Optimizing Research Payoff, 1: A Simple Way to Increase Research Efficiency

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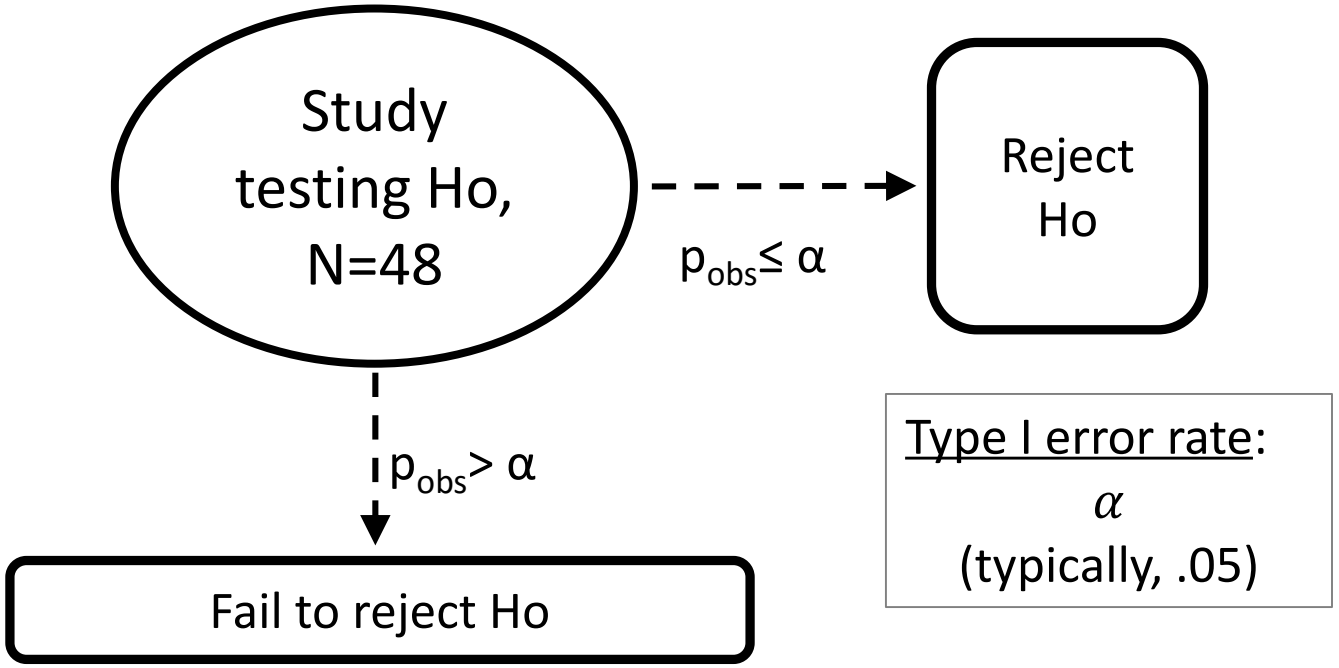
Avoidable waste in the production and reporting of research evidence. *Chalmers & Glasziou (2009)*

Biomedical research: increasing value, reducing waste. *Macleod et al. (2014):* "85% of research investment—equating to $200 billion of the investment in 2010—is wasted."

How can we do better?

1. A statistical model for assessing the research payoffs of traditional Ho testing.
2. An alternative "replication-based" strategy for Ho testing that often produces higher payoffs.

Traditional strategy



Type I error rate:
α
(typically, .05)

Payoffs for Traditional Ho Testing

Research Scenario Parameters:

