McMaster University

SCIENCE
Department of Kinesiology

Action preparation: Information-processing

KINESIOL 1E03 - Motor control and learning

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Fall 2021 Week 4
Lecture 8

Review from last lecture

There are two basic control systems that guide action

CLOSED-LOOP CONTROL: a class of control in which, **during** the course of an action, feedback is **compared** against a standard (or reference) to enable an action to be carried out as planned

OPEN-LOOP CONTROL: a class of control in which **all** the information needed to initiate and carry out an action as planned is contained in the **initial instructions** to the effectors

Feedback provides a means for achieving control objectives

- *Our driving example again*:
  - Speed limit is 50 km/h
  - Your speed is 60 km/h
  - Error is -10 km/h (50 - 60)
- Fundamental objective of this class of control is to **reduce errors to 0** or **as close to 0** as makes no practical difference

Feedback provides a means for achieving control objectives

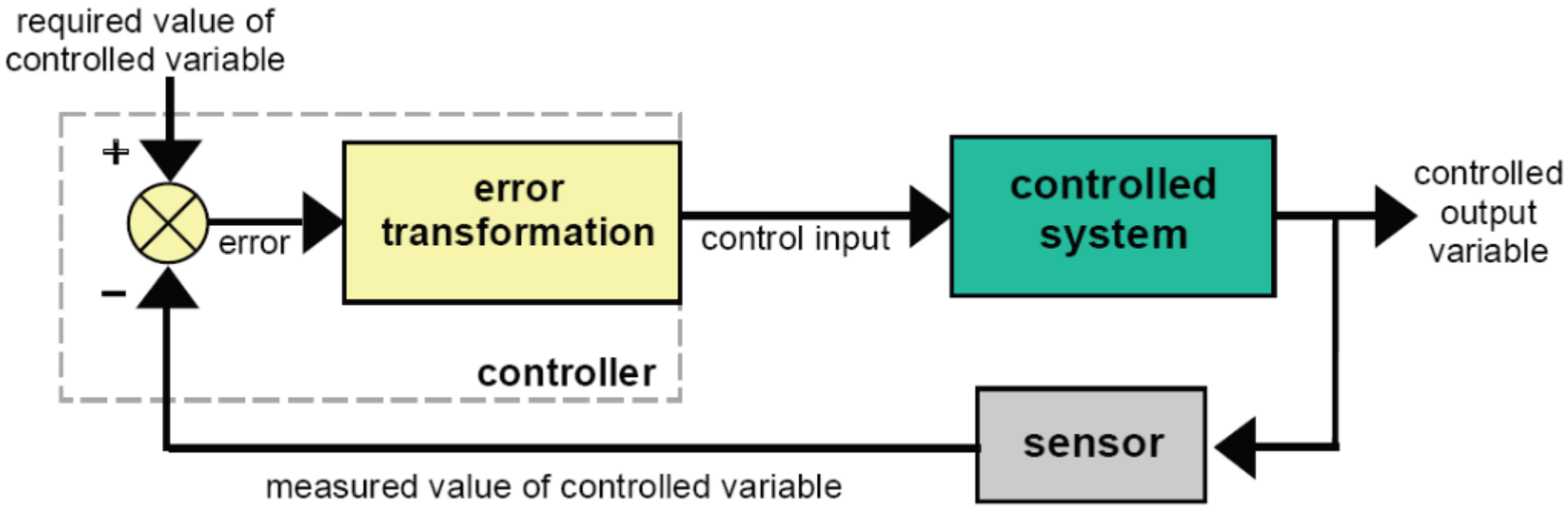
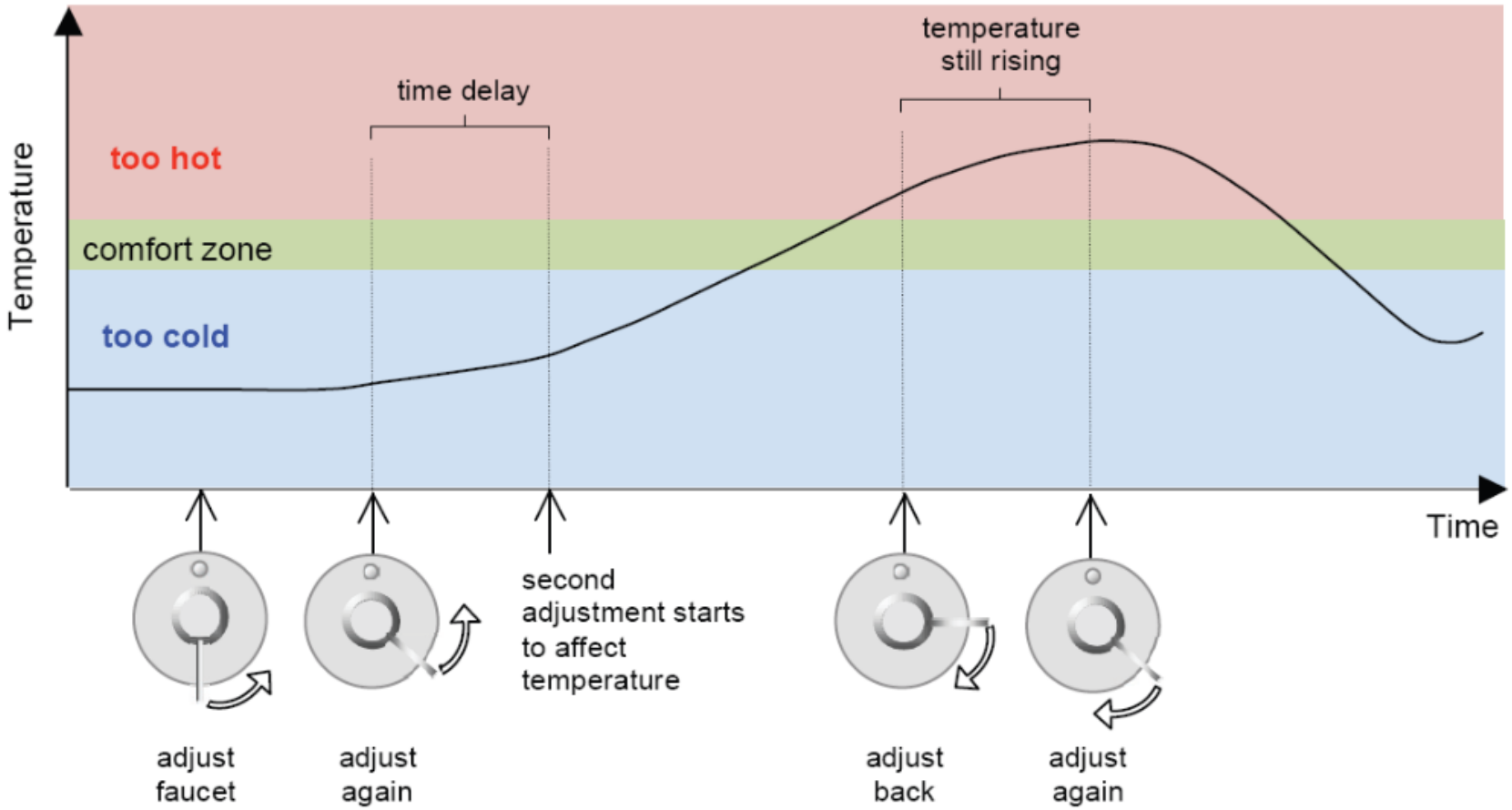


