Review questions

- What are the four items in the SEEV model?
- What is change blindness?
  - Changes in the physical world, although visible by the eye (or audible by the ear, etc), are not detected.
- What does focused attention mean?
  - Ignore sensory info not selected; Suppress distracters

Check previous lecture slides to find the answers.

SYDE 543
Cognitive Ergonomics

Attention and Multitasking

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Overview of today's lecture

- What is multitasking?
- How to study multitasking performance?
- Types of attention resources
- Task switching and interruption

Multitasking

- For example,

Multitasking

- Perform multiple tasks at the same time. (divided attention)

- Task hierarchy, e.g.,
  - Driving from location A to B
    - Select route, decide where to turn
    - Watch traffic signals and signs
    - Control speed and lane position
      - Monitor mirrors, speedometers, etc.
      - Press pedals, turn steering wheels, control turning signals

- Driving itself contains multiple components.
- Each study may have its own focused task level.
- You need to decide the level of grain when talking about single-task or multi-tasks.

Multitasking

- Multitasking, time-sharing, parallel processing
- What do they mean?
- Two possibilities:

- Truly parallel processing
- Concurrent, simultaneous
- E.g., walking and talking/thinking

- Task switching, time-sharing
- Interruption and resumption
- E.g., reading book and text messaging

- Which is the case? also depends on the selected time scale (granularity)
- Rapid task switching may appear the same as truly parallel processing. (think computer multiple threads)

How to test dual-task performance?

- You are asked to test whether using this new console would impact driving performance/safety.
- What do you plan to do?

What do you want to test?
- Can you interact with it while driving?
- How fast does it react?
- How accurate is voice control?

What do you do?
- Get test subject to use it in a real situation
- Get them to have a text conversation entirely in voice
- Test it in a controlled environment, eg VR
- Get base line with existing console or without any console and compare performance (driving and otherwise) with the new one.

Multitasking research paradigm

- For driving, define performance or safety measures
  - Example: lane deviation, brake reaction time, traffic violations
- For console interaction tasks, define performance measures
  - Example: task completion time, error, satisfaction
- Equipment, population, practice (testers used should reflect the population), instruction
- Measure single task and dual task performance
- Compare single vs dual task performance

Multitasking research paradigm

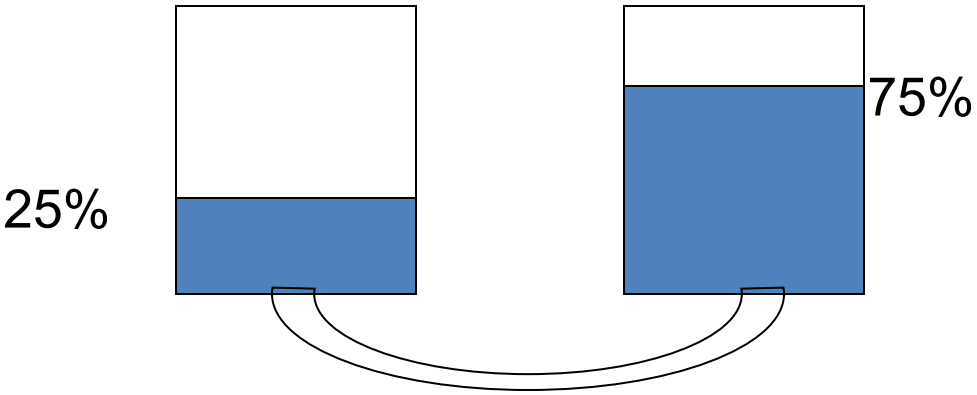
- In general,
- Single task: T1 only, T2 only
- Dual task: T1 and T2 simultaneously
- Compare performance measure
  - For T1, T1-only vs T1 in dual
  - For T2, T2-only vs T2 in dual
  - Dual-task **interference**: lower performance in dual condition

Attention resources

- Multitasking performance is determined by attention resources.
- However, it is difficult to directly measure attention resources.

- **Type of attention resource**
  - **Single resource theory**
  - **Multiple resource theory**

Single resource theory



Dual-task example

- Analogy to water in multiple tanks.
- Views attention as resources that can be allocated in any manner between multiple tasks, but can not exceed 100% total.