4800 Ss, N=48 → 100 studies

2-sample *t*-tests

α=0.05, 1-tailed

Base rate of false Ho's = .1

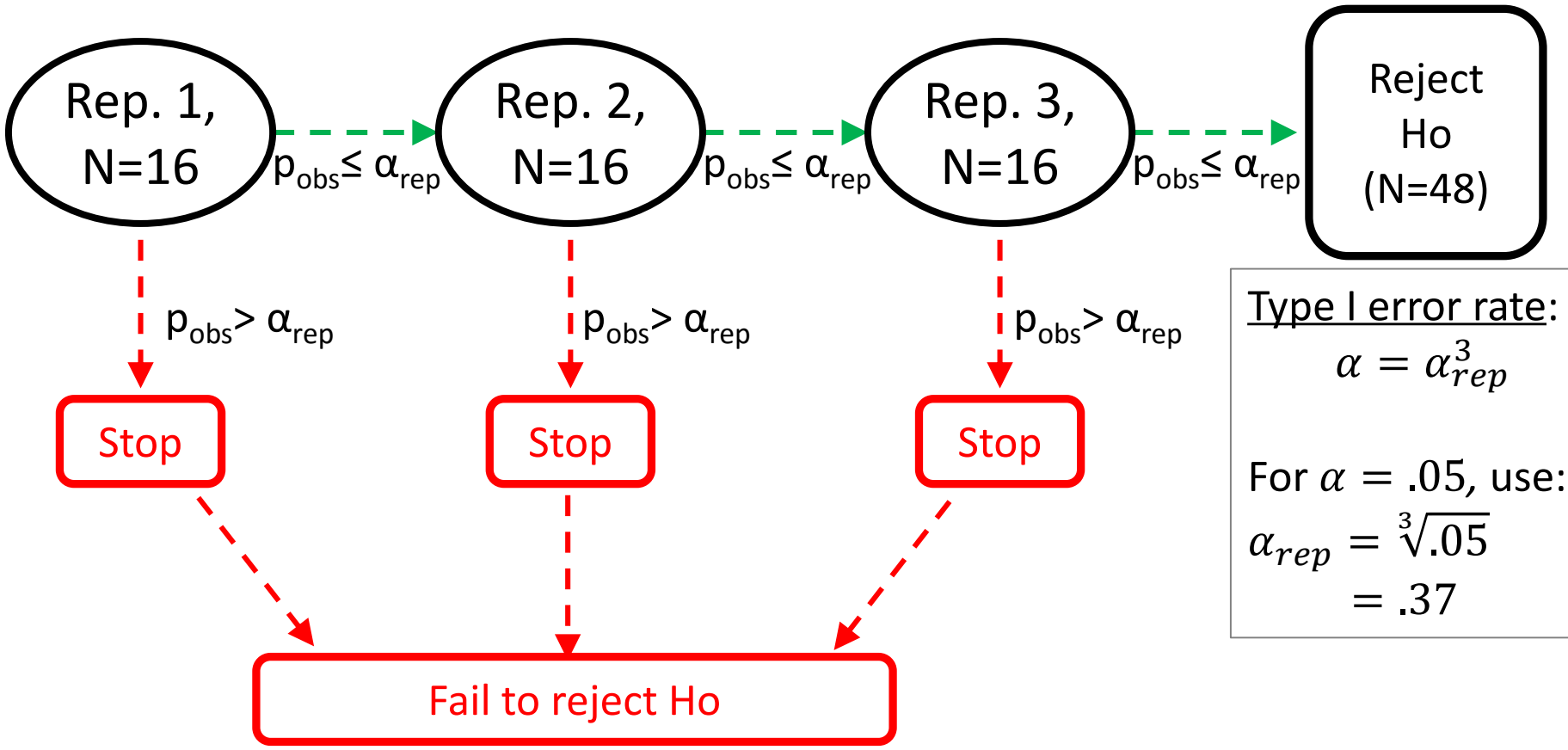
90 studies: Ho is true

10 studies: Ho is false
Effect size=0.5
→power=0.525

Outcome	N_i	Payoff Pay_i	N_i x Pay_i
5% → False positive	4.5	-2.0	-9.00
95% → True negative	85.5	0.1	8.55
52.5% → True positive	5.25	1.0	5.25
47.5% → False negative	4.75	-0.2	-0.95