Fig: Tresilian 2012

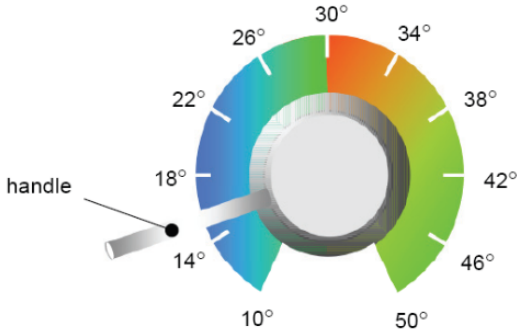
Closed-loop control can be ineffective when there are time delays

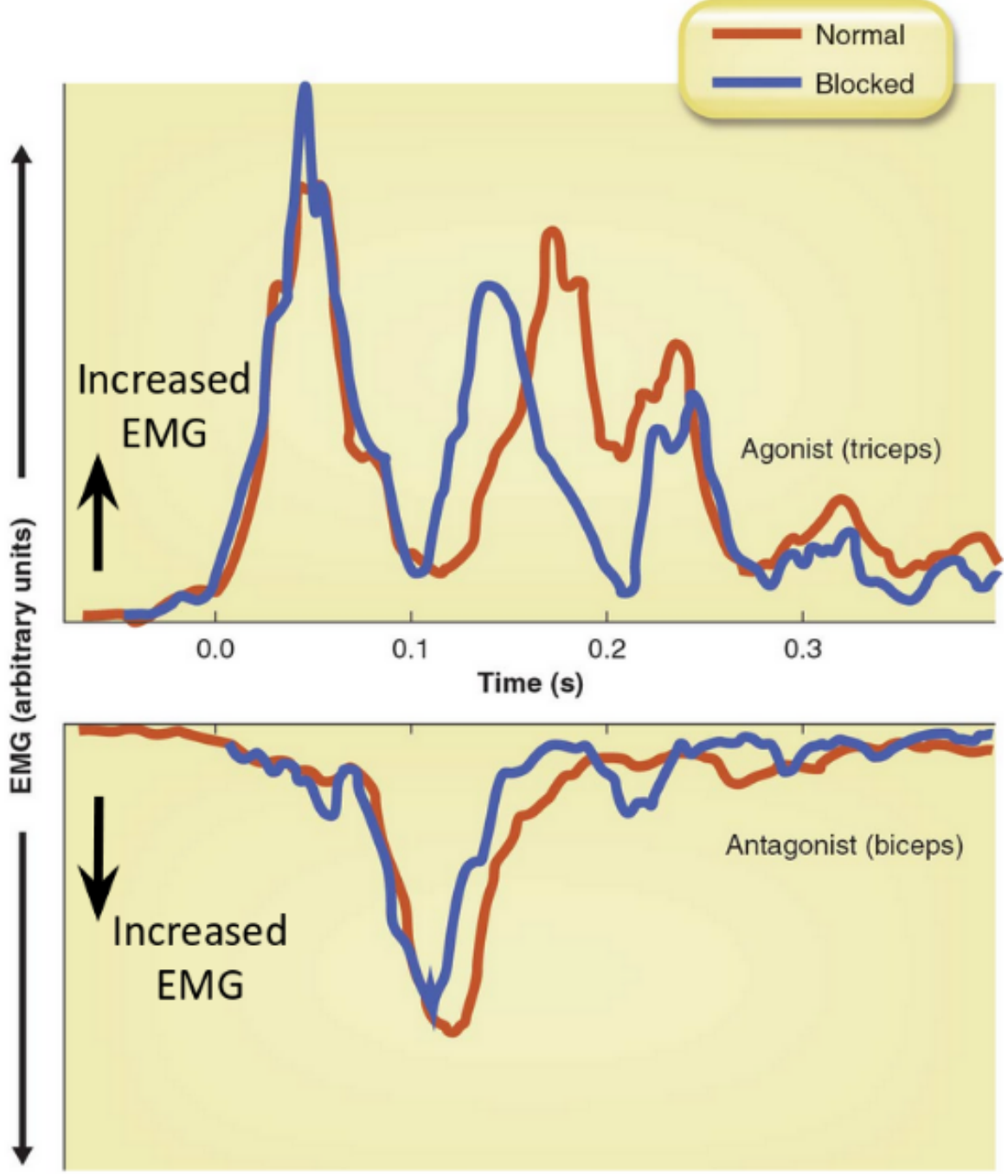


In the absence of disturbances, control may be possible without using feedback

Open-loop control: a style of control in which the output of the controlled system is not fed back to the controller. What the controlled system is actually doing has no effect on the control inputs supplied by the controller

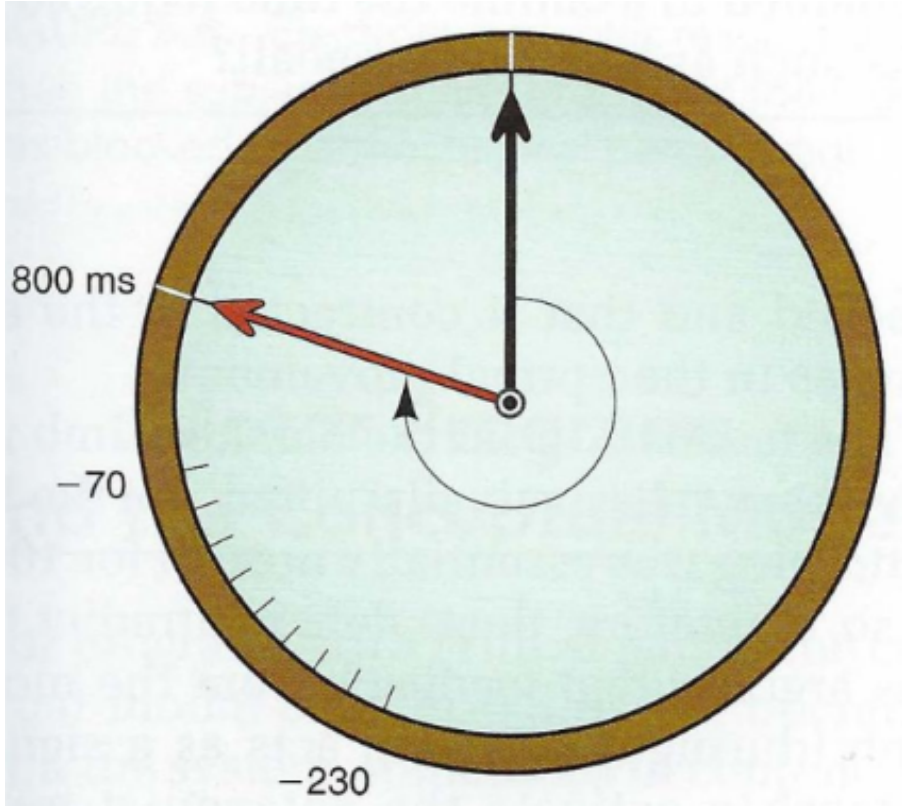
Open-loop control **requires detailed knowledge** about the controlled system

