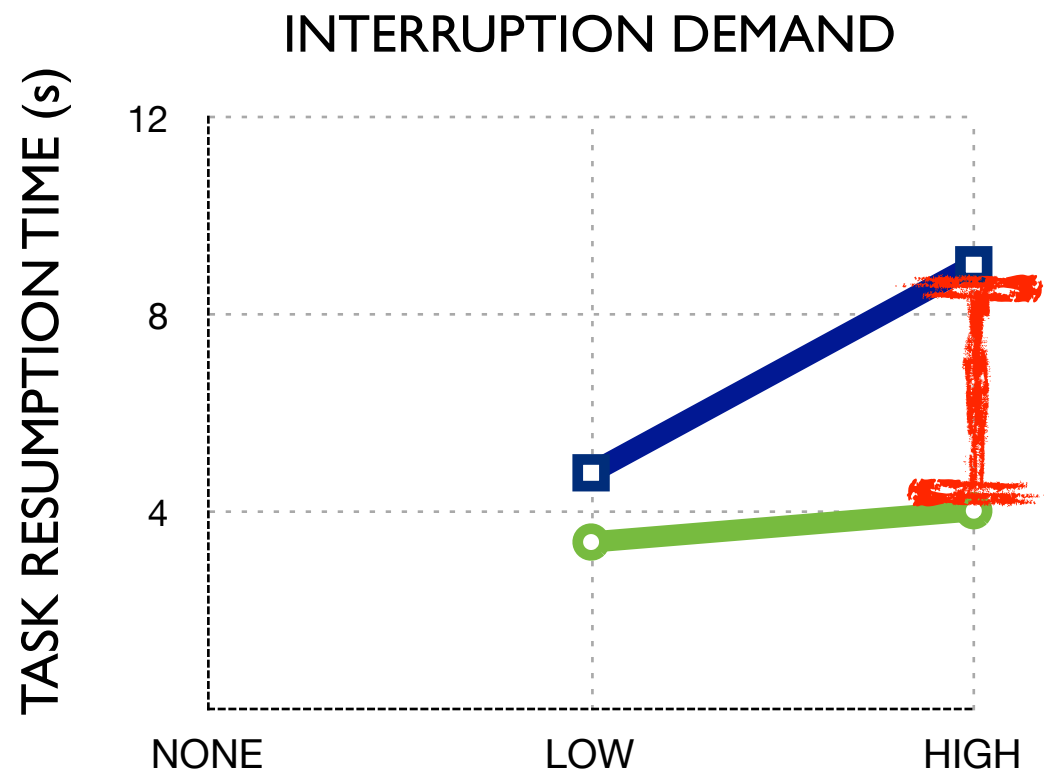
- accuracy
- task resumption time
- task completion time

