Experimental design

How would you evaluate fertilizer effect?

Discuss with partner (5')

Figure 1:

Experimental design principles

Replication

Replication!

Figure 2:

Replication

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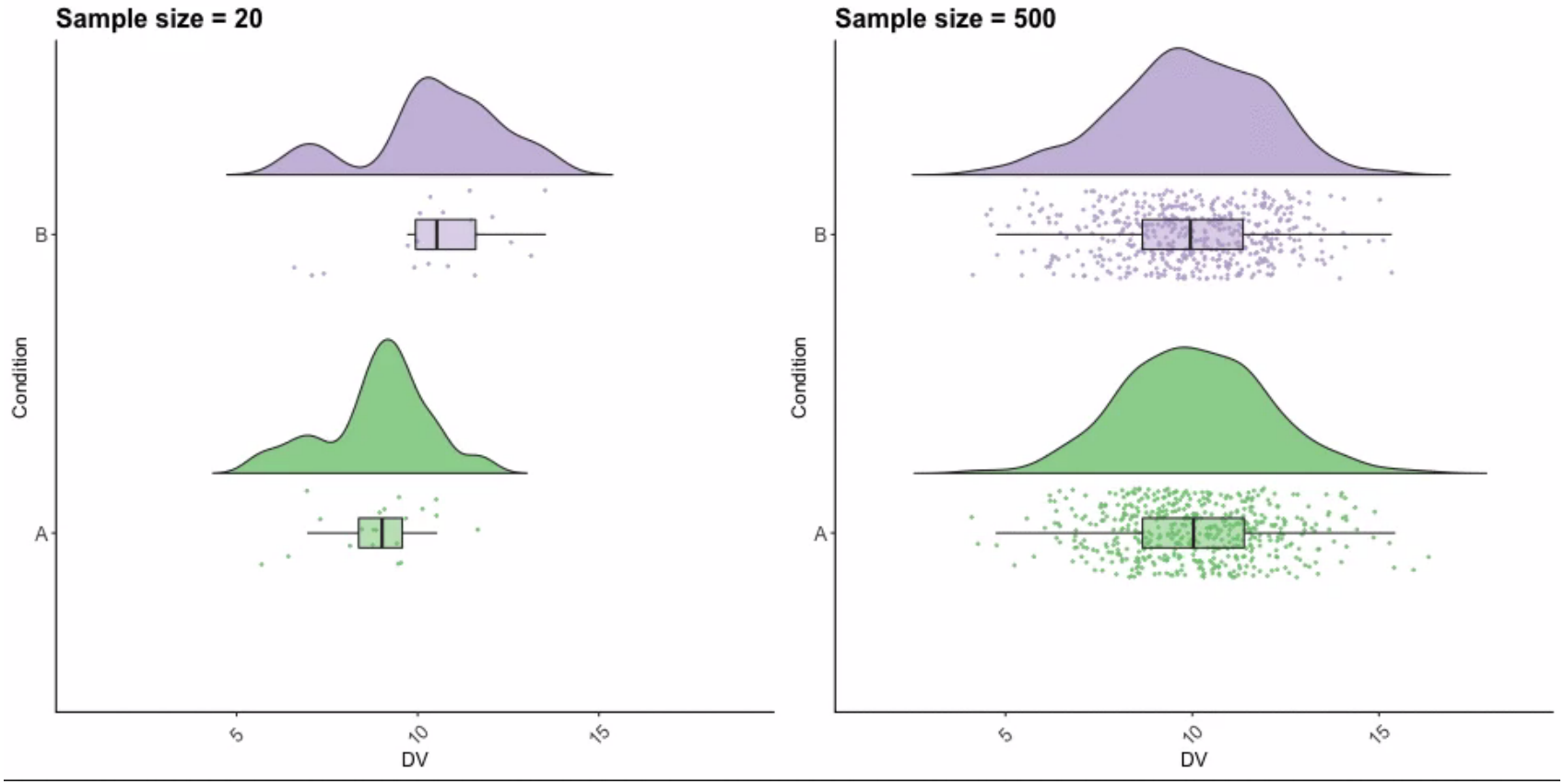
- How many? As much as you can! See Gelman & Carlin 2014.
- Traditionally, ecology studies have had too low sample sizes.
- Low sample sizes miss subtle effects, but also prone to bias.

