Stat 412/512

Multivariate Responses

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Your turn

Measurement unit – the thing you the response on..

A sampling unit is … the unit selected from a population by sampling.

An experimental unit is … unit that was randomized to the treatment (treatment get applied to)

Multivariate responses

When multiple response measurements are made on an experimental or sampling unit, the response is **multivariate**.

A **repeated measure** is a special kind of multivariate response, where the **same variable** is measured several times on each sampling or experimental unit.

Not to be confused with **replicates**! Replicates are **multiple experimental units** at each combination of treatments.

Types of repeated measures

Longitudinal Studies

Response is measured on each unit at multiple times. Units are randomized to treatments at the start.

Crossover Experiments

Response is measured on each unit after each treatment. The order each unit receives treatments is randomized.

Split-plot with repeated measures

Two factors involved. Units are randomized to levels of the first factor at the start, then response is measured after each level of the second factor (in a random order).

Split plot with repeated measures at several locations

Two factors involved. Groups of units (like fields) are randomized to levels of the first factor, then units within each group are randomly assigned to levels of the second factor. then we measure over time

Strategies

1. A single univariate analysis on a summary of the multivariate response.

   average, minimum, maximum, end point, slope etc.

2. Separate univariate analyses on several summaries.

   only if uncorrelated, and you don't need to adjust for making many comparisons

3. Multivariate analysis on several summaries.

   Hotelling's T^2

4. Treat subject as a factor.

   If multiple measurements on one individual are independent (i.e. chimp and signs study)

case1601: Short and long term memory

Hypothesis: The hippocampal formation is not a repository of permanent memory.

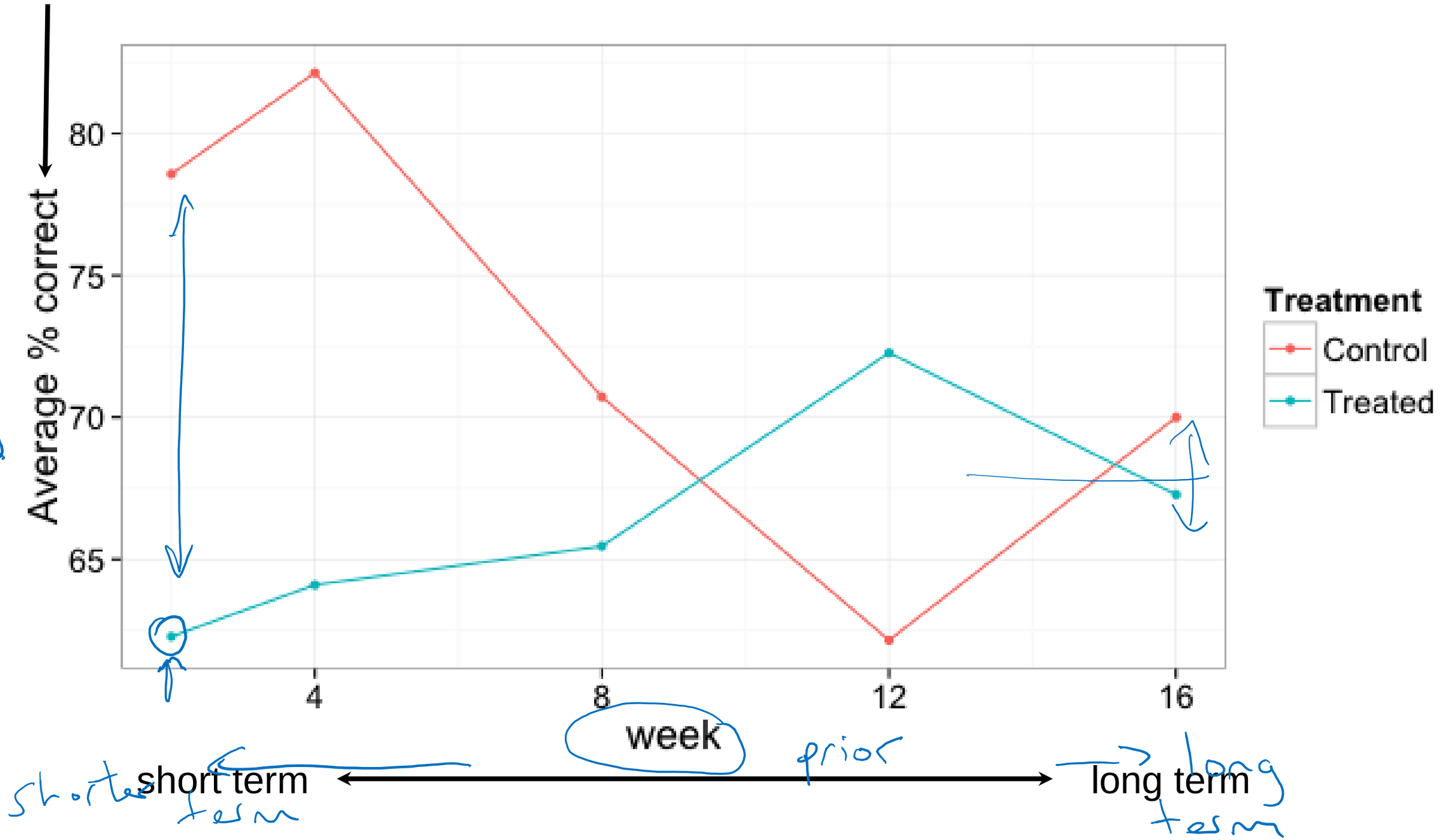
18 monkeys trained to recognize 100 objects, 20 at each of 2, 4, 8, 12 and 16 weeks prior to treatment.