**OLD** less accurate than **YOUNG**

**No effect** of interruption  
demand on **accuracy**

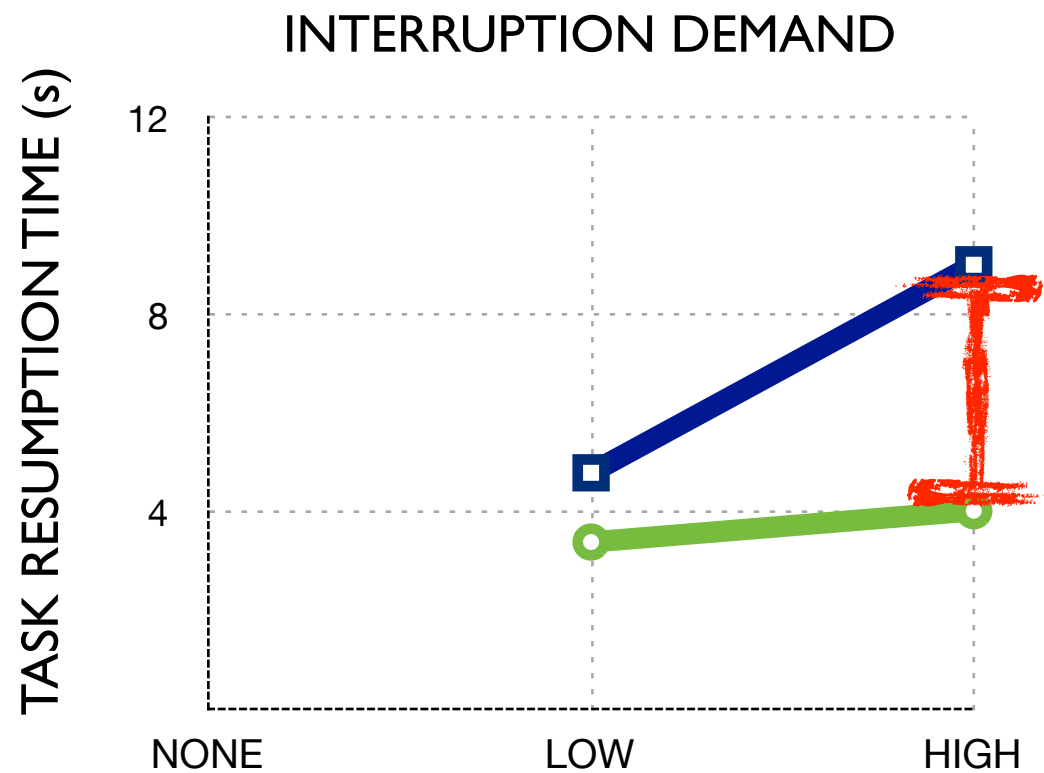
# **Key results - VERBAL task**

# Key results - VERBAL task

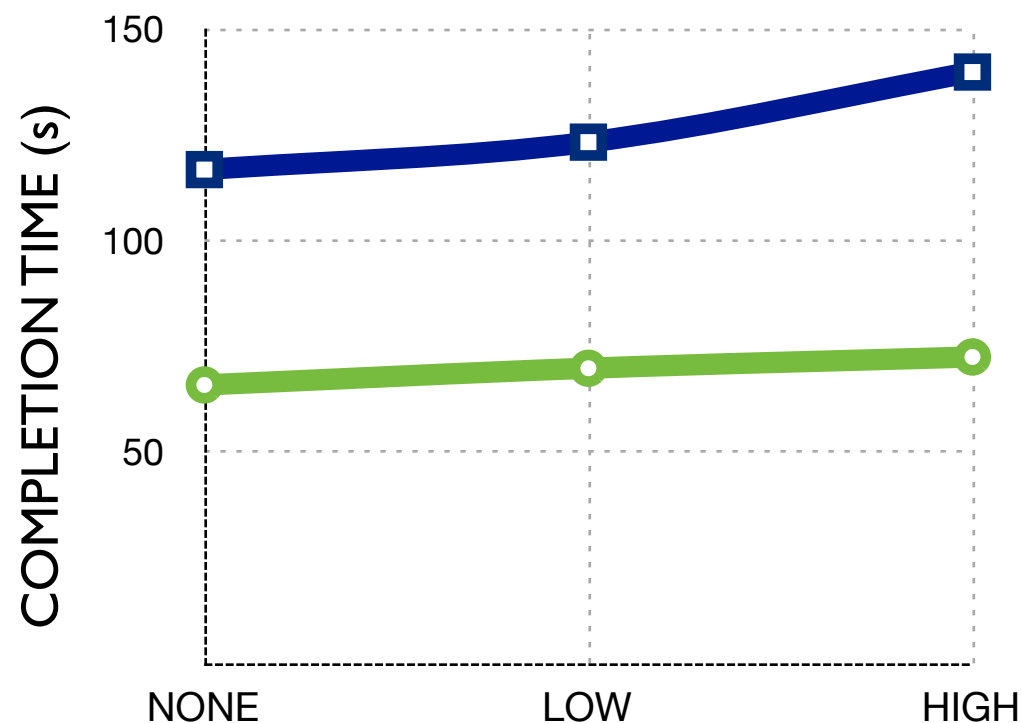


**OLD** disproportionately slower than **YOUNG** to resume the task

# Key results - VERBAL task

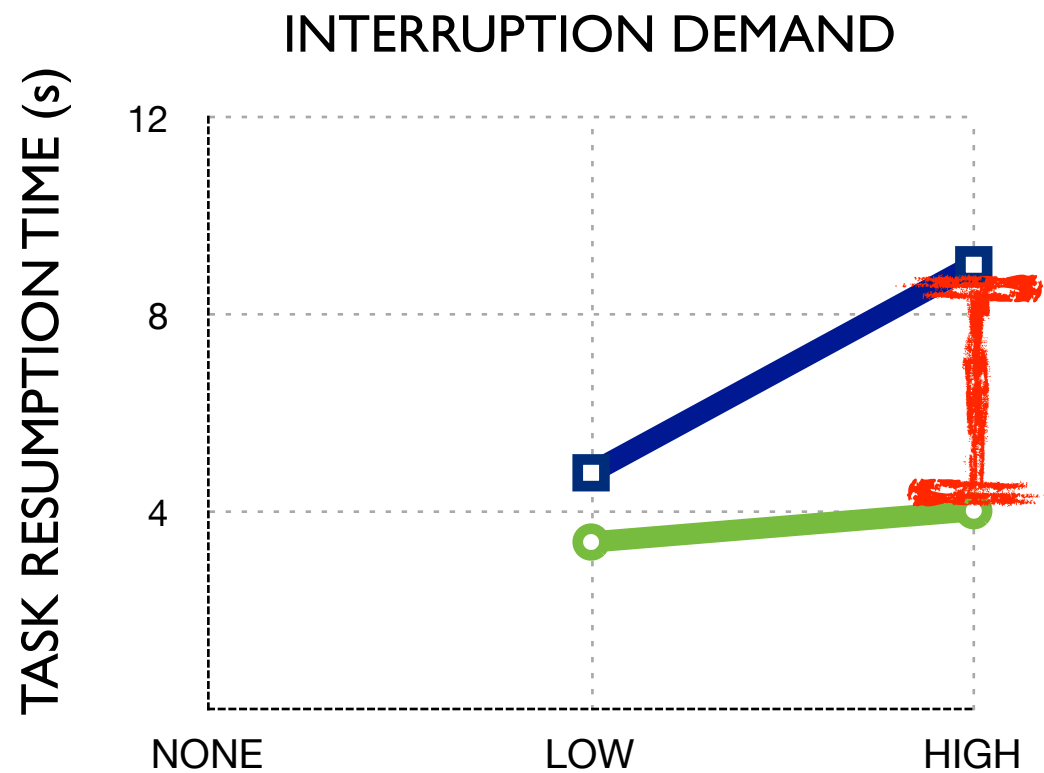


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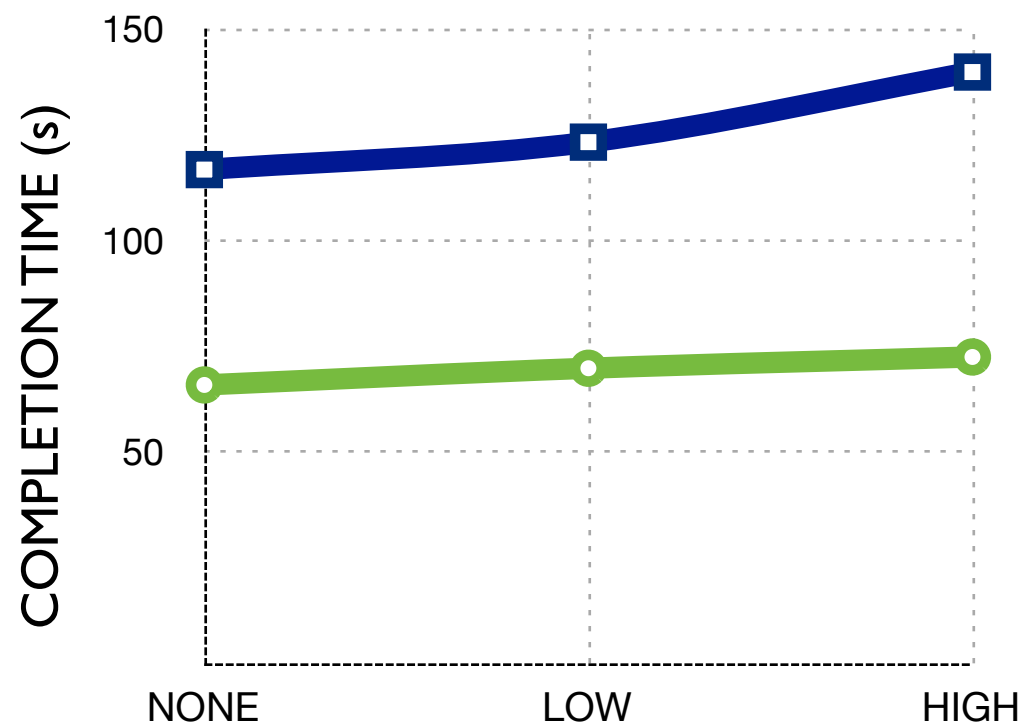


