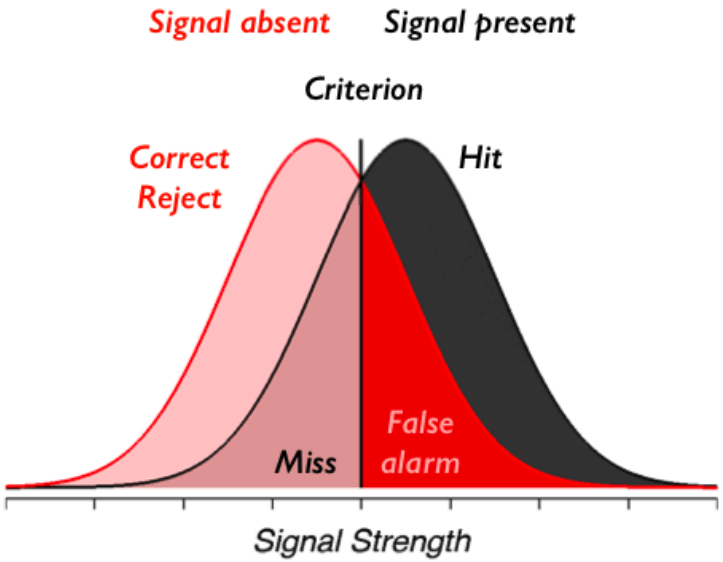
Class Schedule

Final Project

Signal Detection Theory

Experiment 1.2
- Signal Detection



Final Project: Requirements

The goal is to have you conduct your own research and then present it in both written and oral forms.

Requirements:

1) Choose a topic that interests you and is related to perception and cognition

This includes a LOT of potential topics, including (but not limited to) – vision, hearing, touch, taste, smell, learning, memory, reading, music, decision making, etc.

2) Form a testable hypothesis
3) Develop experimental methods
4) Collect data

Types of data include (but not limited to) reaction times, accuracy, comparison judgments (A > B), subjective ratings

5) Analyze data (statistics)
6) Write a report
7) Give an oral presentation
8) Re-write the report

Collaboration is encouraged, as this is an integral part of science. You are free to discuss your ideas/project with your peers, and ask others to help with the execution of your experiment if necessary. However, you must work alone on your paper.

Final Project: Timeline

The final project consists of: an experiment designed by the student (with instructor consultation on a weekly basis); a written report of the background, methods, results and conclusions; a revision of the written report based on instructor comments; and a brief oral presentation of the results. The final project will be completed (and have points assigned) in a multi-step manner:

FP idea -- general question/methods	due 3/15 email draft 3/14	1 pt
Midterm exam	3/22	15 pts
FP methods refined	3/29	-----
Data collection day	4/5	-----
FP introduction	due 4/12	2 pts
FP paper	due 4/19	24 pts
FP oral presentation	due 4/26	5 pts
Paper revisions	due 5/3	8 pts
Total		40 pts

Final Project: Written Report

Title: informative, catchy, avoid complexity

Abstract

•Concise summary of topic (background & hypothesis), methods, results, and conclusions (~250 words)

Introduction

- General context (big picture)
- Review relevant previous work (~ 6-10 references)
- What is the "question" you wish to answer?
- What are the hypotheses?
- Preview of the results / conclusions

Methods

- Explain procedures in sufficient detail to replicate

Results

- Describe obtained data: text, graphs and/or tables
- Support by statistics

Discussion

- What do the results indicate? Draw conclusions.
- Discuss in the context set in the Introduction
- Any limitations; suggests for future work; implications

References: APA journal style

Length: ~10-12 pages; printed copy

Format: Times New Roman or Arial, 12pt, double-spaced, 1 inch margins

Figures: embedded in text with their legends below (make a 2x1 table)

http://www.rochester.edu/college/honesty/

Final Project: Oral Report

Each student will give a 6 minute presentation (with 2 minutes of Q & A). The goal is to provide a **brief** overview of what you did, what you found, and what it means.

Logistics:

•6-8 PowerPoint (compatible) slides

1.Big picture/background

2.Question/hypothesis

3.Methods

4.Results/statistical analysis

5.Conclusions

6.Limitations/future studies/implications

•Email on 4/24

In addition, good class participation is expected … i.e., you should ask your classmates questions about their projects!

Final Project: Ideas

Pick a topic that you are interested in.
Perception/Cognition are relevant topics in many (if not all) areas – sports, music, law, economics, art, technology, food, etc.

Hypothesis driven research – start with a QUESTION that you are interested in, and then worry about how to test it.