11 monkeys treated by blocking access to their hippocampal formation, 7 monkeys as controls.

Response: % of objects learnt at 2, 4, 8, 12 and 16 weeks prior, that were correctly identified.

If the hypothesis is correct, then treated monkeys should have similar long term memory to control monkeys, but worse short term memory.

averaged over monkey's (the experimental unit)



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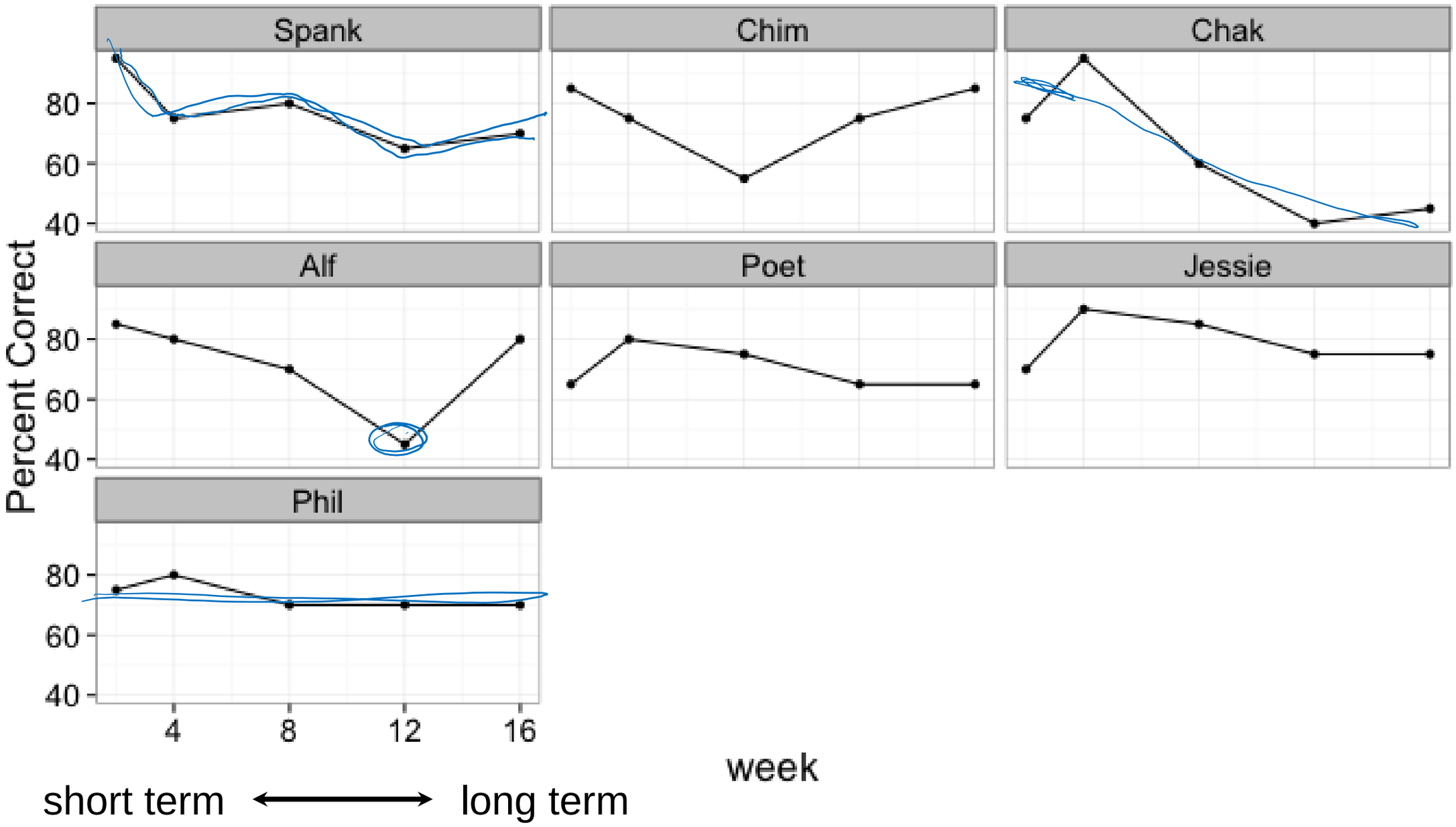
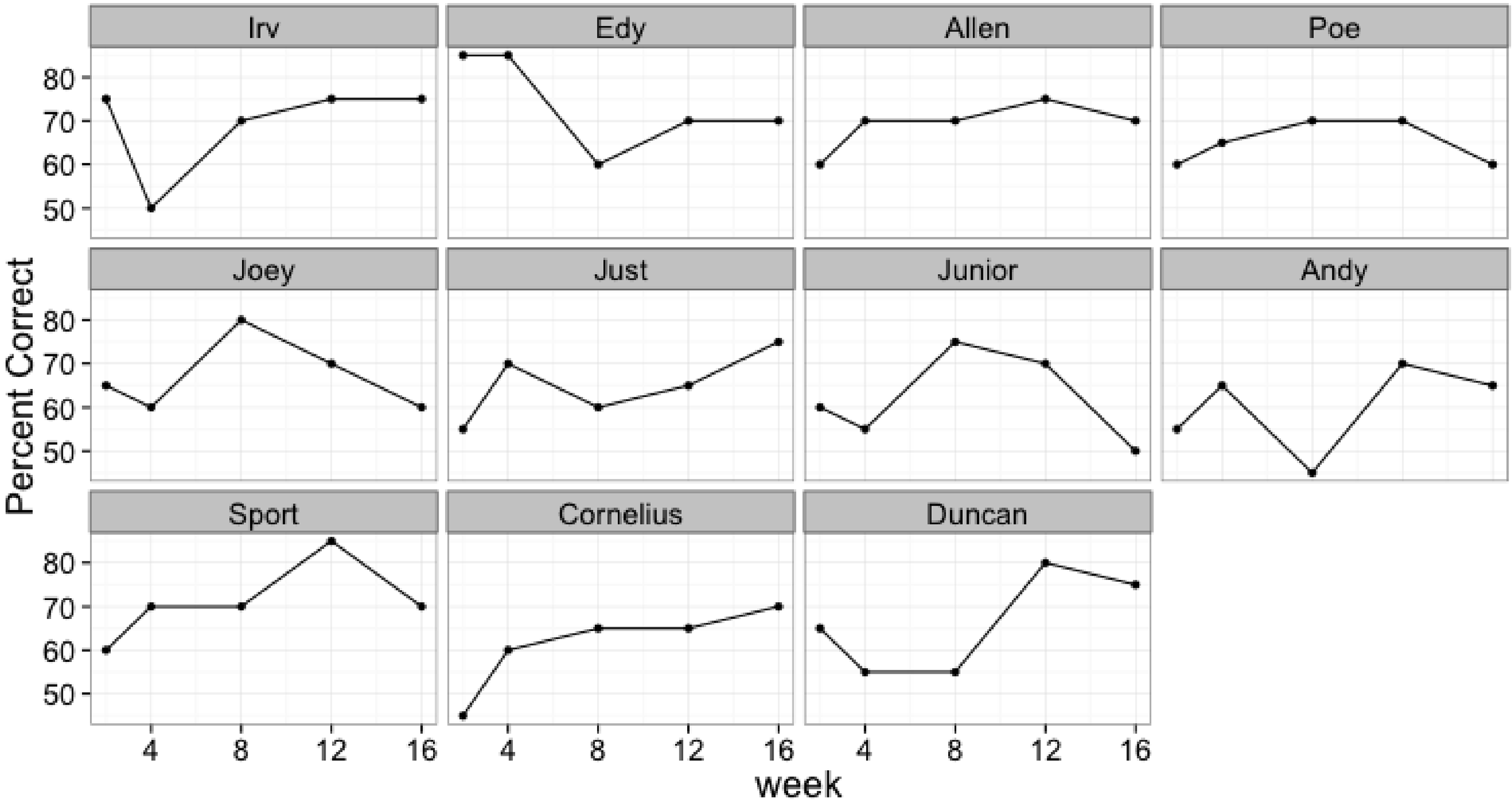
Control monkeys



