

# Introduction

PSYC 573

---

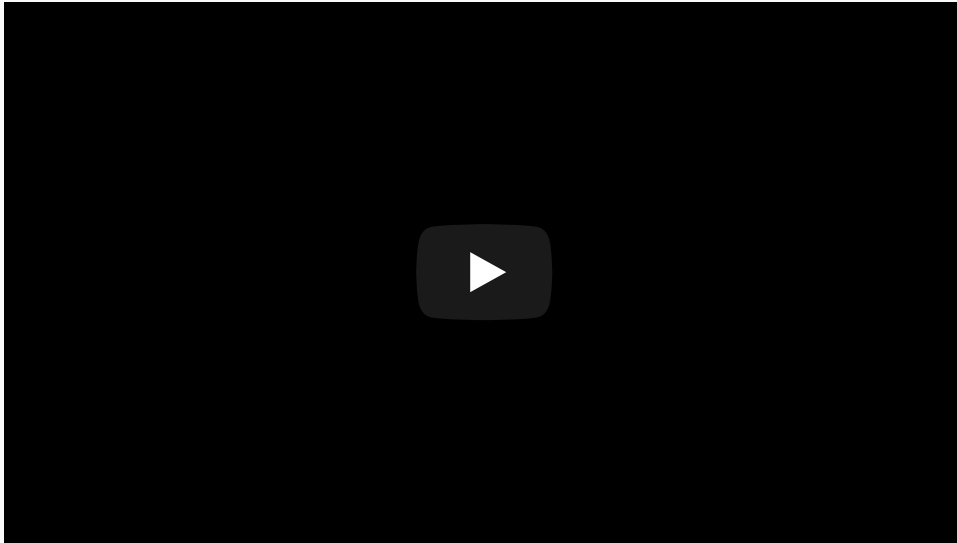
University of Southern California

January 11, 2022

# History of Bayesian Statistics

---

- Video intro: <https://www.youtube.com/watch?v=BcvLAW-JRss>



- A nice popular science book by Sharon Bertsch McGrayne: *The theory that would not die*

# Historical Figures

Thomas Bayes (1701--1762)



- English Presbyterian minister
- "An Essay towards solving a Problem in the Doctrine of Chances", edited by Richard Price after Bayes's death

Pierre-Simon Laplace (1749-1827)



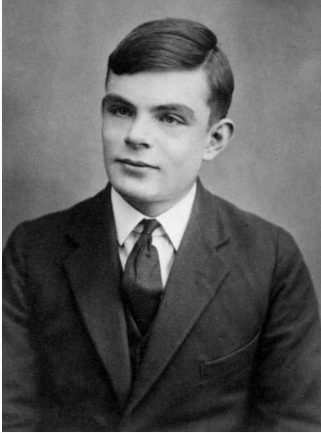
- French Mathematician
- Formalize Bayesian interpretation of probability, and most of the machinery for Bayesian statistics

# In the 20th Century

- Bayesian---way to do statistics until early 1920s
- Ronald Fisher and Frequentist scholars took over
  - "The theory of inverse probability is founded upon an error, and must be wholly rejected" (Fisher, 1925, p. 10)<sup>1</sup>

[1]: Aldrich, J. (2008). R. A. Fisher on Bayes and Bayes' theorem.  
*Bayesian Analysis*, 3(1), 161--170.

# Resurrection



- Alan Turing's algorithms in code breaking in World War II
- *Markov Chain Monte Carlo* (MCMC) algorithm
  - Bring Bayesian back to the main stream of statistics