**OLD** NOT disproportionately slower to complete the task

# Key results - VERBAL task



**OLD** disproportionately slower than **YOUNG** to resume the task

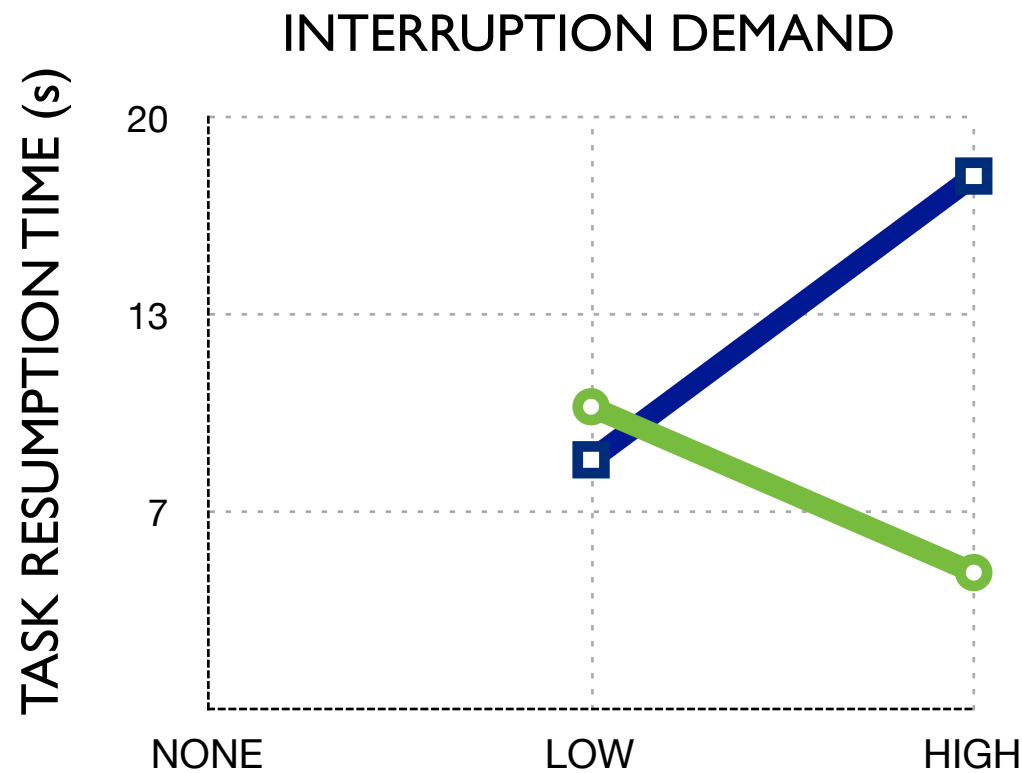


**OLD** NOT disproportionately slower to complete the task

Compensation following interruption



# Key results - SPATIAL task



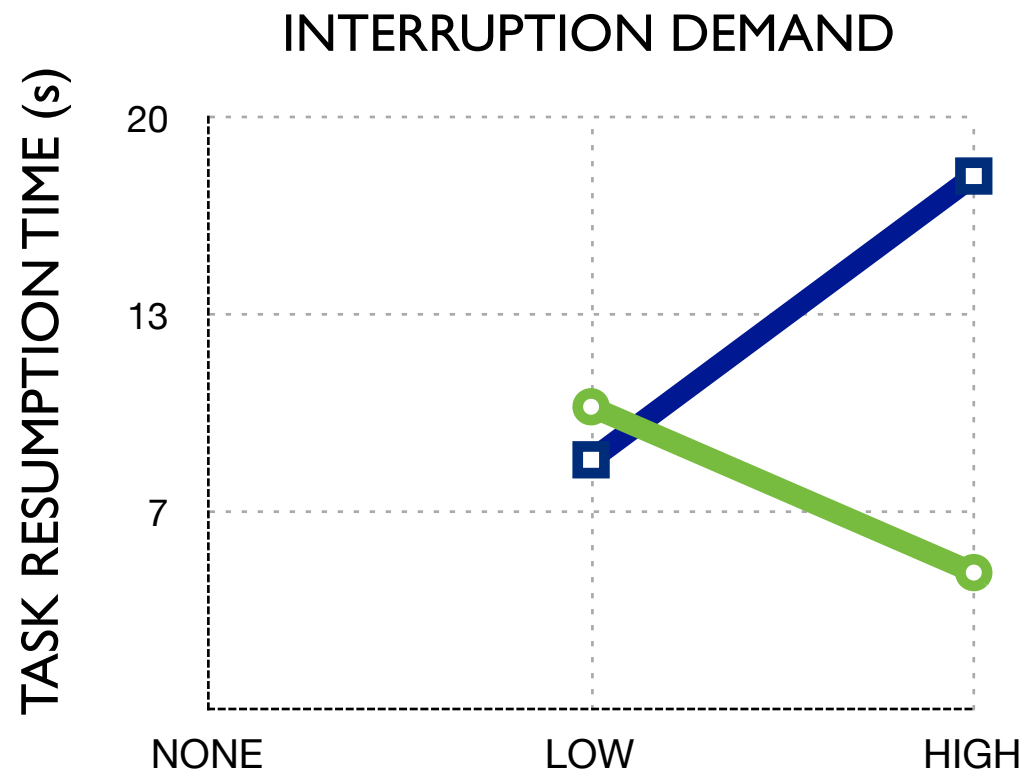
Interruption demand affected **YOUNG** and **OLD** differently

**OLD** **slower** to complete the task, **except** in LOW-demand condition

Possible mind wandering

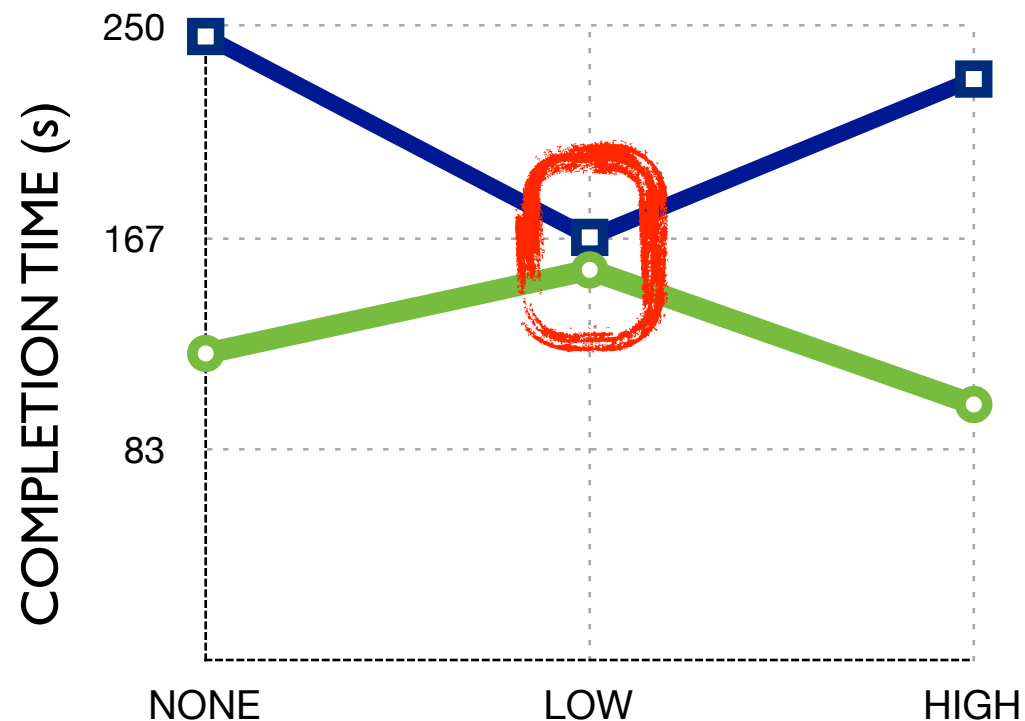
**OLD** more conscientious?