Low sample sizes very sensitive to random noise



https://twitter.com/ajstewart_lang/status/1020038488278945797

Sample size is very important

See *The evolution of correlations*

Stopping rules:

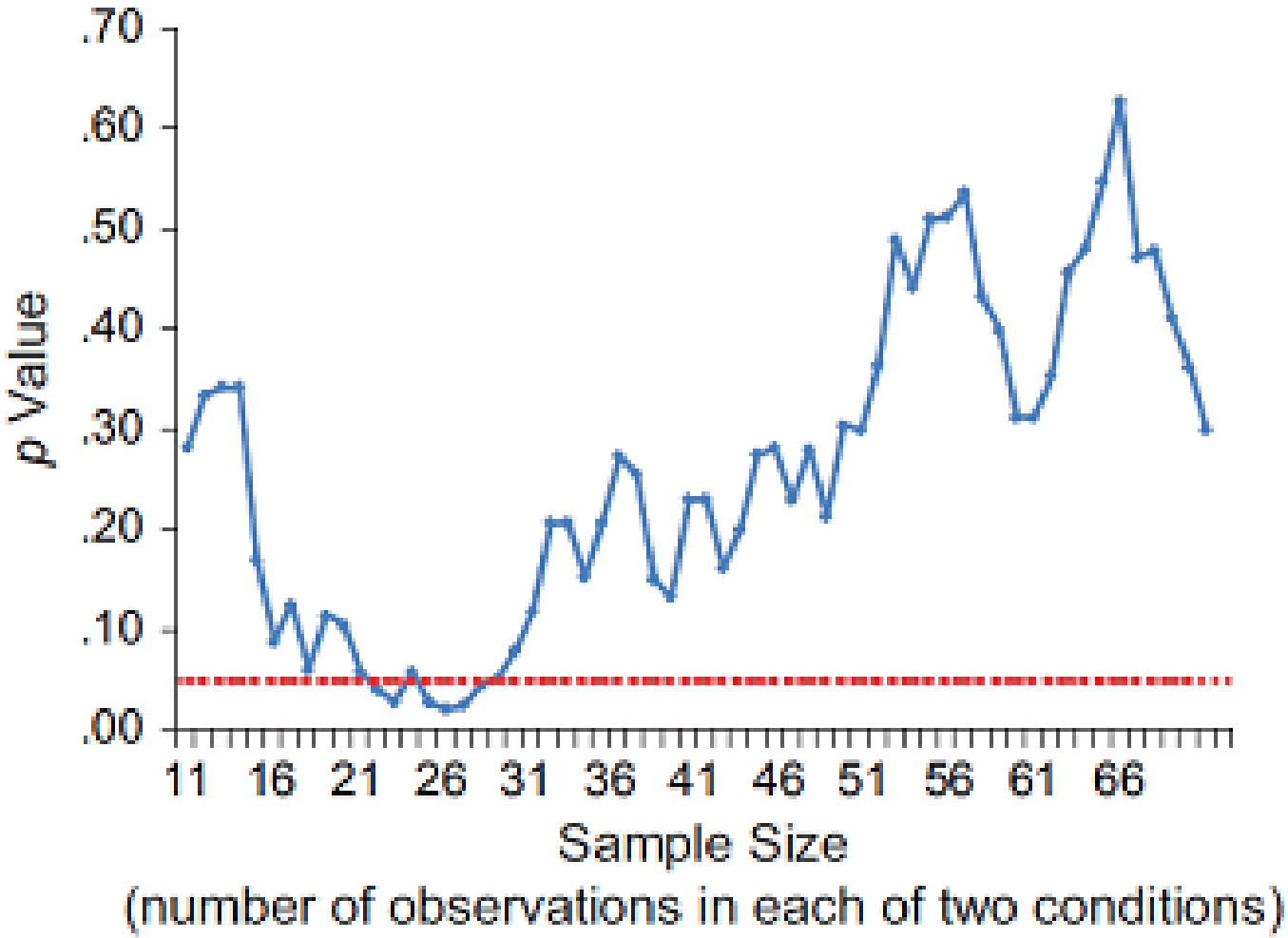


Fig. 2. Illustrative simulation of *p* values obtained by a researcher who continuously adds an observation to each of two conditions, conducting a *t* test after each addition. The dotted line highlights the conventional

Sample size estimation

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- Do simulations. Power/Sample size analyses (e.g.).
- Plan to have at least **10-30 observations per predictor**.
- Complex models (w/ many predictors, interactions etc) require **high** sample sizes.

Randomization

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Figure 4:

Randomization

- Haphazard $\neq$ Random

Randomization

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- Stratify: randomize within groups (e.g. species, soil types)

Controls

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- Measure before & after treatment.
- Consider blind designs to avoid observer bias.

Experimental design principles

1. Replication

Experimental design principles

1. Replication
2. Randomization

Experimental design principles

1. Replication
2. Randomization
3. Controls

To read more

- Ruxton & Colegrave. Experimental Design for the Life Sciences. OUP