McMaster University

SCIENCE
Department of Kinesiology

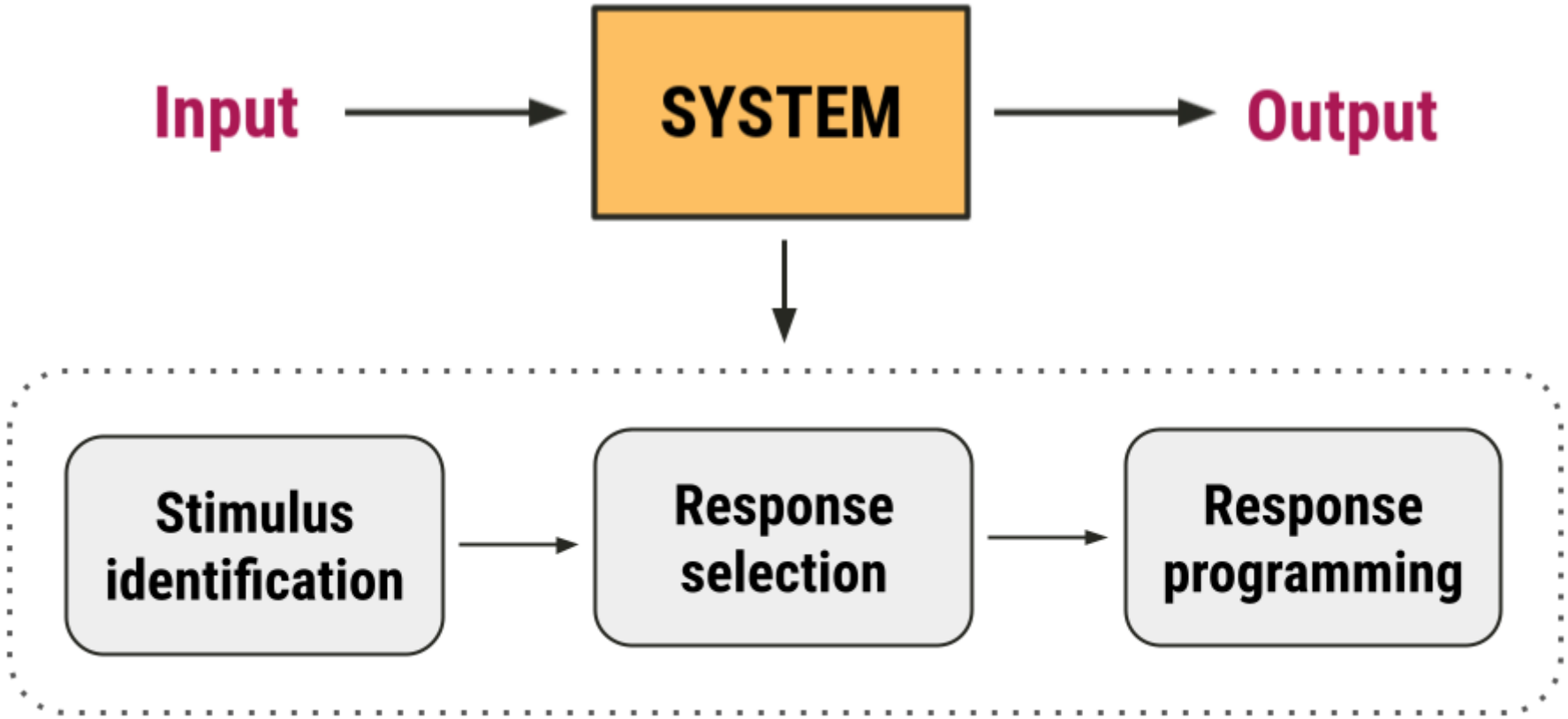
Action preparation: Compatibility and complexity

KINESIOL 1E03 - Motor control and learning

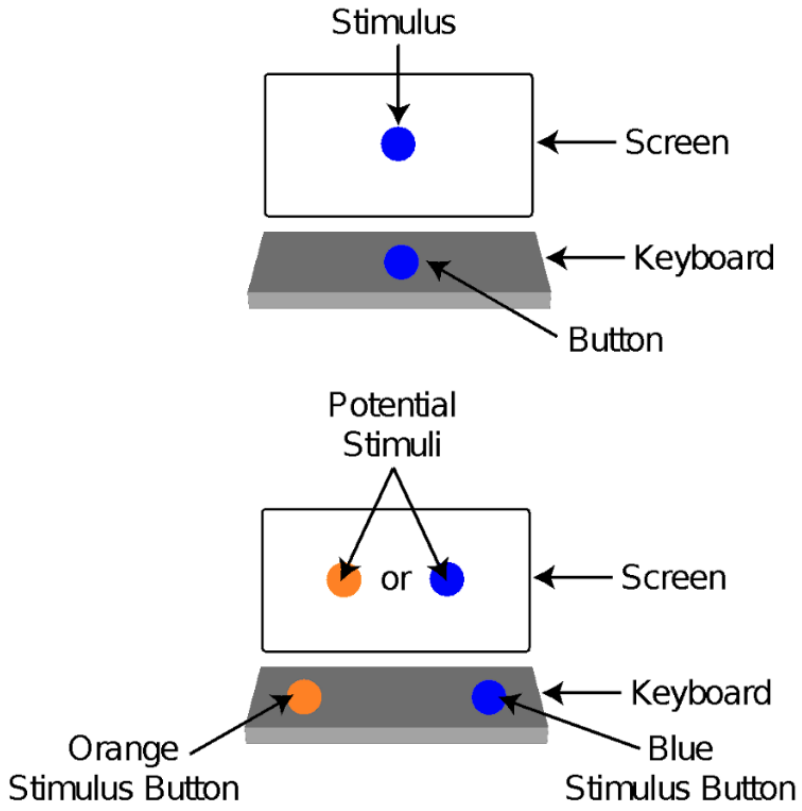
Laura St. Germain
Fall 2022 Week 4
Lecture 9

Review from last lecture

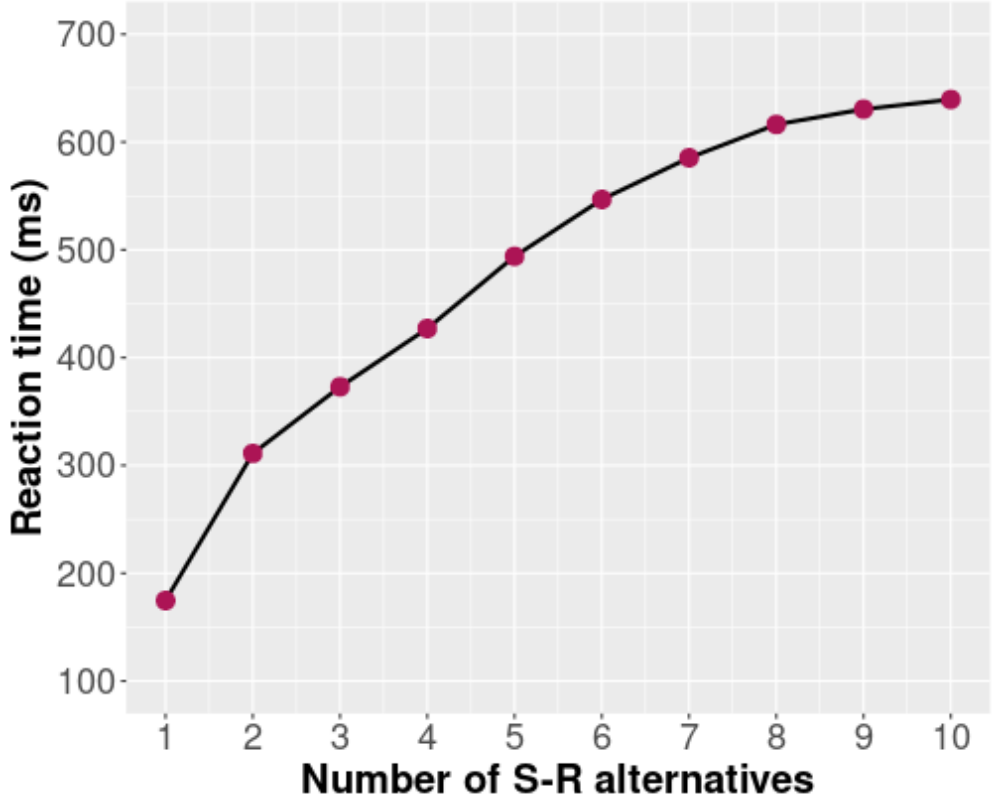
A key assumption of the information-processing model is that the stages are non-overlapping

