Type 1 and Type 2 Errors

Error control: Goal: not to make a fool out of yourself too often in the long run.

To stake, or not to stake?

Some definitions:

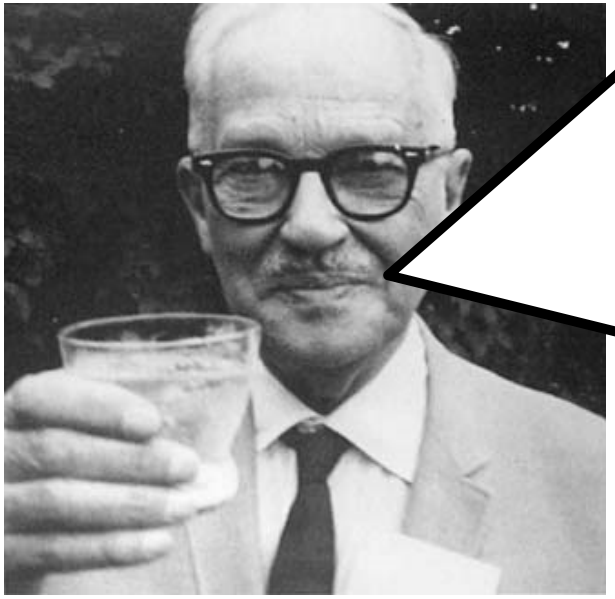
H0 is the **null** hypothesis

H1 is the **alternative** hypothesis

α is the probability of a significant result when **H0** is true. (**Type 1 error** rate).

β is the probability of a non-significant result, given that **H1** is true (**Type 2 error**)

1-β is the probability of a significant result when **H1** is true. **(statistical power)**



Error rates are **frequentist** concepts. They are about the long run!

	H0 True	H1 True
Significant Finding	False Positive (α)	True Positive (1-β)
Non-Significant Finding	True Negative (1- α)	False Negative (β)

What will your next study show?

H0 and H1: 50% prob.

$\alpha = 5\%$ $1-\beta = 80\%$

	H0 True (50%)	H1 True (50%)
Significant Finding α = 5%, 1-β=80%	False Positive 5%*50%=2.5%	True Positive 80%*50%=40%
Non-Significant Finding 1-α = 95%, β=20%	True Negative 95%*50%=47.5%	False Negative 20%*50%=10%

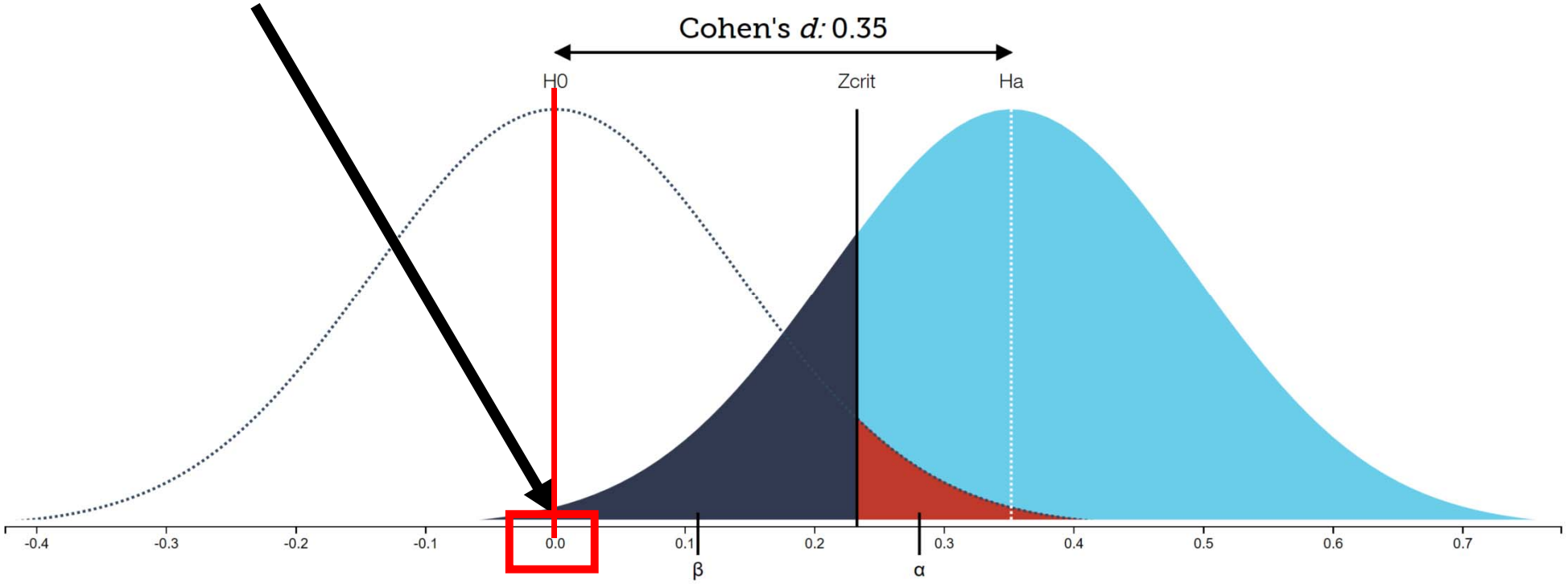
The most likely outcome is a **true negative**. How can you improve this?

