

COGS 105

Research Methods for Cognitive Scientists



Week 4, Class 1:
Behavioral Methods II: One Last Round of RT

A Literature Review on Reaction Time

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Last updated: September 2013

Reaction time has been a favorite subject of experimental psychologists since the middle of the nineteenth century (reviewed in Deary *et al.*, (2011)). However, many of these papers are hard to understand for the beginning student. In this review, I have summarized the major literature conclusions that are applicable to undergraduate laboratories using my *Reaction Time* software.

I hope this review helps you write a good report on your reaction time experiment. I also apologize to reaction time researchers for omissions and oversimplifications.

[Leave this review and go to Biology Homepage.](#)

[Kinds of Reaction Time Experiments](#)

[Mean Simple Reaction Times](#)

[Reaction Times in Simple vs. Recognition vs. Choice Experiments](#)

[Number of possible valid stimuli](#)

[Type of Stimulus](#)

[Stimulus Intensity](#)

[Other Factors Influencing Reaction Time](#)

[Arousal](#)

[Relevance of Stimulus to Survival](#)

Reaction Times

- **Simple:** detect “X”
 - Typically about 200ms
- **Recognition:** respond to “X” (not Y)
 - Can be much longer depending on the complexity of the **discrimination**
- **Choice:** respond right with “X”, left to “Y”
 - Also, much longer (typically longer than recognition).

First, Some Final Mechanics...

- **Conditions**
 - For example, select **two groups of stimuli** that let you compare reaction time
 - **Control for other factors** which could **confound** your conclusions: e.g., length of words (in characters, syllables)
- **Setup** your task
 - You have to choose an **inter-stimulus interval** (ISI); time between trials should be random to some extent so that participants do not anticipate stimulus (see **lab exercise**).
 - Make sure that the stimulus presentation is **randomized!** Avoids order effects.

First, Some Final Mechanics...

- **Sample participants** from a pool
 - SONA? Friends? Etc.?
 - Always be wary of **biases** that are present in your participant recruitment. Age? **WEIRD**? Etc. Of course, we often cannot avoid these biases but we move forward anyway.
- **Data cleaning** and **import**
 - Import into software (e.g., Excel)
 - **Identify errors** (e.g., responses for incorrect choices); **discard errors**
 - Organize data and **calculate statistics**

Why is RT Useful?

RT as Guiding Principles for Video Game Design



Important Note

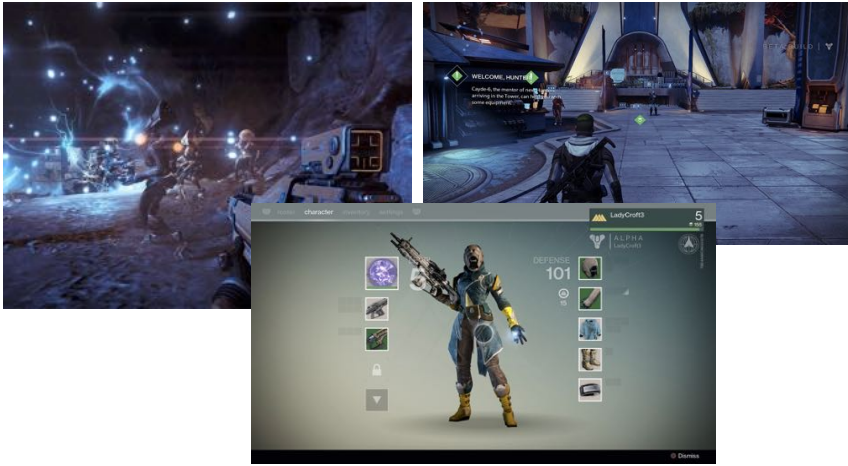
Rick is not a gamer.

He is a wannabe gamer.

In that he wants to game.

But mostly does not.

Destiny



Caveat

- Reaction time studies are directly relevant to design issues of video games and other design problems, but...
- It is important to note, however, that these “laws of RT” are variable and quite sensitive to context. Keeping that in mind... let's go...

Hick's Law

RT goes up as a function of the number of options.