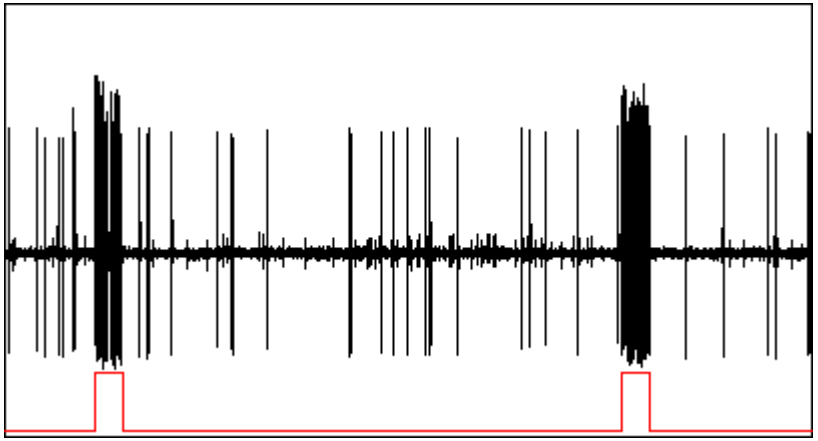
Remember there are time constraints – you need to complete the project in only a few weeks.

Highlighting and retrieval
Colors and memory
Background noise and memory
Vocal fry and attractiveness
Exercise and memory
Gum chewing and memory
Stroop effect and personality
Priming for taste
Smell and memory
Cross sensory encoding and retrieval
Iconic memory w/caffeine
Fatigue and memory
Personality and word recall
Eye dominance and hand-eye coordination
Basketball expertise and recognition memory
Video gaming and executive function
Effect of mood on reasoning
Emotional state and time perception
Misspelling and reading
Doodling vs mental imagery and memory
Mnemonics and memory
Interest and memory
Intelligence and attention
Political beliefs and categorization

Signal Detection Theory

Detection theory or **signal detection theory** (SDT) is a means to quantify the ability to discern between information-bearing patterns of input (containing stimuli) and random patterns that distract from the information (noise).

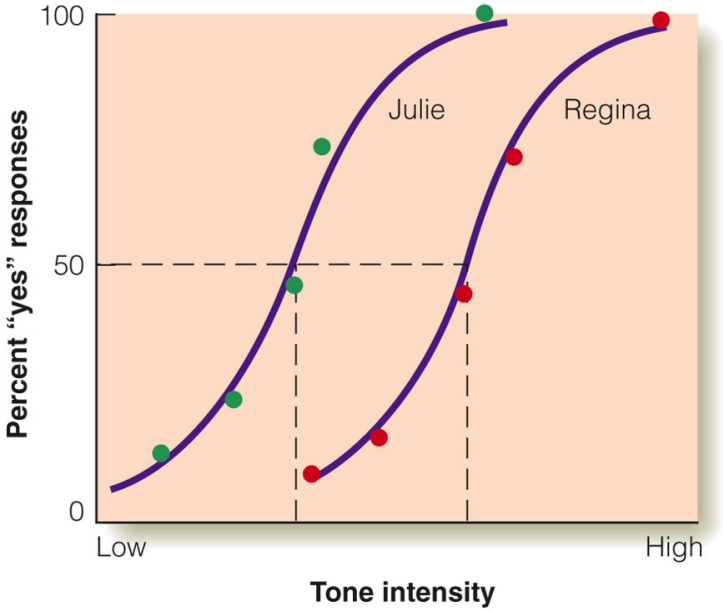
SDT is used by psychologists to measure the way we make decisions under conditions of uncertainty. SDT assumes that the decision maker is not a passive receiver of information, but an active decision-maker who makes difficult perceptual judgments under conditions of uncertainty.



SDT: Sensitivity and Bias

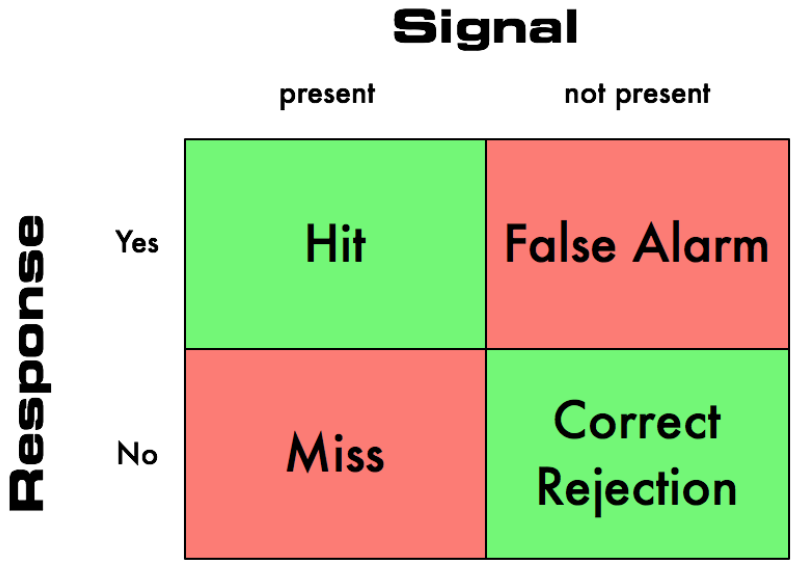
Sensitivity (discriminability) refers to how hard or easy it is to detect that a target stimulus is present from background events.

Bias (criterion) is the extent to which one response is more probable than another. That is, a receiver may be more likely to respond that a stimulus is present or more likely to respond that a stimulus is not present. Bias is independent of sensitivity.