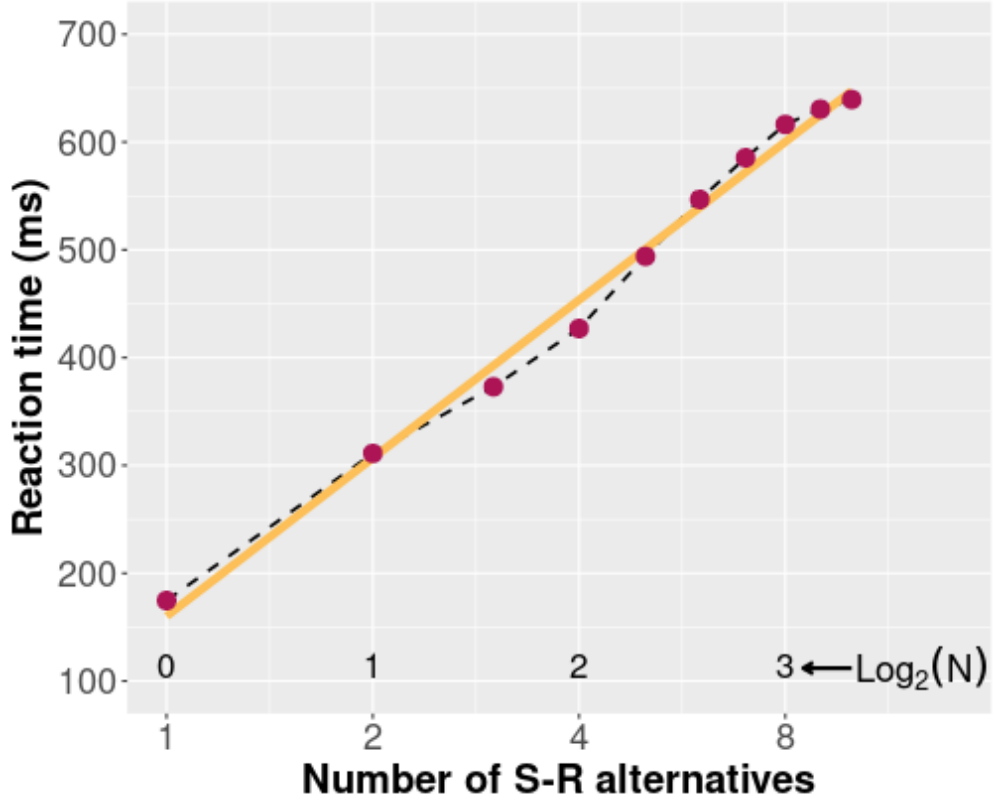


Studying the impact of the number of stimulus-response alternatives on reaction time in the lab



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

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

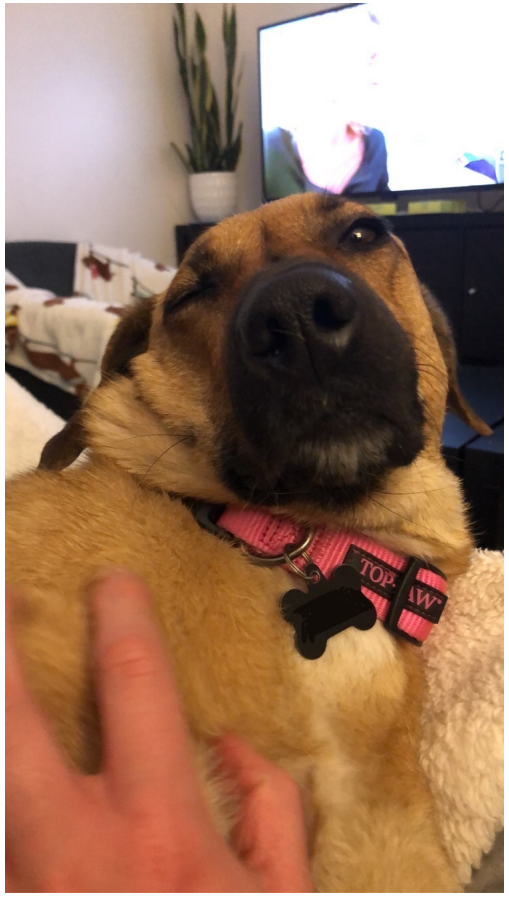
where:

- *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

Information is related to **uncertainty** and the amount of uncertainty **reduced** by a stimulus

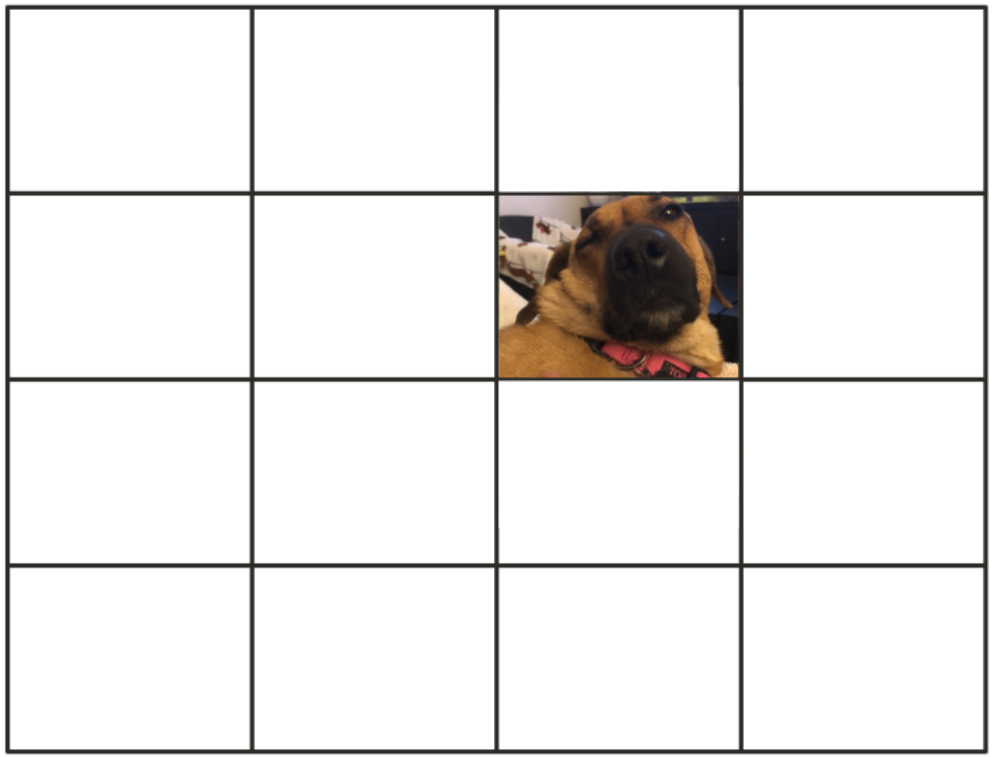
Meet Ginger[1]...the MAClab mutt



[1]Voted the **cutest dog** of the lab 2022

Amount of information

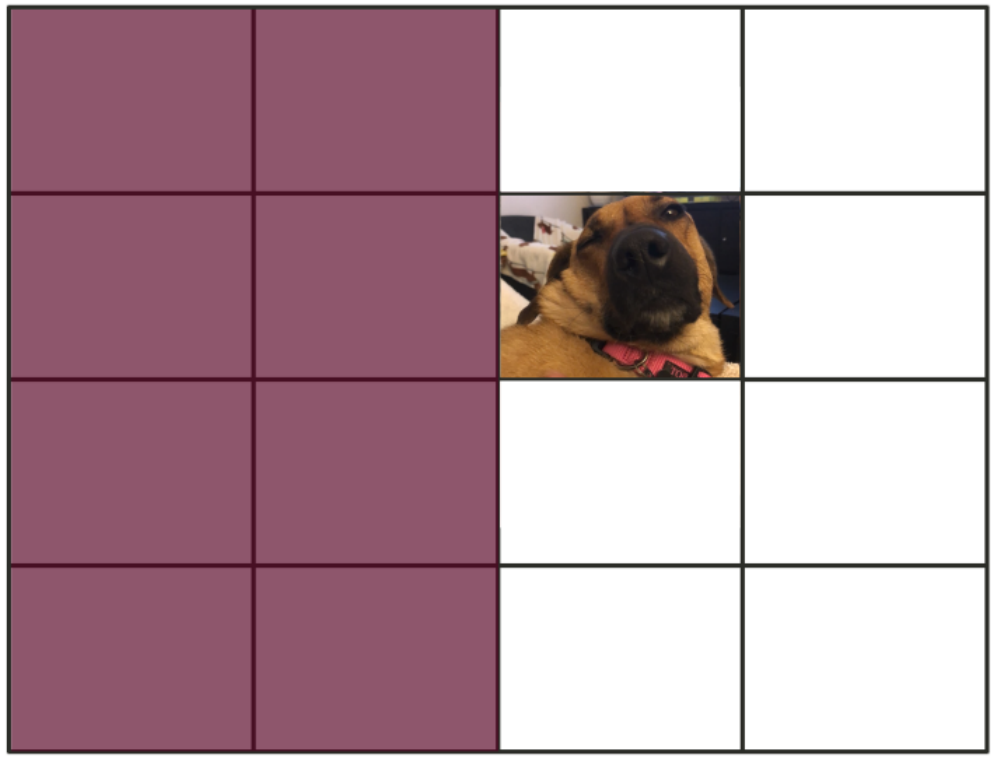
Q1: Is Waldo in the left half?



