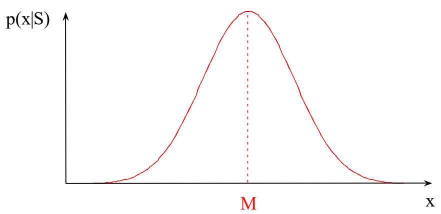
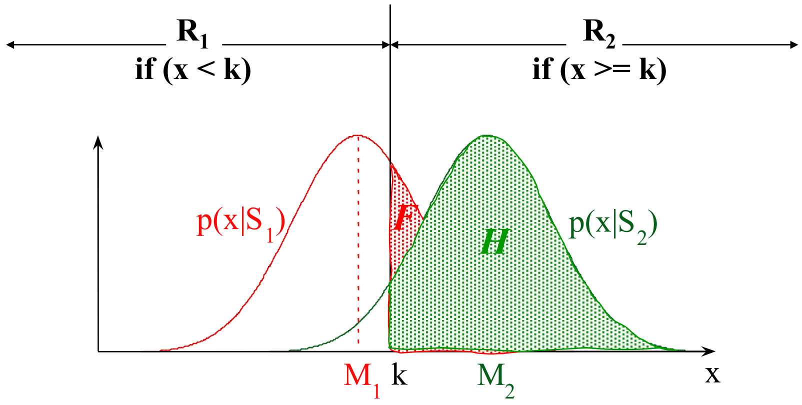
A Decision Model for Psychophysics (*Cont.*)

Reading: Macmillan & Creelman, Chaps. 1 & 2

Decision Model for 1-I Exp.



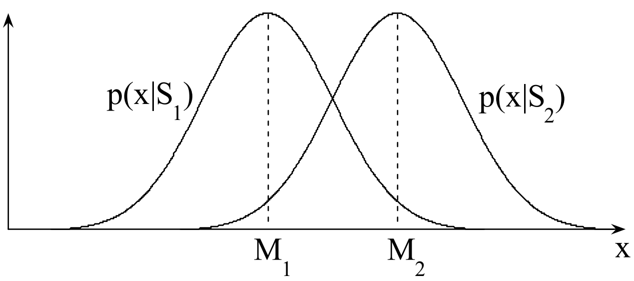
- **A (Perceptual) Decision Space**
  - **x: random variable ("decision axis")**
  - **Each stimulus presentation determines a value of x**
  - **p(x|S): conditional probability density function**
  - **M: mean/expected value** $M = \int_{-\infty}^{+\infty} x \, p(x \mid S) \, dx$



$$F = \mathrm{P}(R_2 \mid S_1) = \int_k^\infty p(x \mid S_1)\,dx$$

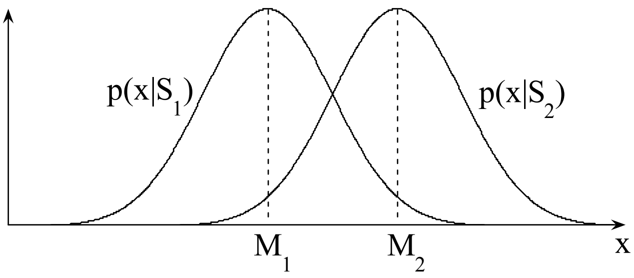
$$H = \mathrm{P}(R_2 \mid S_2) = \int_k^\infty p(x \mid S_2)\,dx$$

Gaussian Model of Density Functions (assuming equal variance)



$$p(x \mid S_1) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-M_1)^2}{2\sigma^2}} \qquad p(x \mid S_2) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-M_2)^2}{2\sigma^2}}$$

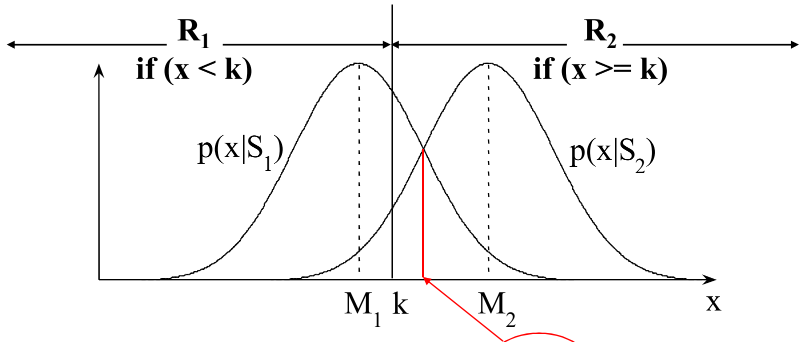
Sensitivity Index d′



$$d' = \frac{M_2 - M_1}{\sigma}$$

- **d′ is the *normalized distance* between means**
- **d′=1 defines the threshold**
- **d′ does not depend on *k***

Response Bias *c*



$$c = \frac{1}{\sigma}\left(k - \frac{M_1 + M_2}{2}\right)$$

- **c is the *normalized distance* between k and *average of means***
- **Point of zero bias**
- **c can change independently of d′ (How?)**

How to Compute d′ and c from Experimental Data?

