

Action execution: Speed and accuracy

KINESIOL 1E03 - Motor control and learning

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Fall 2022 Week 6
Lecture 11

Review and finishing up last lecture

What is attention?

- **limited capacity** to engage in multiple cognitive and/or motor activities **simultaneously**
- **selective** attention to specific **environmental features** when we perform motor skills
 - this can happen either through **intentional** or **incidental** processes
- in **multi-task** situations, performance can suffer for two broad reasons:
 - **structural interference** occurs when physical or neurological structures are the cause of the reduced performance (e.g., eyes, limbs, etc)
 - **capacity interference** occurs when required attentional resources exceeds some attentional limit



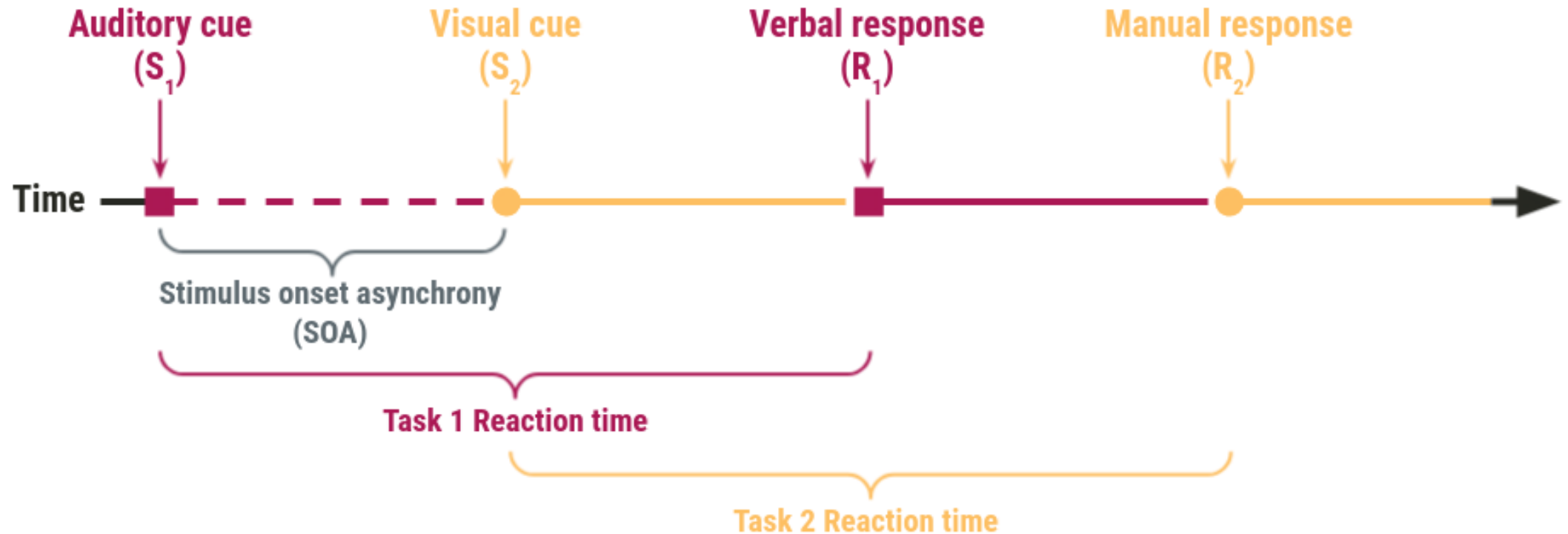
The time between the presentation of two stimuli can have a strong influence on performance

Task 1 alone: **Say** a word (e.g., "*TOP*") as quickly as possible when you **hear** an auditory cue

Task 2 alone: **Press** a key with your right hand when you **see** a visual cue

Sequential: Perform Task 1 **then** Task 2 but **manipulate** time **between** the auditory and visual cues

The time between the presentation of two stimuli can have a strong influence on performance

