Optimizing Research Payoff, 2: The Quest for an Optimal Alpha

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STATISTICAL MODELING in PSYCHOLOGY
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Supported by

Alexander von Humboldt
Stiftung/Foundation

Overview of Talk

1. Current controversy about critical α level
2. Optimizing research payoff and α level
3. Optimal α level should maximize overall research payoff

Current Debate

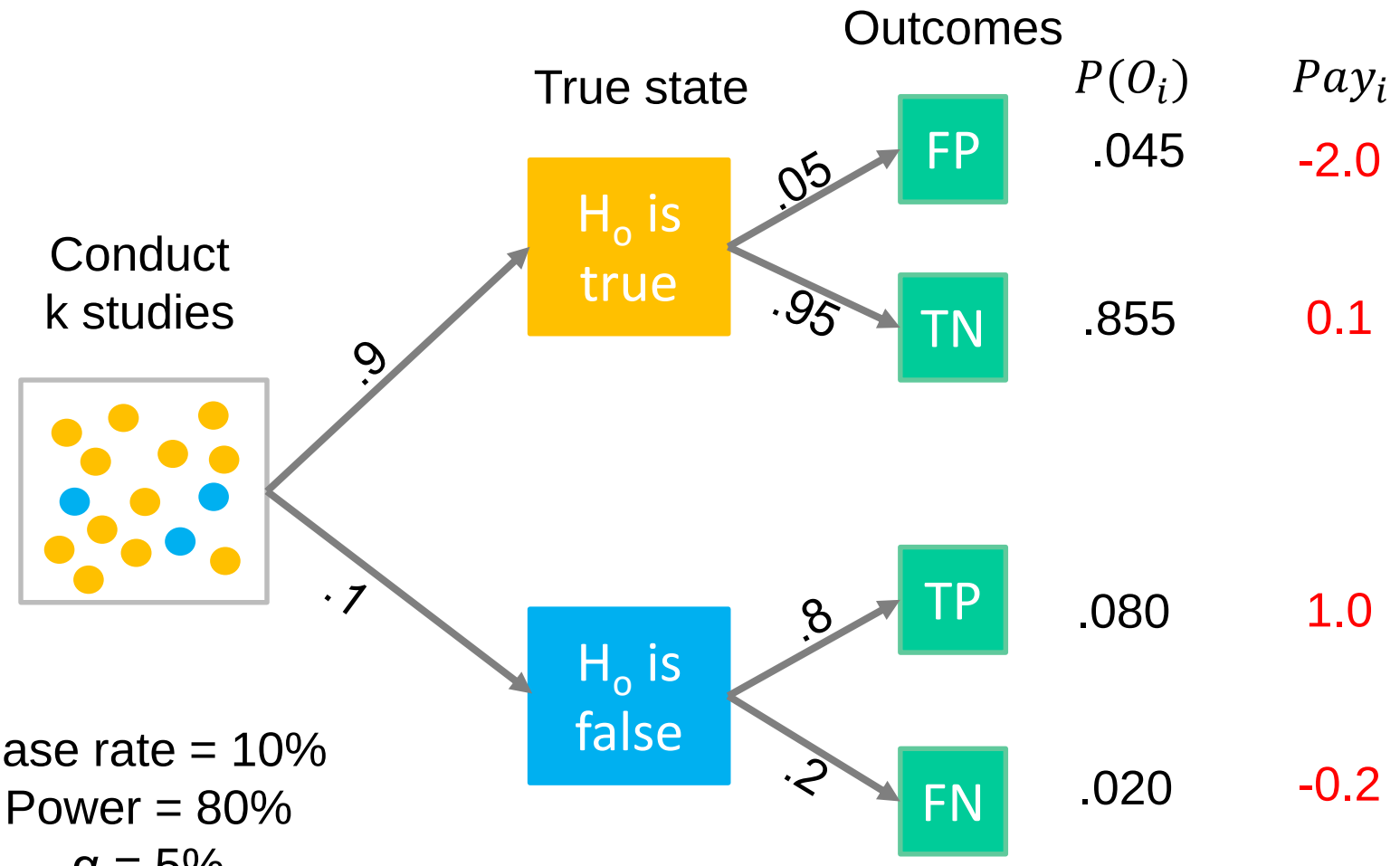
- Benjamin et al. (72 authors)
  - $\alpha = 0.5\%$ instead of 5%
  - lower rate of false positives
  - higher replication rate
- Lakens et al. (88 authors)
  - negative consequences
  - higher rate of false negatives