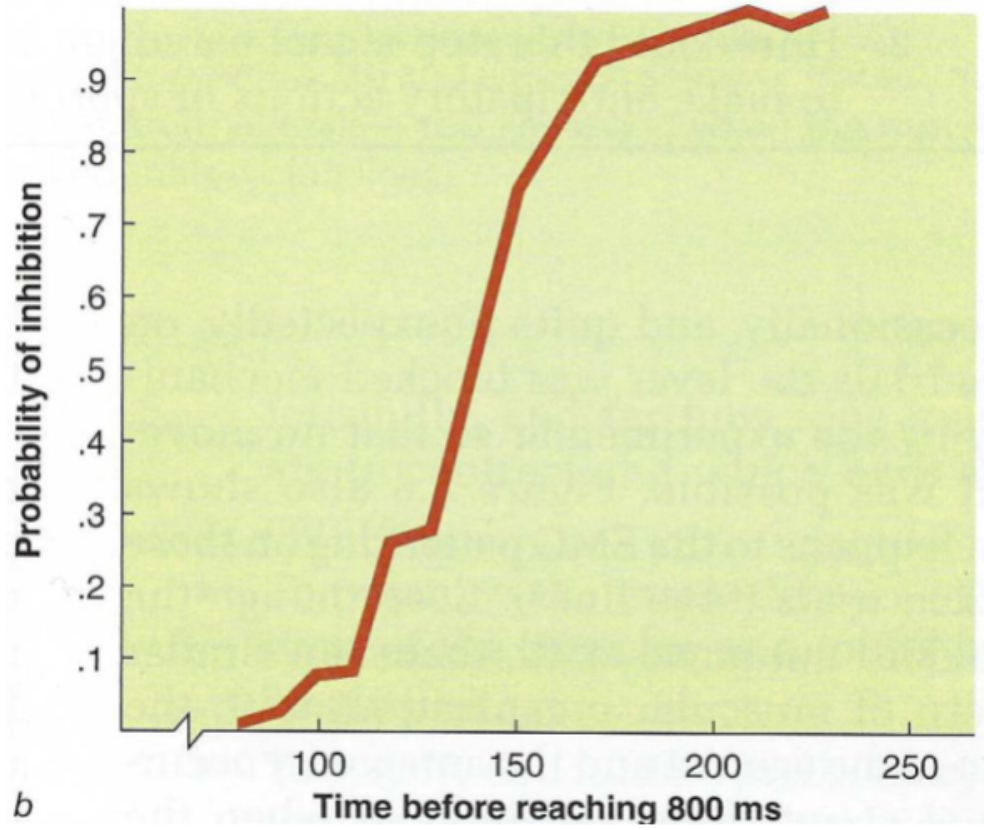




Wadman et al. 1979

Lift finger to stop sweep hand at 10 o'clock position





Any questions?