{H, F} ⟶ {z(H), z(F)} ⟶ {d′, c}

	R_1	R_2
S_1	$f(R_1\|S_1)$	$F=f(R_2\|S_1)$
S_2	$f(R_1\|S_2)$	$H=f(R_2\|S_2)$

Normal Deviates

$$H=\int_{-\infty}^{z(H)}\frac{1}{\sqrt{2\pi}}e^{-\frac{x^2}{2}}dx$$

$$F=\int_{-\infty}^{z(F)}\frac{1}{\sqrt{2\pi}}e^{-\frac{x^2}{2}}dx$$

$$d'=z(H)-z(F)$$

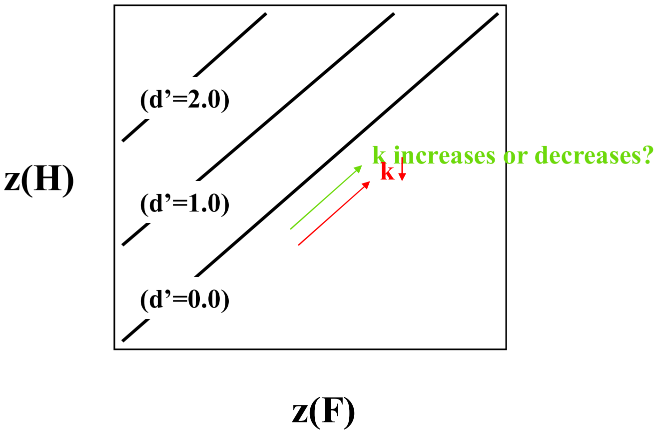
$$c=-\frac{z(H)+z(F)}{2}$$

ROC for d′

- ROC: Receiver Operating Characteristic (Isosensitivity Curve)
- Question: Given the same pair of S_1 and S_2 (d′ is fixed), how would performance (H, F) vary with *k*?
- ROC plotted as z(H) vs. z(F) has a particularly simple form:

  z(H) = z(F) + d′

ROC: $z(H) = z(F) + d'$

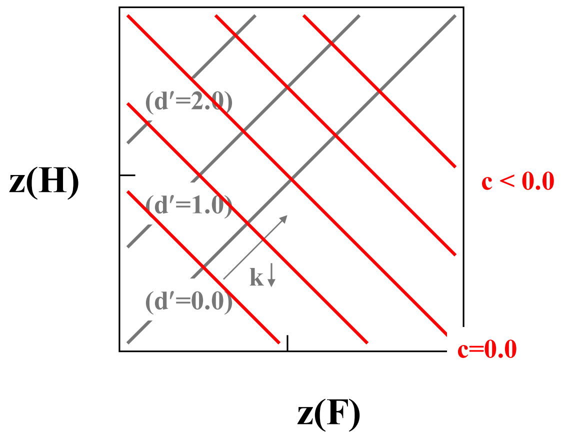


ROC for c

- Isobias Curve
- Question: Given the same criterion (c is fixed), how would performance (H, F) vary with S_1 and/or S_2?
- ROC plotted as z(H) vs. z(F) has a particularly simple form:

  $z(H) = -z(F) - 2c$

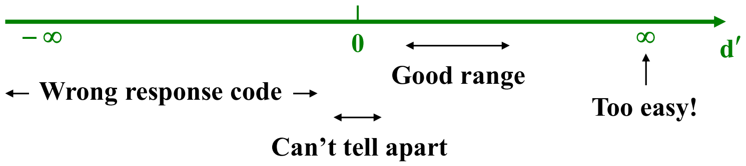
ROC: $z(H) = -z(F) - 2c$



How to Design a 1-I Exp.?

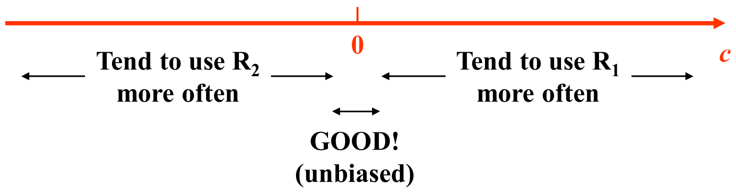
- How to choose S_1 and S_2?
- How to choose probabilities of presenting S_1 or S_2 on each trial?
- The issue of Stimulus-Response compatibility (S-R compatibility)
- How many trials?
- How many subjects?
- How to detect "bad" subjects?

More on Sensitivity Index d′



- Possible values: 0 – 4.65 (H=.99, F=.01)
- Avoid d′=0.0 and d′= ∞
- My preference: 0.5 – 2.5
- My preference: keep c<10%×d′

More on Response Bias *c*



- If *c* is large, investigate why (unless it is part of the experimental design).

Your Results

- Do you understand how the experimental data are organized, and how the different results are calculated?
- Do you think the results are as expected?