Total payoff = 3.85

Replication-based strategy



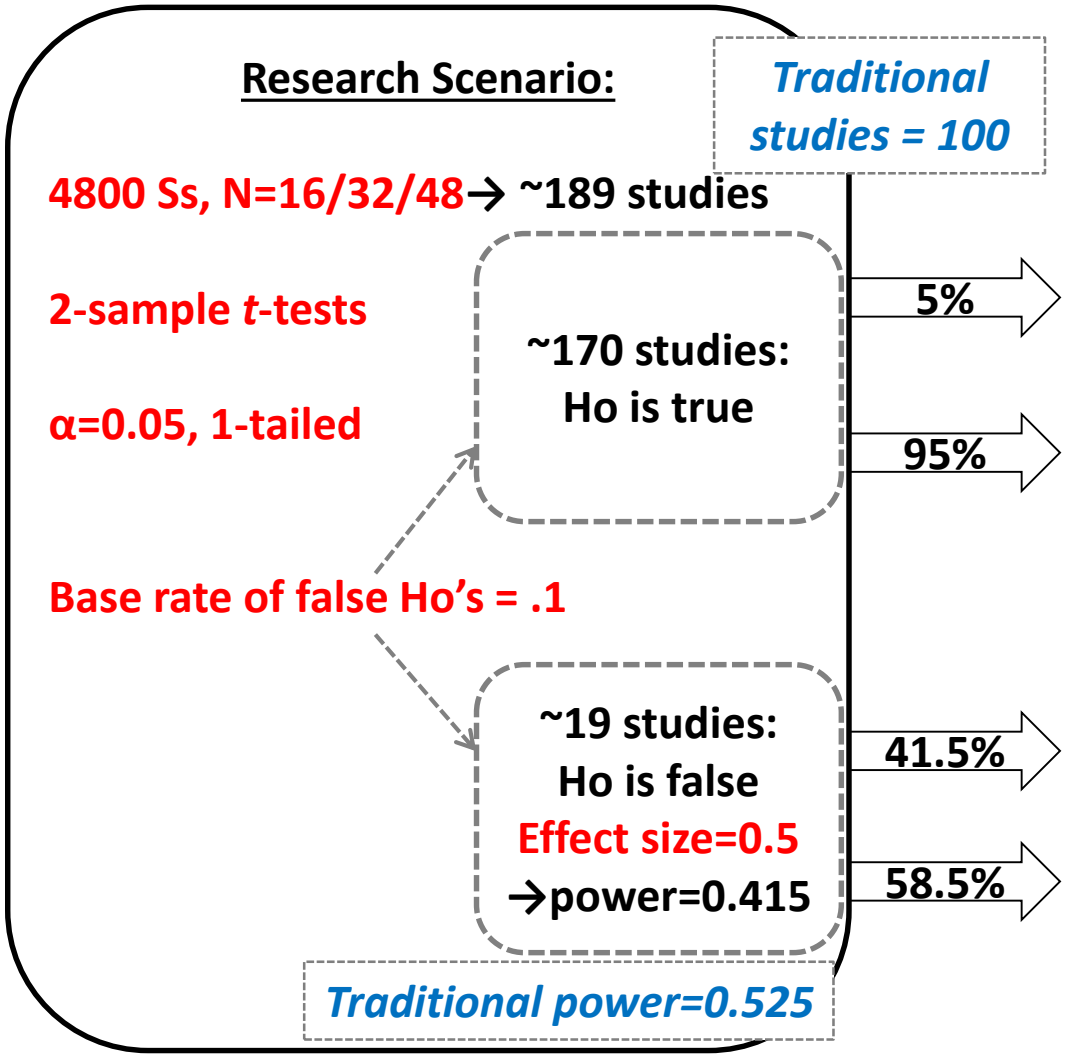
Type I error rate:

$$\alpha = \alpha_{rep}^3$$

For $\alpha = .05$, use:

$$\alpha_{rep} = \sqrt[3]{.05} = .37$$

Payoffs for Replication Strategy



Outcome	N_i	Payoff Pay_i	N_i x Pay_i
False positive	8.5	-2.0	-17.00
True negative	161.9	0.1	16.19
True positive	7.86	1.0	5.25
False negative	11.08	-0.2	-0.95

