Design based on the two-trials rule

Design of replication studies

Sample size of replication study

- Direct replication → procedures of replication study as closely matched as possible to original study
- But same sample size as in original study can lead to a very low power (Goodman, 1992)

  → proper sample size calculation is essential

A COMMENT ON REPLICATION, *P*-VALUES AND EVIDENCE

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What is used in practice

Standard sample size calculation

- – Goal is to have between 80% and 95% power in the replication study to detect the effect estimate from the original study.

- – Original effect estimate is sometimes shrunken by a factor of 50%.

- – Uncertainty of original effect estimate is ignored
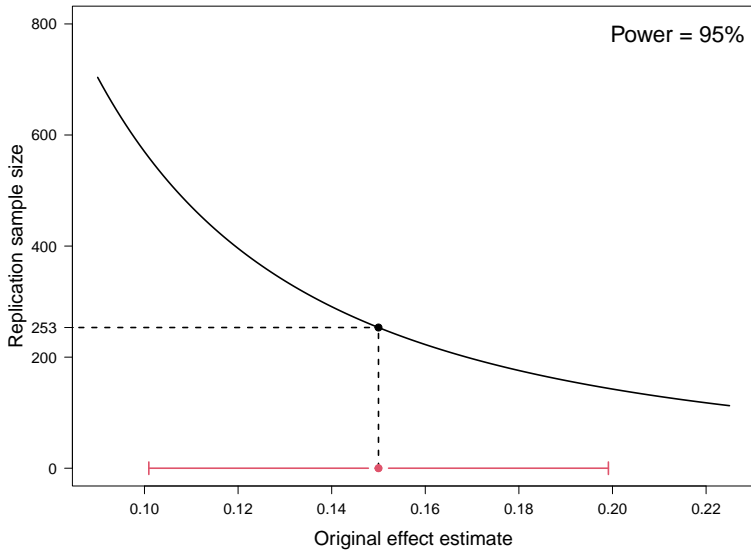
Standard sample size calculation
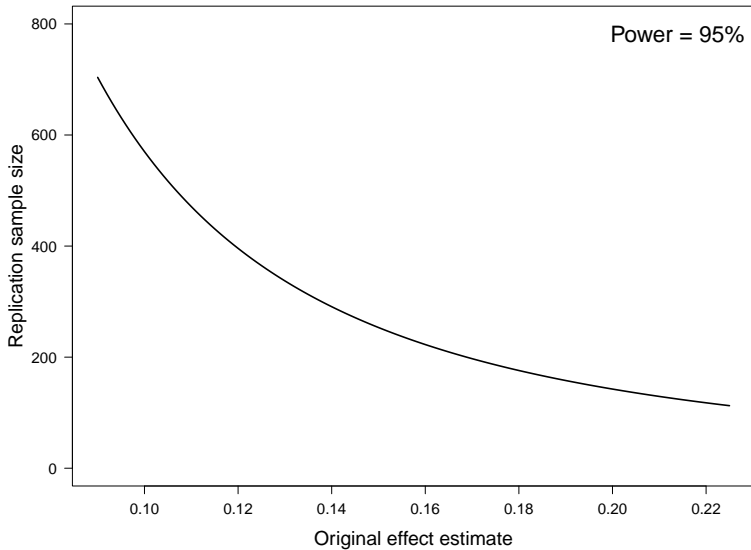
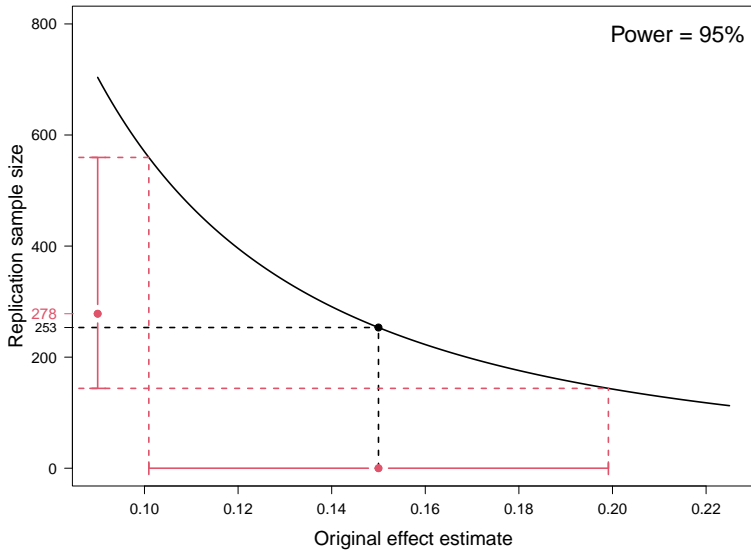# Standard sample size calculation
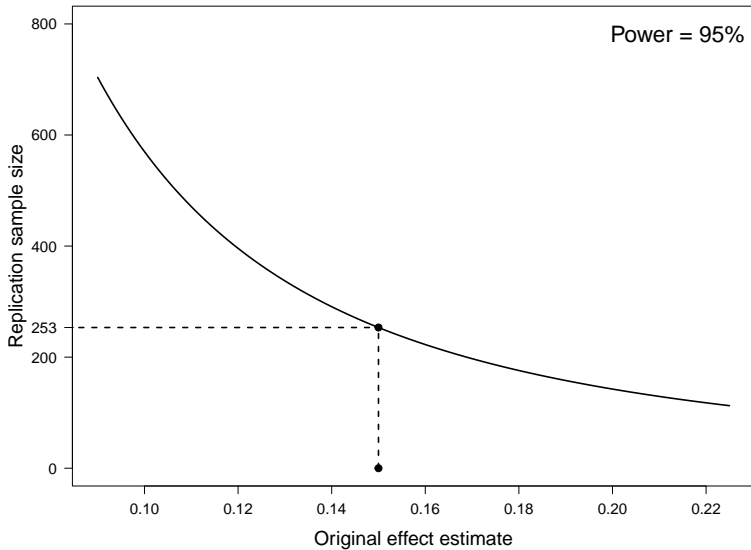
Incorporation of uncertainty