SDT: Theory

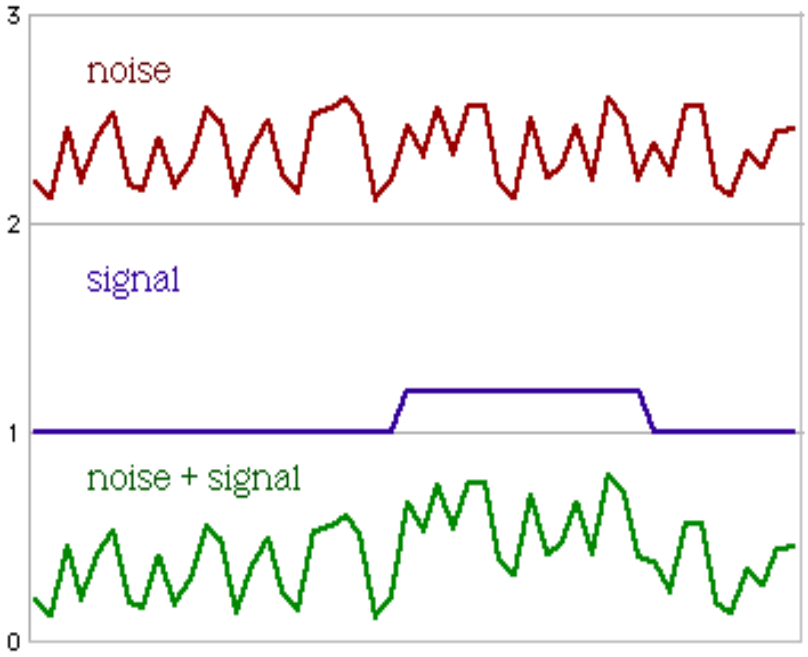
In basic signal detection theory there are two possible states for a signal: present or absent. Individuals attempting to detect the signal will either say it is present or absent. Combined that leads to four possible combinations, labeled as follows:

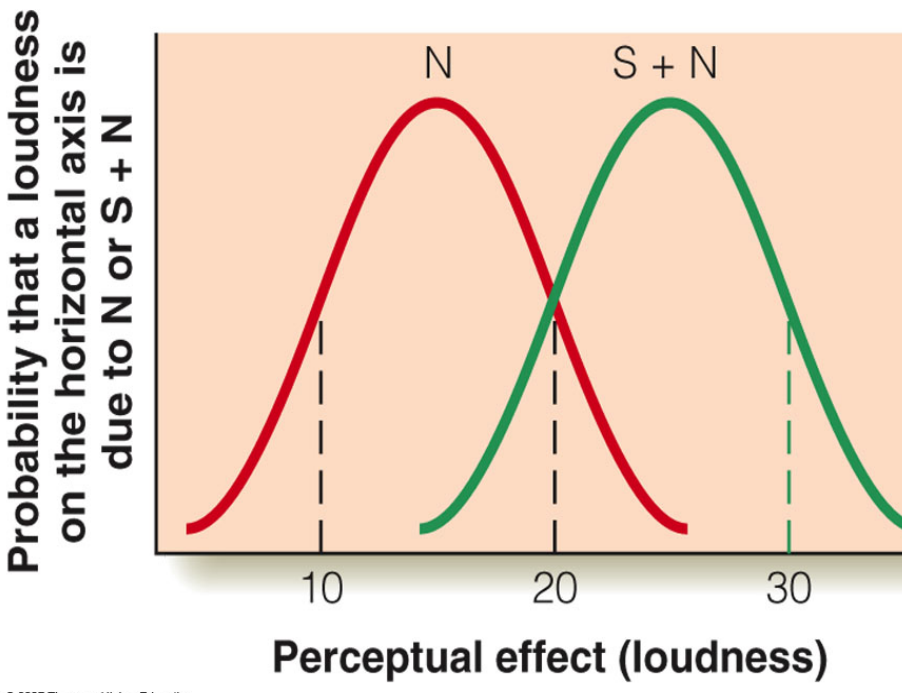


Accuracy is highly valued, so algorithms that generate only hits and correct rejections are ideal. In reality this does not happen because identifying hits and correctly rejecting false alarms become contradictory goals (i.e., increasing the likelihood of detecting weak signals usually leads to more false alarms). The evolutionary tradeoff is to set the optimal threshold criterion (bias).