Resource demand

- Attention resources are limited.
- Tasks have different levels of demands
- **Automatic processing**: less attention required
  - Skills that require no (or very little) attention, e.g.,
    - Breathing
    - Walking
    - Riding a bike (assuming you've done it for years)
- **Controlled processing**: more attention required
  - E.g., mental math computation, listening to lectures

- A continuum exists from completely automatic to not automatic at all

Multitasking is Common in Healthcare

Physicians in emergency departments

- Simultaneously attending to 5.1 patients
- Interrupted every 9 minutes

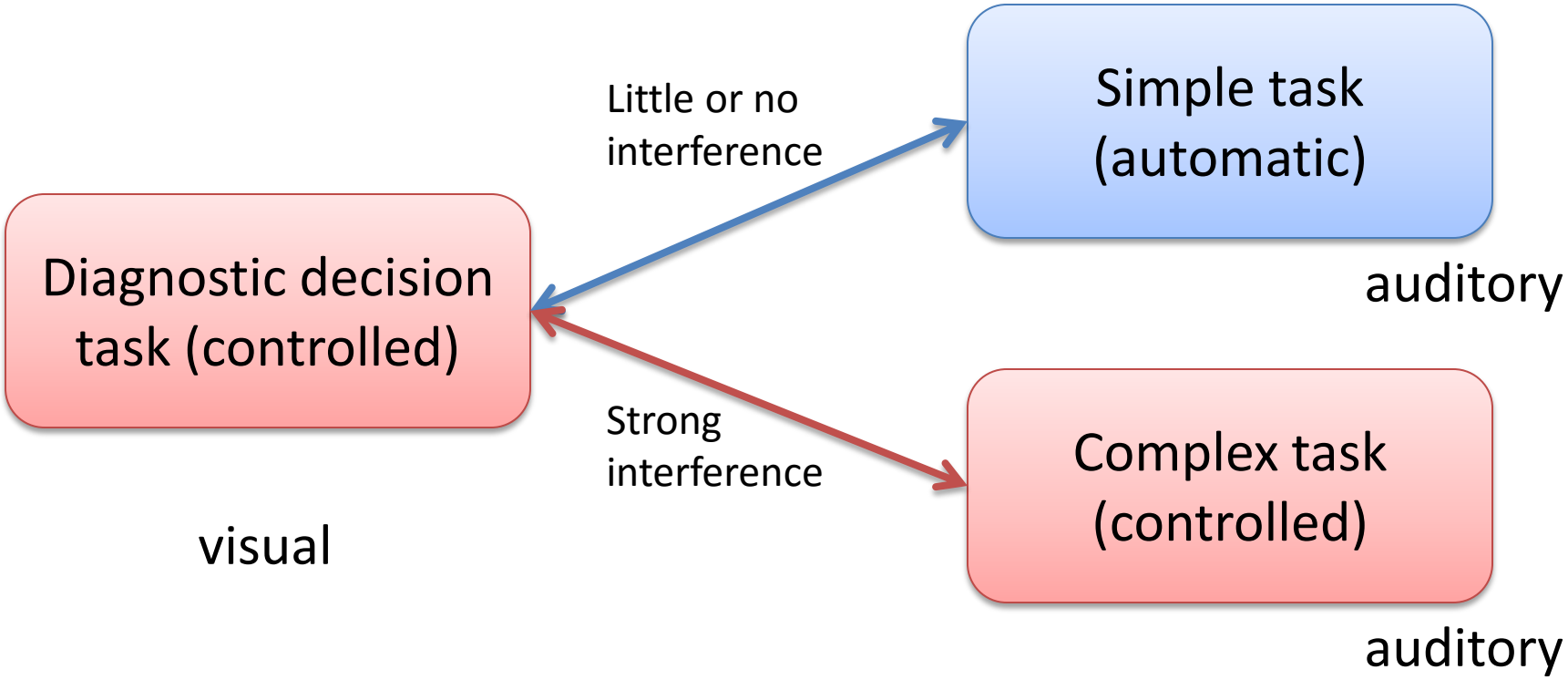
(Chisholm et al., 2000; Laxmisan et al., 2007; Leape, 2012)

Does multitasking affect decision performance?

Effects of concurrent tasks on diagnostic decision making: An experimental investigation
S Cao, Y Liu (2013). IIE Transactions on Healthcare Systems Engineering 3 (4), 254-262