	H0 True (50%)	H1 True (50%)
Significant Finding α = 5%, 1-β=99%	False Positive 5%*50%=2.5%	True Positive 99%*50%=49.5%
Non-Significant Finding 1-α = 95%, β=1%	True Negative 95%*50%=47.5%	False Negative 1%*50%=0.5%

	H0 True (50%)	H1 True (50%)
Significant Finding α = 1%, 1-β=80%	False Positive 1%*50%=0.5%	True Positive 80%*50%=40%
Non-Significant Finding 1-α = 99%, β=20%	True Negative 99%*50%=49.5%	False Negative 20%*50%=10%

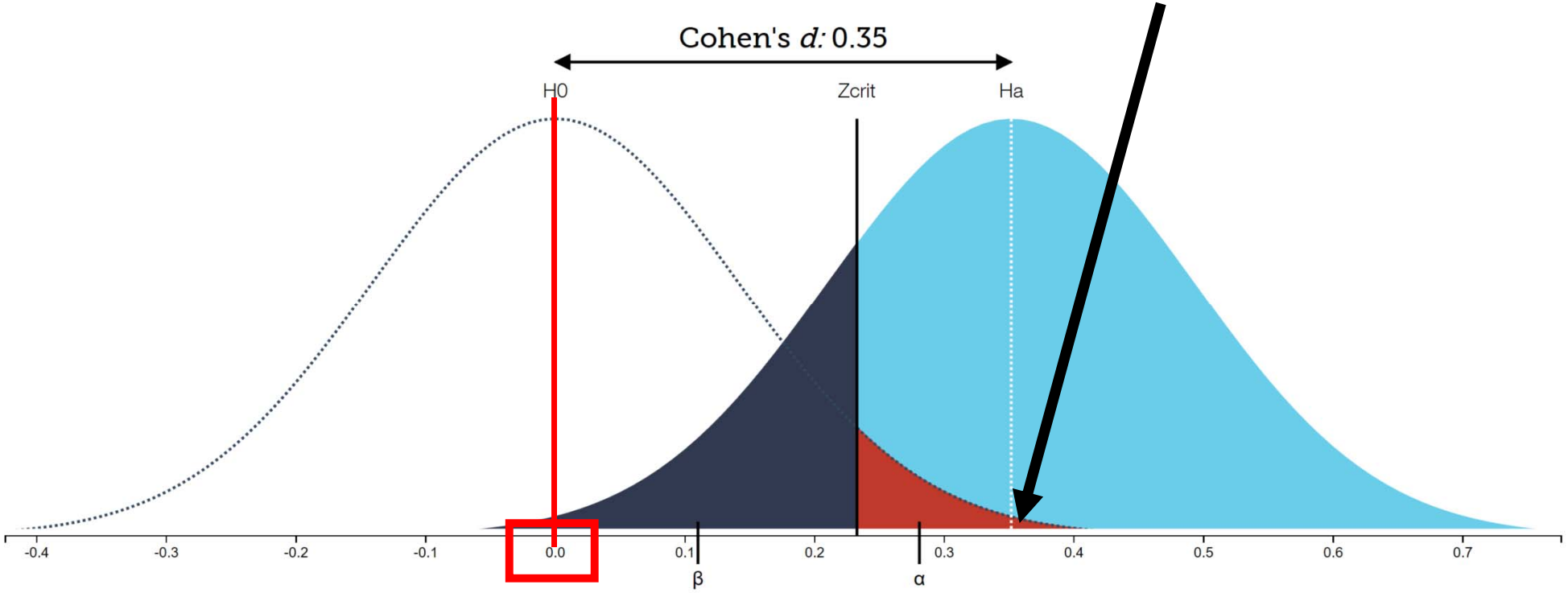
	H0 True (10%)	H1 True (90%)
Significant Finding α = 5%, 1-β=80%	False Positive 5%*10%=0.5%	True Positive 80%*90%=72%
Non-Significant Finding 1-α = 95%, β=20%	True Negative 95%*10%=9.5%	False Negative 20%*90%=18%