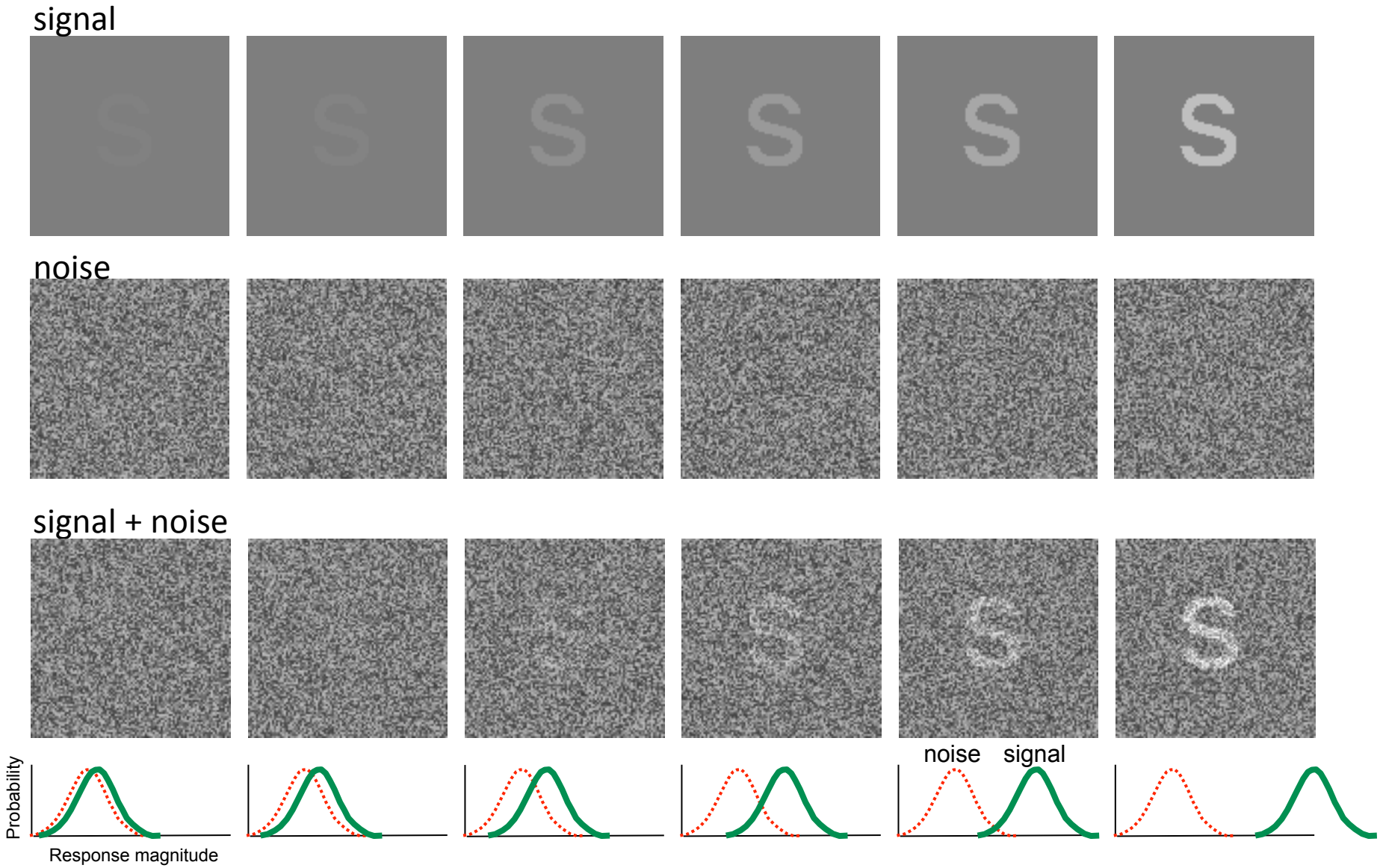
SDT: Signal and Noise

In a SD experiment, each stimulus is either a case of “just noise” or “signal plus noise”, where “noise” is anything that complicates detection of the “signal”. Examples of noise include: background noise on a hearing test; toy guns in a suitcase; misleading evidence in a trial; scar tissue on a medical image; and birds on a radar screen