# Key results - SPATIAL task



Interruption demand affected **YOUNG** and **OLD** differently

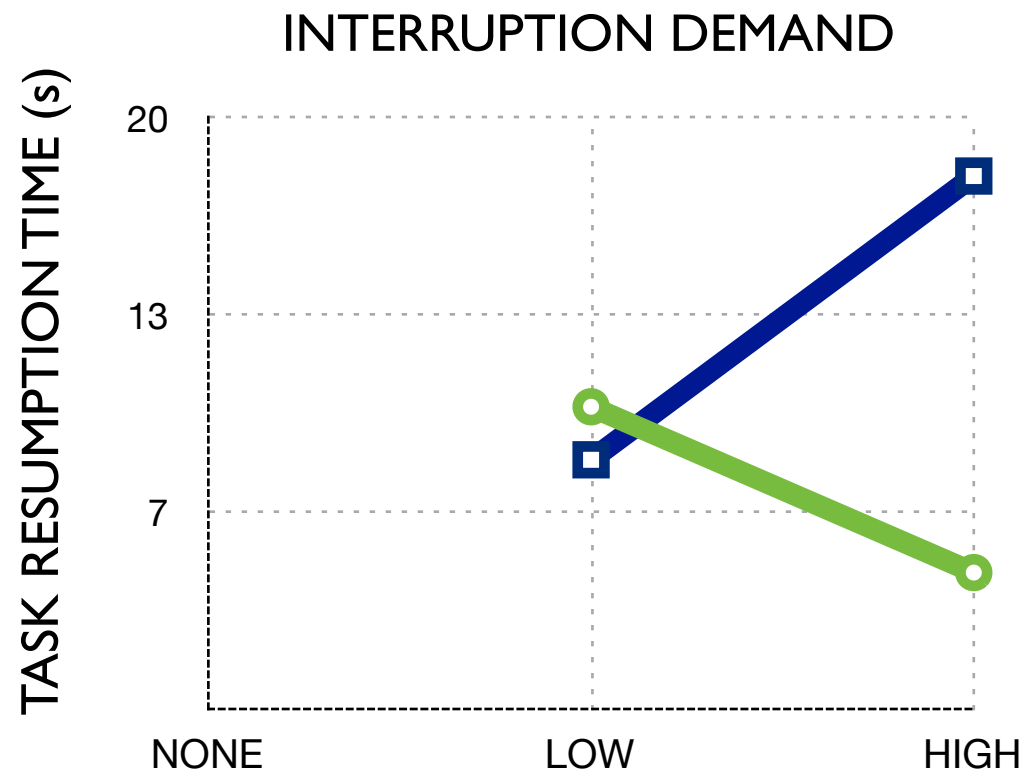
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Possible mind wandering

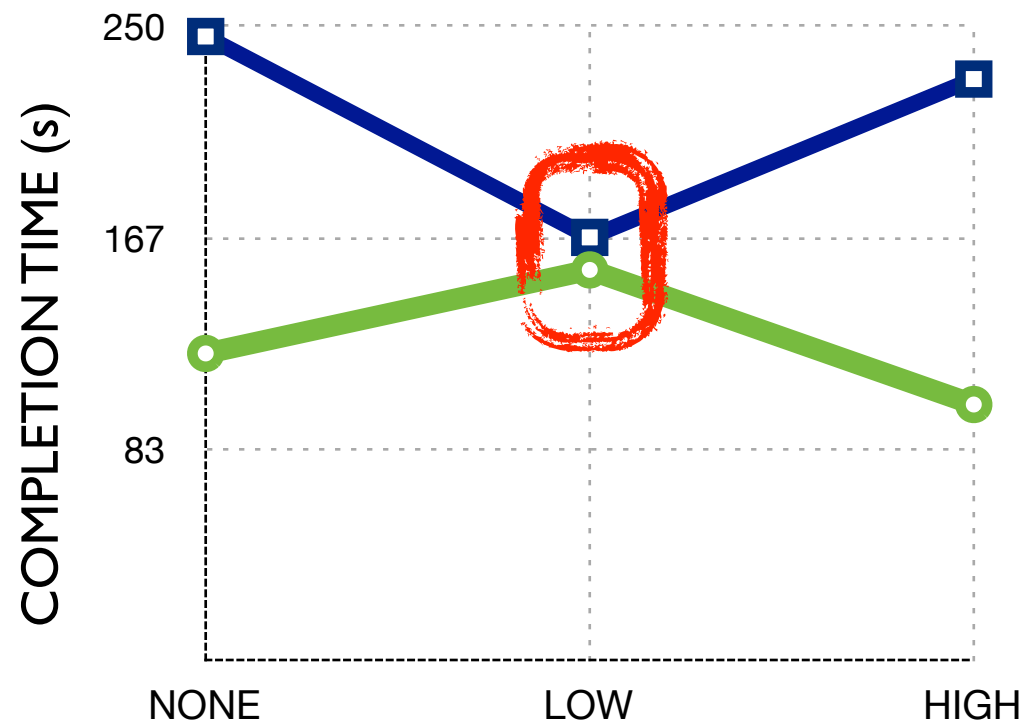
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# Key results - SPATIAL task



Interruption demand affected **YOUNG** and **OLD** differently

**OLD** **slower** to complete the task, **except** in LOW-demand condition



Possible mind wandering

**OLD** more conscientious?

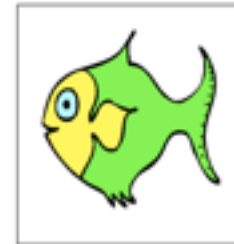
Valid interrupting tasks:  
further research needed

Methodological  
implications:  
**Interruption  
Validity**

WATCH these images.  
DO NOT CLICK on them.



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



Valid interrupting tasks:  
further research needed

Methodological  
implications:  
**Interruption  
Validity**




Design  
implications:

# **Preventing interruptions**

# Prevent interruptions with prompts specific to each test

Design  
implications:

## Preventing interruptions



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?