Amount of information

Q1: Is Waldo in the left half?

- NO...uncertainty reduced by half



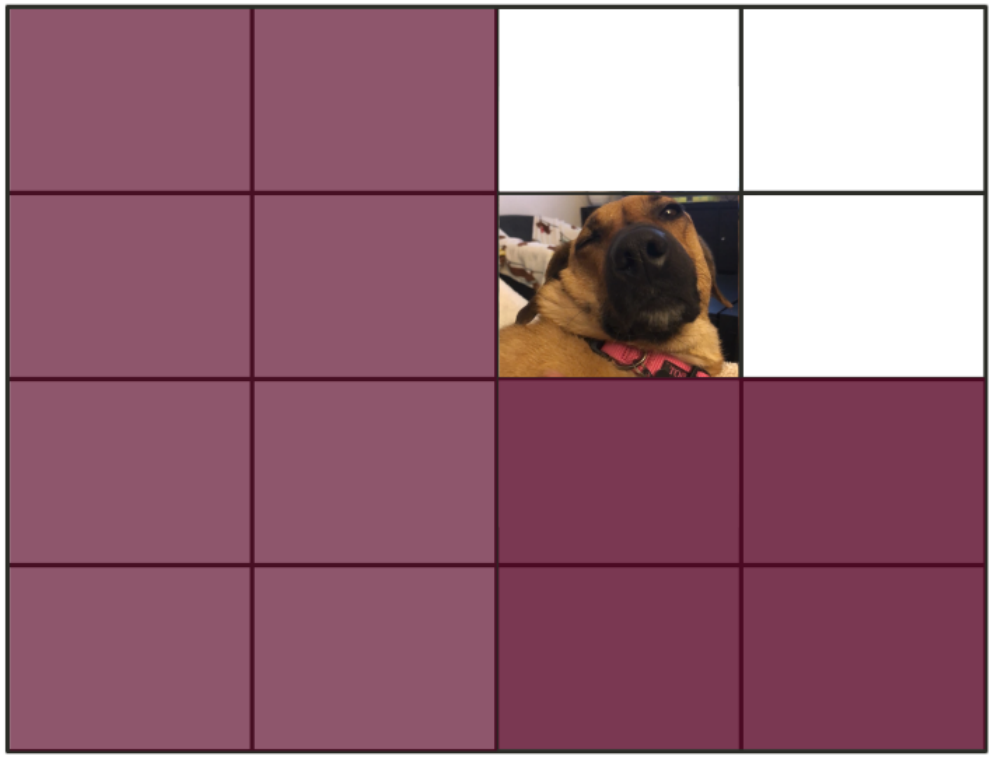
Amount of information

Q1: Is Waldo in the left half?

- NO...uncertainty reduced by half

Q2: Is Waldo in the top half?

- YES...uncertainty reduced by half



Amount of information

Q1: Is Waldo in the left half?

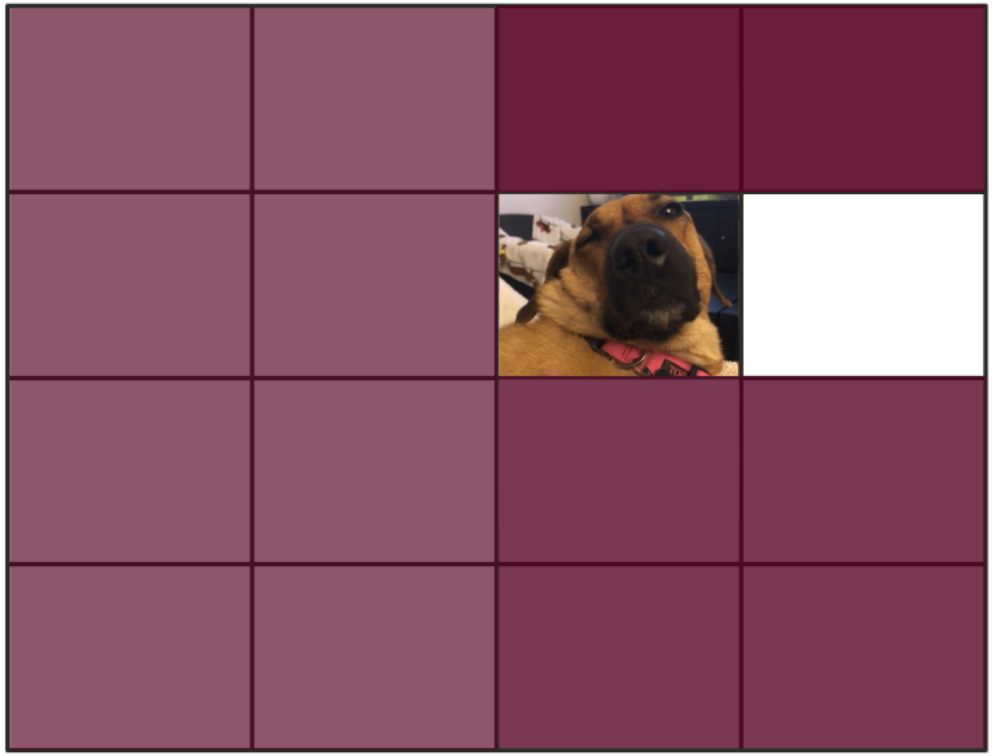
- NO...uncertainty reduced by half

Q2: Is Waldo in the top half?

- YES...uncertainty reduced by half

Q3: Is Waldo in the top half?

- NO...uncertainty reduced by half



Amount of information

Q1: Is Waldo in the left half?

- NO...uncertainty reduced by half

Q2: Is Waldo in the top half?

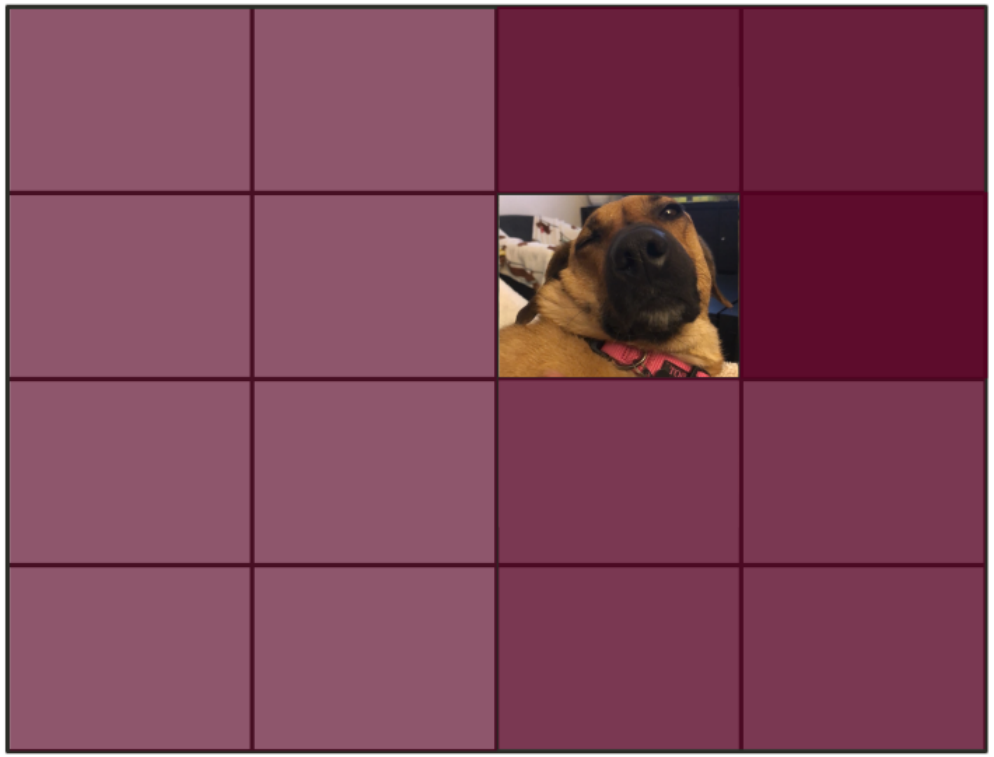
- YES...uncertainty reduced by half

Q3: Is Waldo in the top half?