# Why Should You Learn About the Bayesian Way?

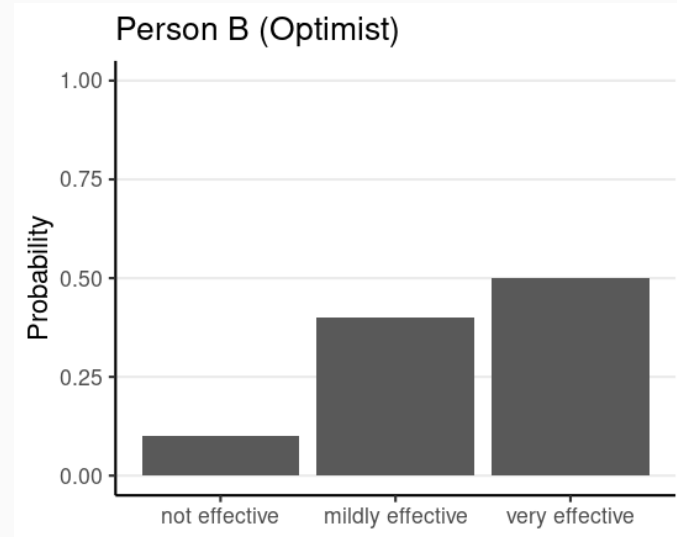
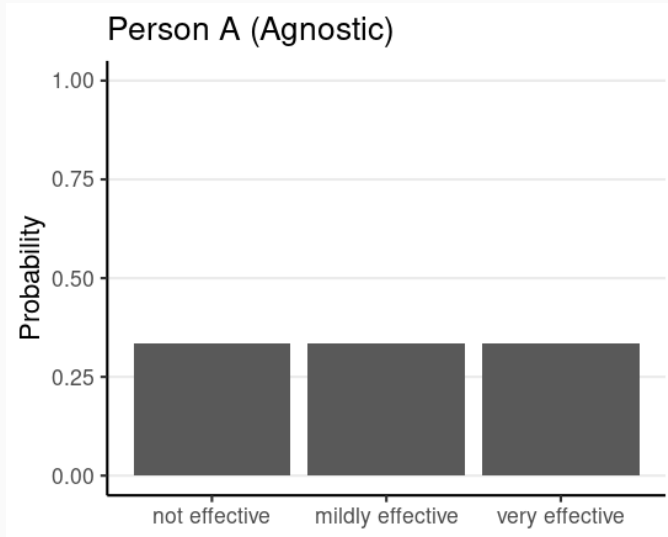
- Gigerenzer (2004): It is one tool of your statistical toolbox
- Increasingly used as alternative to frequentist statistics
- Computationally more stable for complex models
- A coherent way of incorporating prior information
  - Common sense knowledge, previous literature, sequential experiments, etc

# Bayesian Idea 1

Reallocation of credibility across possibilities

Hypothetical example: How effective is a vaccine?

Prior (before collecting data)

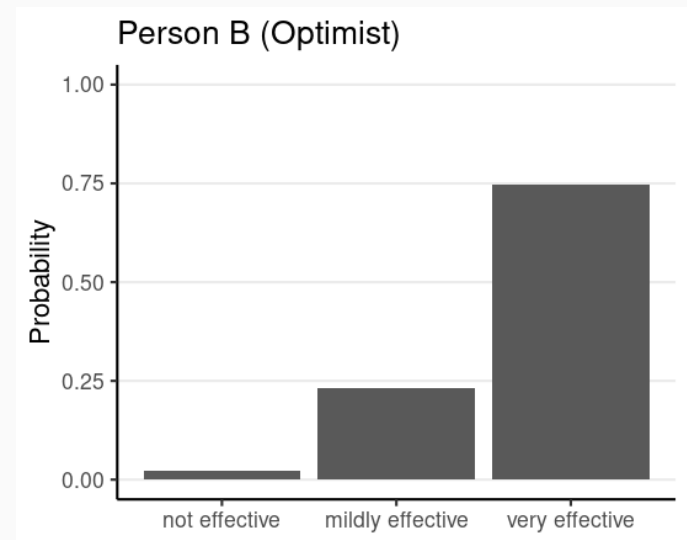
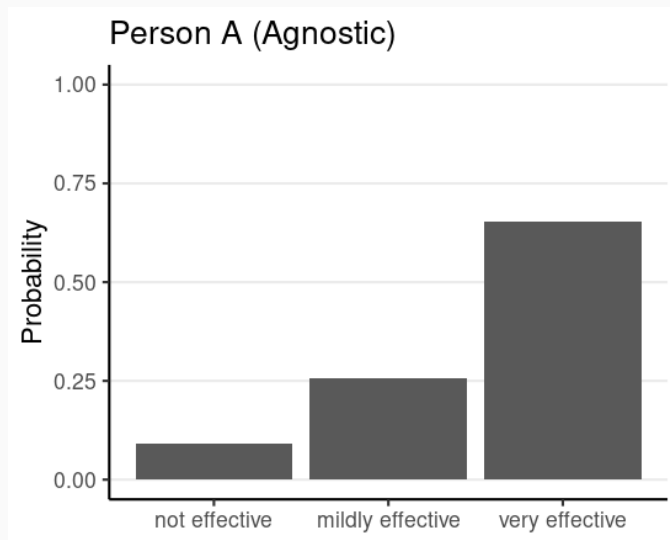