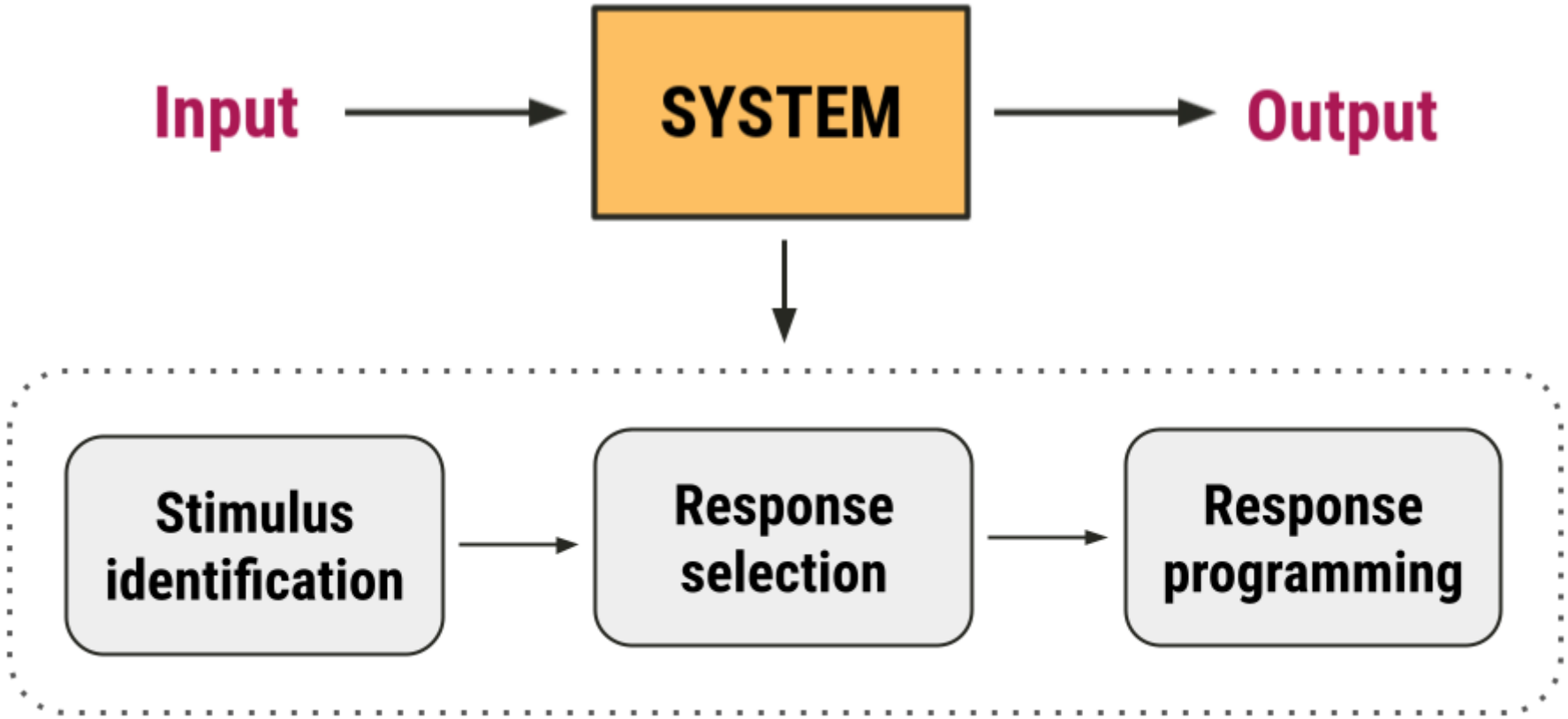
Learning objectives

1. Discuss how reaction time can be used as an **index of motor preparation**.
2. Identify and describe the **3 stages** of information-processing.
3. Describe how the **property** of a stimulus can influence reaction time.
4. Explain how **Hick's Law** describes the relationship between the number of response choices and reaction time using examples.

Take-home message:

Although reaction time is one of the simplest performance measures, its use has had a profound influence on the development of motor behaviour research.

A key assumption of the information-processing model is that the stages are non-overlapping



A key assumption of the information-processing model is that the stages are non-overlapping

Stimulus Identification

- Primarily a sensory stage
- A representation of the stimulus can be created which is passed into the next stage

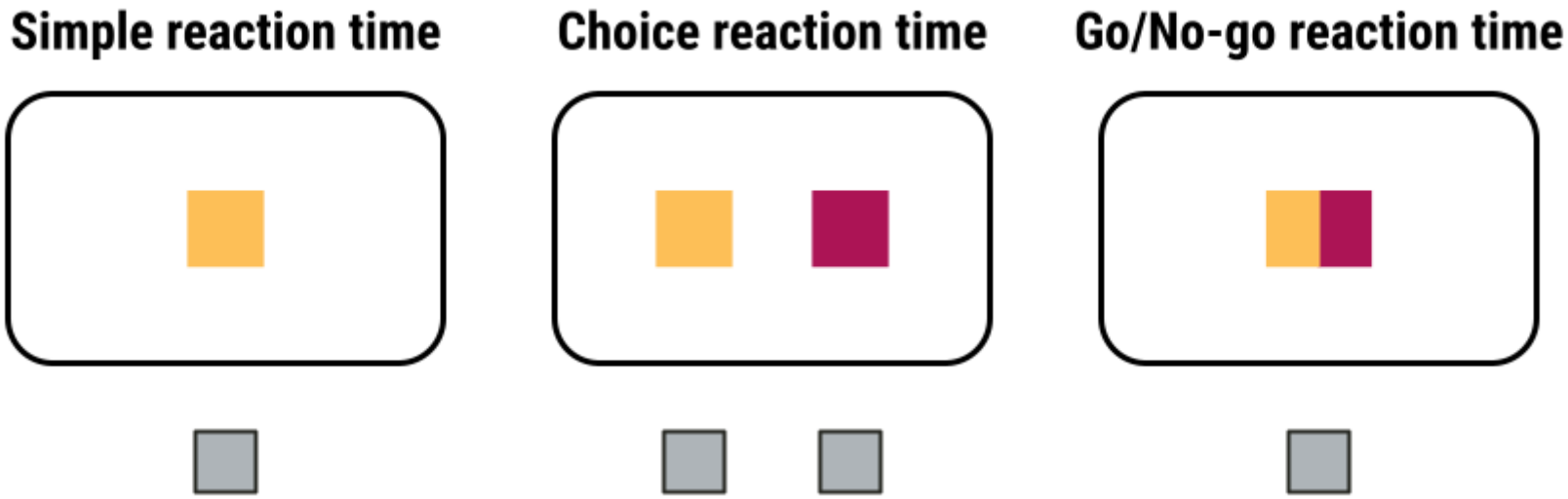
Response selection

- A decision has to be made about what response to make, given the nature of the stimulus
- This stage may be by-passed

Response programming

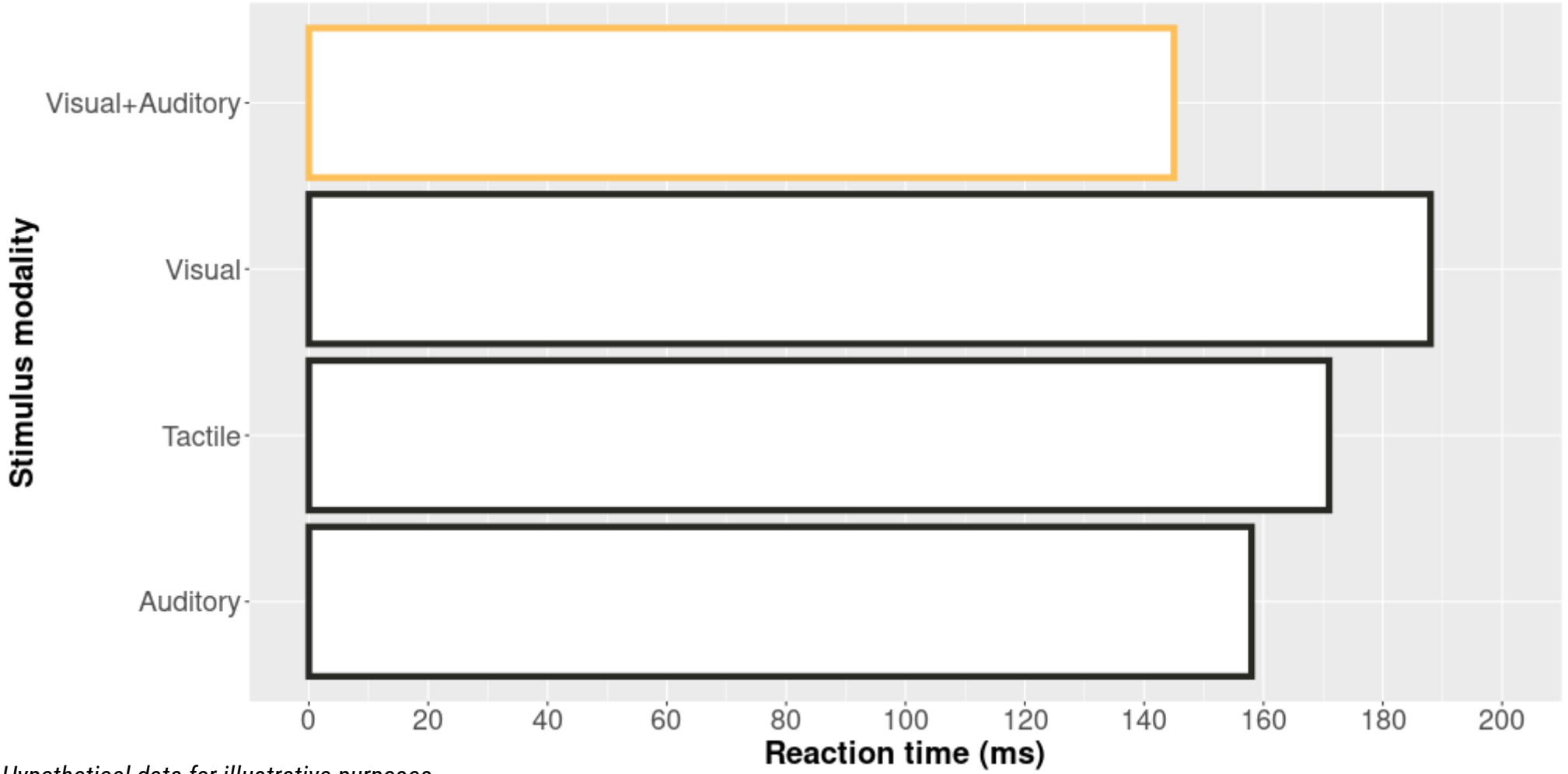
- The motor system must be organized to make the desired action