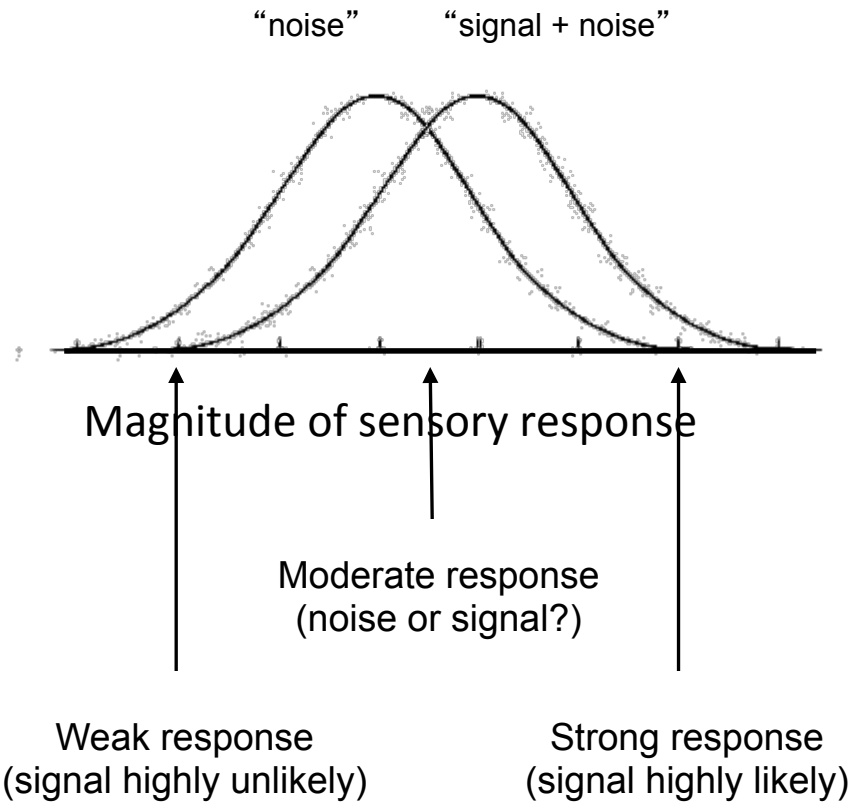




SDT: Signal plus Noise



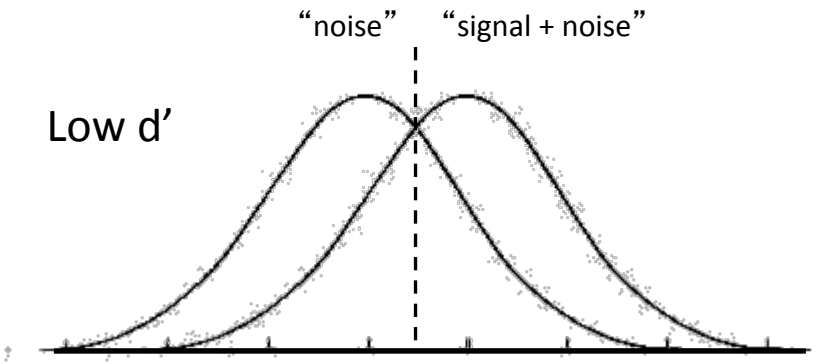
SDT: Is Signal Present?

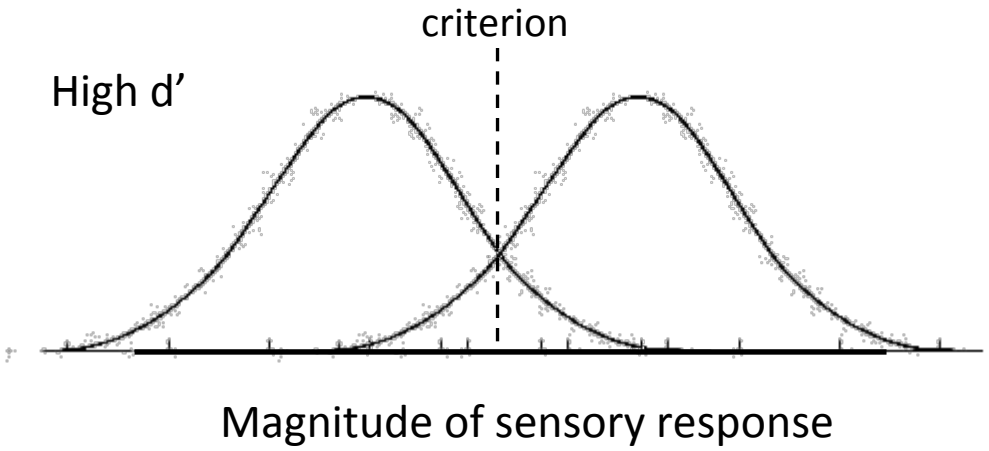


SDT: Discriminability

Discriminability:
how well the observer can separate the presence of signal from its absence
~ overlap between the two distributions

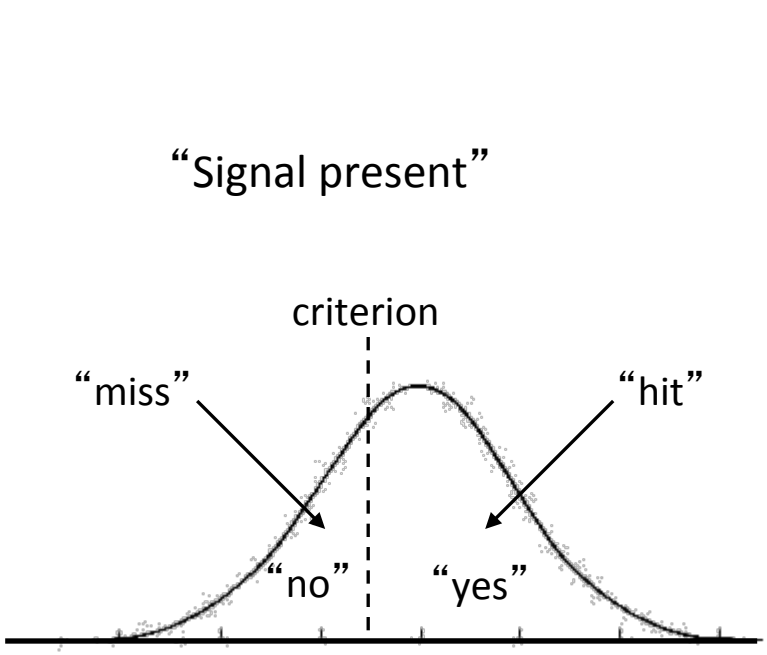
Measured by **d'** (discriminability index, also called sensitivity)