# Updating Beliefs

After seeing results of a trial

- 4/5 with the vaccine improved
- 2/5 without the vaccine improved



# Possibilities = Parameter Values

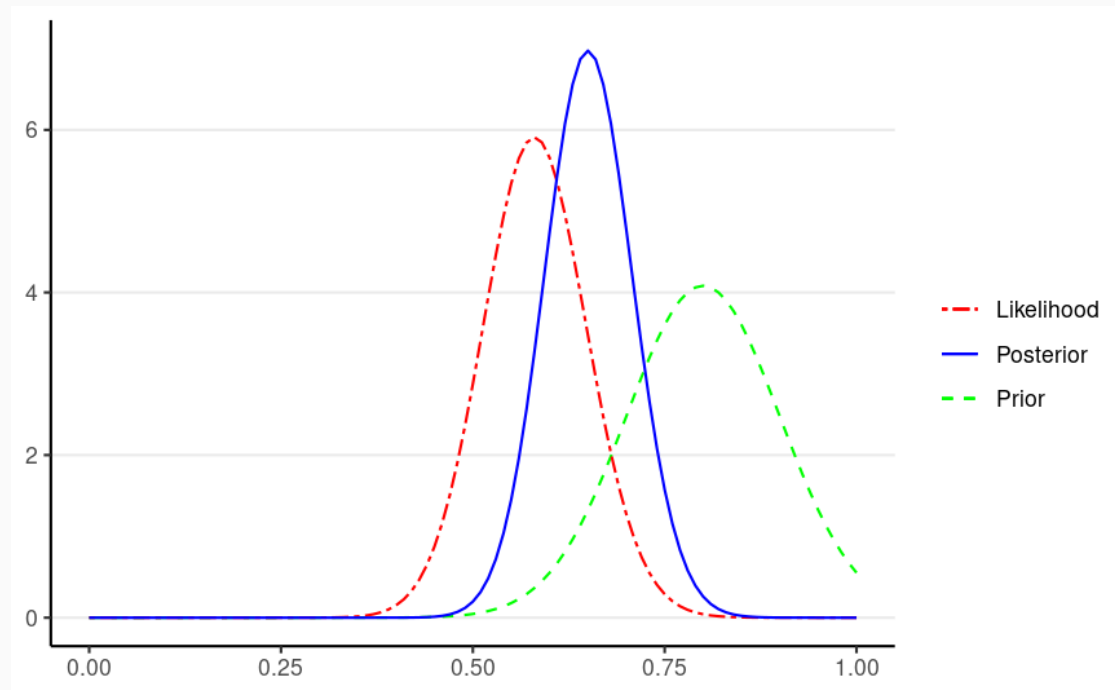
- Parameter: Effectiveness of the vaccine
- Possibilities: Not effective, mildly effective, very effective

Here the parameter is a discrete variable

- Parameter: Risk reduction by taking the vaccine
- Possibilities:  $(-\infty, \infty)$  (Any real number)