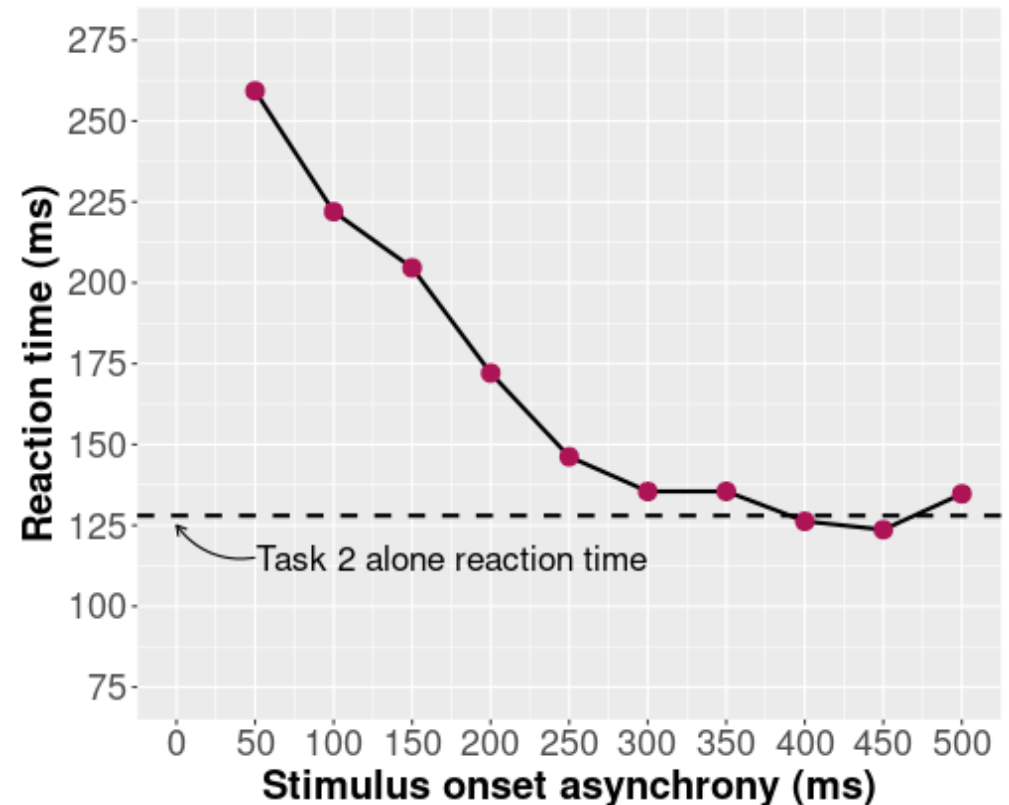


Psychological refractory period (PRP) decreases as SOA increases

Task 1 reaction time: 161 ms

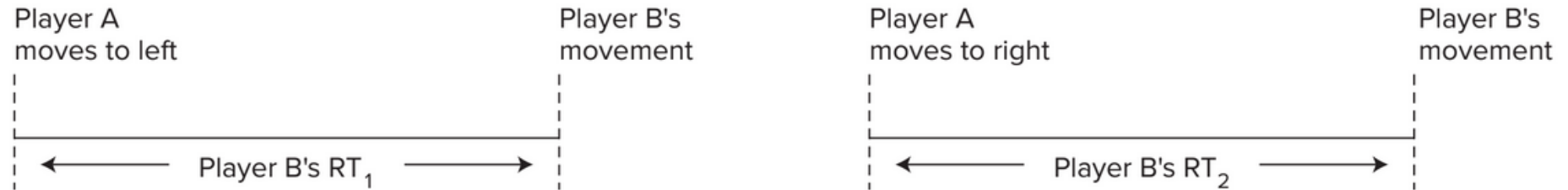
Task 2 (control) reaction time: 128 ms

We need to **compare** the reaction times of **Task 2 in the sequential condition** (Task 1 then Task 2) to the **Task 2 alone** (i.e., control condition) to determine whether a **PRP** happened

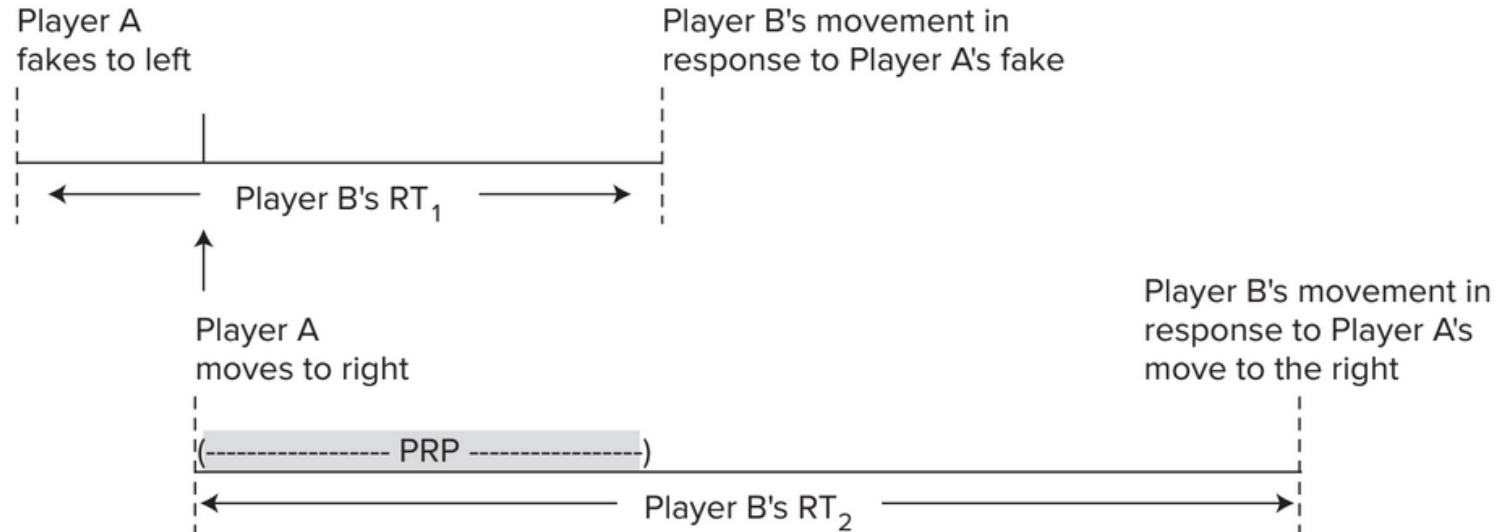


The psychological refractory period in action...