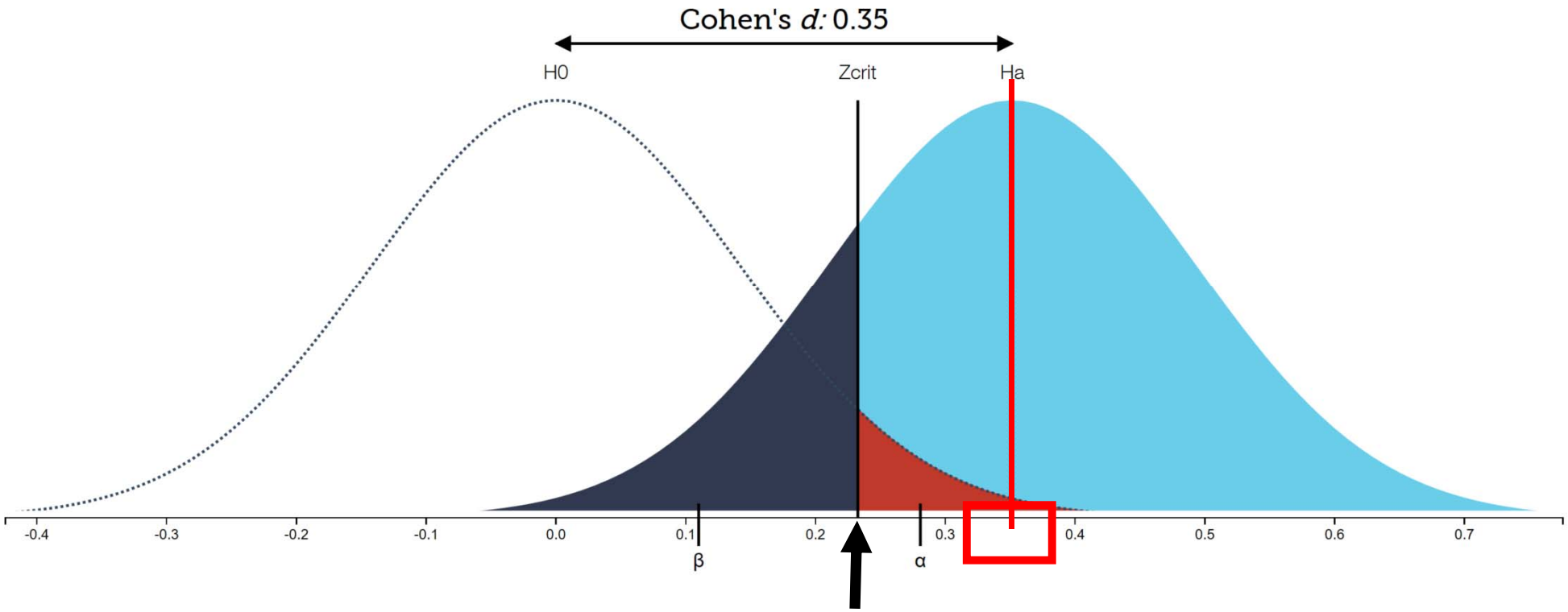
Distribution if H0 is true
Centered on 0