Choosing the Optimal α Level

- Optimal α depends on
  - Base rate of true effects
  - Effect size and sample size

- But also on resources and payoff values
  - Gains associated with TP and TN
  - Losses associated with FP and FN

A Statistical Model of the Research Process



Total payoff $= k \cdot \sum_i P(O_i) \cdot Pay_i$

Two Researchers

2-sample t-test
Base rate = 10%
Effect size = 0.5
Power = 80%
1,900 Ss

	Researcher 1	Researcher 2
α (1-tailed)	5%	0.5%
# Ss per experiment	100	190
# Experiments, k	19	10
Total payoff	1.4	1.6

Two Researchers

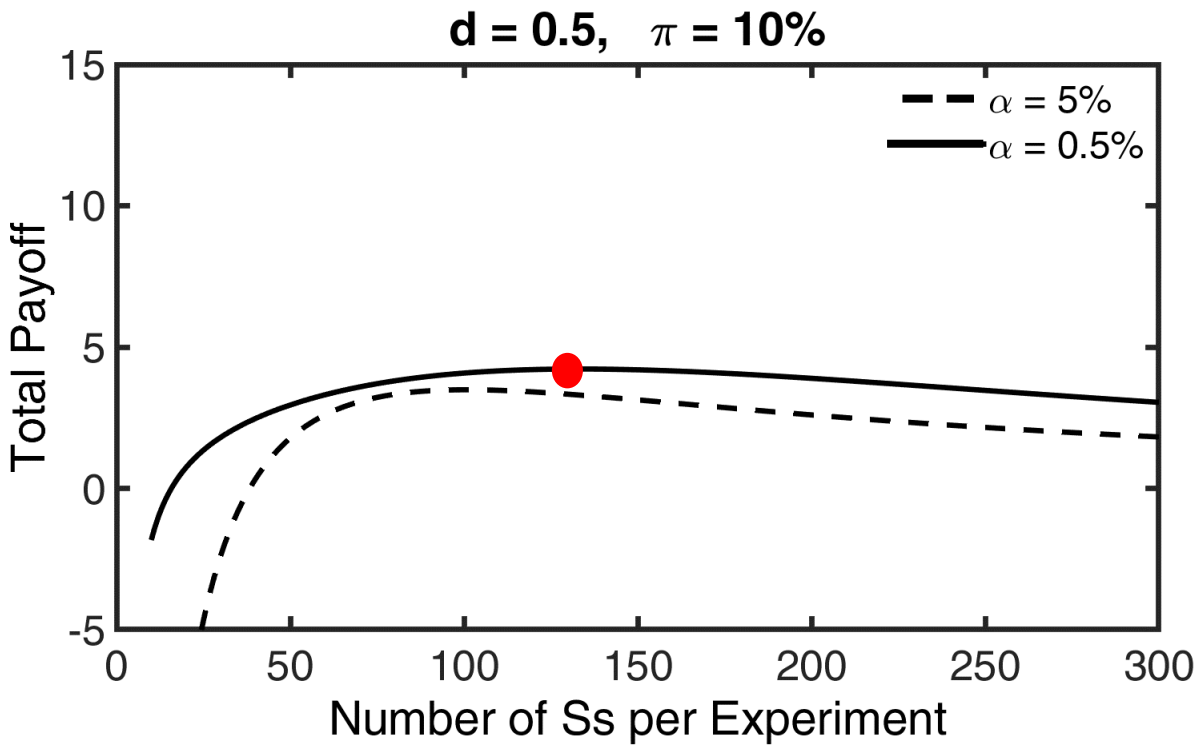
2-sample t-test
Base rate = **20%**
Effect size = 0.5
Power = 80%
1,900 Ss