Total payoff = 4.79

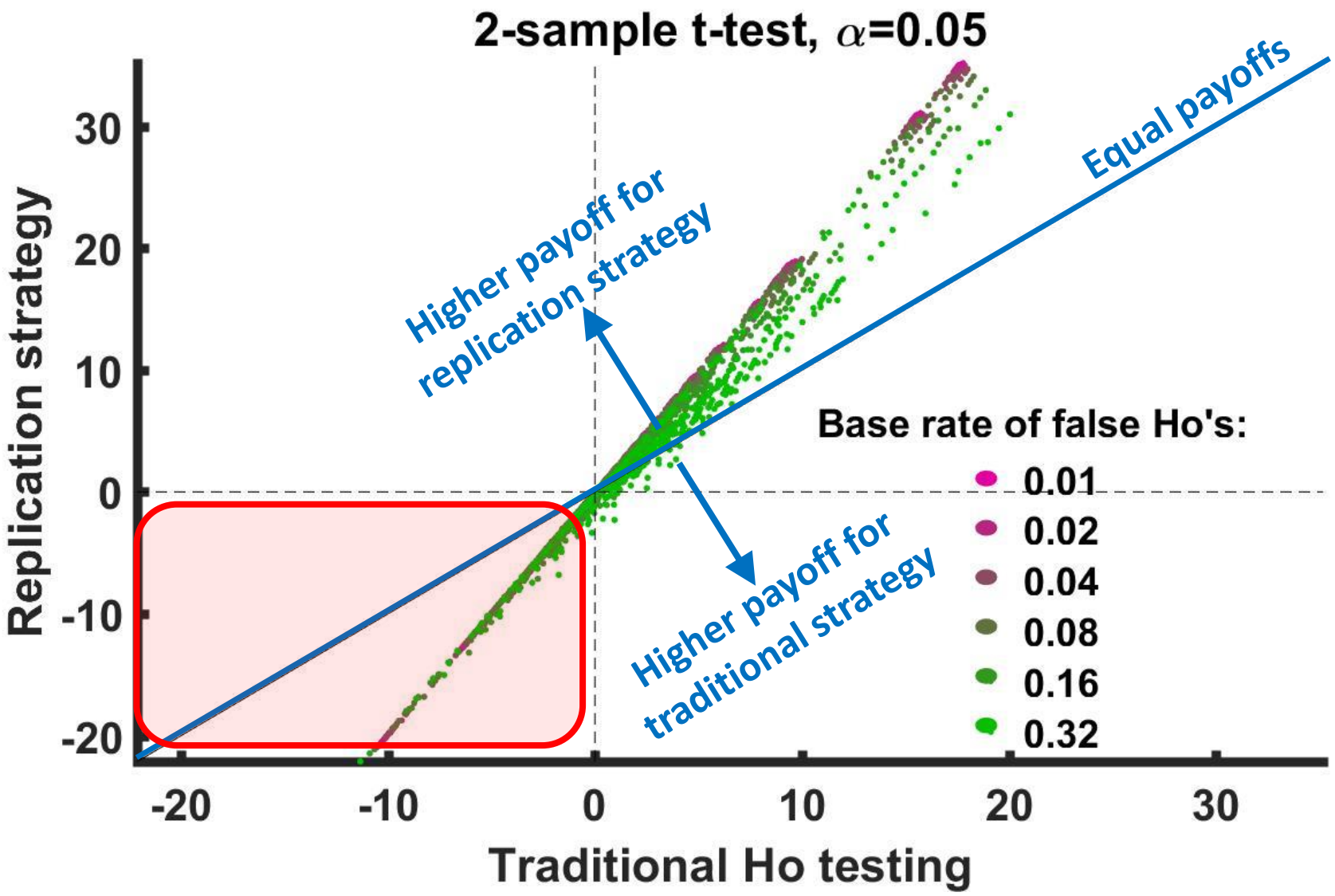
Traditional payoff = 3.85

What About Other Research Scenarios?

We compared expected payoffs under all 2,592 possible combinations of these parameter values:

Parameter:	Parameter values checked:
• base rate of false Ho's	• 0.01, 0.02, 0.04, 0.08, 0.16, 0.32
• effect size	• 0.2, 0.5, 0.8
• sample size	• 24, 48, 96
• outcome payoffs:	
▪ true positive	▪ 1
▪ true negative	▪ 0, 0.1, 0.2, 0.5
▪ false positive	▪ -1, -2, -5
▪ false negative	▪ 0, -0.1, -0.2, -0.5

Expected Payoffs



Conclusions

Replication-based strategy looks promising:

- Simple extension of existing Ho testing methods
- Increases payoffs in many research scenarios

Limitations:

- Single main Ho to be rejected
- Works best when base rate of false Ho's is low

Extensions: Are there even better strategies?

We *must* have a quantitative research payoff model to decide

Thanks for your attention. Questions?

Next talk: Which α level works best with the traditional strategy?