- NO...uncertainty reduced by half

Q4: Is Waldo in the right half?

- NO...uncertainty reduced by half



Amount of information

Q1: Is Waldo in the left half?

- NO...uncertainty reduced by half

Q2: Is Waldo in the top half?

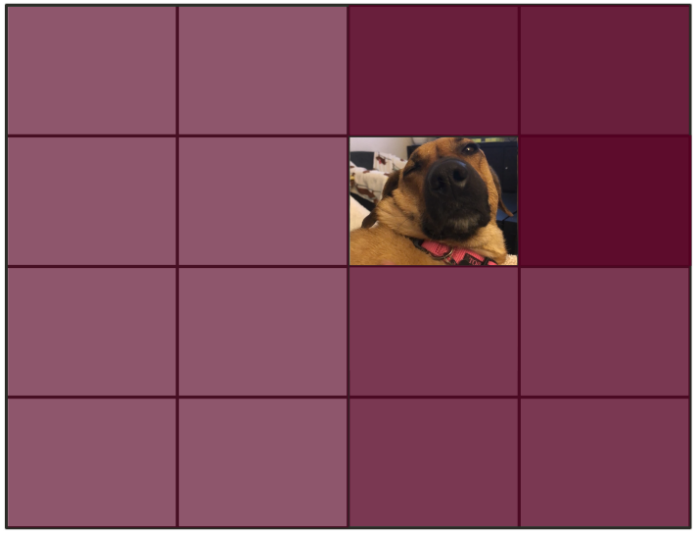
- YES...uncertainty reduced by half

Q3: Is Waldo in the top half?

- NO...uncertainty reduced by half

Q4: Is Waldo in the right half?

- NO...uncertainty reduced by half



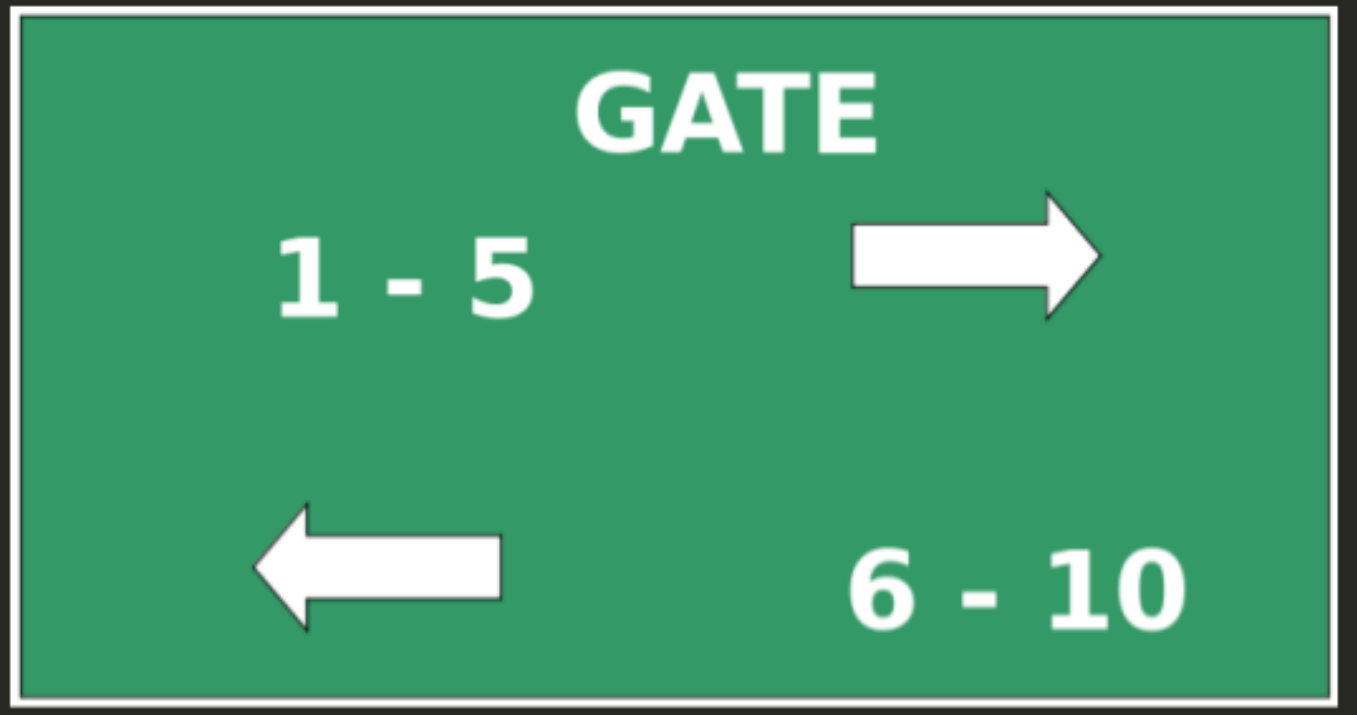
$$Log_2(N) = Log_2(16) = 4$$

OR

$$2 * 2 * 2 * 2 = 16$$

(i.e., 4 binary decisions)

Any questions?


GATE
1 - 5
6 - 10

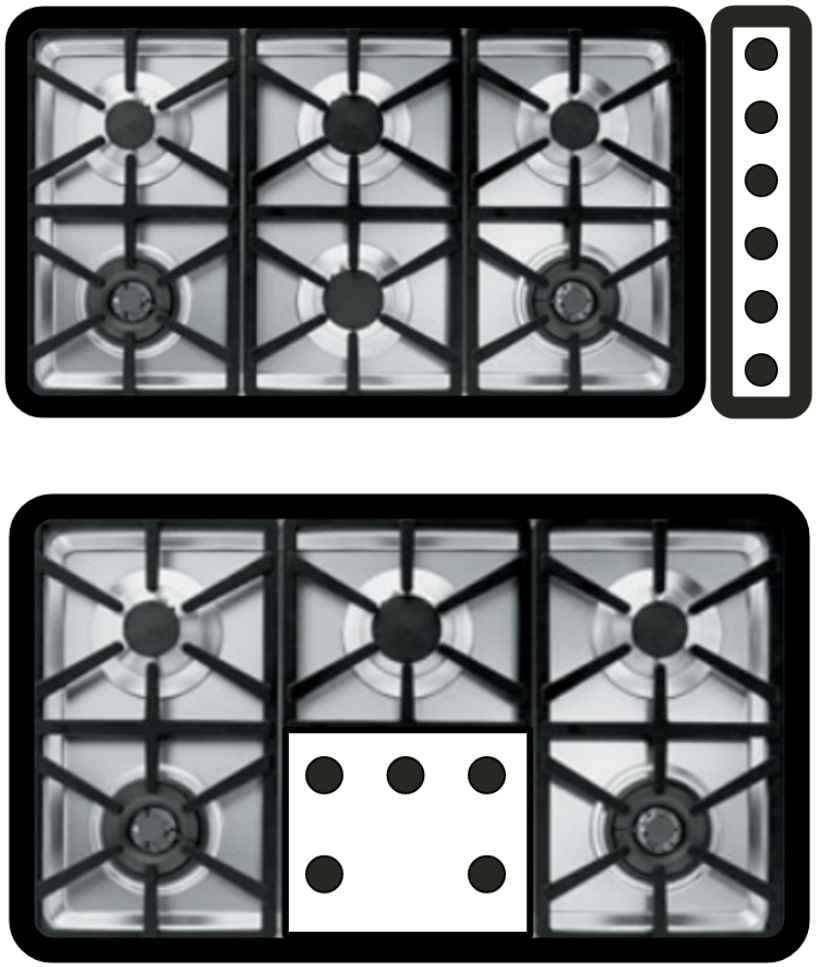
Learning objectives

1. Describe what is meant by stimulus-response **compatibility** and how it affects action preparation.
2. Describe the **spatial** and **anatomical** accounts for stimulus-response compatibility effects in the lab.
3. Explain how response **complexity** influences action preparation.

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.