Here the parameter is a continuous variable

Using Bayesian analysis, one obtains updated/**posterior probability** for every possibility of a parameter, given the **prior** belief and the **data**



# Steps of Bayesian Data Analysis

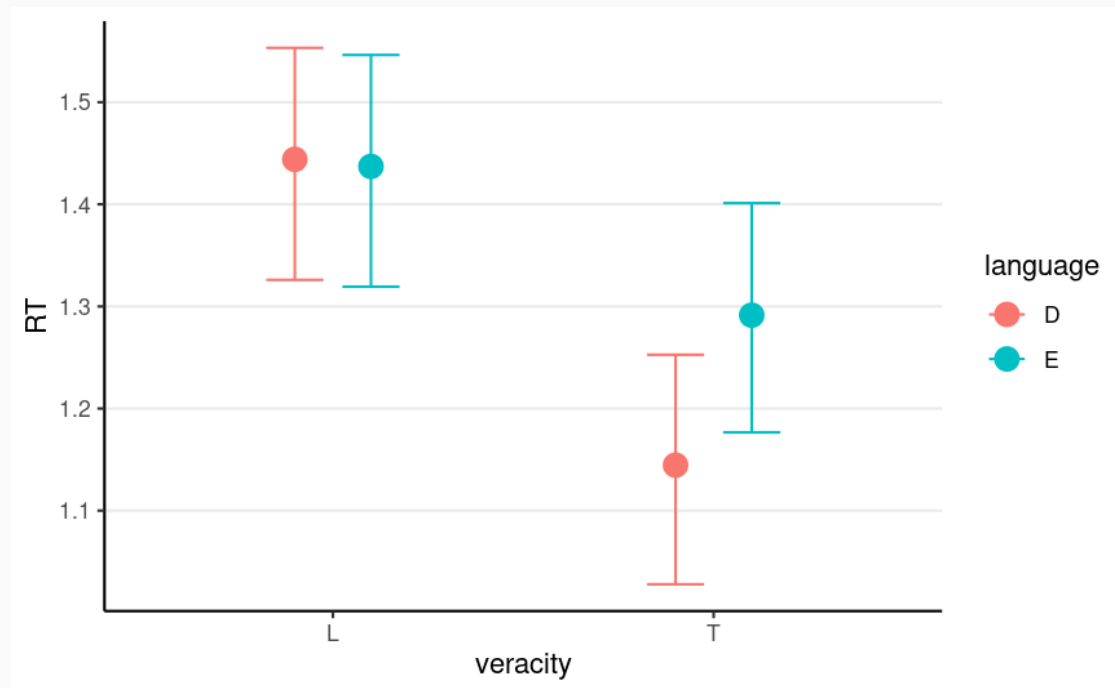
"Turning the Bayesian crank"

1. Identify data
2. Define a mathematical model with parameters
3. Specify priors on parameters
4. Obtain and interpret posterior distributions of the parameters
5. Posterior predictive check