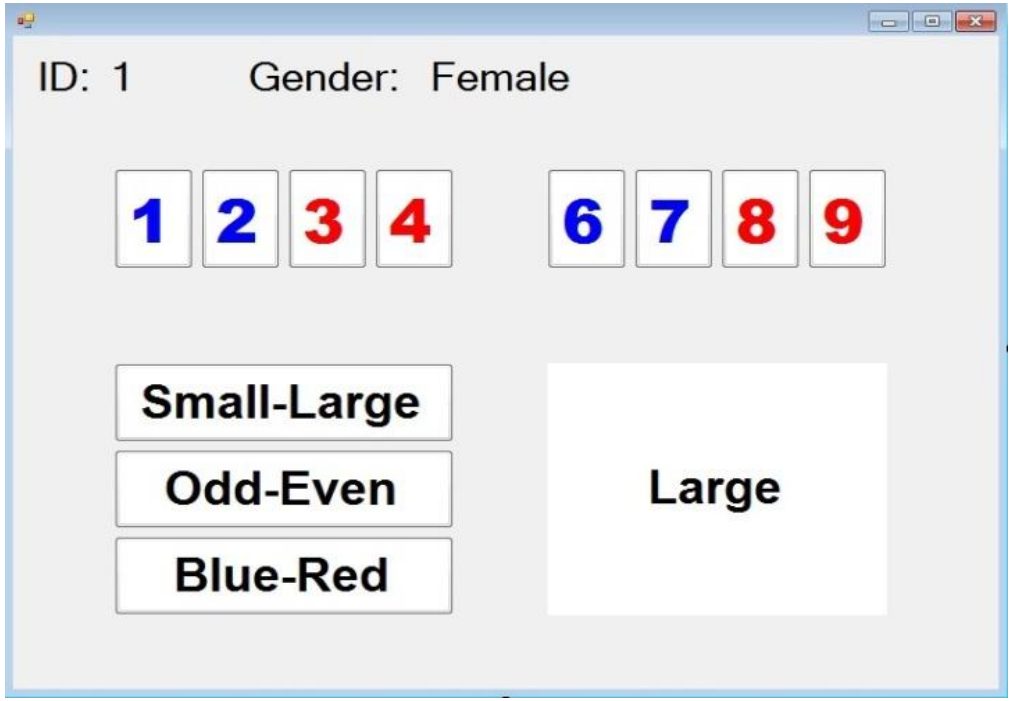
Experiment Hypotheses

- Performance interference



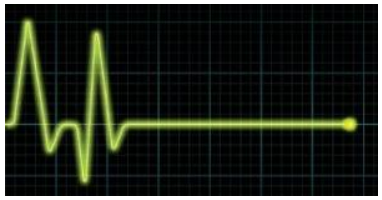
Abstract Diagnostic Decision Making Task

- 1 true disease among 8 choices
- 3 diagnostic tests
- Measure task completion time, error rate



Concurrent Tasks (Auditory)

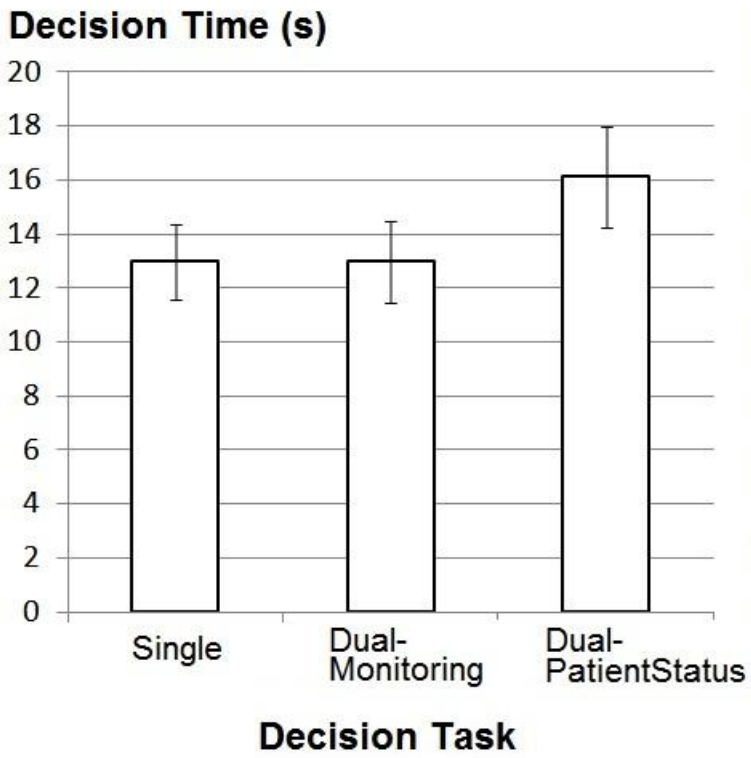
- Sound monitoring (Simple)
  - Beep sounds resemble cardiac monitor
  - Press key when hearing a flat tone

