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## Tools for estimating and comparing behavioral variation

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# Comparing behavioral variation requires multiple approaches

## Tools for estimating and comparing behavioral variation

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### CONTEXT

- Understanding how behavioral variation is generated is important
- Repeatability is a common metric for **reporting behavioral variation**
- Is repeatability the best metric for **comparing variation** among populations, sexes or studies?

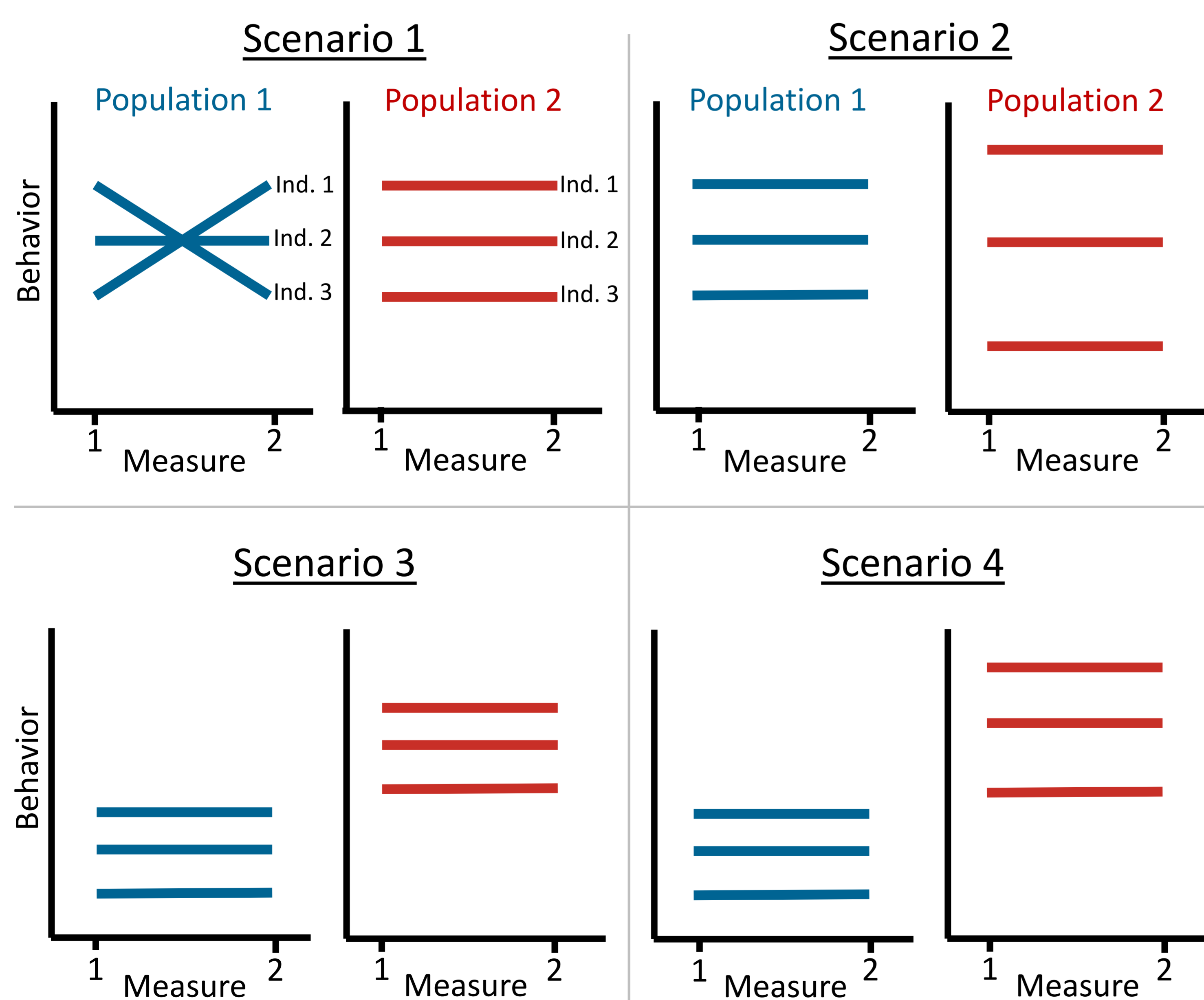
**Repeatability:** proportion of variation due to individual differences in behavior