# Example

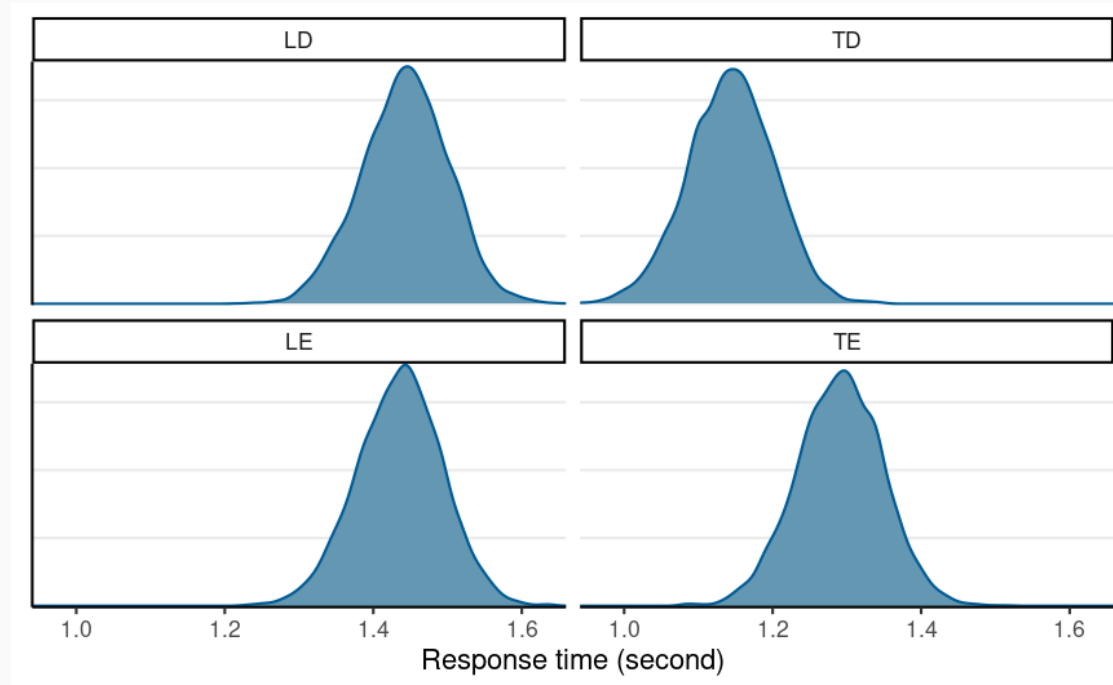
Frank et al. (2019, Cognition and Emotion)

- Response time for 2 (Dutch--native vs. English--foreign)  $\times$  2 (lie vs. truth) experimental conditions