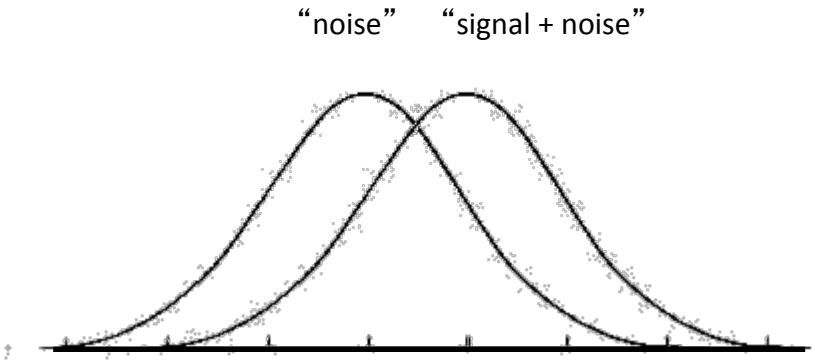




SDT: Choice of Criterion (Bias) 1

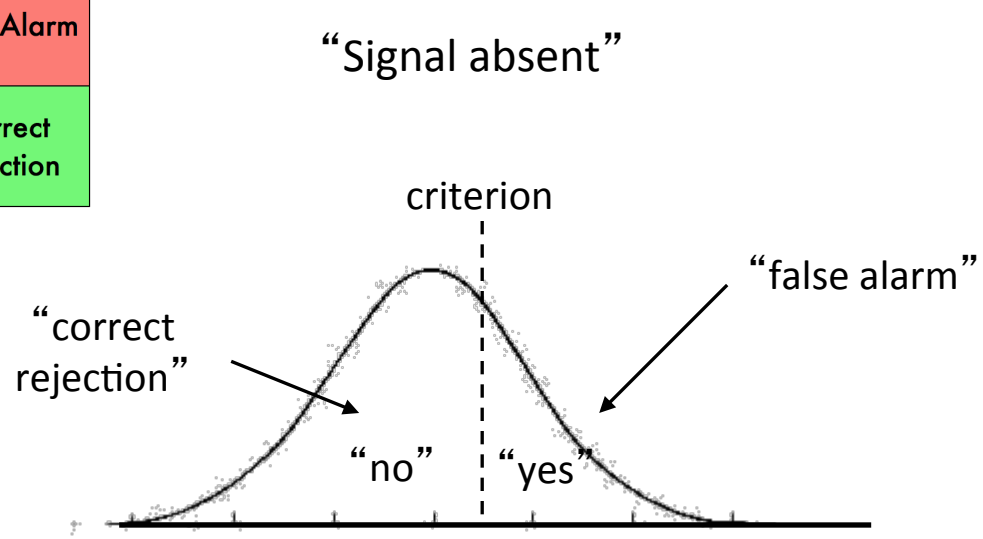
Response	Signal: present	Signal: not present
Yes	Hit	False Alarm
No	Miss	Correct Rejection

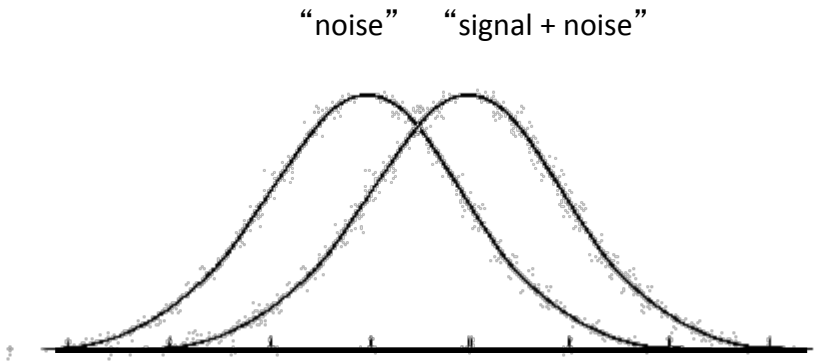




SDT: Choice of Criterion (Bias) 2

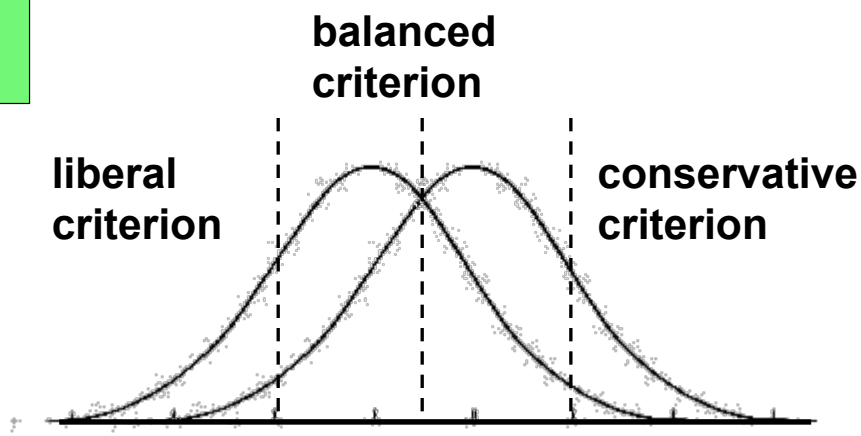
Response	Signal: present	Signal: not present
Yes	Hit	False Alarm
No	Miss	Correct Rejection