A profile plot, each unit plotted separately

Treated monkeys



short term ⟷ long term

Questions of interest

The hypothesis breaks down into two related comparisons:

Do treated monkey's have similar long term memory to control monkeys? Yes

Do treated monkeys have similar short term memory to control monkeys? No

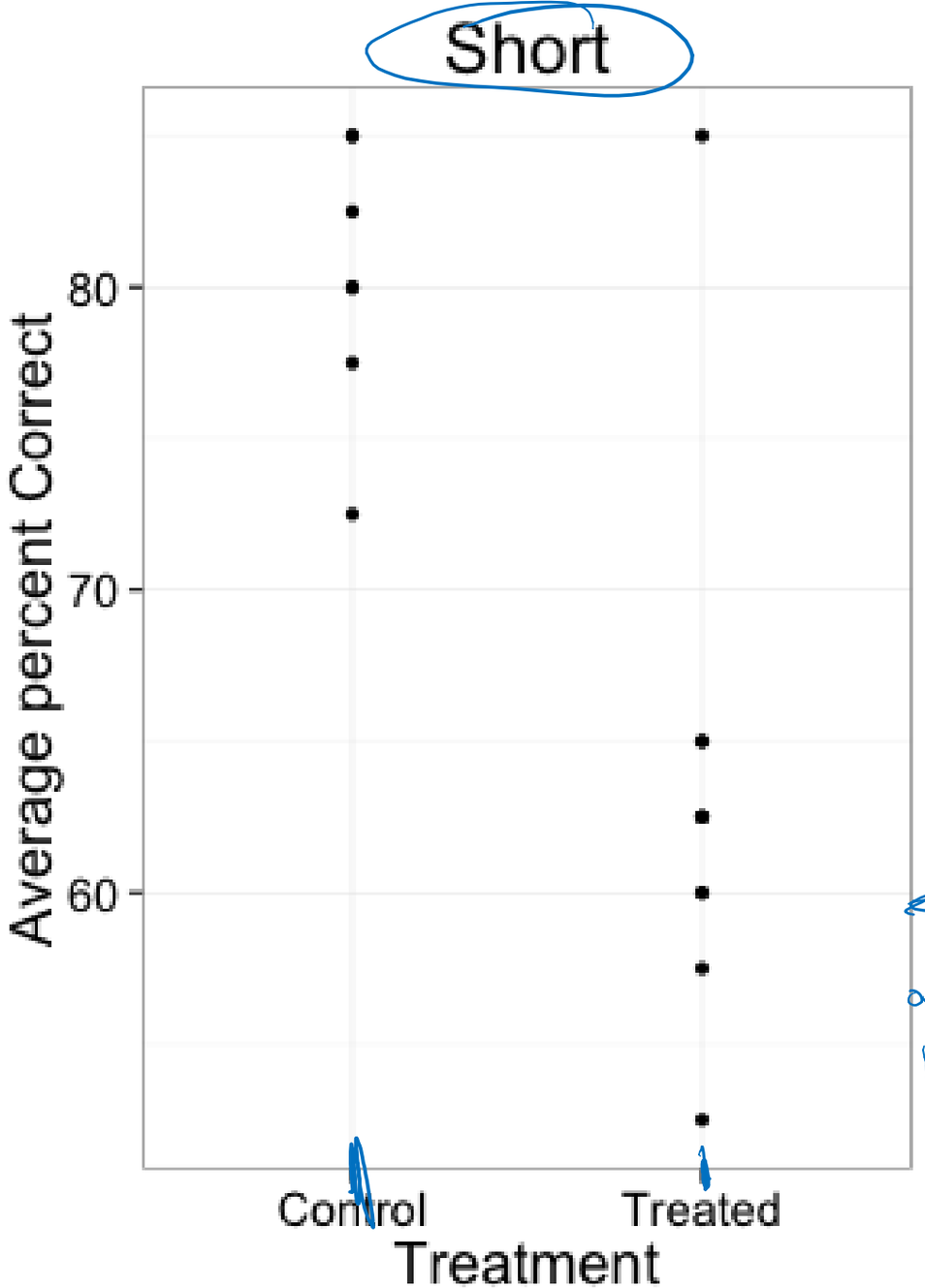
Two summaries

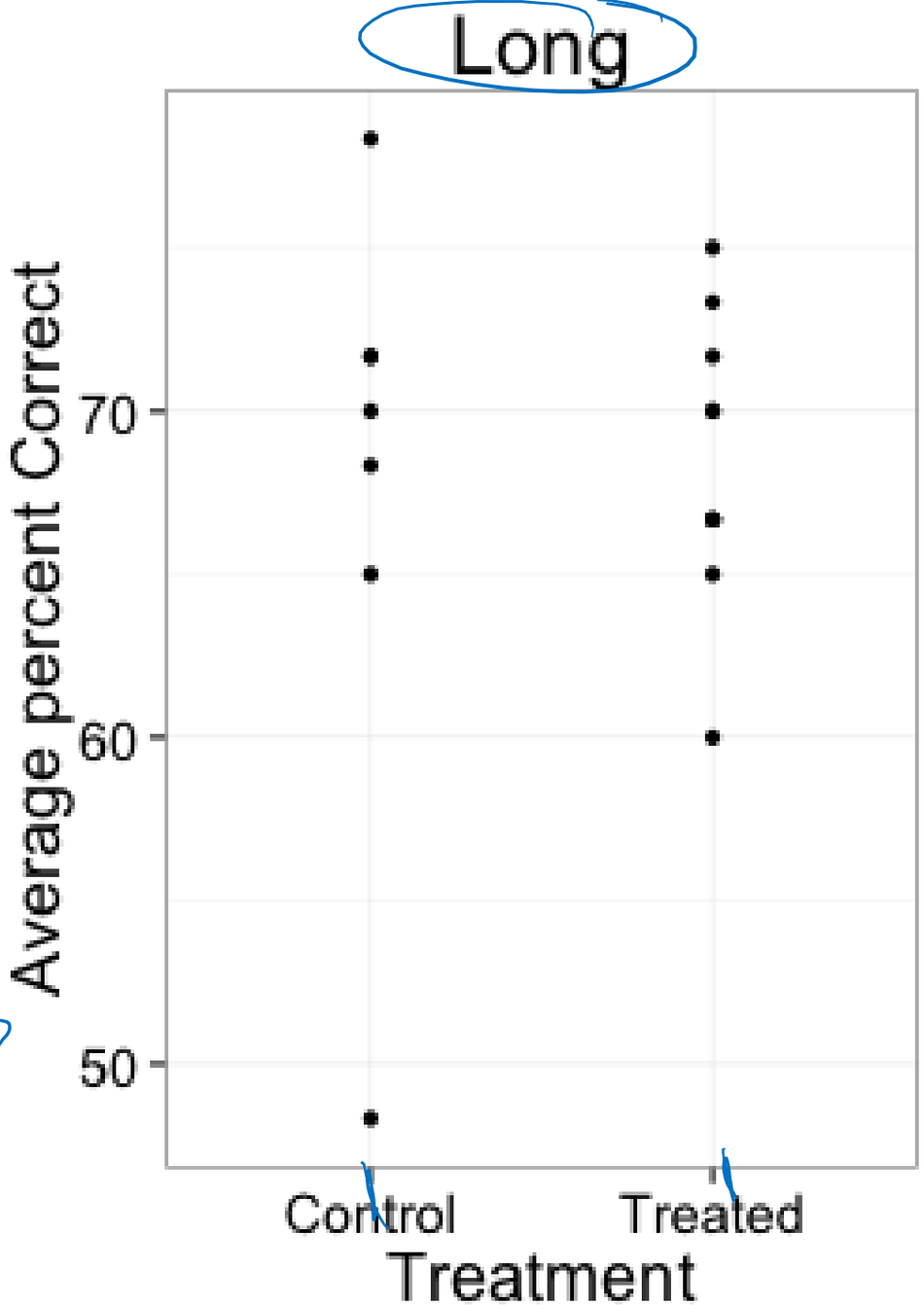
The researchers chose to summarise:

long term memory by the average of the % correct from objects learnt at 8, 12 & 16 weeks

short term memory by the average of the % correct from objects learnt at 2 & 4 weeks.