Measured as a ratio of among ( $V_i$ ) and within-individual ( $V_w$ ) variances

$$R = \frac{V_i}{V_i + V_w}$$

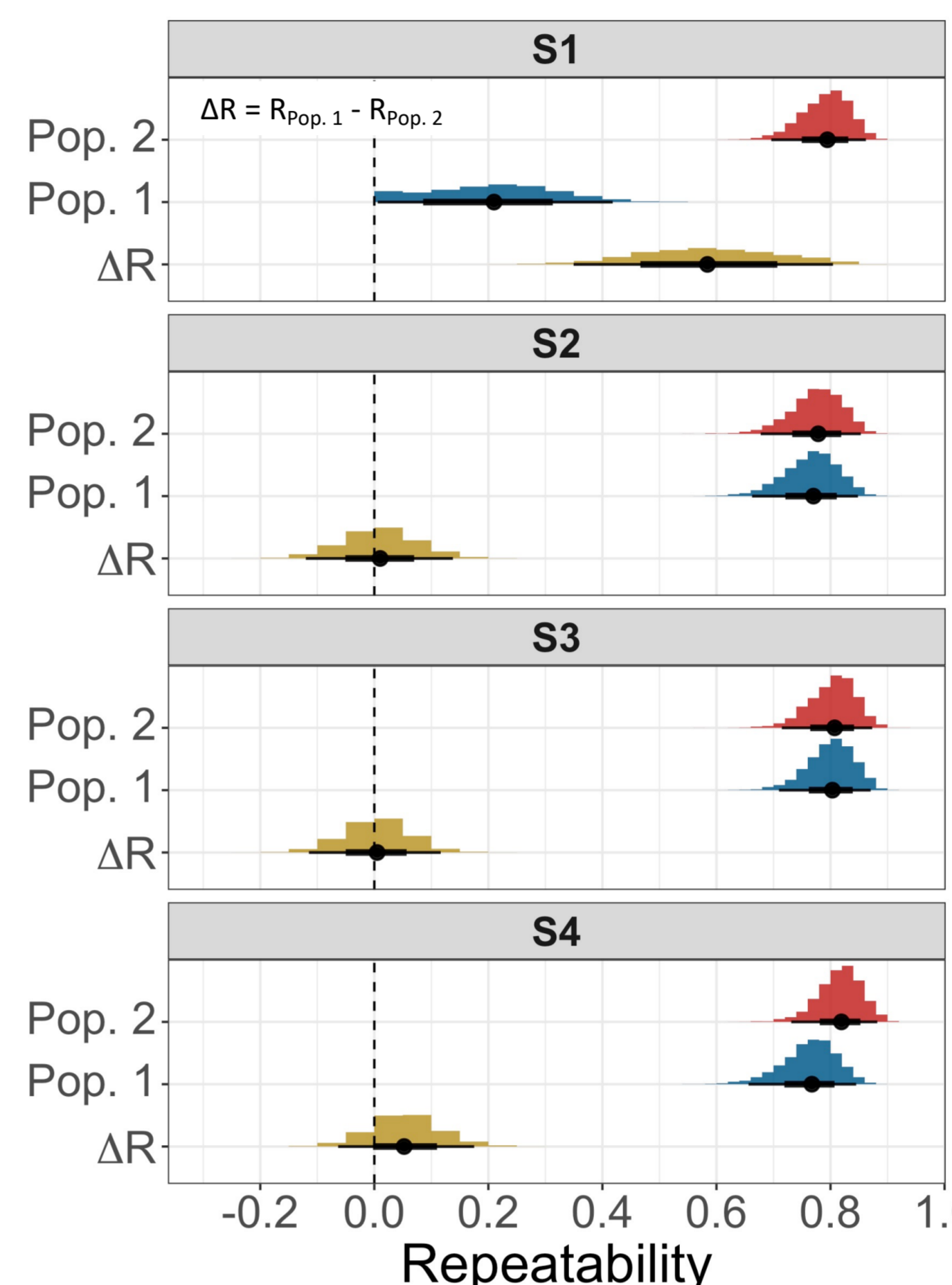
→ Inference on genetic variation and irreversible plasticity
→ Inference on reversible plasticity

**QUESTION: In each scenario, which population has the highest repeatability?**



## HOW SHOULD WE COMPARE BEHAVIORAL VARIATION?

### TOOL 1: DIFFERENCES IN REPETABILITY



**Fig. 1.** Posterior distribution of repeatability ( $R$ ) and the difference in repeatability ( $\Delta R$ ) by scenario.