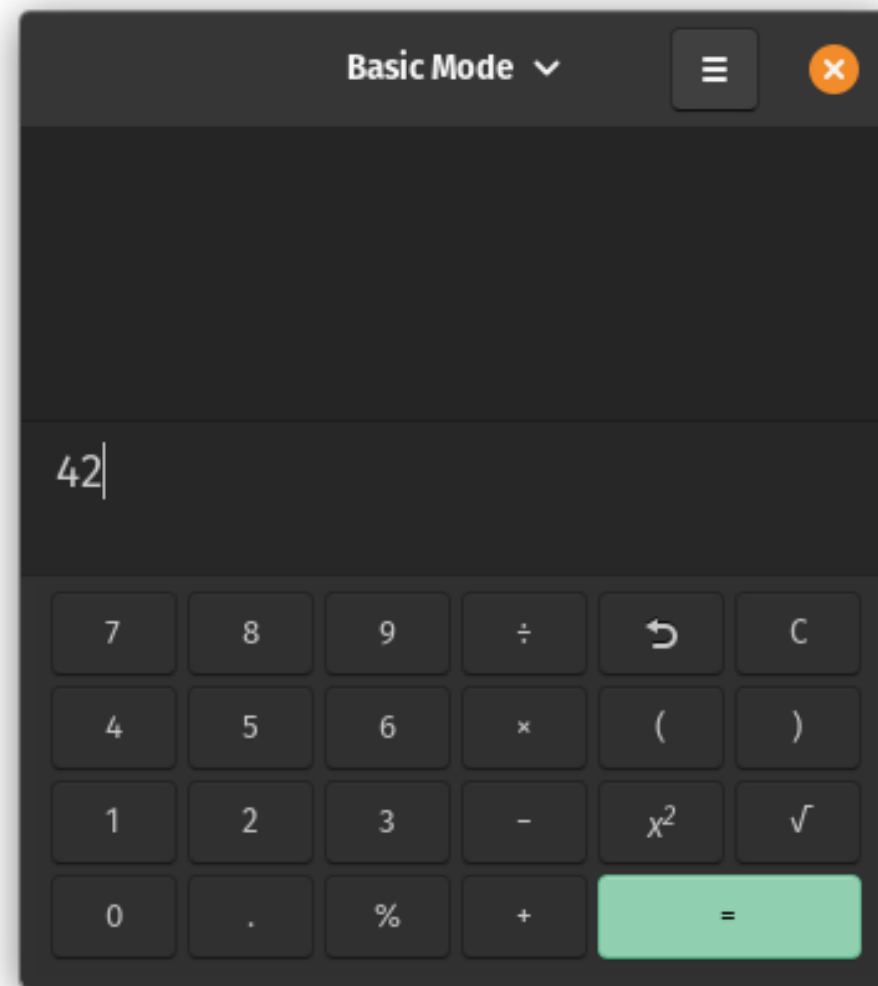
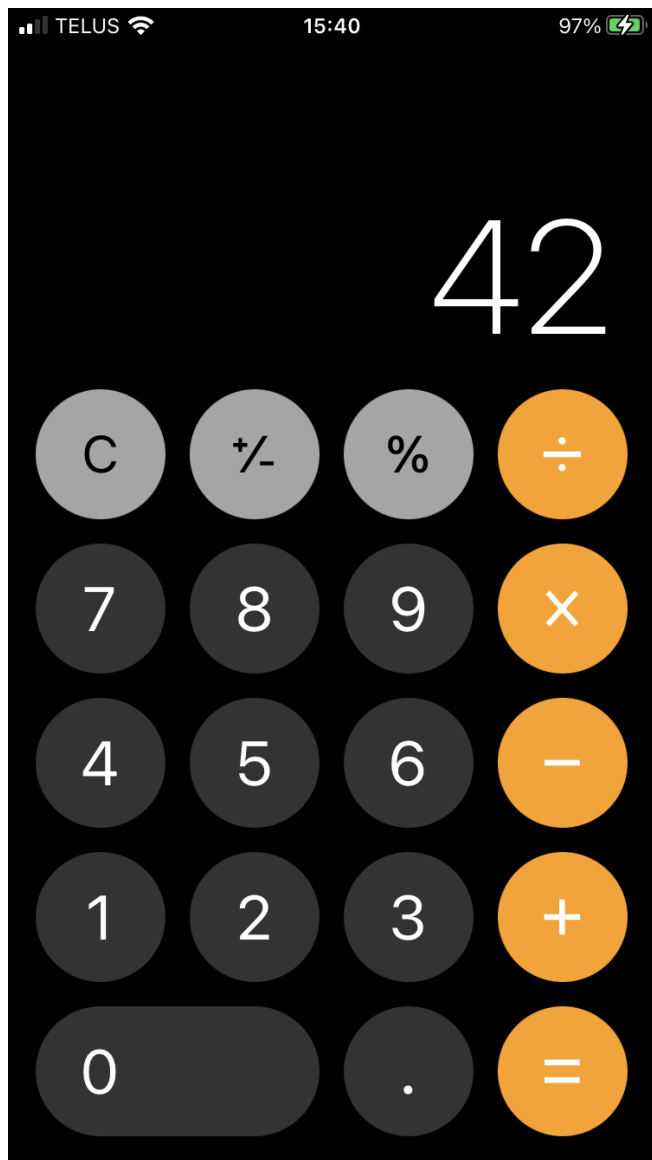
a. No-fake situations:



b. Fake situation:



Any questions?