Back

4

Next

Back

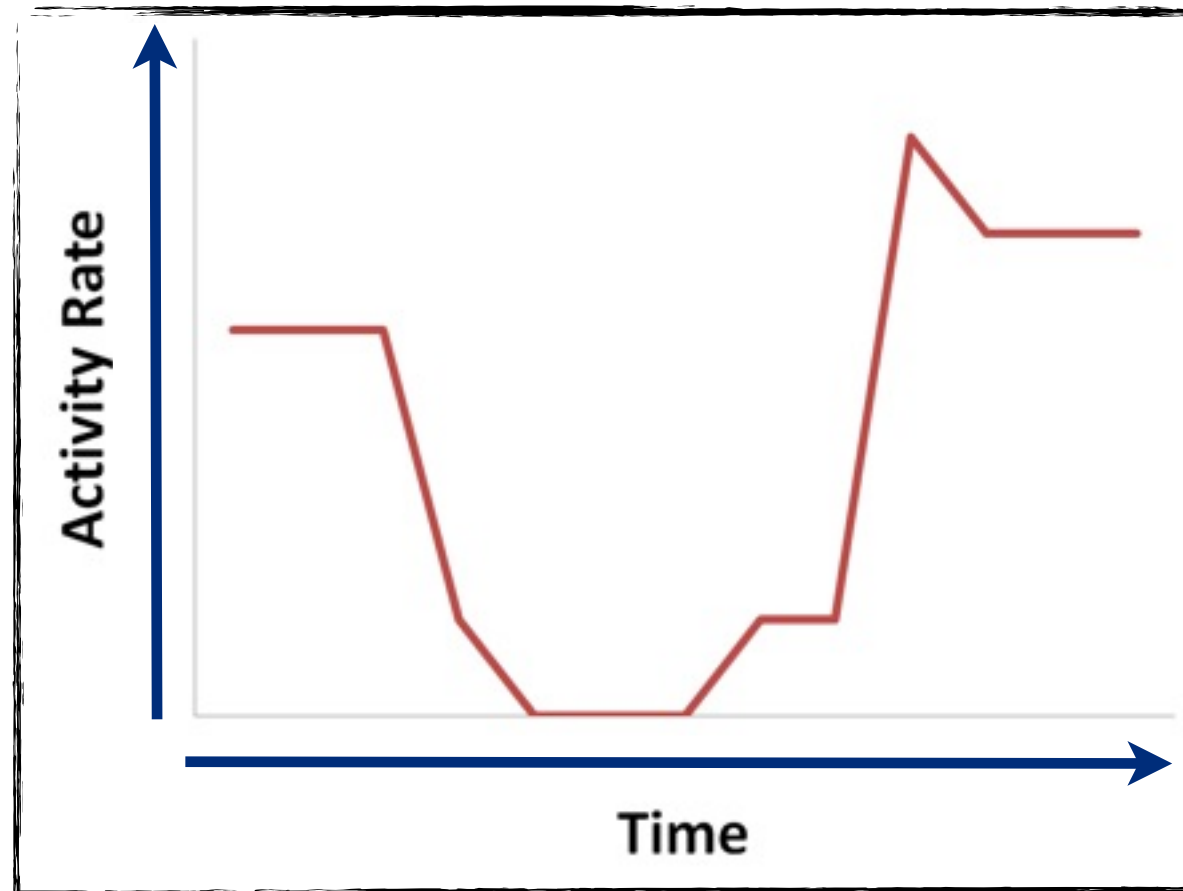
4

Next

Copyright 2003

If completion time important,  
monitor activity rates.

Design  
implications:  
**Detecting  
interruptions**





If completion time important,  
monitor activity rates.

Design  
implications:

# **Detecting interruptions**

**20 seconds** of inactivity  
was detected in the trial  
you just completed.

Were you interrupted?

**No**

**Yes**

Replace interrupted trials or  
restart interrupted tests

Segment tasks,  
set inactivity thresholds

Design  
implications:  
**Beyond  
C-TOC**

The image shows a screenshot of a travel website interface. The main form is for booking flights, with tabs for 'Flights', 'Flight Pass', 'Hotels', 'Cars', and 'Vacations'. The 'Flights' tab is active. The form includes fields for 'Travel' (Round-trip), 'Leaving from', 'Going to', 'Departure date', 'Return date', 'Adult (16+)', 'Country of residence', and 'Promotion Code (optional)'. A 'Check-in' button is visible at the bottom of the flight form. Overlaid on the right is a 'Send Money Now' modal. This modal has a title 'Send Money Now' and a sub-header 'I'm paying someone in:'. It includes a dropdown menu for the country (Canada), an 'Amount' input field, and a 'Currency' dropdown (CAD - Canadian Dollars). Below these are radio buttons for 'My payment is for:' with options 'Friends and Family' and 'Buying Something'. A 'CONTINUE' button and 'Step 1 of 3' progress indicator are at the bottom of the modal. At the very bottom of the modal, there is a 'Send money with:' section showing logos for VISA, MasterCard, American Express, BANK, and PayPal.

**Flights** Flight Pass Hotels Cars Vacations

Travel Round-trip Multi-city

Leaving from  
Going to

Departure date DD/MM/YYYY  
Return date DD/MM/YYYY

Adult (16+) 1 Children?

Country of residence Canada

Promotion Code (optional) ?

**Check-in**

**Send Money Now**

I'm paying someone in:  
Canada

Amount: Currency: CAD - Canadian Dollars

My payment is for:  
☐ Friends and Family  
☐ Buying Something

**CONTINUE** Step 1 of 3

Send money with: VISA MasterCard BANK PayPal

# **Future Work**

# **Future Work**

Interruptions and **clinical groups**

# Future Work

Interruptions and **clinical groups**

Designing **valid interruption levels**

# Future Work

Interruptions and **clinical groups**

Designing **valid interruption levels**

Age and interruption **strategy**

# Summary

**Divergent** effects of interruption demand between

- age groups
- primary tasks

**Implications** for C-TOC and other applications used by older adults



brehmer [at] cs.ubc.ca

# Summary

**Divergent** effects of interruption demand between

- age groups
- primary tasks

**Implications** for C-TOC and other applications used by older adults





# Hypotheses

H1. Overall, **YOUNG** adults will perform better than **OLD** adults.

H2. **OLD** adults will incur a disproportionately greater cost of interruption

H3. **H1 + H2** will be more pronounced in the VERBAL task

# Supported

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**Supported**

H1. Overall, **YOUNG** adults will perform better than **OLD** adults.