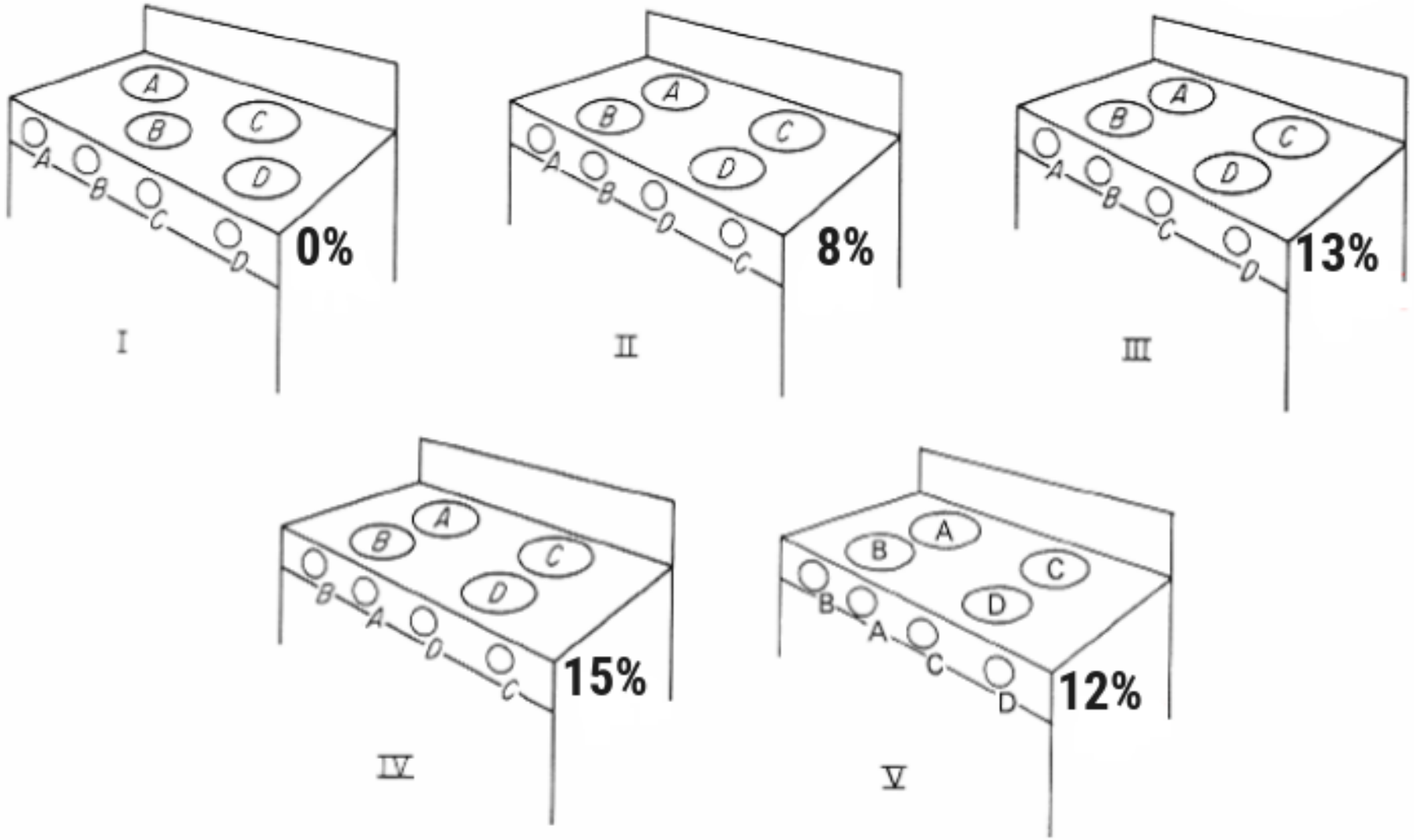
Stimulus-response compatibility



- refers to the **naturalness** of the mapping between the **stimulus** and the **required response**
- when compatibility is **high**...
  - **faster** learning
  - **faster** reaction times
  - **fewer** errors
  - **lower** mental workload
  - **higher** user satisfaction
- most common type is **spatial** compatibility

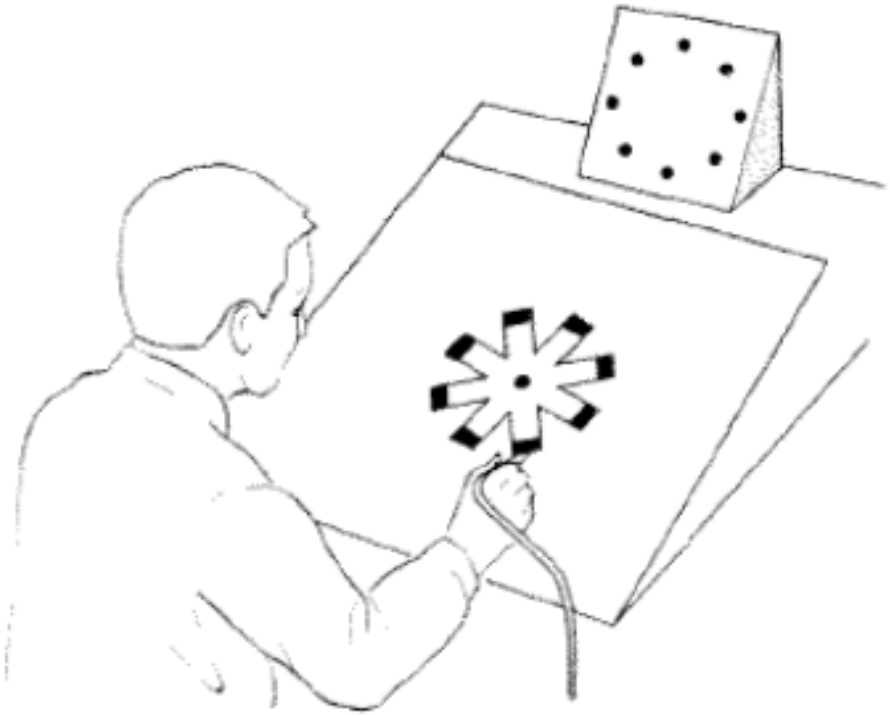
Average error rates

Chapanis and Lindenbaum, Ray and Ray

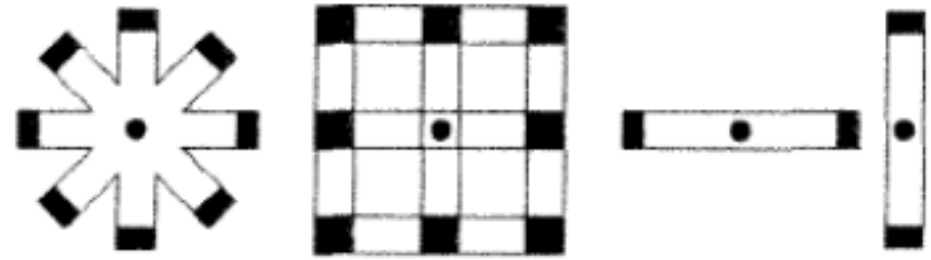


(Sanders and McCormick, 1993, after Chapanis and Lindenbaum, 1959)

S-R compatibility decreases reaction time and errors



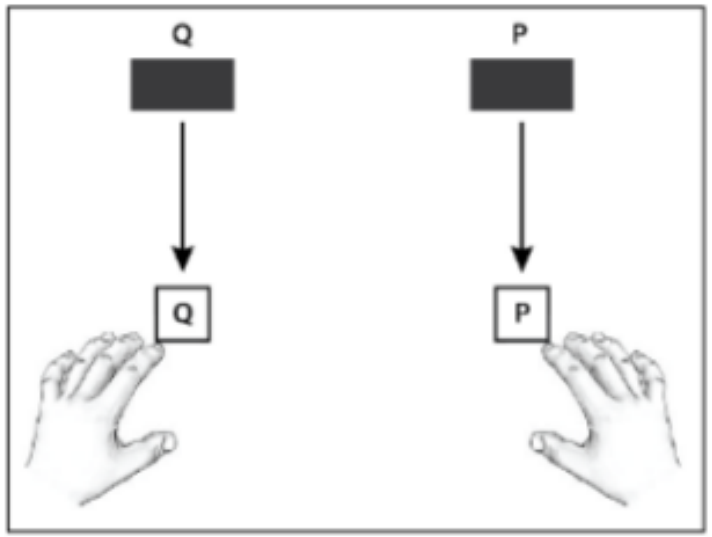
Response patterns

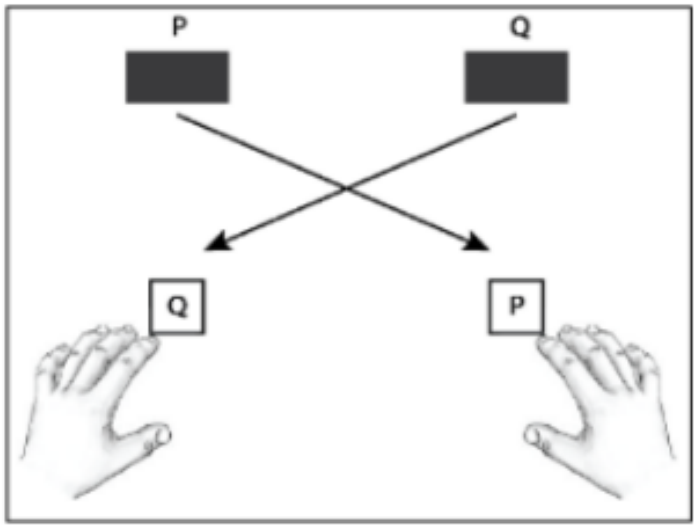


390 ms **4.4%**	430 ms **7.5%**	580 ms **11.6%**
450 ms **6.6%**	410 ms **3.4%**	580 ms **17.8%**
770 ms **16.3%**	580 ms **18.8%**	480 ms **8.4%**