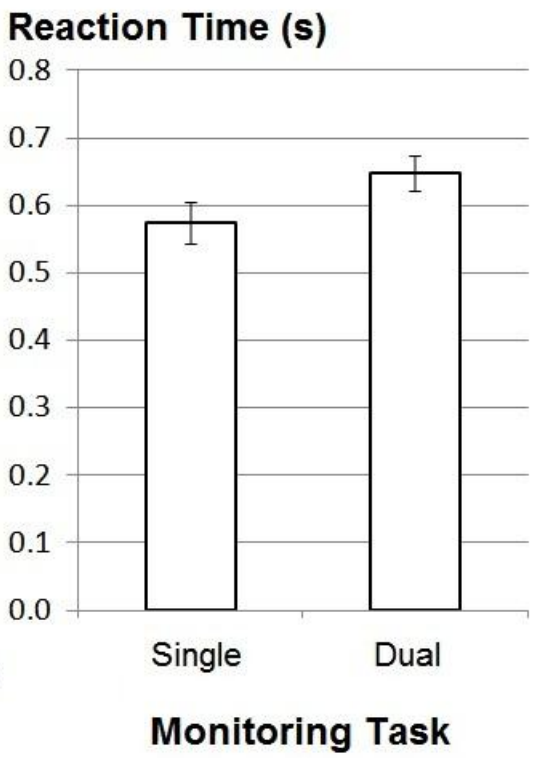


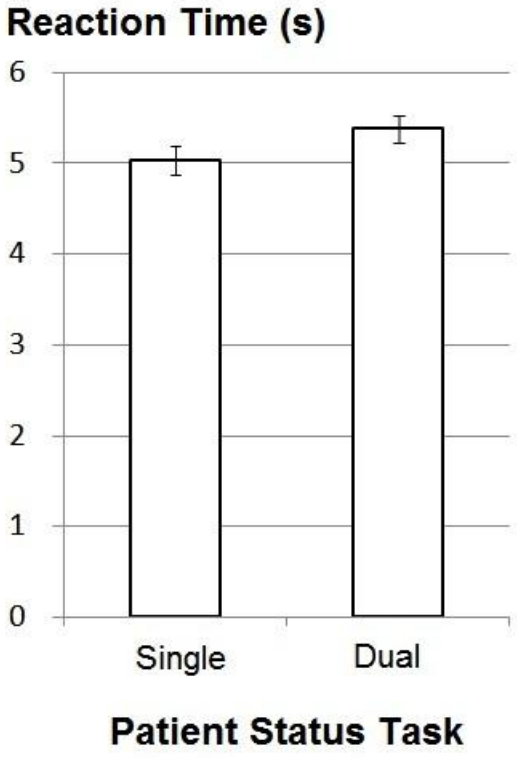
- Patient status tracking (Complex)
  - Track the emergency levels of three simulated patients
  - Patient: Alpha, Bravo, and Charlie
  - Emergency level: Low, Medium, and High
  - “Update. The emergency level of Patient Charlie has changed to High.”
  - “Question. Is the emergency level of Patient Bravo at the Low level?”

Results: Performance

- 30 participants
- Significant effect of the complex task on diagnostic time.
- Diagnostic error rate not significantly affected.







Attention resources

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- However, it is difficult to directly measure attention resources.