**Partially  
Supported**

H2. **OLD** adults will incur a disproportionately greater cost of interruption

H3. **H1 + H2** will be more pronounced in the VERBAL task

**Supported**

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Partially  
Supported

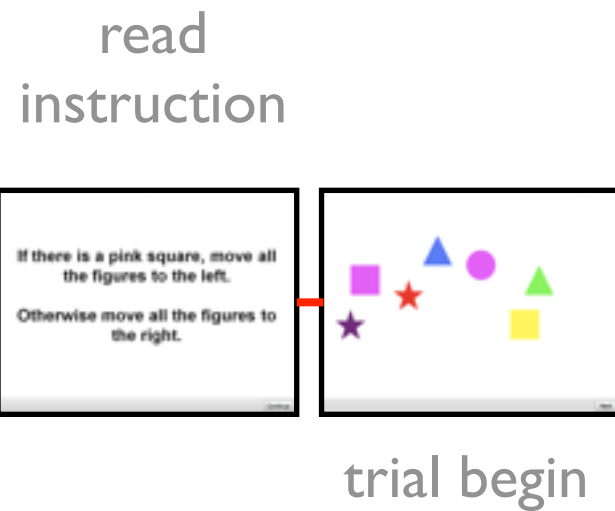
H2. **OLD** adults will incur a disproportionately greater cost of interruption

Partially  
Supported

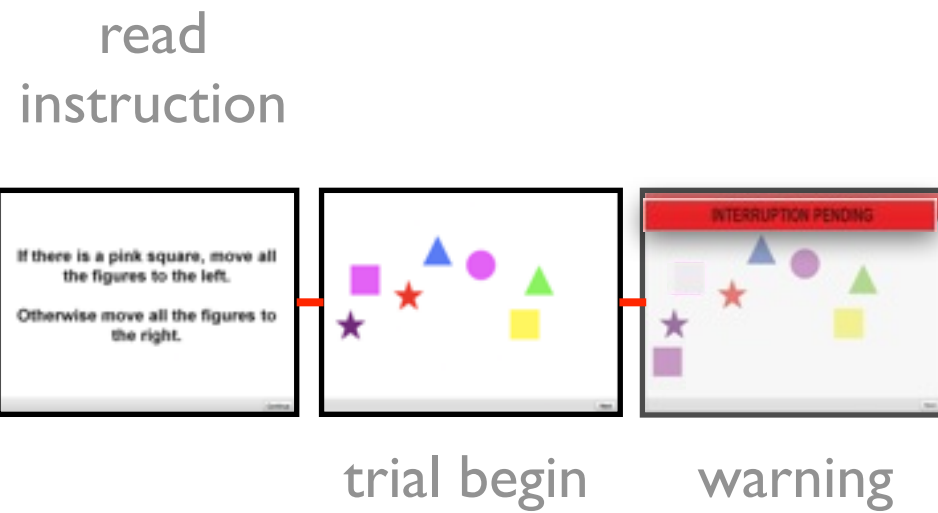
H3. **H1 + H2** will be more pronounced in the VERBAL task