Movements can be made quickly at the cost of accuracy or accurately at the cost of speed



Learning objectives

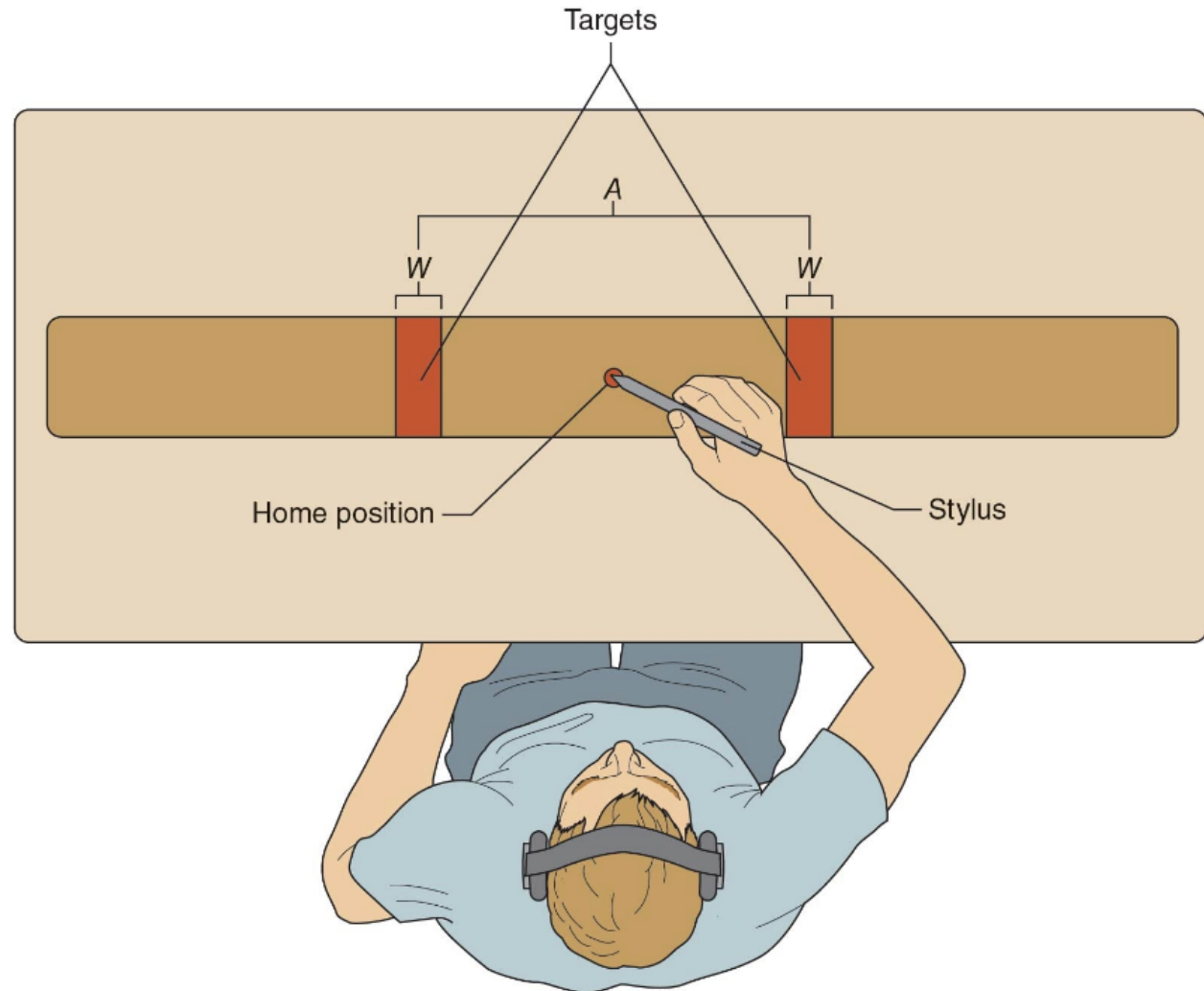
1. Identify and describe factors that **influence** movement **speed** and **accuracy**.
2. Explain **Fitts'** Law.
3. Identify and discuss practical examples of **speed-accuracy trade-offs** in every day life.

Take-home message:

The sensorimotor system is often faced with conflicting goals. Under such conditions, it has to achieve some sort of balance between these goals.

Target width and movement amplitude impact movement time

Instructions: Make alternating movements between the targets as **quickly** and **accurately** as possible for a specified total time (e.g., 10 s)