Recall our three types of reaction time tasks



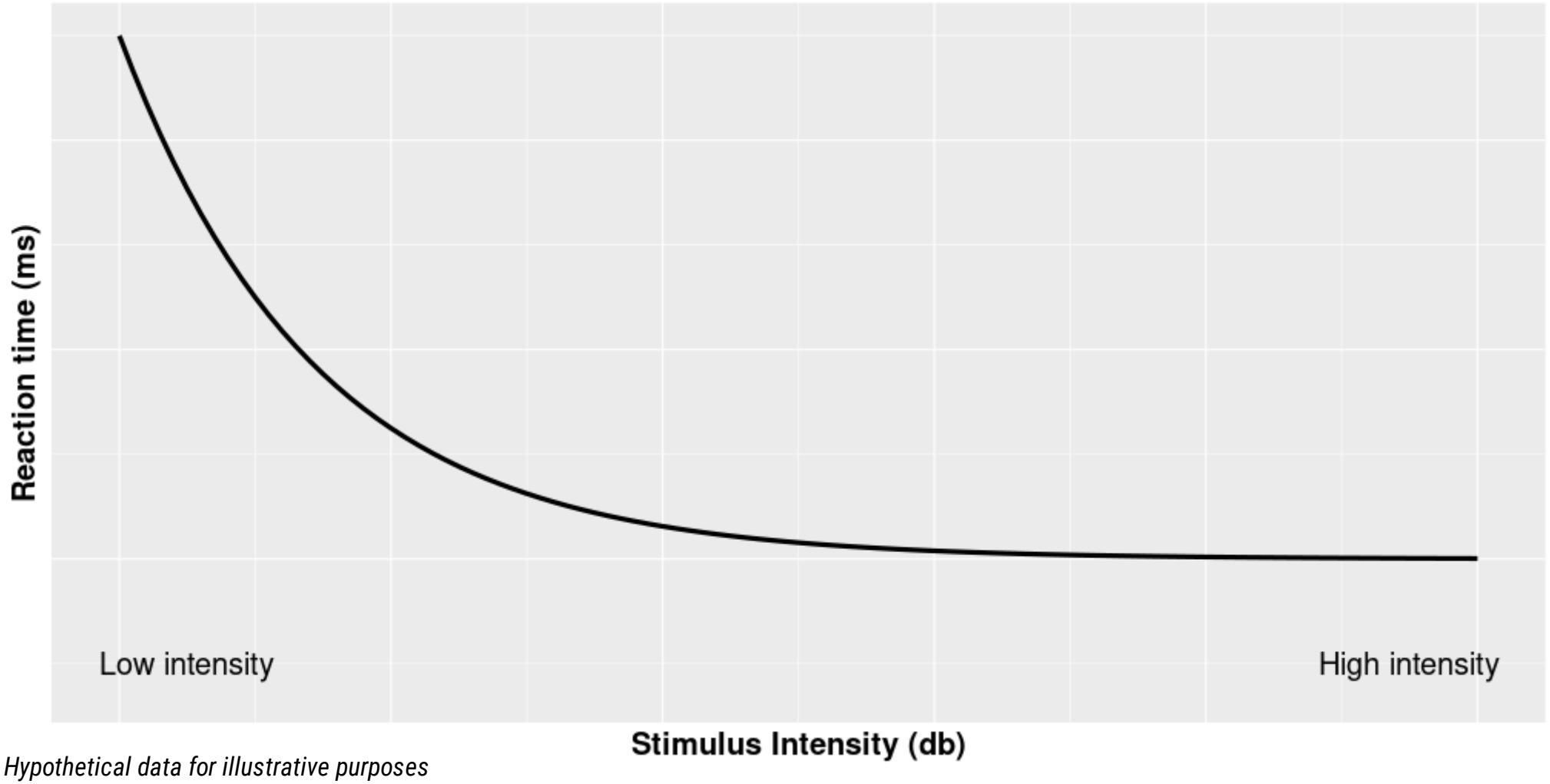
- The **stages** in our information-processing model are **differentially** impacted by the **type** of reaction time task being performed