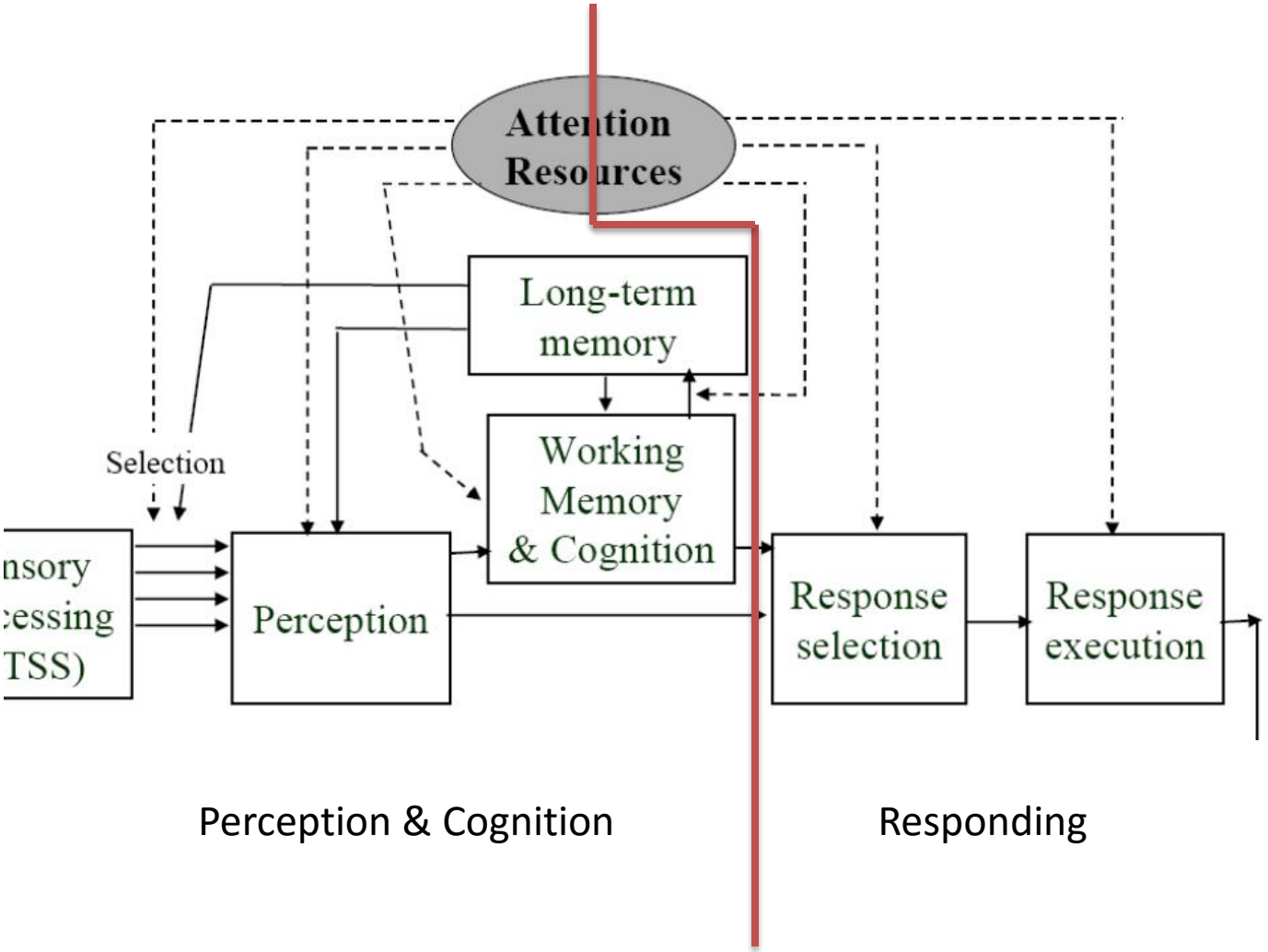
- Type of attention resource
  - Single resource theory
  - **Multiple resource theory**

Multiple Resources (Wickens)

1. Stages
   - Perception & Cognition
   - Responding
2. Processing codes
   - Verbal
   - Spatial
3. Perceptual modality
   - Auditory
   - Visual (4. focal vs. ambient)
   - Tactile

Stages

- Processed in different brain regions.
- E.g., reading a book and spinning a pencil



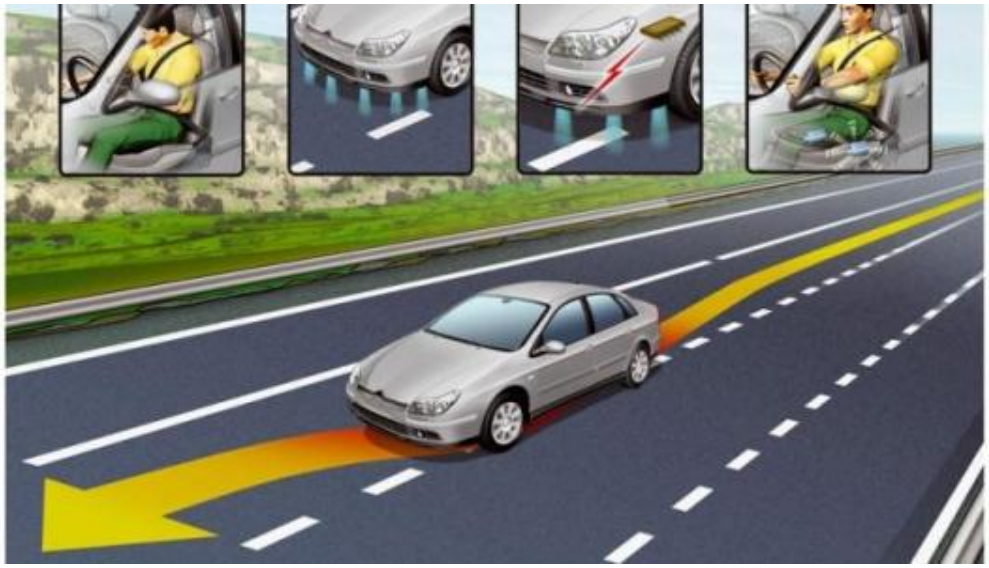
Processing Codes

- Verbal vs. Spatial
  - Verbal
    - Reading text, listen to a conversation
  - Spatial
    - Direction, object rotation, spatial localization

- Little overlap
  - Listening to a radio story and walking to home (turn left/right)
- Large overlap
  - Listening to a radio story and writing an essay

Perceptual modalities

- Visual, Auditory, and Tactile
  - It is easier to perform two tasks at the same time when they use different modalities than when they use the same modalities
  - Little overlap: driving and listening to the radio
  - Large overlap: having a conversation and listening to the radio



A good idea?