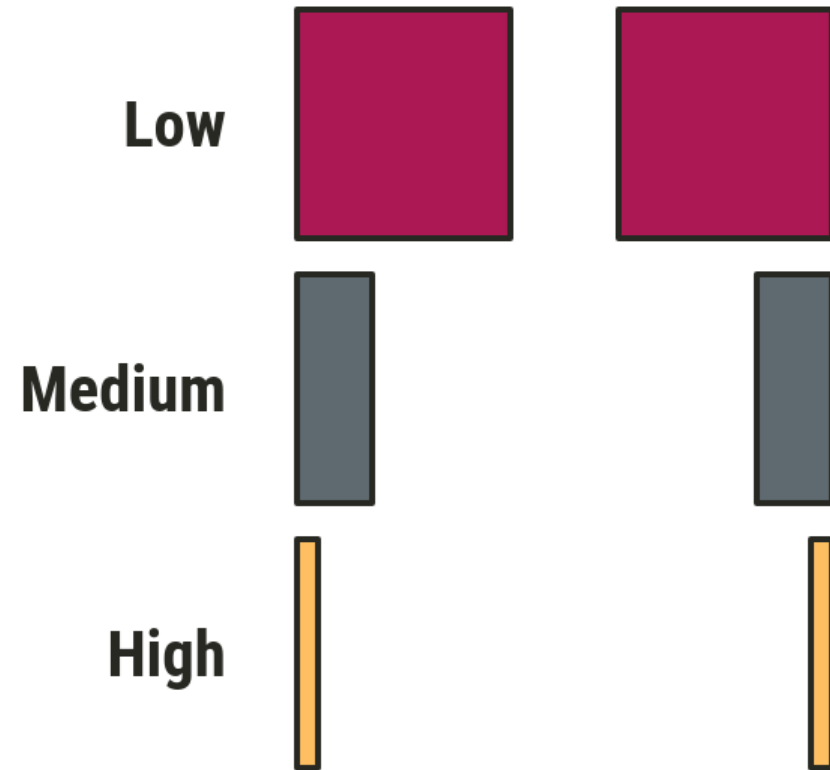
We can manipulate task difficulty with changes in width and/or amplitude

$$MT = a + b \log_2(2A/W)$$

where:

- a = y-intercept
- b = slope
- A = amplitude
- W = width
- $\log_2(2A/W)$ = **index of difficulty**

Q: What does this remind you of?