From: http://rpsychologist.com/d3/NHST/

Distribution if H1 is true
Centered on d = 0.35

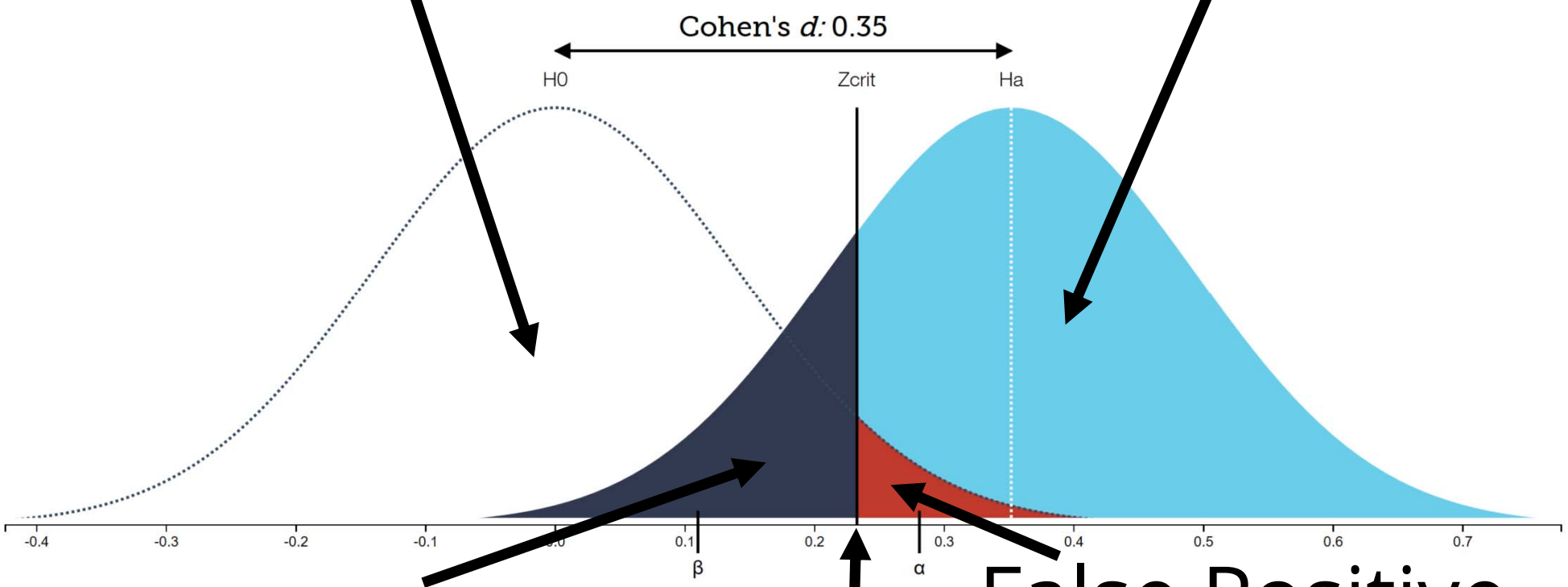




Critical Value ($p = 0.05$)

True Negative

True Positive

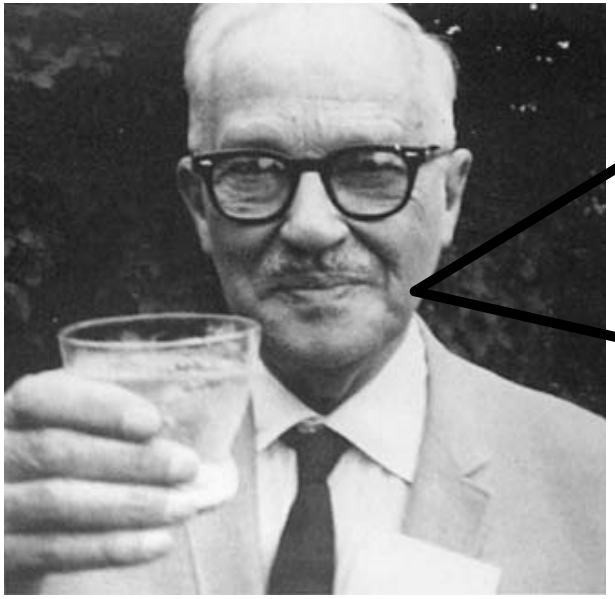


False Negative

(p = 0.05)

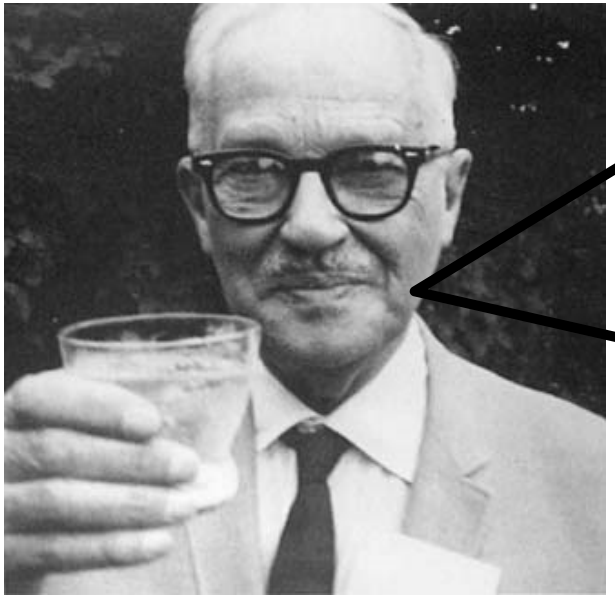
False Positive

Which error rates should you aim for?



Is it more serious to convict an innocent man, or to acquit a guilty?

[Neyman & Pearson, 1933]



Determining how the balance must be struck should be left to the investigator.

[Neyman & Pearson, 1933]

Cohen recommended **80% power** (hoping this recommendation would be ignored)


α = 0.05

Controlling error rates is useful when **designing** studies, to prevent you from making a fool of yourself, **in the long run.**