Stimulus modality influences simple reaction time



Hypothetical data for illustrative purposes

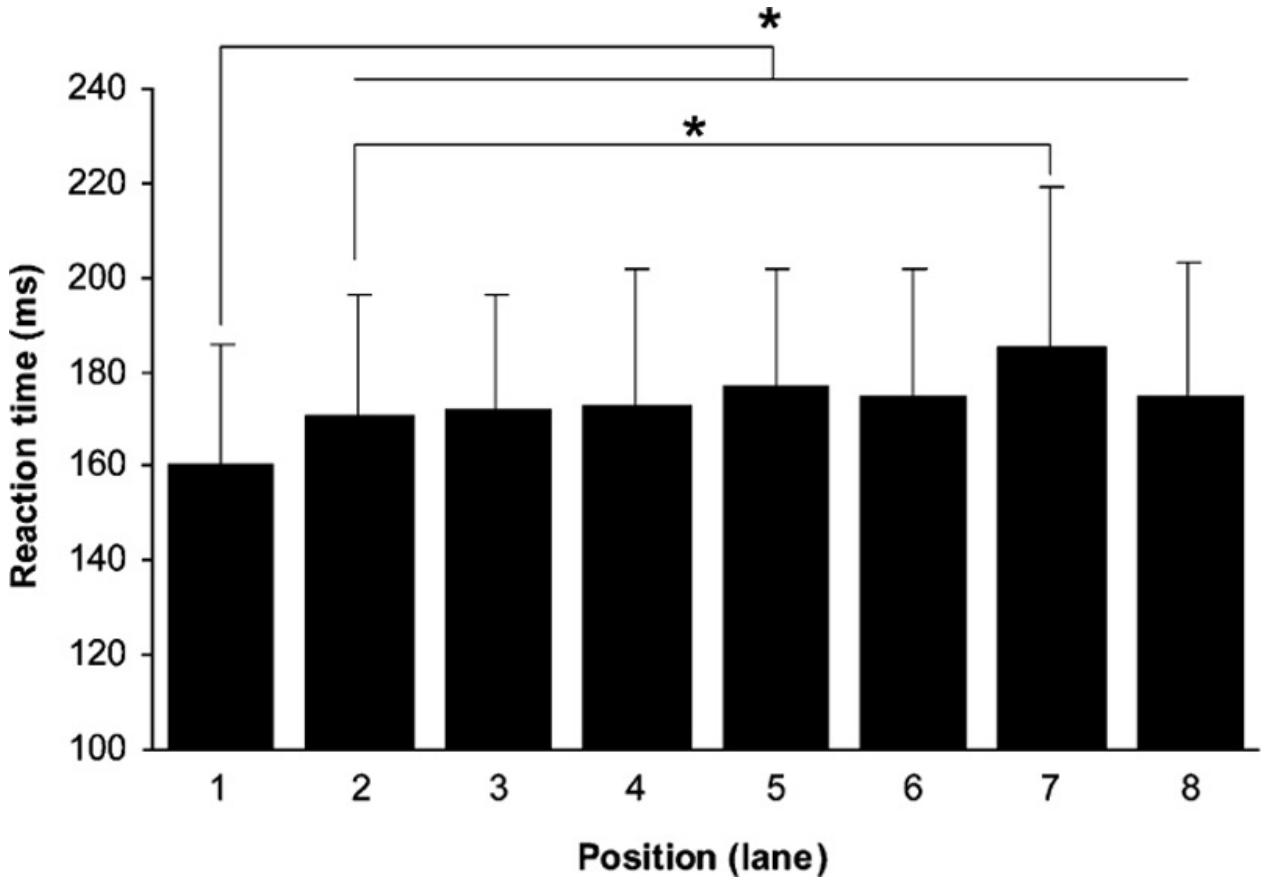
Stimulus intensity influences simple reaction time



Hypothetical data for illustrative purposes

A real-world example of a stimulus intensity effect

Mean reaction time data (and standard deviation) from the 100 m sprint and 110/100 m hurdles events grouped according to starting position. 2004 Olympic Games



Brown et al. 2008 (https://doi.org/10.1249/mss.0b013e31816770e1)