Calculating the index of difficulty

Different index of difficulty (ID) for same distance

Amplitude = 2 cm | Target width = 2 cm

$$ID = \log_2(2A/W)$$

$$ID = \log_2(2 * 2/2)$$

$$ID = \log_2(2)$$

$$ID = 1 \text{ bit}$$

Amplitude = 2 cm | Target width = 1 cm

$$ID = \log_2(2A/W)$$

$$ID = \log_2(2 * 2/1)$$

$$ID = \log_2(4)$$

$$ID = 2 \text{ bits}$$

Calculating the index of difficulty

Same index of difficulty (ID) for different distances and target widths

Amplitude = 4 cm | Target width = 1 cm

$$ID = \log_2(4A/W)$$

$$ID = \log_2(2 * 4/1)$$

$$ID = \log_2(8)$$

$$ID = 3 \text{ bits}$$

Amplitude = 8 cm | Target width = 2 cm

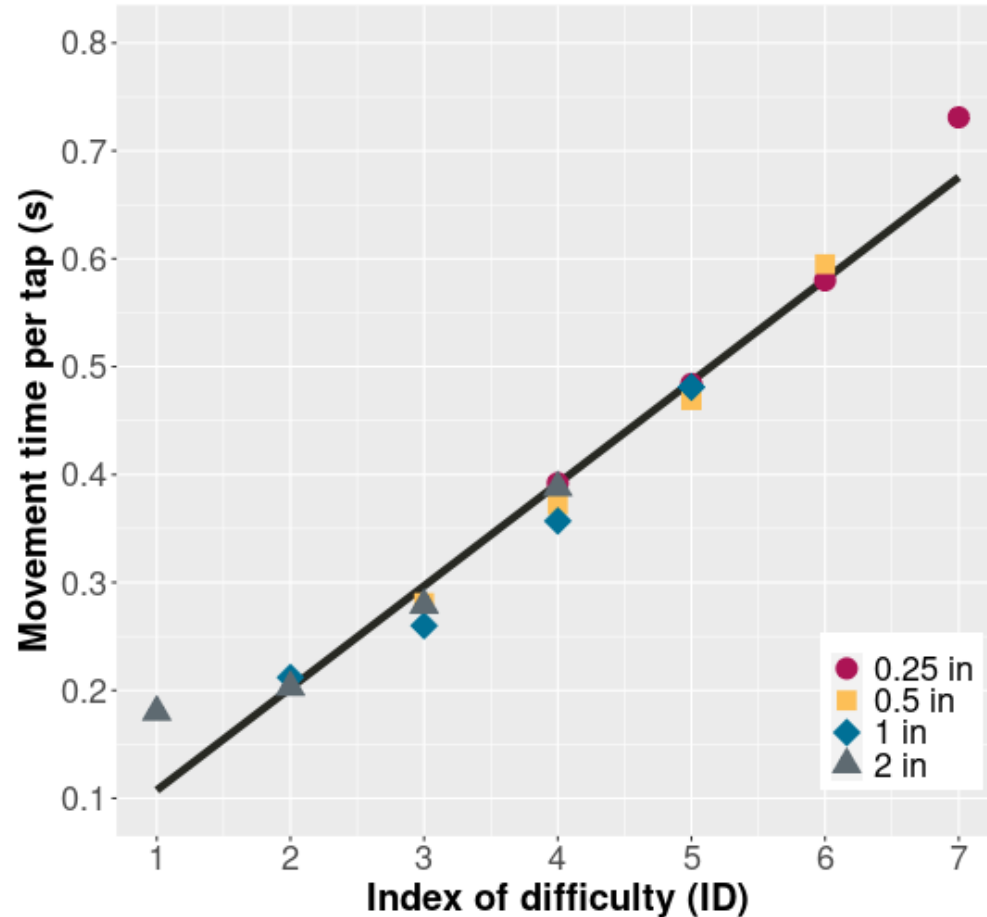
$$ID = \log_2(2A/W)$$

$$ID = \log_2(2 * 8/2)$$

$$ID = \log_2(8)$$

$$ID = 3 \text{ bits}$$

ID determines movement time per tap