	Researcher 1	Researcher 2
α (1-tailed)	5%	0.5%
# Ss per experiment	100	190
# Experiments, k	19	10
Total payoff	2.8	2.2

Example Total Payoff Graphs

Ss = 10,000

Outcome	Pay_i
TP	1
FP	-1
TN	0
FN	0



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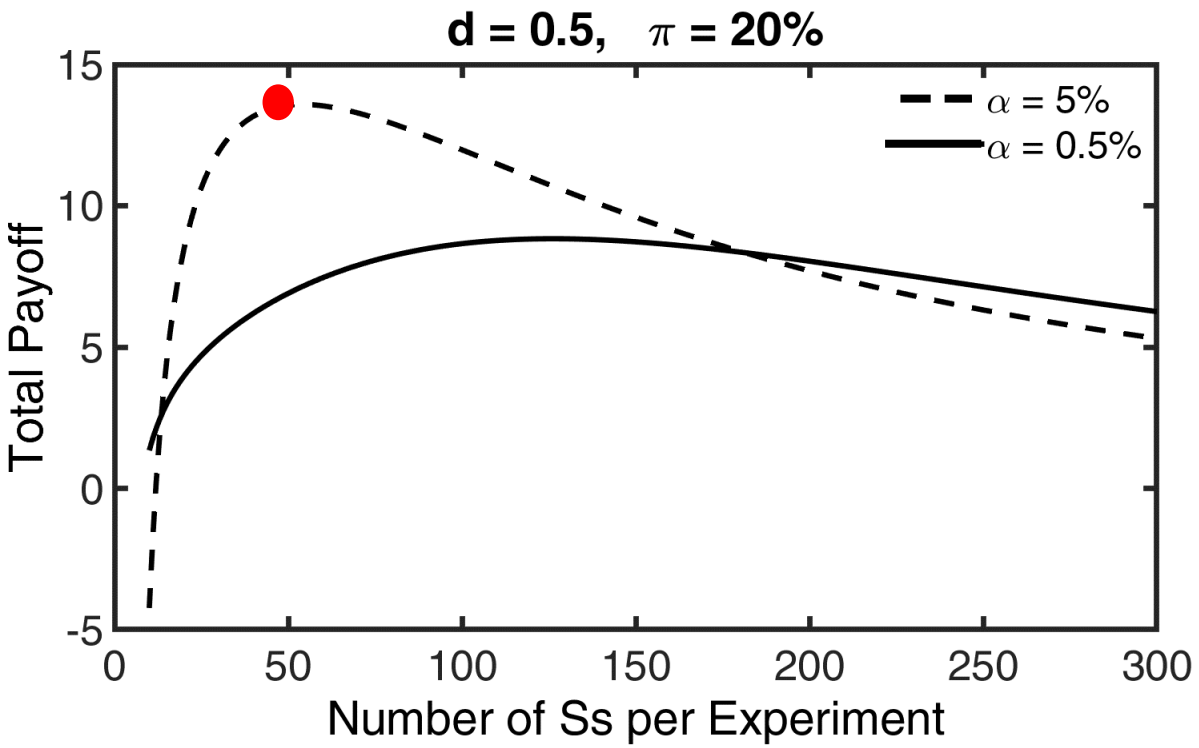