How does product design affect the user experience?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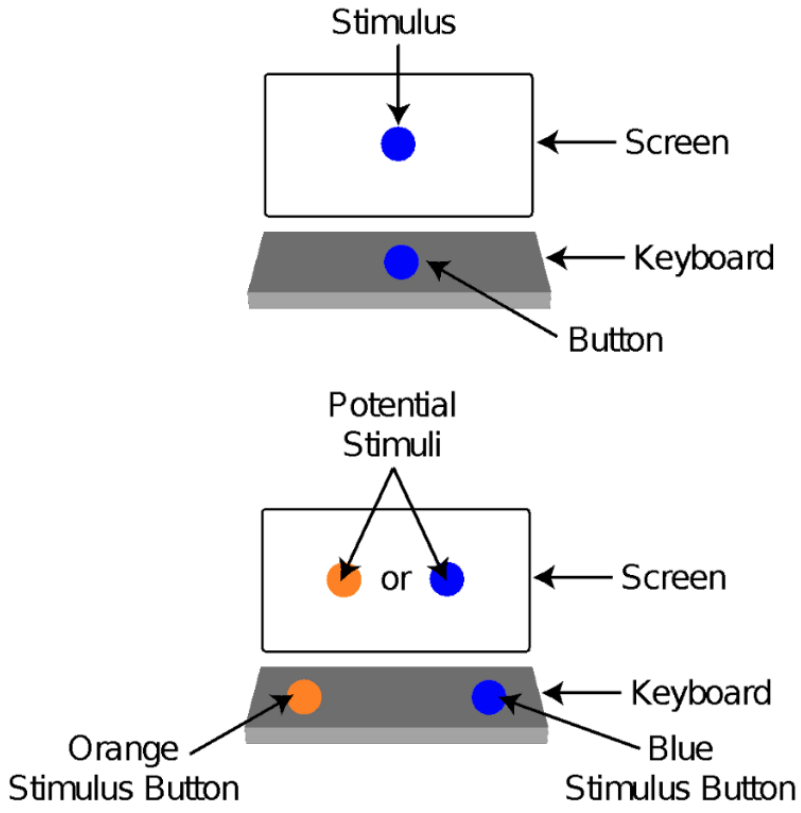
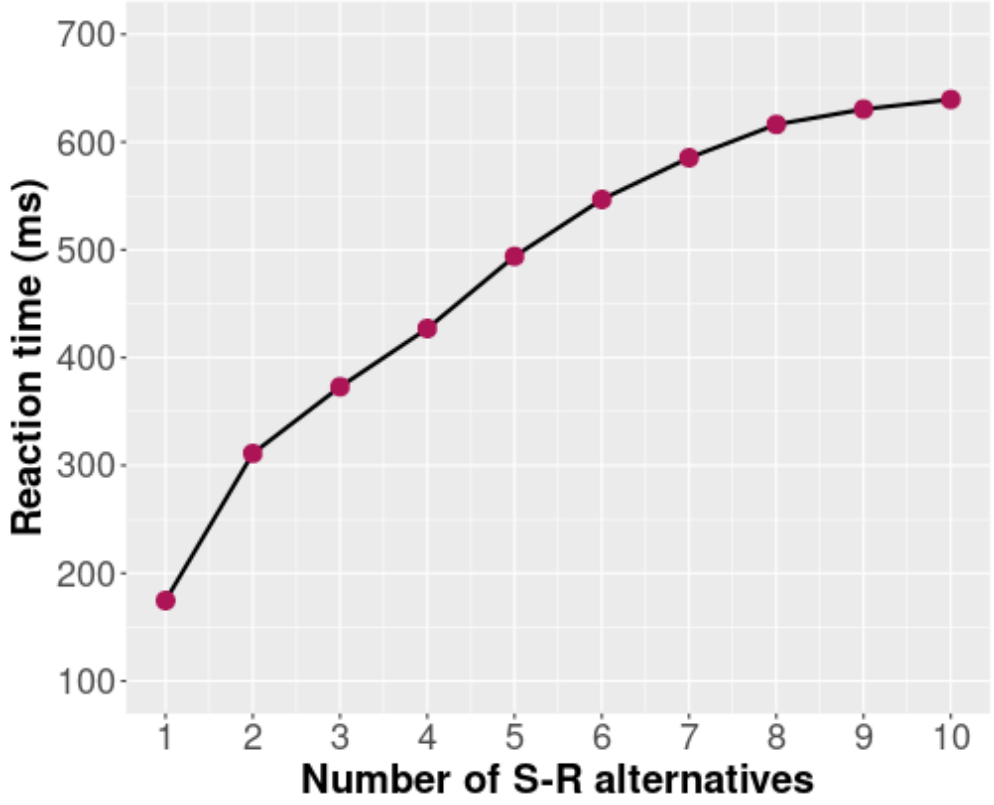
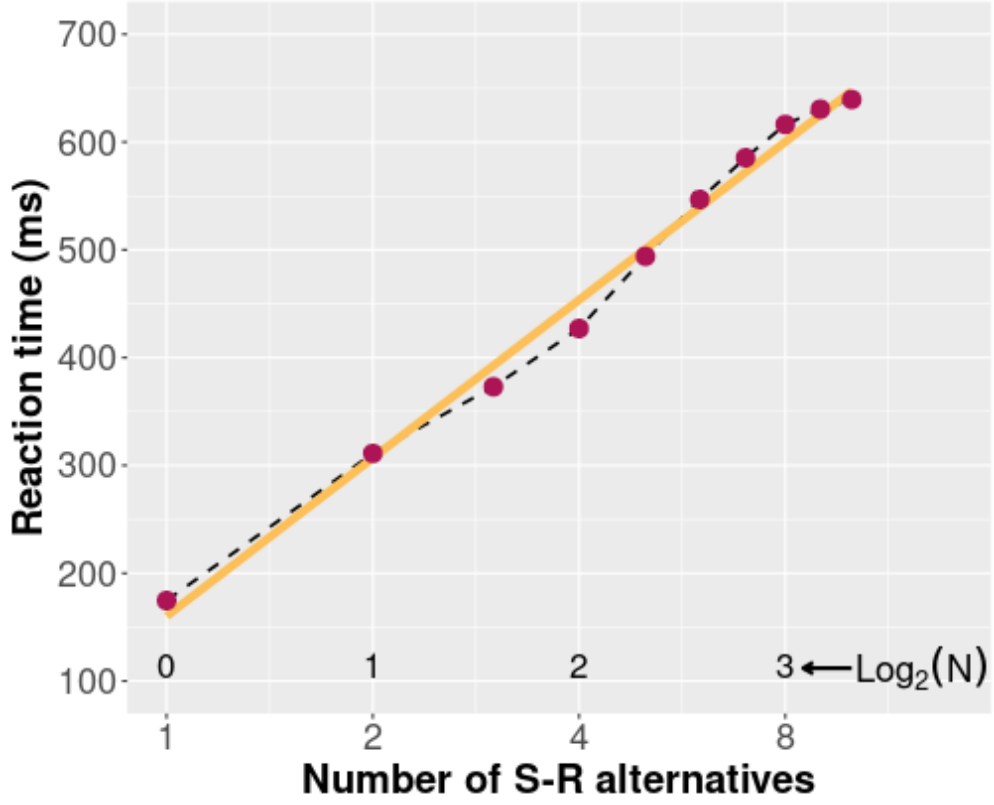
Studying the impact of the number of stimulus-response alternatives on reaction time in the lab



Reaction time increases with the number of stimulus-response alternatives





Approximate data from Merkel 1885 through plot digitization

The number of choice and reaction time can be capture with a log-linear equation (i.e., **Hick's Law**)

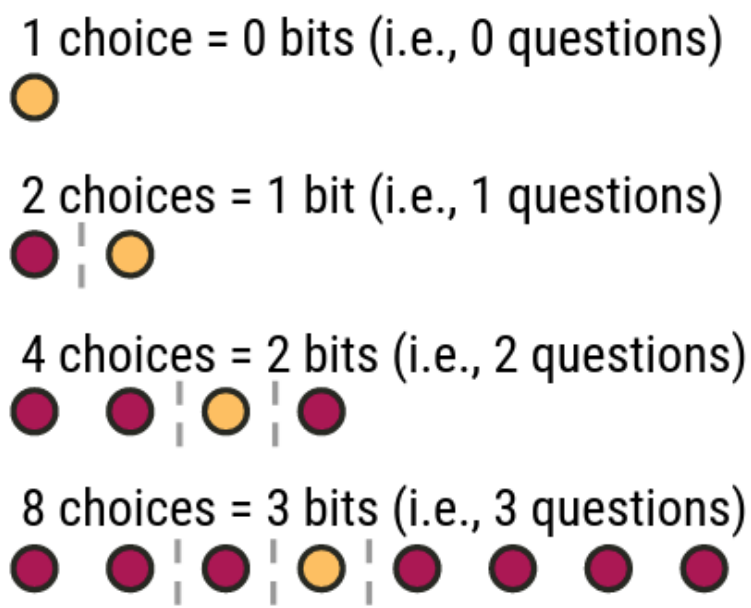
$$RT = a + b \log_2(N)$$

where:

- *a* = y-intercept
- *b* = slope
- *N* = number of S-R alternatives
- $\log_2(N)$ = **bits** of information

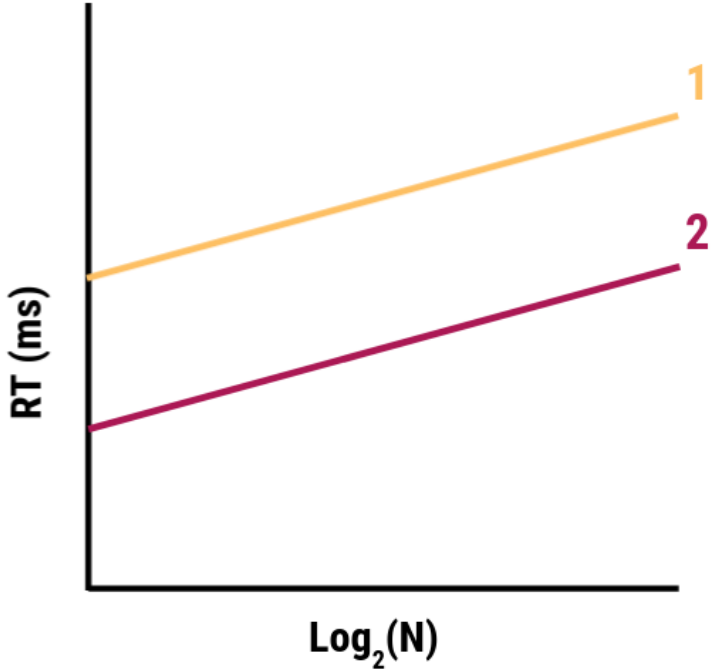
One bit = the amount of information needed to reduce the original uncertainty in half