Visual (focal vs. ambient)

Limitations of multiple resource theory

- Qualitatively
  - Identify important factors
  - If share less common resources, less interference.

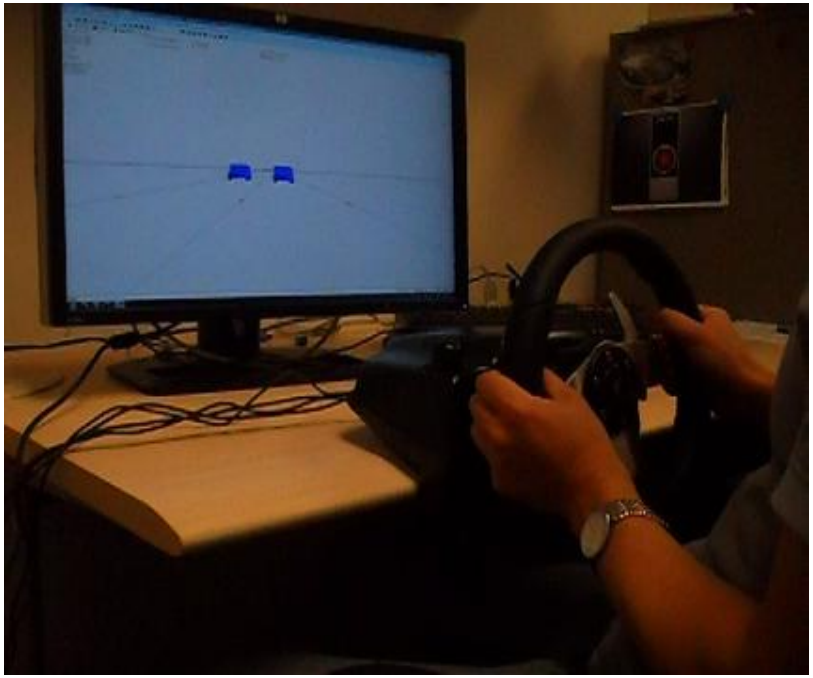
- Limitations
  - Cannot quantitatively predict.
  - Still need empirical studies.
  - A single general attention resource may still exist.

Driver multitasking study example

Concurrent processing of vehicle lane keeping and speech comprehension tasks

Driver Multitasking: Experiment

- Designed and programmed experiment focusing on lane keeping & sentence comprehension
- Task (Single or Dual), Driving speed (36 or 72 km/h)



Participants hear: e.g.,

Input sentence: "*the bicycle blocked the car.*"

Probe sentence: "*the car was blocked by the bicycle.*"
(active or passive, true or foil)

Press key for same or different.

Driver Multitasking: Summary

- The results suggest that performing a secondary speech comprehension task for a limited period of time may not immediately affect the primary task performance (i.e., lane keeping)

- but it increases drivers' mental workload

  and reduces drivers' capability to comprehend speech.

Concurrent processing of vehicle lane keeping and speech comprehension tasks
S Cao, Y Liu (2013). Accident Analysis and Prevention 59, 46-54

Ontario Distracted Driving Law

- http://www.mto.gov.on.ca/english/safety/distracted-driving.shtml
- In Ontario, it is illegal for drivers to talk, text, type, dial or email using hand-held cell phones and other hand-held communications and entertainment devices.

Eyes on the road

- In general, don’t let eyes off the road for over 2 second.

- Pioneer Days on Rt 128
- John Senders
- https://www.youtube.com/watch?v=kOguslSPpqo

Attention resources

- Multitasking performance is determined by attention resources.