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Design prior

– *Conditional*: ignores uncertainty of original study
– *Predictive*: reflects that there is uncertainty about the true effect after the original experiment

Power of the two-trials rule

in absolute terms

Conditional design prior

$$\text{Power} = \Phi\left(\frac{\hat{\theta}_o \sqrt{n_r}}{\sigma} - z_{1-\alpha}\right)$$

Predictive design prior

$$\text{Power} = \Phi\left(\sqrt{\frac{n_o}{n_o + n_r}}\left(\frac{\hat{\theta}_o \sqrt{n_r}}{\sigma} - z_{1-\alpha}\right)\right)$$

Power of the two-trials rule

in relative terms

Conditional design prior

$$\text{Power} = \Phi\left(z_o\sqrt{c} - z_{1-\alpha}\right)$$

Predictive design prior

$$\text{Power} = \Phi\left(\frac{1}{\sqrt{c+1}}\left(z_o\sqrt{c} - z_{1-\alpha}\right)\right)$$

Power of the two-trials rule
with shrinkage

Conditional design prior

$$\text{Power} = \Phi\left((1 - s)z_o\sqrt{c} - z_{1-\alpha}\right)$$

Predictive design prior

$$\text{Power} = \Phi\left(\frac{1}{\sqrt{c+1}}\left((1 - s)z_o\sqrt{c} - z_{1-\alpha}\right)\right)$$

Design based on replication success (the sceptical p-value)

Power for replication success

Conditional design prior

$$\text{Power} = \Phi\left(z_o\sqrt{c}(1 - d_{\min})\right)$$

Predictive design prior

$$\text{Power} = \Phi\left(\frac{1}{\sqrt{c+1}}\left(z_o\sqrt{c}(1 - d_{\min})\right)\right)$$