Converting S-R alternatives to bits (i.e., amount of information)

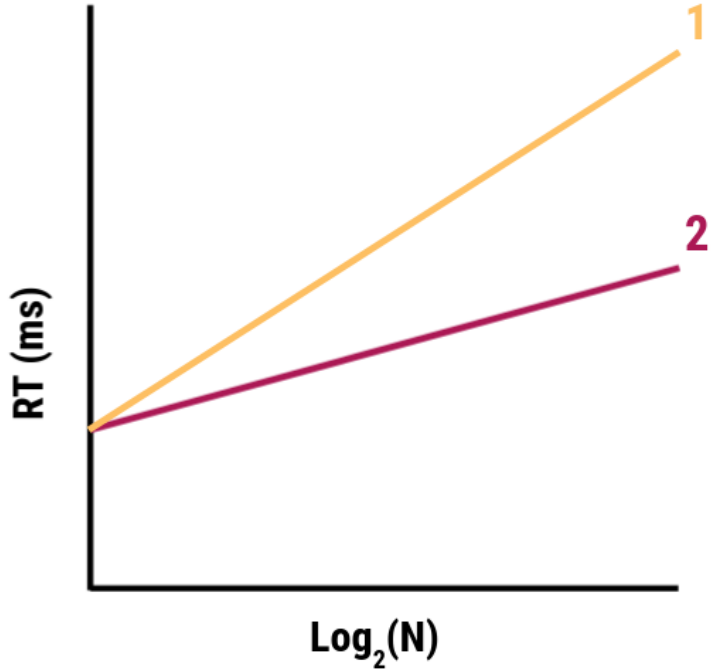


Understanding the parameters *a* and *b* in the equation for Hick's Law

The **y-intercept** (*a*) is the expected reaction time when no choice is required (i.e., simple reaction time task)



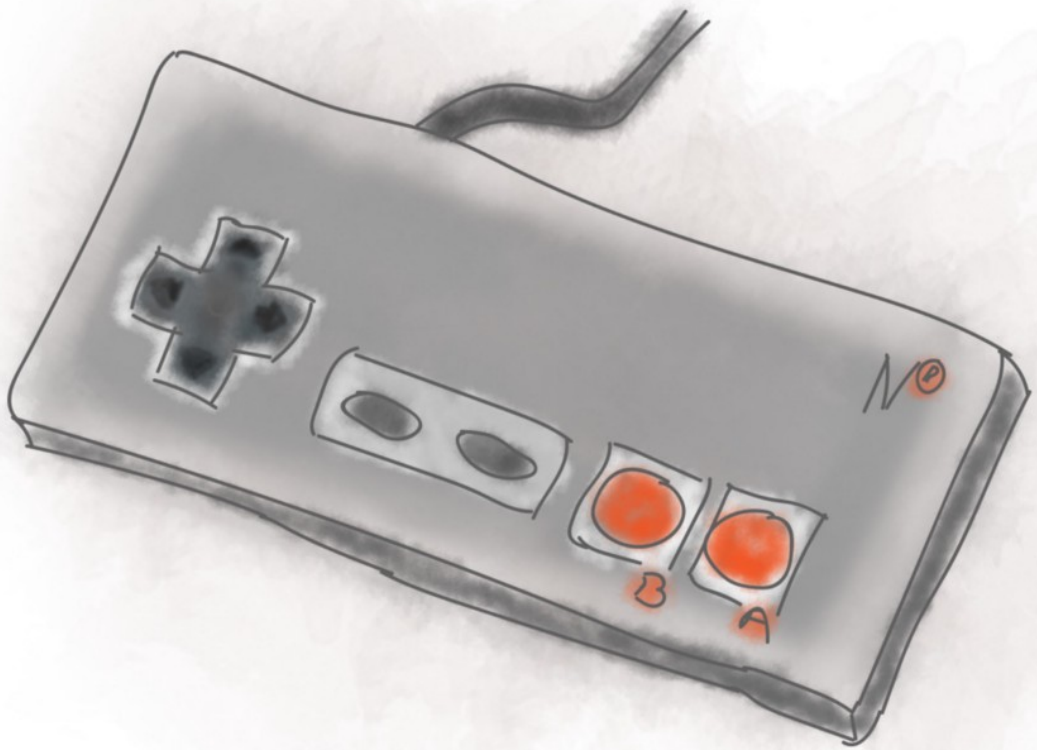
The **slope** (*b*) is the expected increase in reaction time when the number of S-R alternatives is doubled



Exceptions to Hick's Law

- If stimulus is **tactile**
  - *Direct stimulus-response relationship*
- If response is a **saccade**
  - *Saccade toward targets are natural and biologically important*
- If **extended practice** is undertaken
  - *42,000 practice trials eliminated typical RT difference between 2- and 4-choice tasks*

How can Hick's Law be used to create better user experiences?



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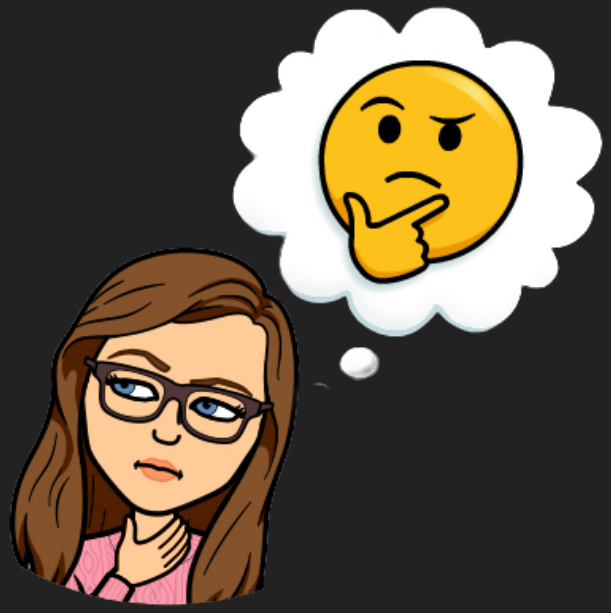

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