Applies to simple decision processes when you are aware of the options.

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



Hick's Law

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

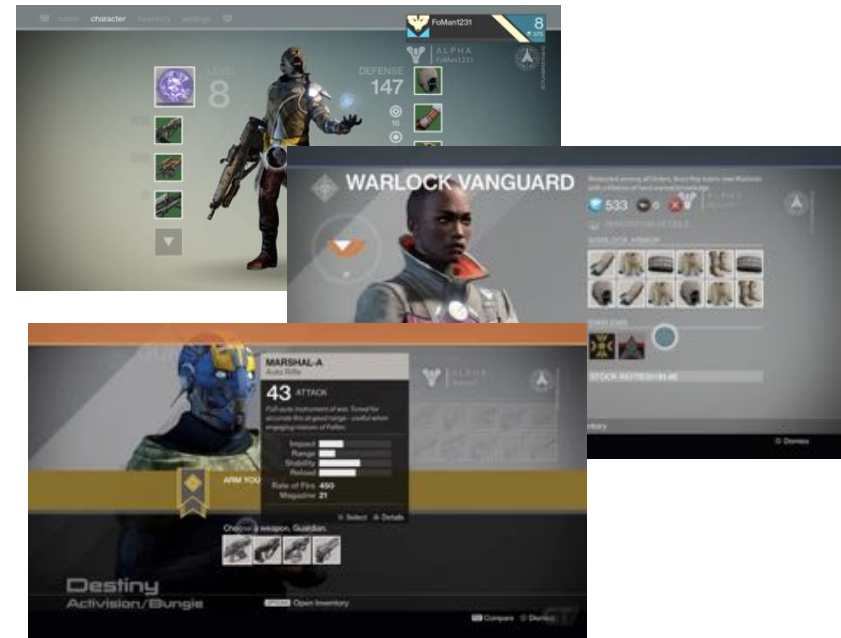
a = how much time is unrelated to the choice process (e.g., 500ms).

b = how much time is added for each option (e.g., 200ms).

n = number of possible responses (choices).

Cool: if you know a and b you can precisely calculate how much longer a menu screen will require (on average).

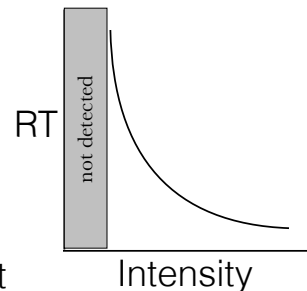
Let's Do It



Stimulus Intensity

In general, the more perceptually salient a target stimulus is, the faster you are to recognize it.

Of course this can vary from person to person too, but the general trend is quite a robust law.



As described in Kosinski reading



optimizing saliency to both enhance game experience but...

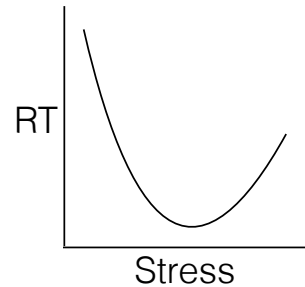
not make it too easy!



“Arousal”

RT can often show an elegant relationship to your level of emotional intensity / stress / arousal.

This function can vary from subject to subject, and in various conditions...



e.g., Welford, 1980



Can we optimize reaction time to bosses?

General level of fear engineered into boss will have impact on playability.

As described in Kosinski reading

Response to Threats

Biological Psychology 84 (2010) 313–317

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho



The fish is bad: Negative food odors elicit faster and more accurate reactions than other odors

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ARTICLE INFO

Article history:

Received 4 December 2009

Accepted 7 March 2010

Available online 21 March 2010

Keywords:

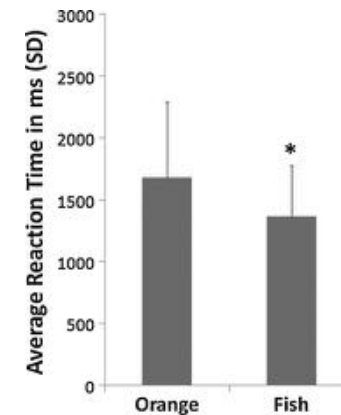
Reaction time
Evolutionary psychology
Odors
Categories