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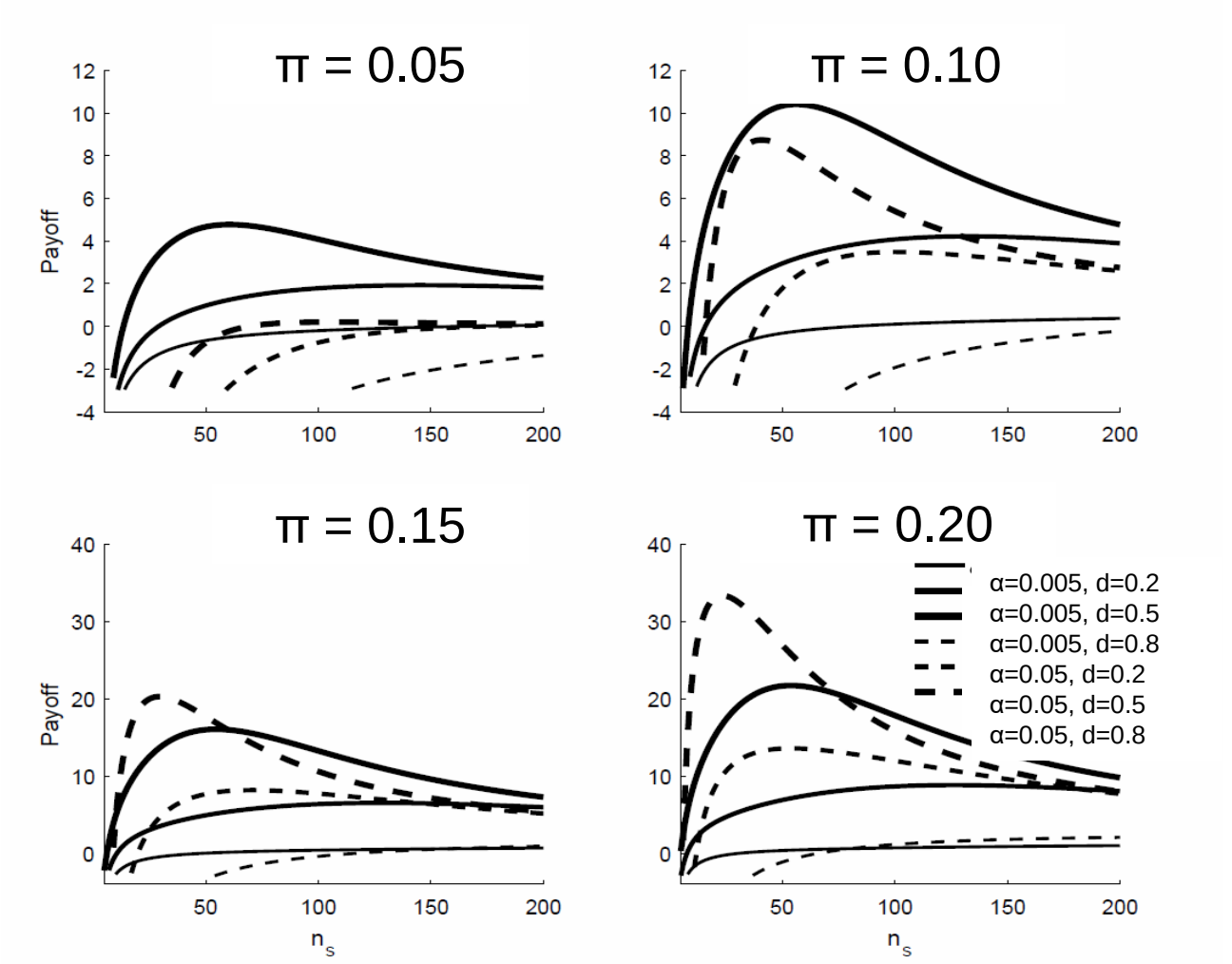
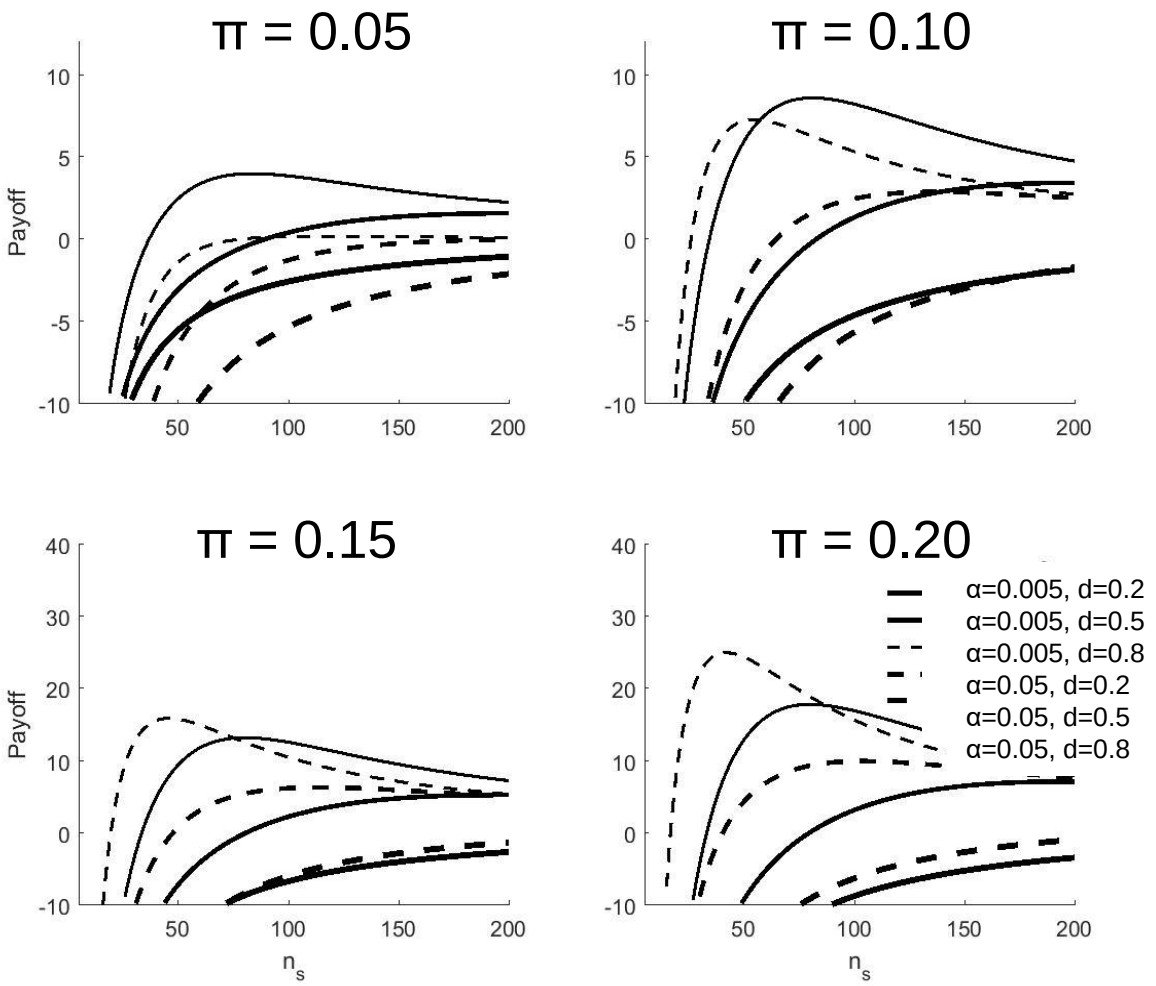