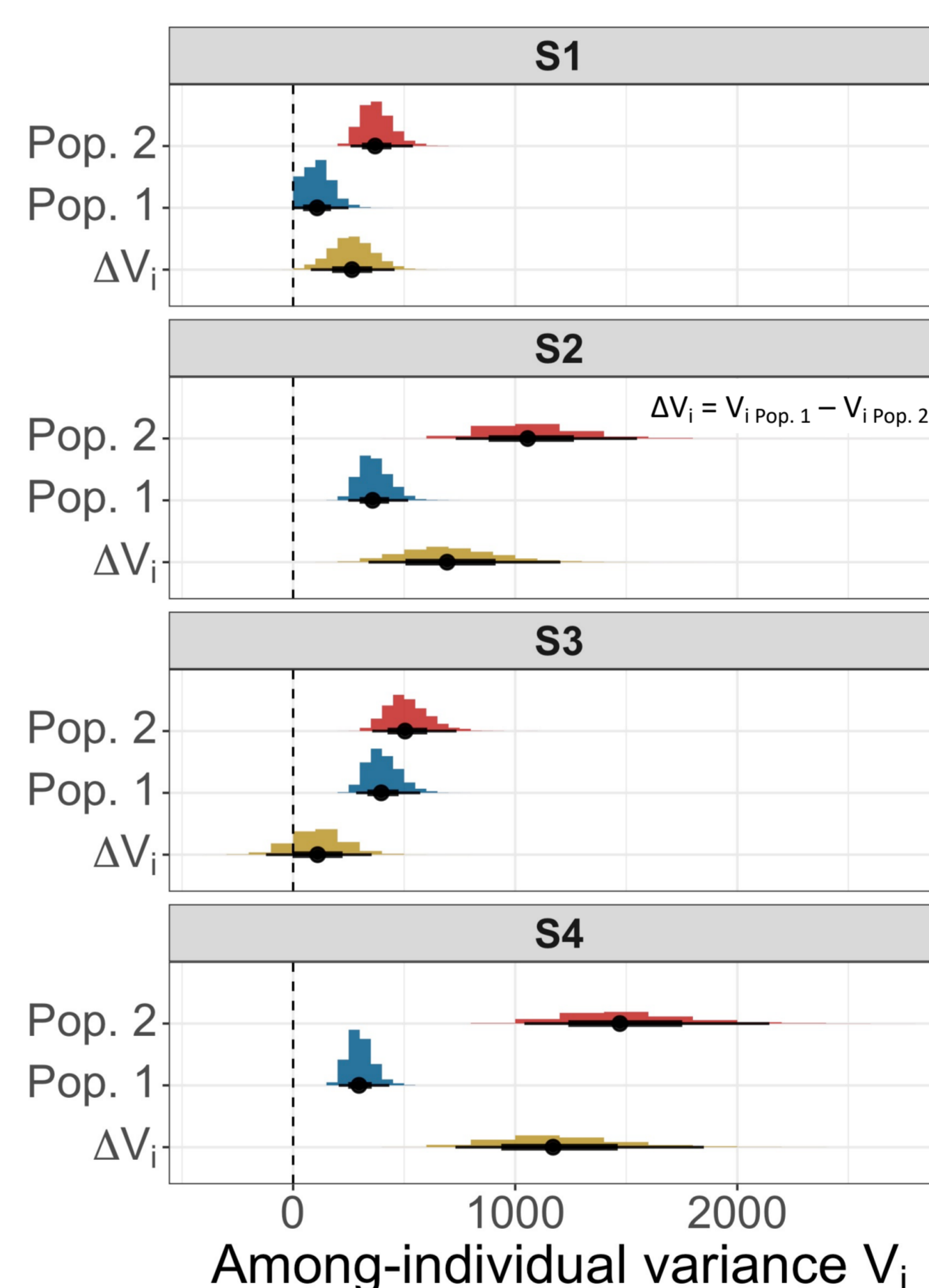
Data simulated according to each scenario with 100 individuals per populations and 2 measures per individual. The data was analyzed using a Bayesian hierarchical mixed model in brms.