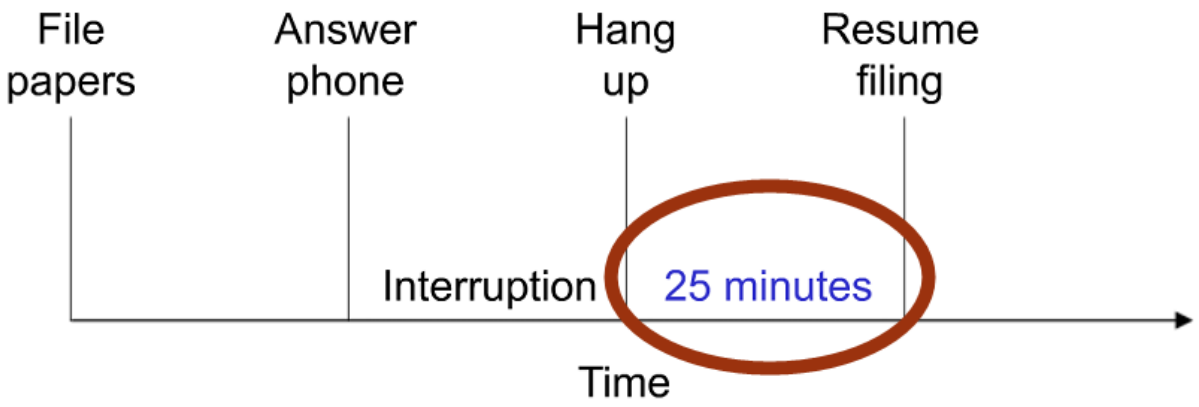
- Type of attention resource
  - Single resource theory
  - Multiple resource theory

- **Task switching and interruption**

Task switching

- Interruption and resumption

Typical office work scenario

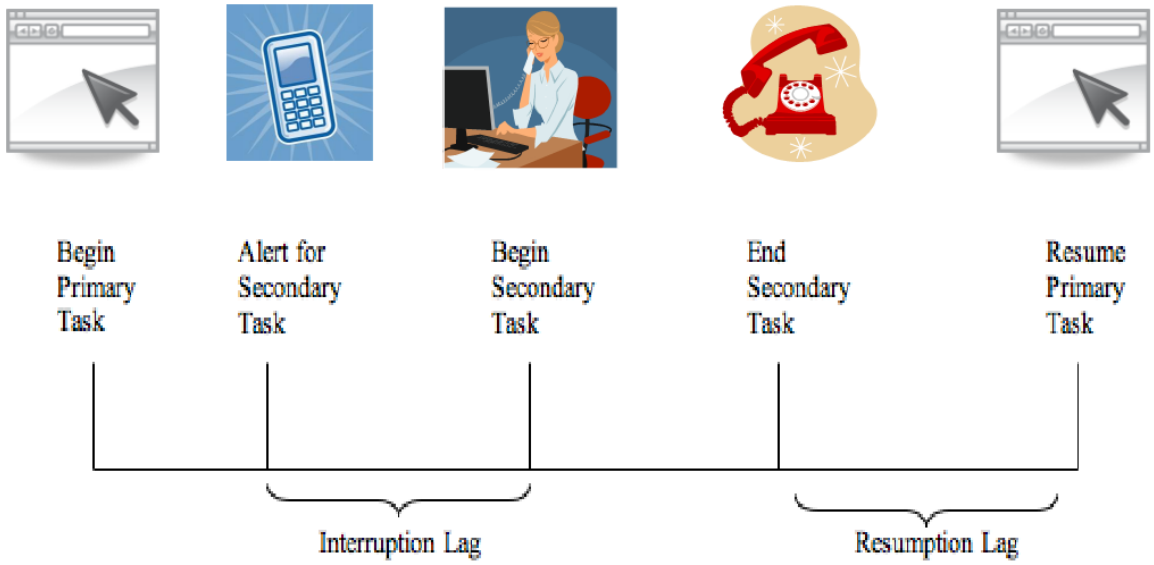


"Meet the Life Hackers"
New York Times
Clive Thompson
10/16/06

From http://www.authorstream.com/Presentation/Marianna-50869-Interruptions-talk-Psycholinguistic-Investigation-Language-Production-Conversational-t-Entertainment-ppt-powerpoint/

Interruptions – Key Terms

- Original task (OT) or primary task
- Interrupting task (IT) or secondary task
- Switch 1: interruption lag
- Switch 2: resumption lag



Altmann & Trafton, 2002

Interruption

- Interruptions are rational when the interrupting task is important and time sensitive.