Fitts & Seeger 1953 (https://doi.org/10.1037/h0062827)

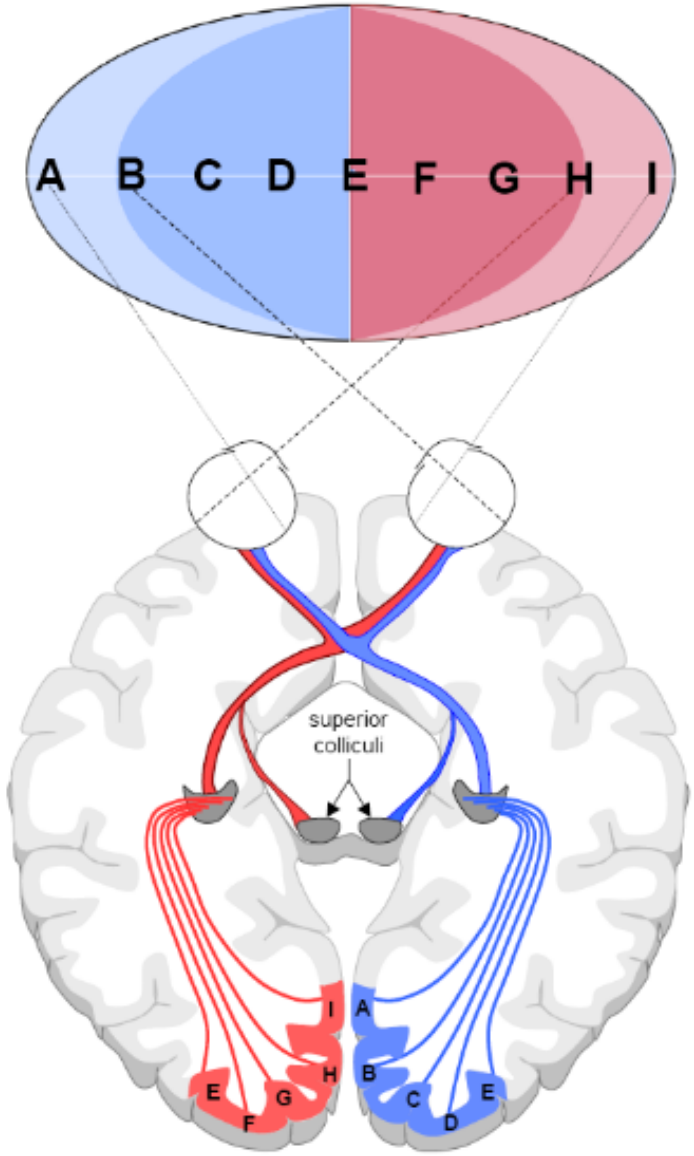
A simple setup to study S-R compatibility in the lab

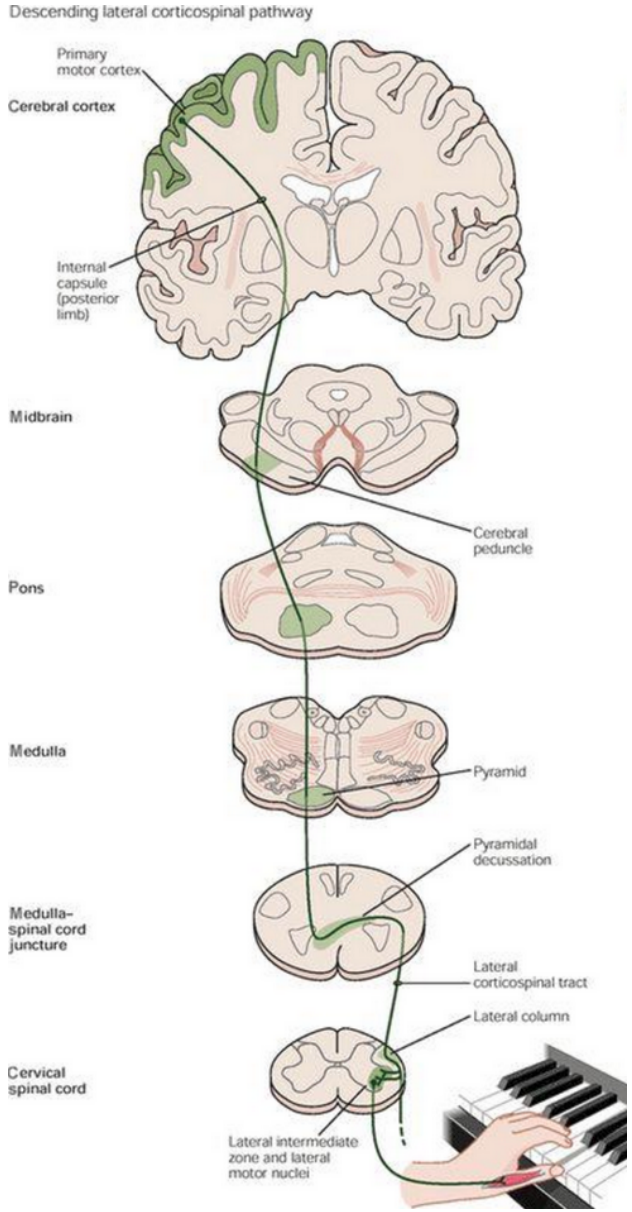




Stimulus-response compatibility: Normal hands

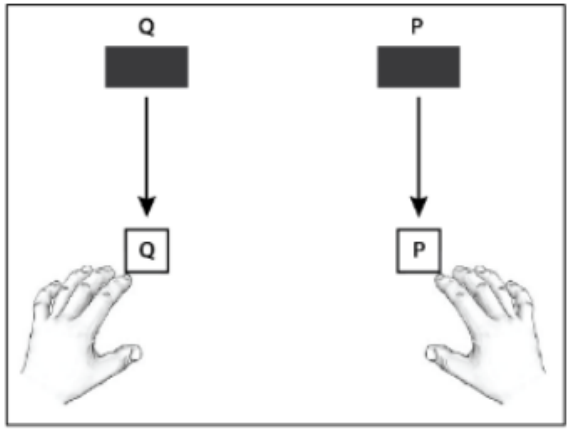
Hypothetical data for illustrative purposes

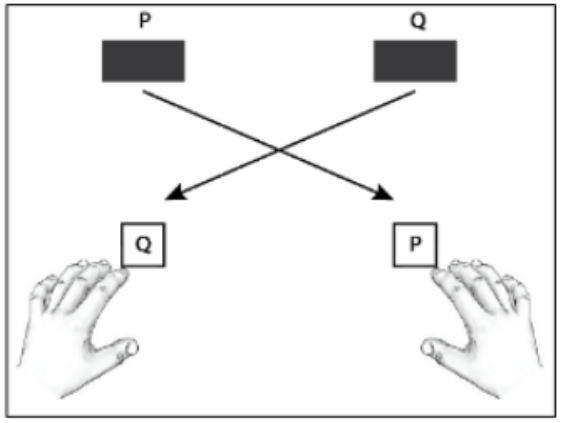


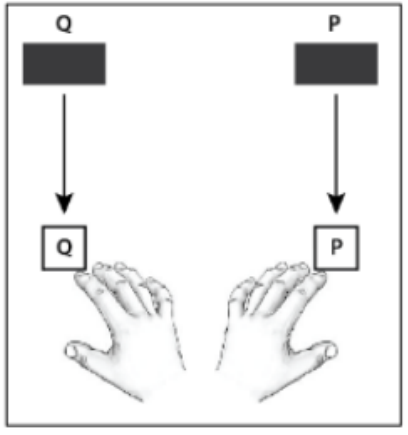


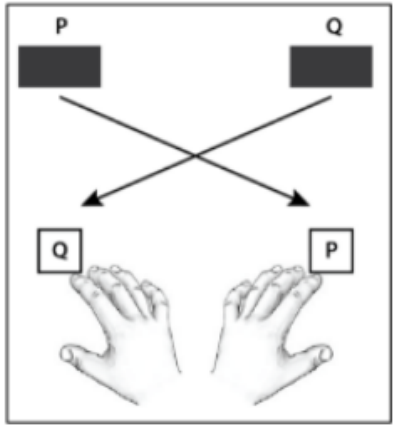
Left: Tresilian 2012 ; Right: Kandel et al. 2013

How can we dissociate between the spatial and anatomical explanations?