SDT: Choice of Criterion (Bias) 3

Response	Signal: present	Signal: not present
Yes	Hit	False Alarm
No	Miss	Correct Rejection



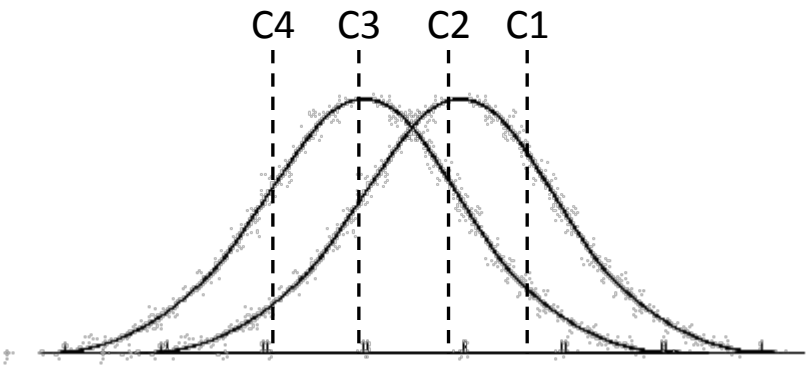
Balanced: false alarm and miss rates are equal

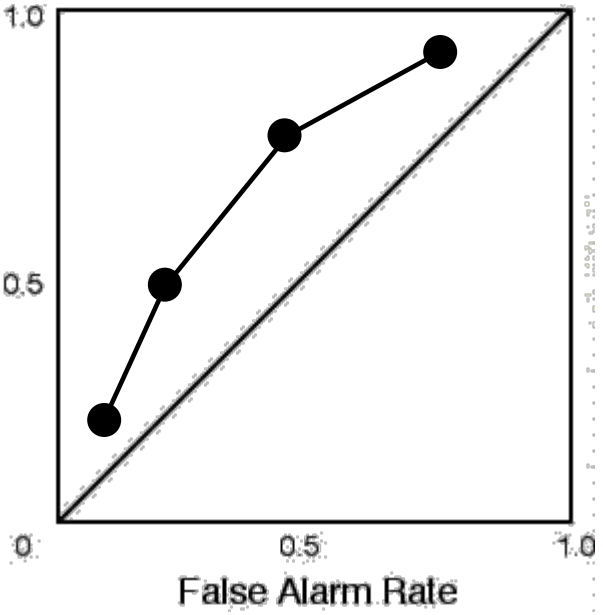
Liberal: the observer says "yes" whenever there may be a signal; false alarm rate is high

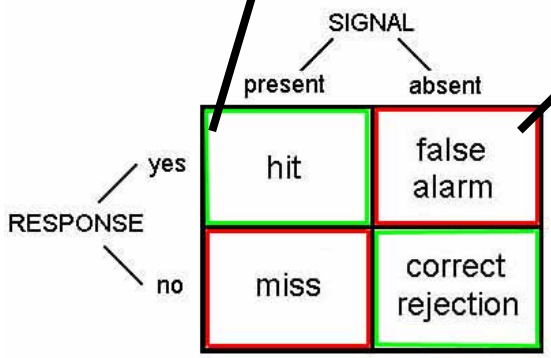
Conservative: decision is yes only when it is almost certain that there is a signal; miss rate is high

Receiver Operating Characteristic 1

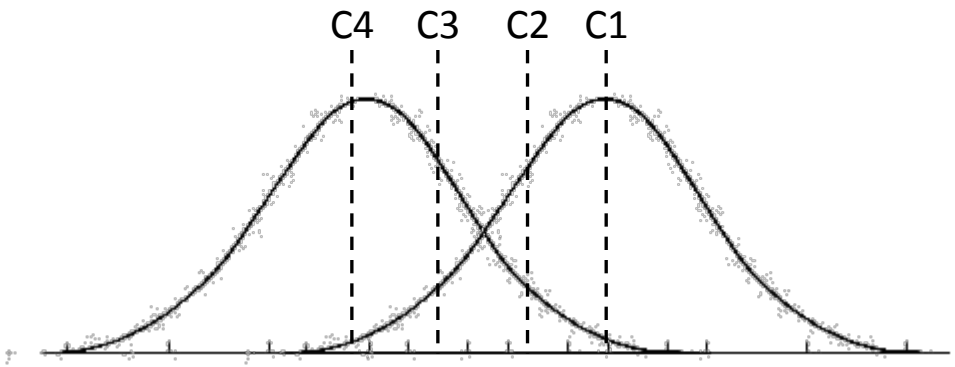
The ROC curve is traced out by plotting Hits against False Alarms as the criterion moves.