Example Total Payoff Graphs

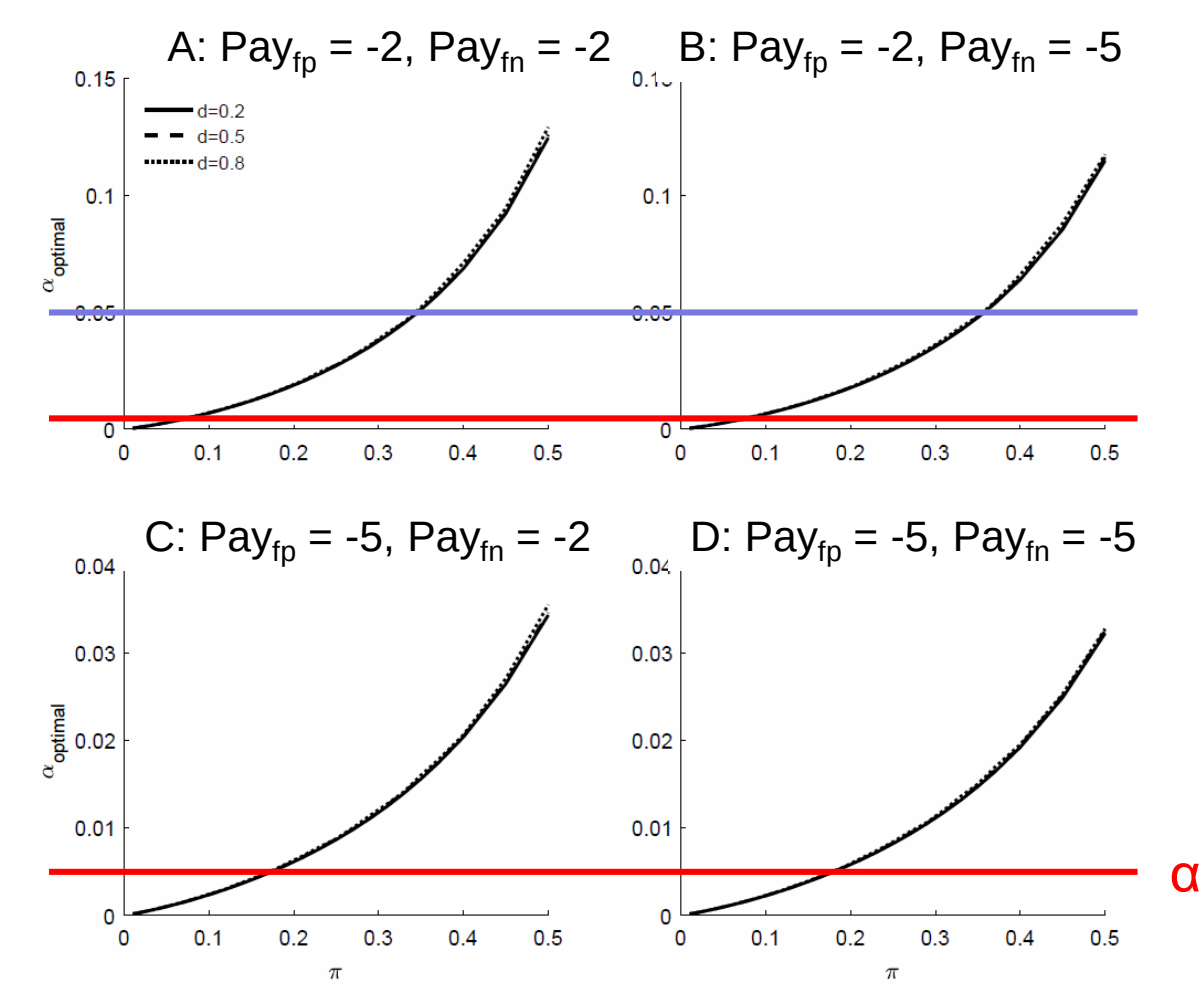
Ss = 10,000

Outcome	Pay_i
TP	1
FP	-1
TN	0
FN	**-0.5**



Optimal α

$$(\alpha_{opt}, n_{opt}) = argmax_{\alpha,n}\ Total\ Payoff(\alpha, n, d, \pi, Pay_{fp}, Pay_{tp}, Pay_{fn}, Pay_{tn})$$



Conclusion

1. Using the wrong α lowers total payoff
2. Optimal α depends on:
   - base rate
   - outcome payoffs
3. Implication: these values must be estimated for any rational selection of α