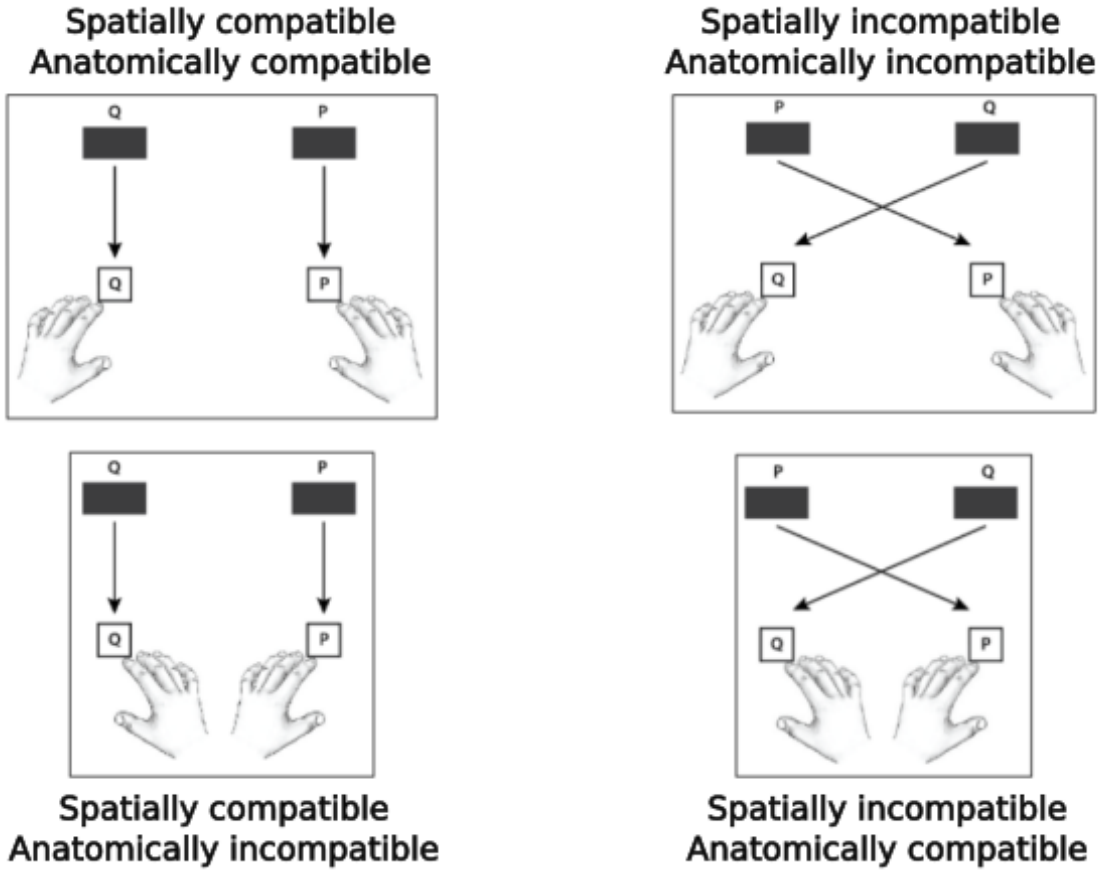




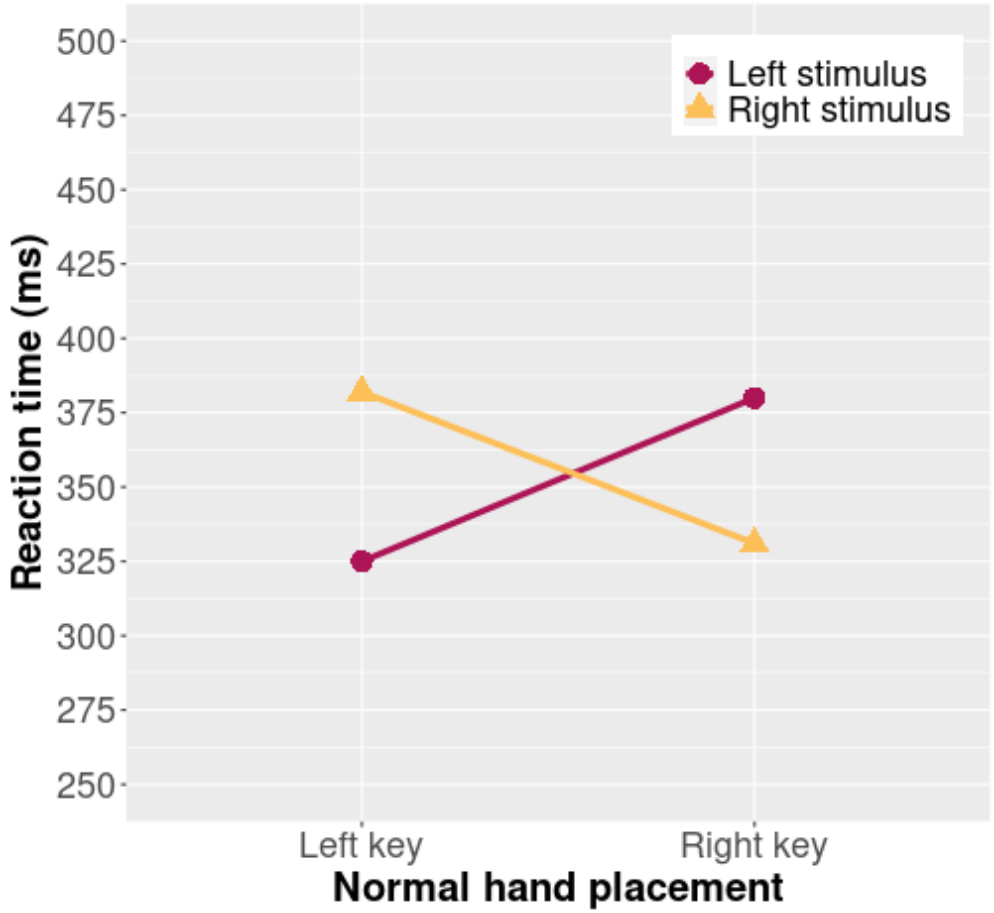


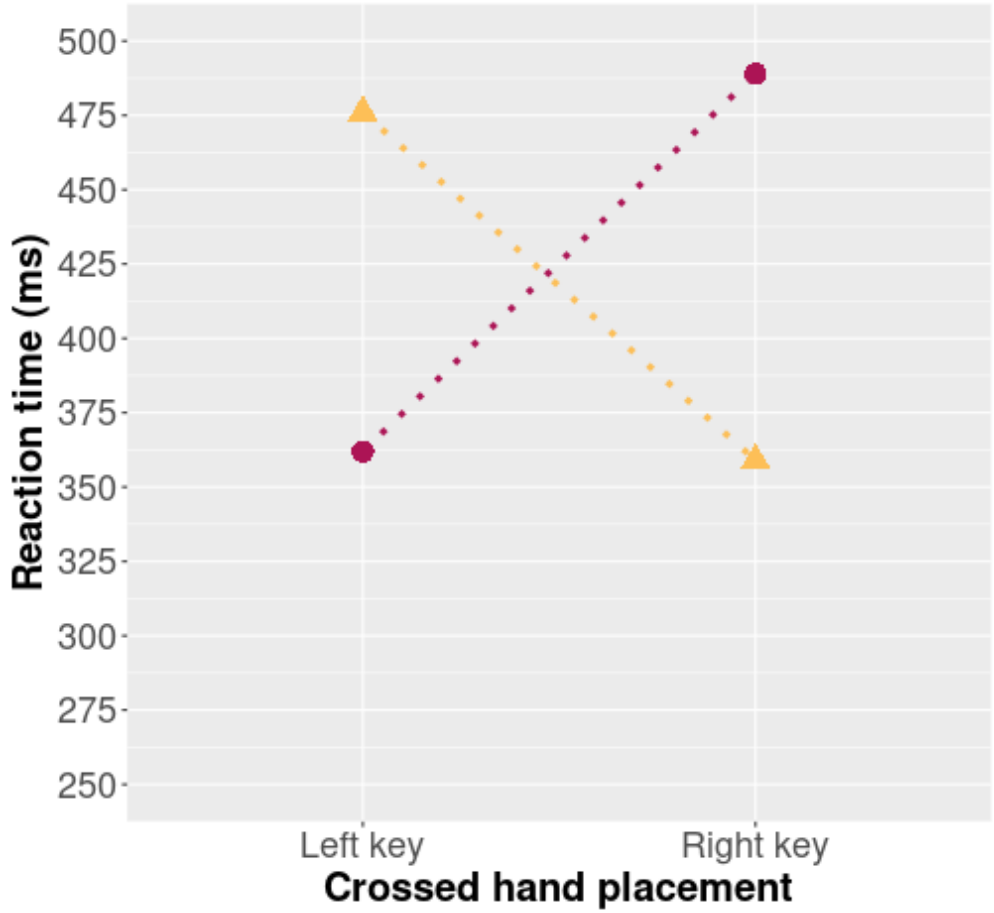


How can we dissociate between the spatial and anatomical explanations?