Repeatability fails to detect meaningful differences between populations in some scenarios (S2, S3, S4)

**Problem:** Repeatability can lead to misleading inferences

**Solution:** Compare among-individual variances

### TOOL 2: DIFFERENCES IN VARIANCE



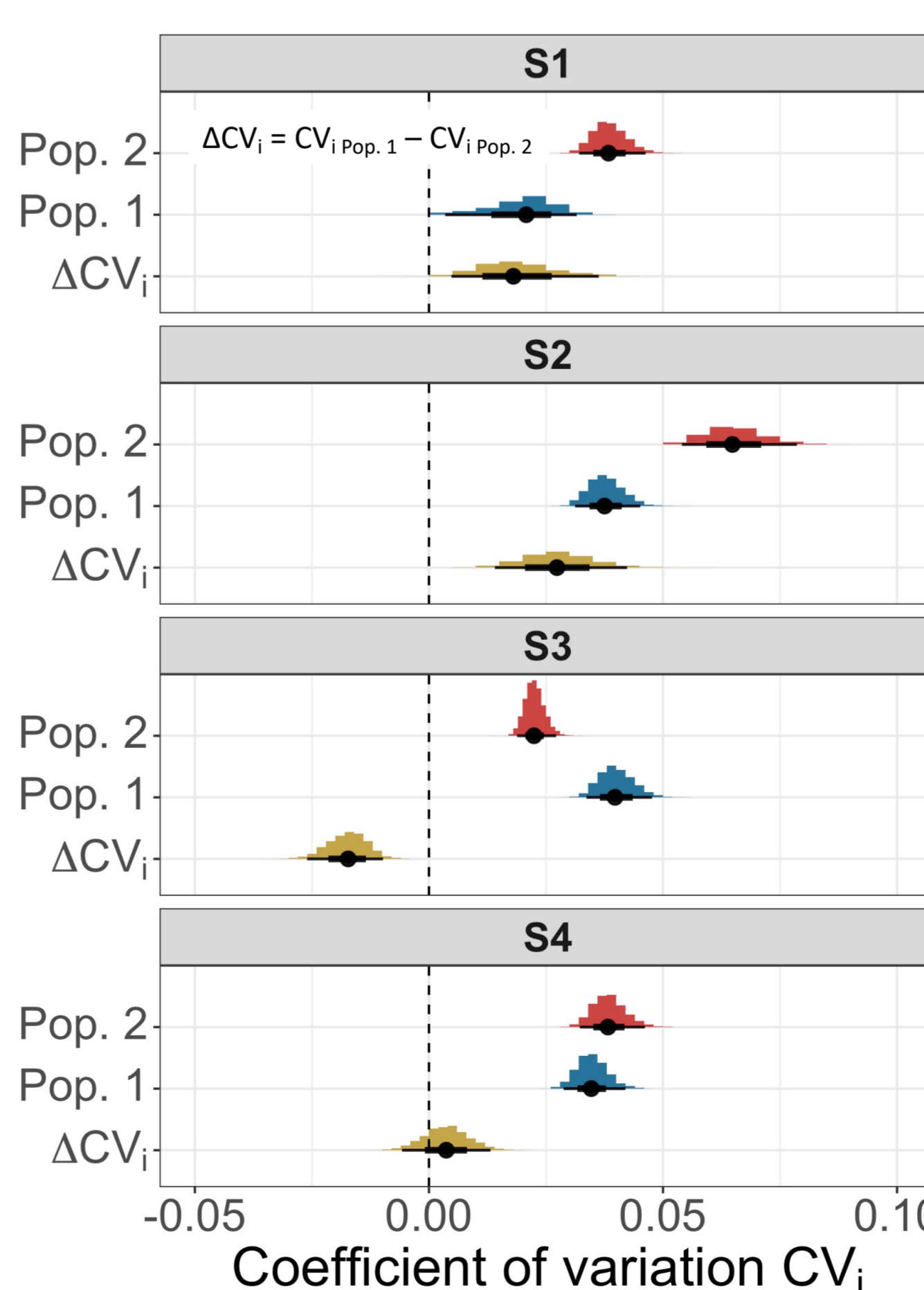
**Fig. 2.** Posterior distribution of among-individual variance ( $V_i$ ) and the difference in variance ( $\Delta V_i$ ) by scenario.

Strong differences detected in S1, S2, S4.

**Problem:** Are these differences biologically meaningful?

**Solution:** Compare the variation relative to the mean with the coefficient of variation (CV)

### TOOL 3: DIFFERENCES IN COEFFICIENT OF VARIATION



**Fig. 3.** Posterior distribution of the coefficient of variation in among-individual differences ( $CV_i$ ) and its difference among population ( $\Delta CV_i$ ) by scenario.

$$CV_i = \frac{\sqrt{V_i}}{\mu}$$

### Conclusions

- Populations can differ because of behavioral differences in mean and/or variance
- To fully understand biological variation, we recommend to report all three types of estimates.