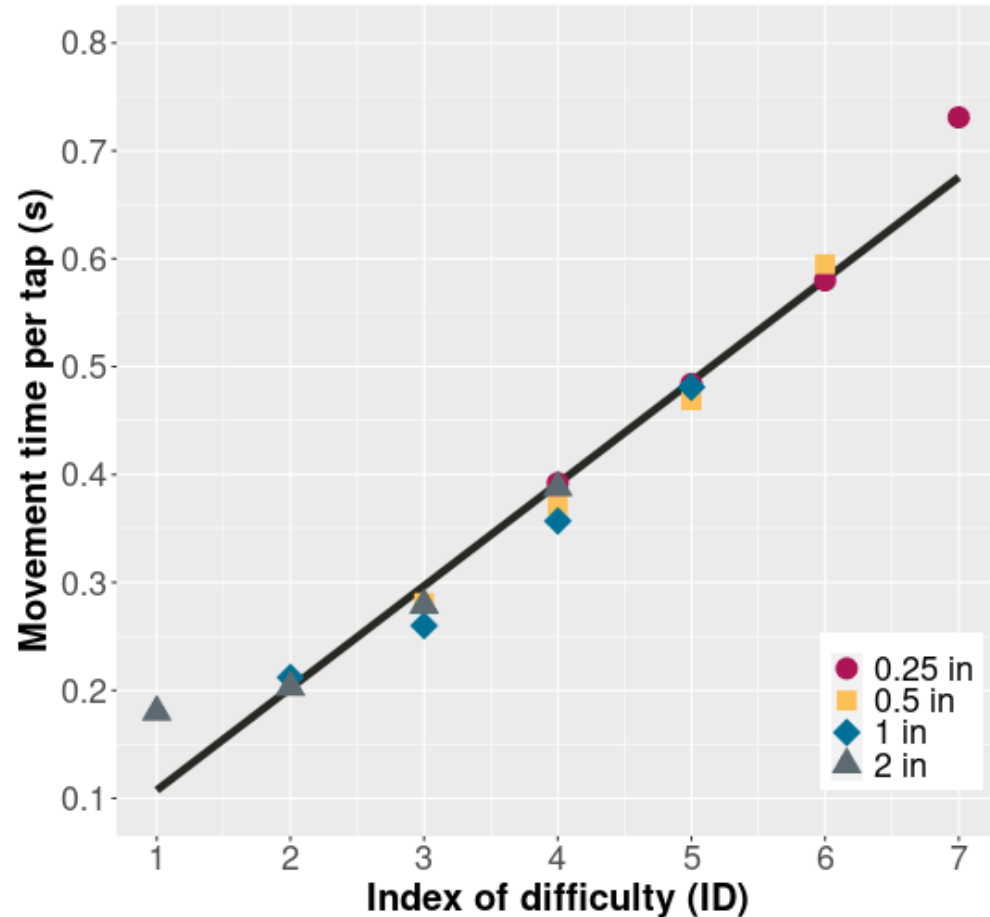
Low index of difficulty



High index of difficulty



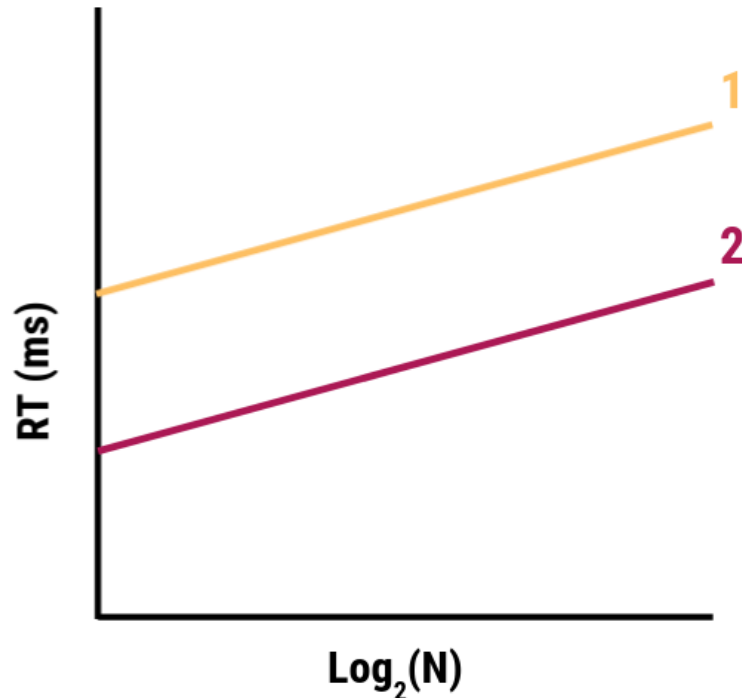
ID determines movement time per tap



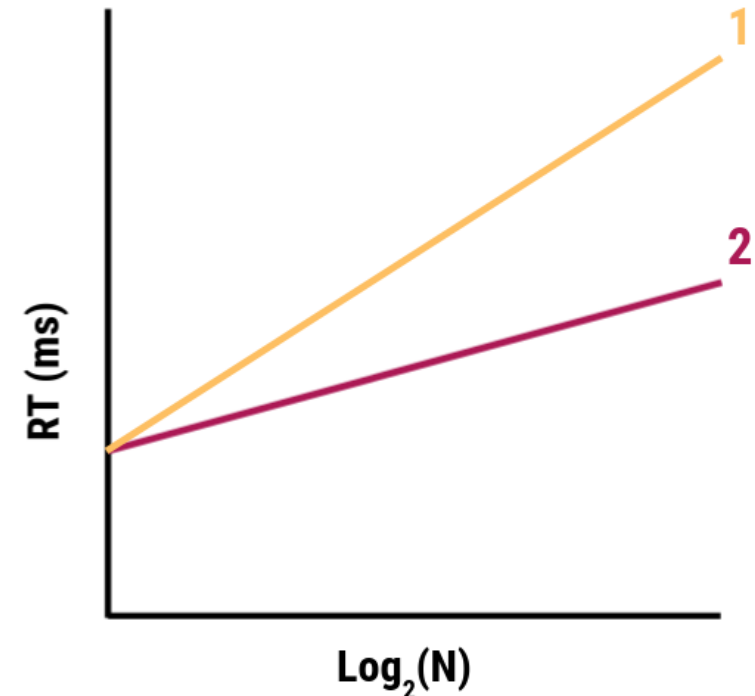
- Movement **time per tap increases** as movement **amplitude increases**
- Movement **time per tap increases** as target **width decreases**
- Movement **time per tap is constant** for a **fixed ratio** of movement **amplitude** to target **width**
- Experience an online Fitts' task:
<http://fww.few.vu.nl/hci/interactive/fitts/>

Understanding the parameters a and b in the equation for Fitts' Law

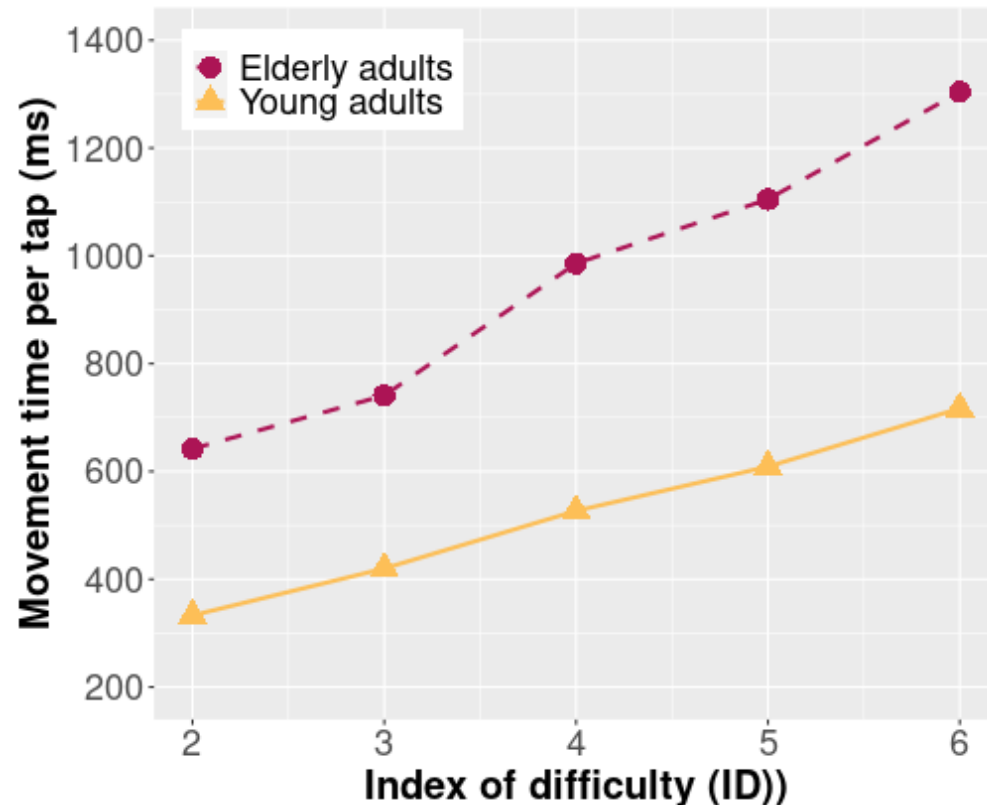
The **y-intercept** (a) is the expected movement time per tap when $ID = 0$



The **slope** (b) is the expected increase in movement time when ID increases by 1 unit