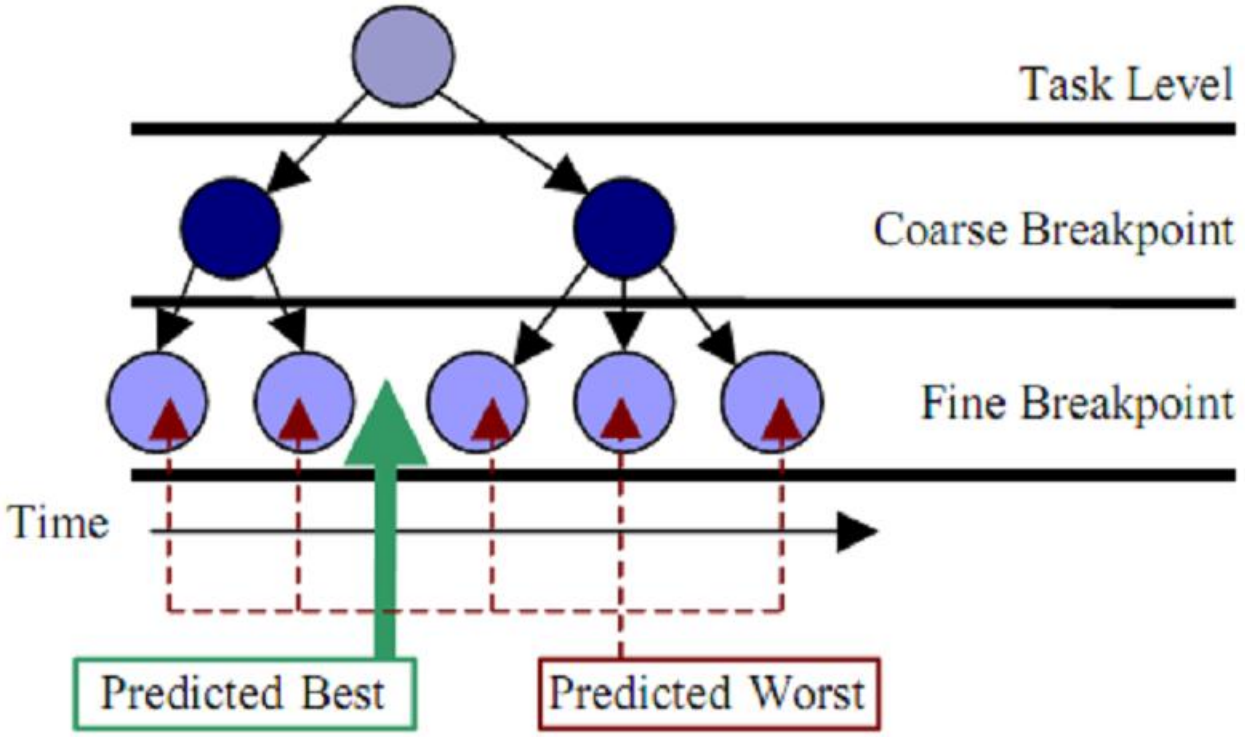
- But, interruptions have potential negative effects
  - Task switch cost
  - Forget to resume OT promptly
  - Miss some steps of OT
  - Confusion between OT and IT

Task switch cost

- Time needed to prepare the stop of OT (Interruption lag)
  - E.g., finish writing a sentence.
  - Save files
  - Take notes for restart

- Time needed to resume and restart OT (Resumption lag)
  - E.g., retrieve memory and previous thoughts
  - Read previous notes

Timing of Interruptions



- E.g., reading a book; writing homework

Task switching

- When interrupting task looks urgent, salient, and personal, people tend to switch task immediately. (the stop of OT not well prepared)
- Countermeasures:
  - IT signal gradually increases salience. (e.g., clock alarm)
  - Look for better timing, sub-task breakpoint
    - People can see if others are busy.
    - How to make machines do this? Intelligent workload management systems
  - Kindly tell an interrupting person to wait a moment and prepare the stop of OT.

Task switching

- When switching is needed, OT salience/engagement may prevent prompt switching to IT.

- Countermeasures:
  - Properly balance salience/engagement between tasks

Task switching

- Forget to resume OT promptly
  - E.g., cooking, interrupted, forget to return until overcooked
- Miss some steps of OT

- **Prospective Memory**
  - **Remembering to do something in the future**
  - **Interrupting task automatically creates need to remember to resume primary in future**

- Countermeasures:
  - Rehearse
  - Set timer
  - Use notes/reminders/check list

Task switching

- Reduce similarity/confusion between OT and IT
- E.g., nurses attending multiple patients
  - Check patient name, identification
  - Check procedure with patients (as a patient, know your procedure)

http://en.wikipedia.org/wiki/Intensive_care_unit

Task switching

- Aging affects multitasking capability
- Training improves multitasking among aging population

Computer Game Playing Shown to Improve Multitasking Skills (2013)
A new study reveals, despite polarized opinion about brain-training packages, that playing a 3-D race car-driving video game reduced cognitive decline in subjects aged 60-85

http://www.scientificamerican.com/article/computer-game-playing-shown-improve-multitasking-skills/

Summary of today's lecture

- What is multitasking?
  - Parallel processing vs. task switching
- How to study multitasking performance?
  - Measure and compare single vs. multitask performance
- Types of attention resources
  - Single resource theory
  - Multiple resource theory
- Task switching and interruption
  - Lag and error