# **Study Design - Interruption timeline**

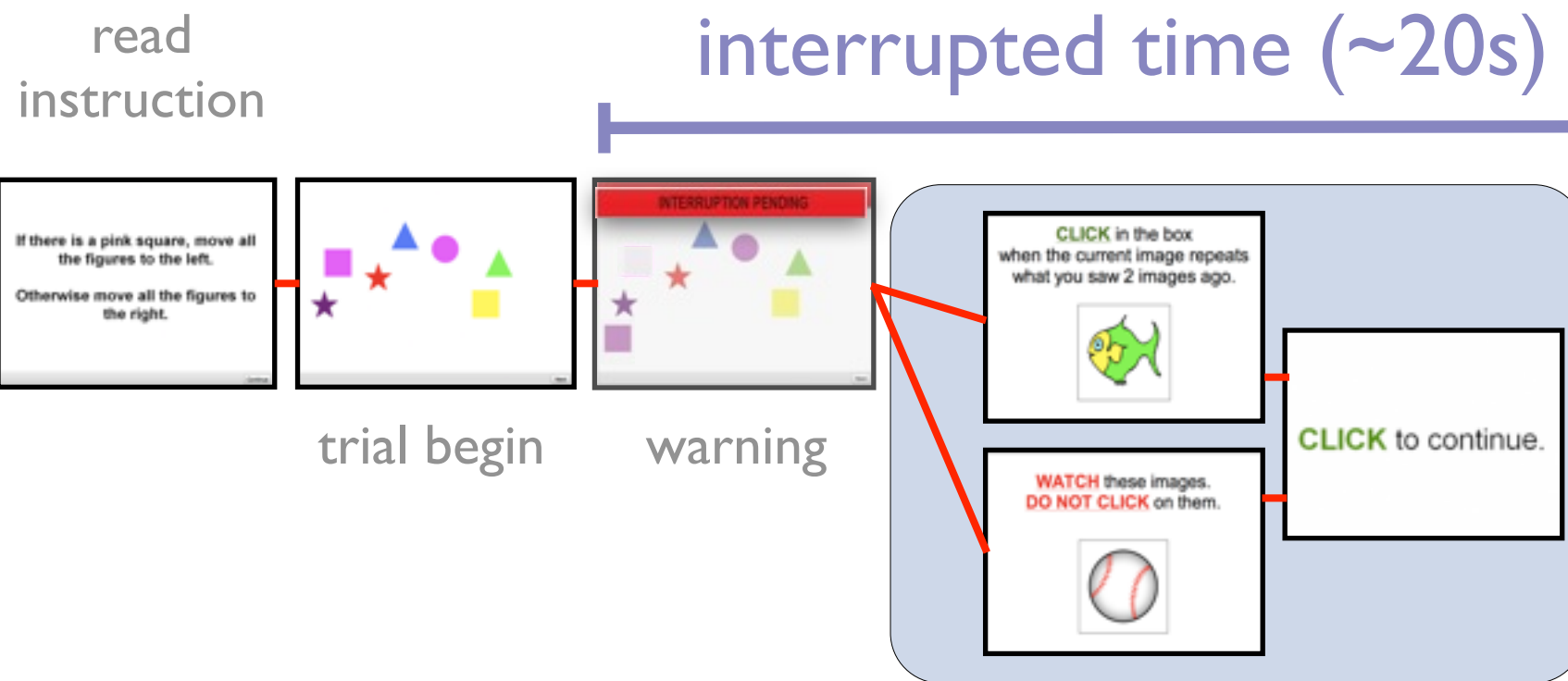
# Study Design - Interruption timeline



# Study Design - Interruption timeline

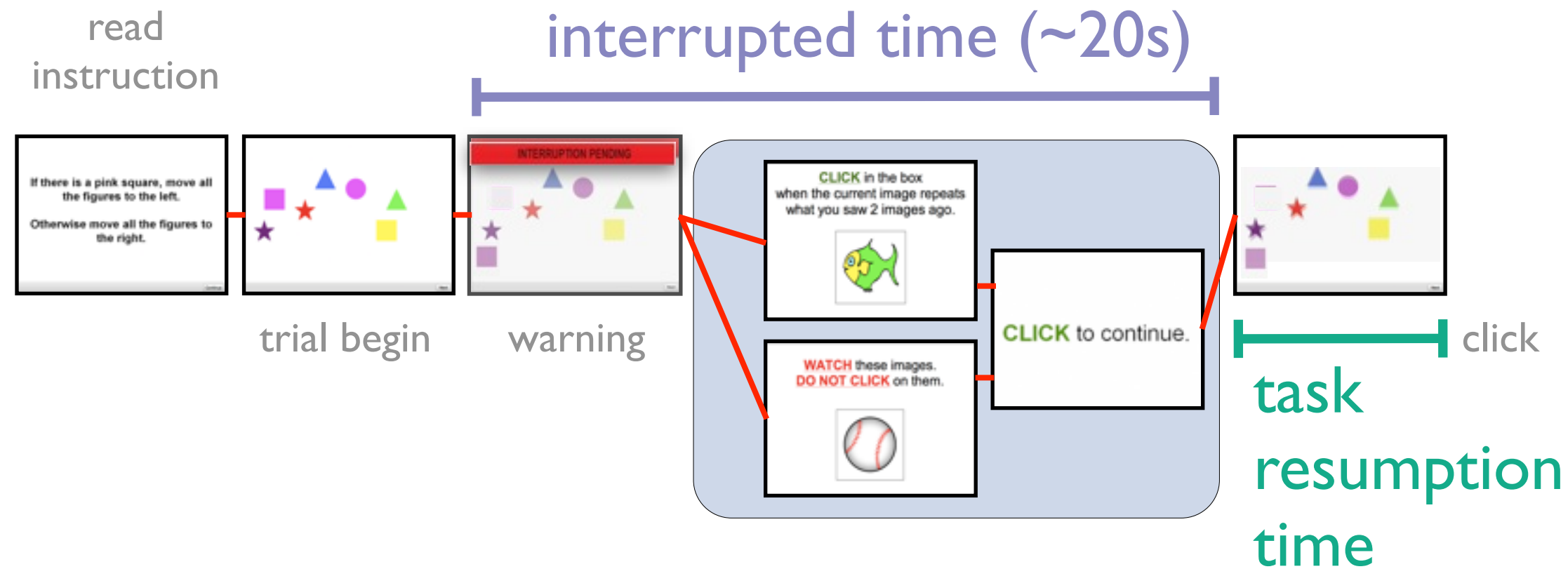


# Study Design - Interruption timeline

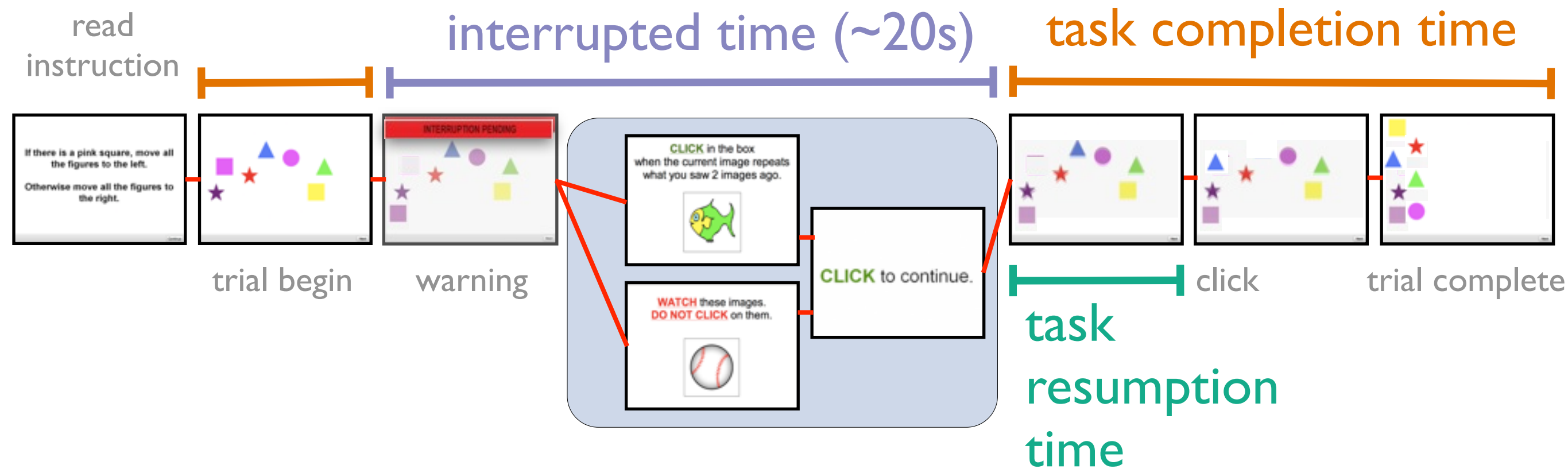




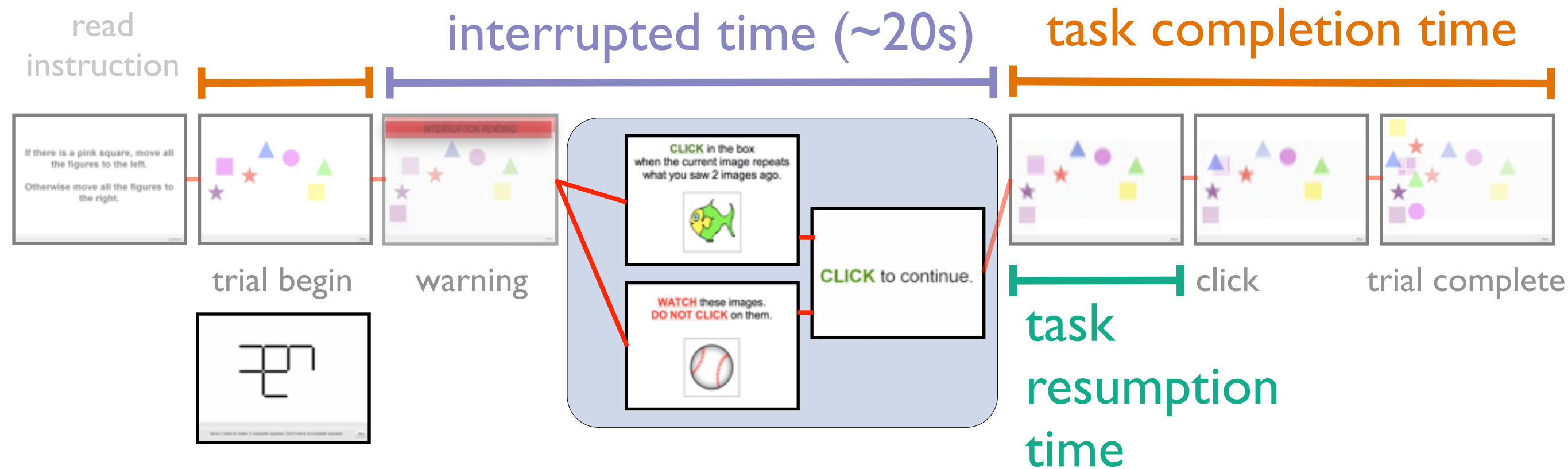