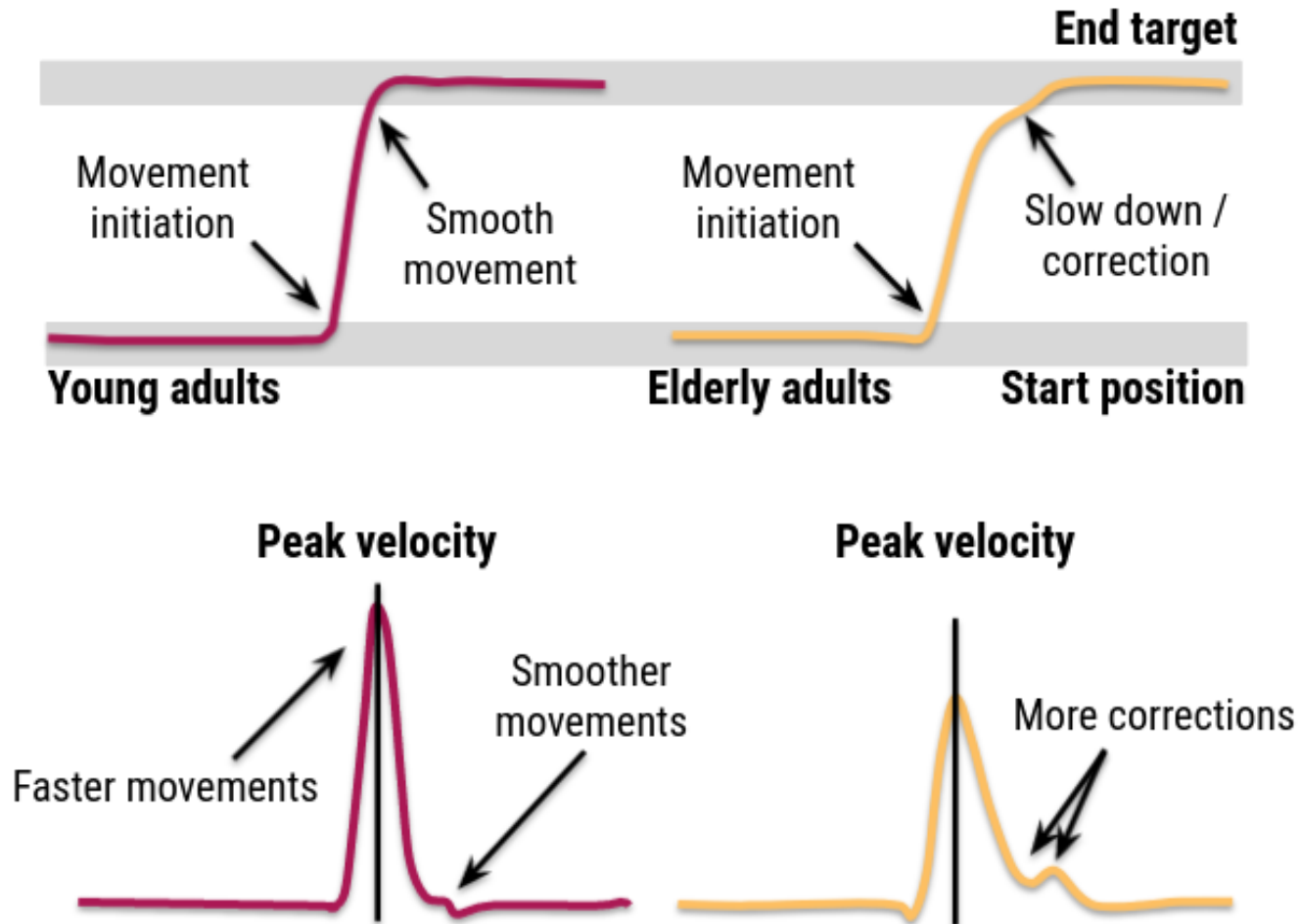


Aging affects both parameters in the equation for Fitts' Law



- **Larger intercept** in the **elderly** adults means unconstrained (i.e., minimal accuracy and amplitude demands) movements are **slower** than **young** adults
- **Larger slope** in the **elderly** adults means a more severe **speed-accuracy** trade-off than **young** adults

Young adults' movements are smoother and faster, with fewer corrections



Golf club design impose a speed-accuracy trade-off

Driver



Iron



Left: https://www.golfchannel.com/sites/default/files/styles/full/public/2018/03/06/gettyimages-923541572_master.jpg; Right: https://www.protourgolfcollege.com/uploads/5/6/1/5/5615801/522284_orig.png

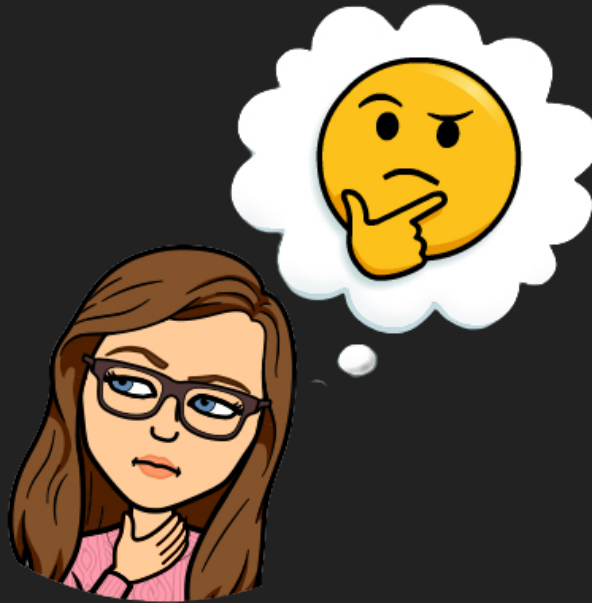
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What questions do you have?



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