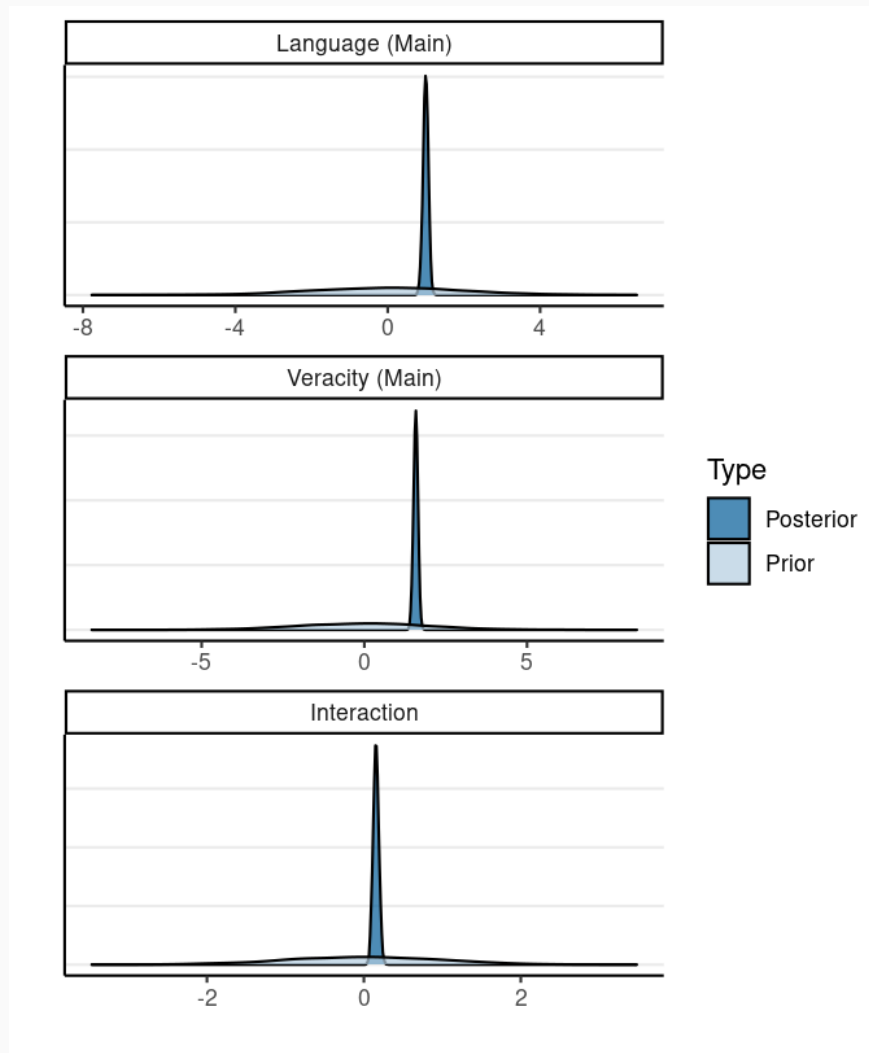


# Posterior of Mean RTs by Conditions

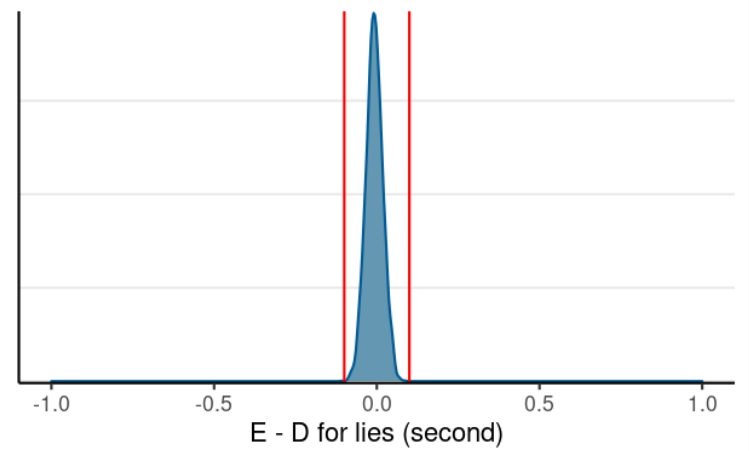
L = Lie, T = Truth; D = Dutch, E = English



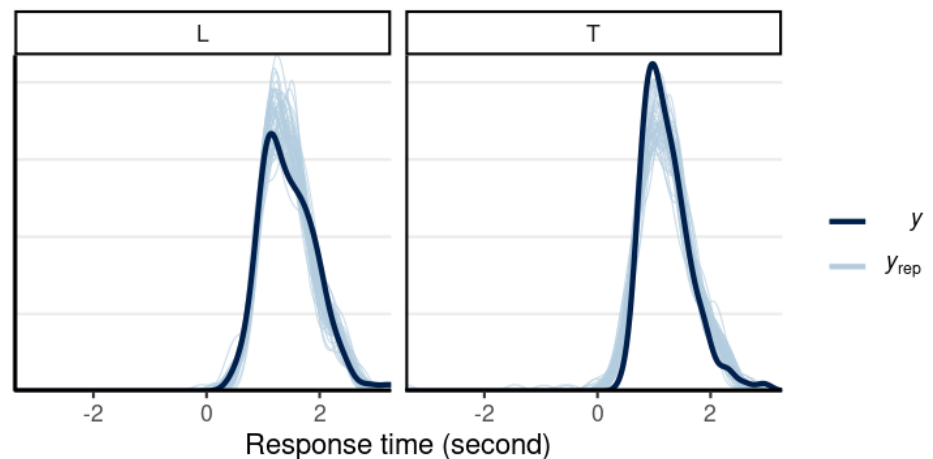
# From Priors to Posteriors



## Accepting the Null



## Posterior Predictive Check





# Multiple Experiments

Kay, Nelson, & Hekler (2016, p. 4525,  
<https://dl.acm.org/doi/abs/10.1145/2858036.2858465>)

# Syllabus

---

# Homework 1

---