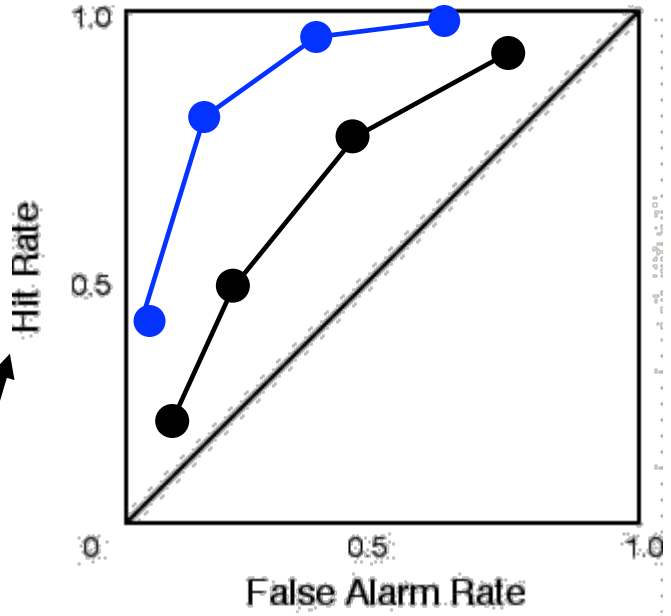


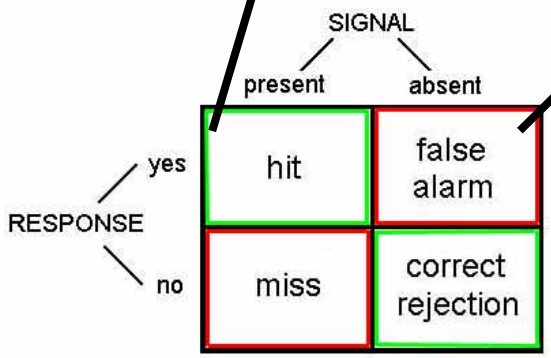




Receiver Operating Characteristic 2







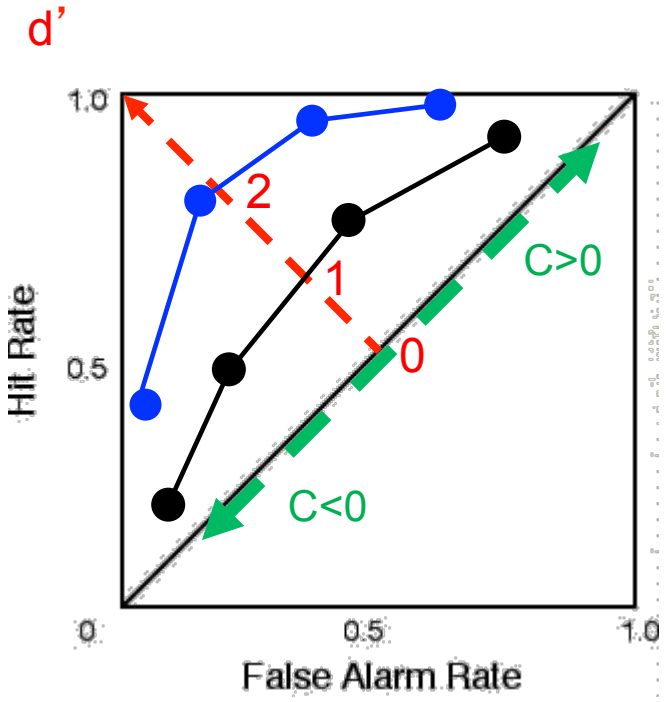
Discriminability and Bias

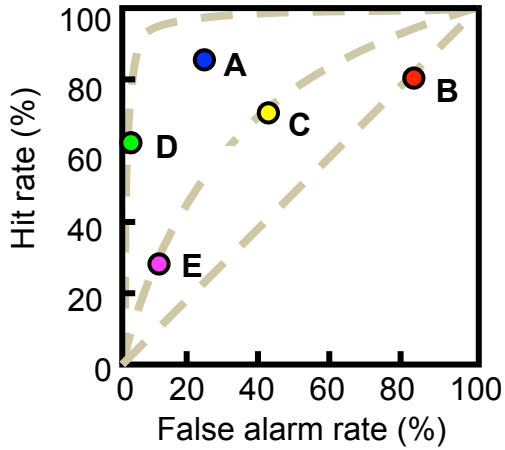
Discriminability (or sensitivity) is greater the closer the data points (ROC curve) are to the upper left corner.

d’ = z for prob(hit) – z for prob(false alarm)

Bias is greater the further the data are away from the diagonal d’ line. Negative C values are towards the lower left corner and indicate a bias towards answering no (a conservative criterion), whereas positive C values are points towards the upper right corner and indicate a bias towards answering yes (a liberal criterion)

C= 0.5 [(z for p(hit) + z for p(false alarm)]





Signal Detection Theory

Explains yes-no decisions

Detecting signal in noise (S + N)
- Noise (N) is what makes detection hard (internal + external noise)

Sensitivity (discriminability) vs. criterion (bias)

Sensitivity (d') depends on
- Signal strength
- Noise strength
- Observer sensitivity

Criterion depends on
- Personal bias
- Cost/benefit factors (risk factors)
- Signal frequency

ROC curve
- Used to visualize SDT concepts & results

Experiment 1.2 Signal Detection