ABSTRACT

Dissociating between ‘good’ or ‘bad’ odors is arguable of crucial value for human survival, since unpleasant odors often signal danger. Therefore, negative odors demand a faster response in order to quickly avoid or move away from negative situations. We know from other sensory systems that this effect is most evident for stimuli from ecologically-relevant categories. In the olfactory system the classification of odors into the food or non-food category is of eminent importance. We therefore aimed to explore the link between odor processing speed and accuracy and odor edibility and valence by assessing response time and detection accuracy. We observed that reaction time and detection accuracy are influenced by both pleasantness and edibility. Specifically, we showed that an unpleasant food odor is detected faster and more accurately than odors of other categories. These results suggest that the olfactory system reacts



olfactometer



Accusatory Instructions

Indicating that participants may have made an error increases reaction time.

E.g., notions of error may increase attention to the task and improve performance (even if it's fake).



Use dialog to prompt players to engage in better attentional processes to stay engaged in the game. If players catch issues themselves / better attention to details / better playability.

Food and Sleep

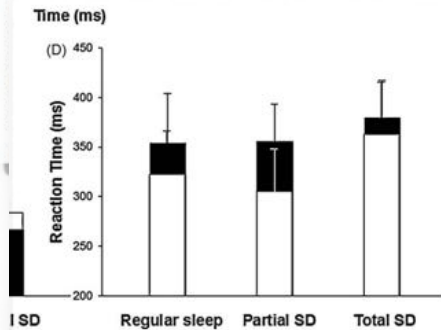
see the study by Jauch-Chara *et al.* under "Fasting."

Fasting. Three days without food does not decrease reaction time, although it does impair capacity to do work (Gutierrez *et al.*, 2001). These results were confirmed by Cheatham *et al.* (2009) found that six months of calorie-limited diets with either high and low carbohydrates did not affect reaction time or any other cognitive measure. Diets high in carbohydrates did result in depressed mood. On the other hand, Jauch-Chara *et al.* (2010) found that sleep deprivation lengthened reaction time and so did acute hypoglycemia, but sleep deprivation and hypoglycemia together did not cause worse effects than either of them separately.

Distraction. Welford (1980) and Broadbent (1971) reviewed studies showing that distractions increase

Food and Sleep

see the study by Jauch-Chara *et al.* under "Fasting."



is recorded at Cz (A) and to target pips recorded at Pz (B) of the oddball t
mol/l (dotted line) as well as mean \pm SEM amplitudes of P3 (C) and react
the hypoglycemia (black bars).

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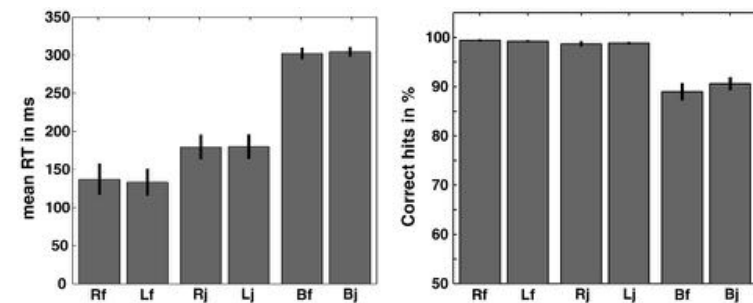
Anticipation

If participants can predict that
a stimulus is coming up they
are considerably faster to
respond (even if they do not
know what the stimulus is).



Jakobs et al., 2009

O. Jakobs *et al.* / *NeuroImage* 47 (2009) 667–677



You could replicate this experiment!

Rf = right hand, fixed ISI
Bj = both hands, random ISI (they use 600-800ms)

As described in Kosinski reading



Can optimize difficulty by
mixing up the prediction...
“ISI” on the aliens “pow
pow” thingies!

RT as Guiding Principles for Video Game Design



Next class...

- Let's move into some methodological specifics:
Details of using reaction time.
- Lab: You will build your own reaction-time
experiment.
- You can build your own creative experimental
idea using the overall process just described.