# Study Design - Interruption timeline



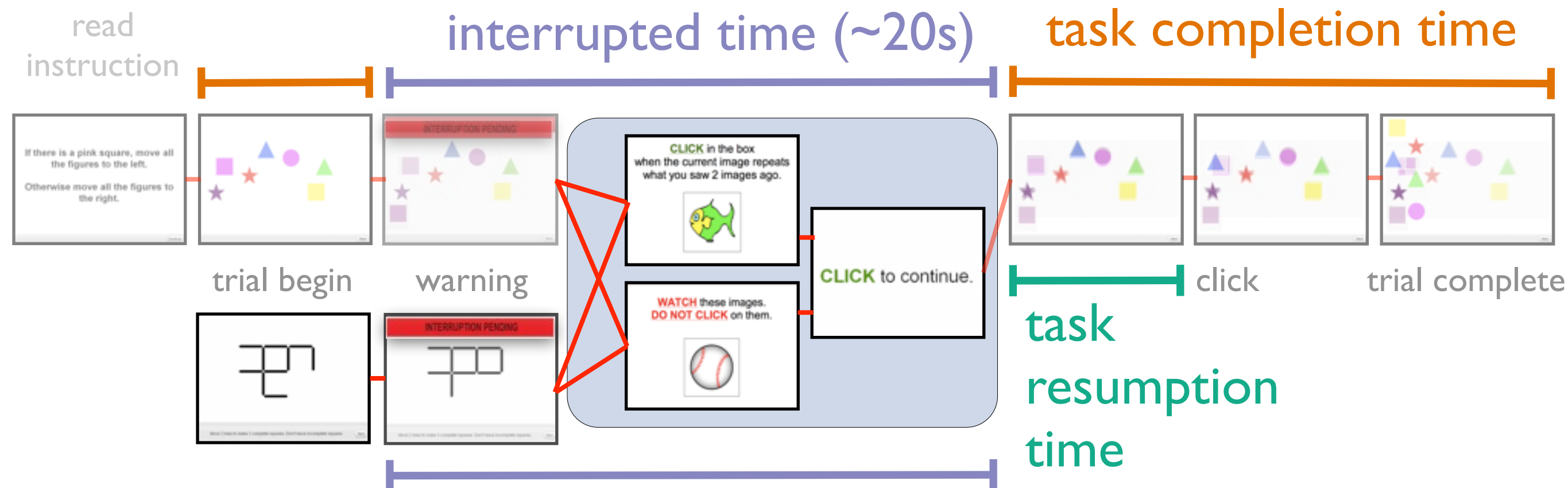
# Study Design - Interruption timeline



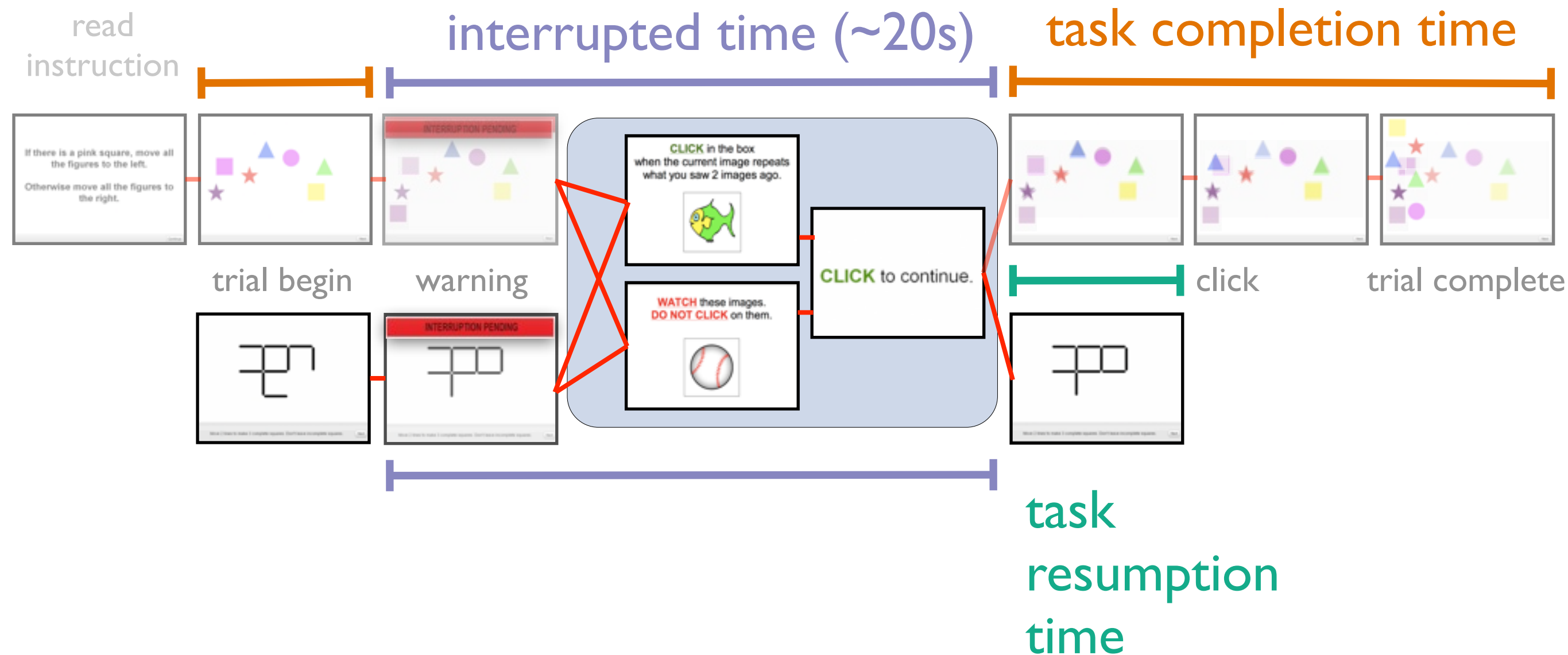
# Study Design - Interruption timeline



# Study Design - Interruption timeline



# Study Design - Interruption timeline



# Study Design - Interruption timeline