Which explanation is supported by this data?





Hypothetical data for illustrative purposes

We can increase the complexity of an action by increasing the number of components to execute

Task A: Simple RT

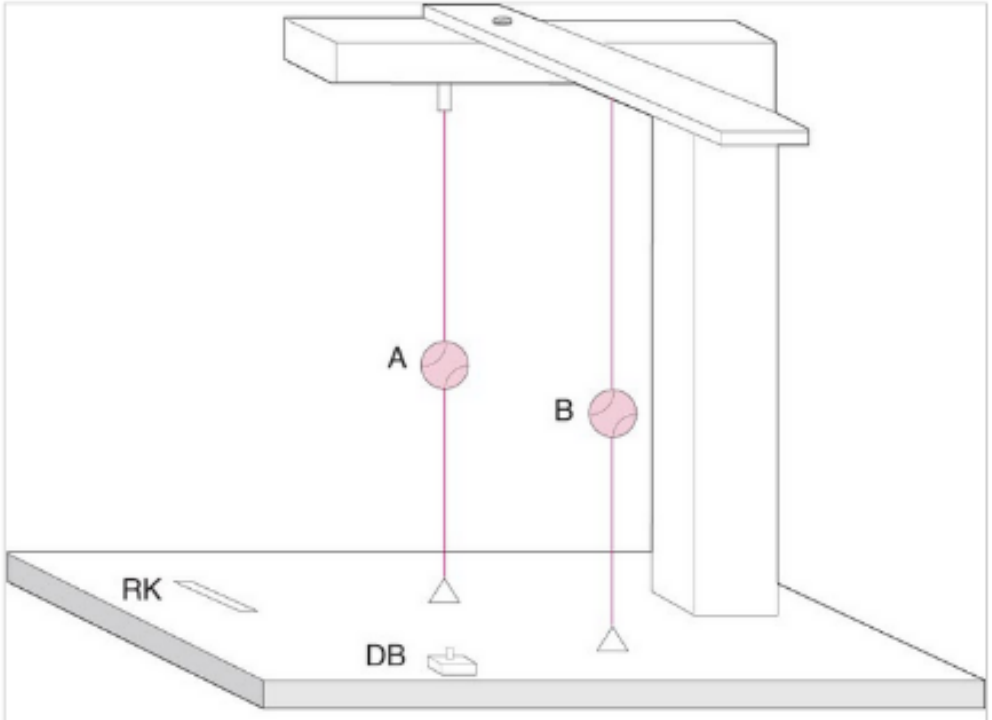
- Lift finger when you hear the auditory tone

Task B: Simple RT + Single action

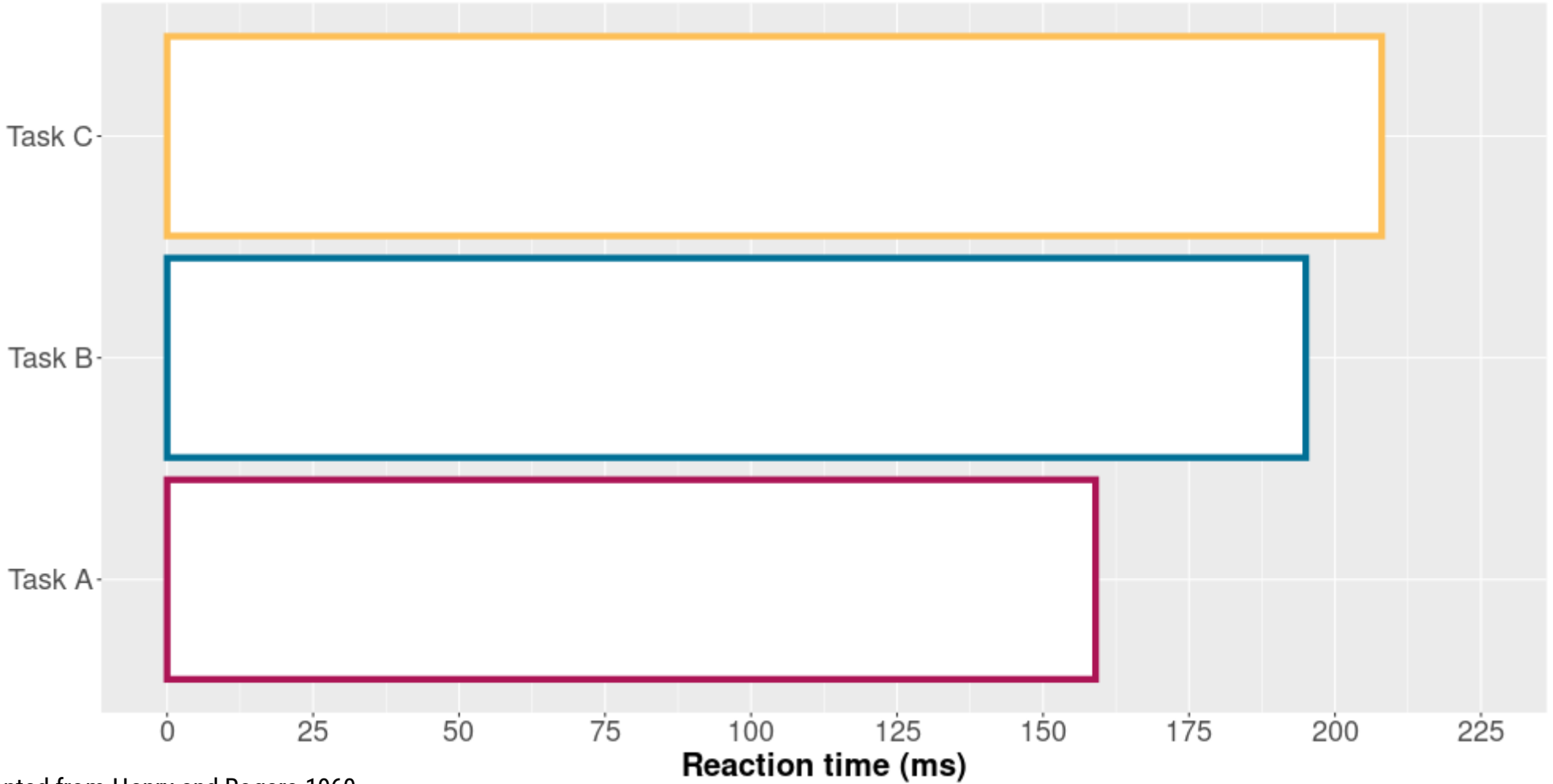
- Lift finger when you hear the auditory tone **THEN** reach and grasp ball A

Task C: Simple RT + Multiple actions

- Lift finger when you hear the auditory tone **THEN** strike ball A **THEN** reach and push button **THEN** strike ball B



Reaction time increases with response complexity



Adapted from Henry and Rogers 1960

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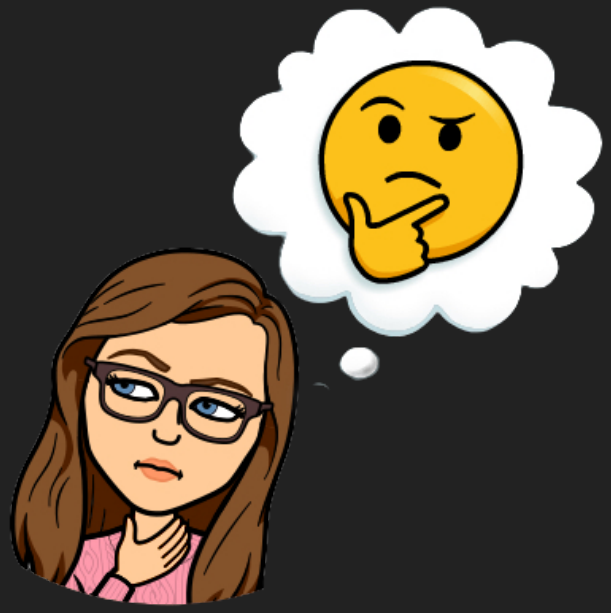
What questions do you have?



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