For inferences to be valid, these should be set out before collecting data, not chosen based on how the data turned out.





Do treated monkeys have similar short term memory to control monkeys?

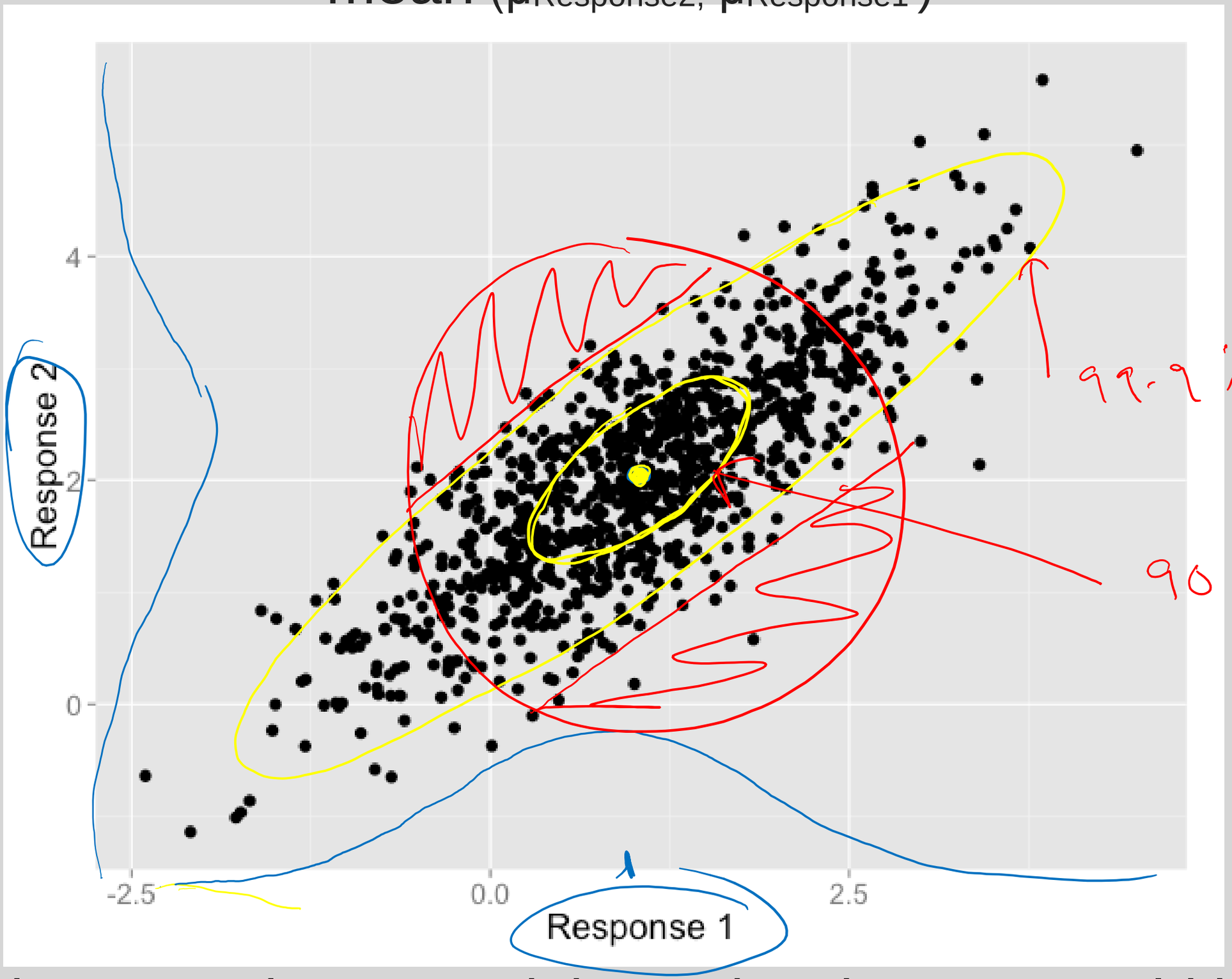
Do treated monkey's have similar long term memory to control monkeys?

Two two-sample t-tests?

If the average short term memory of a monkey was uncorrelated with its average long term memory, we could proceed with two separate analyses.

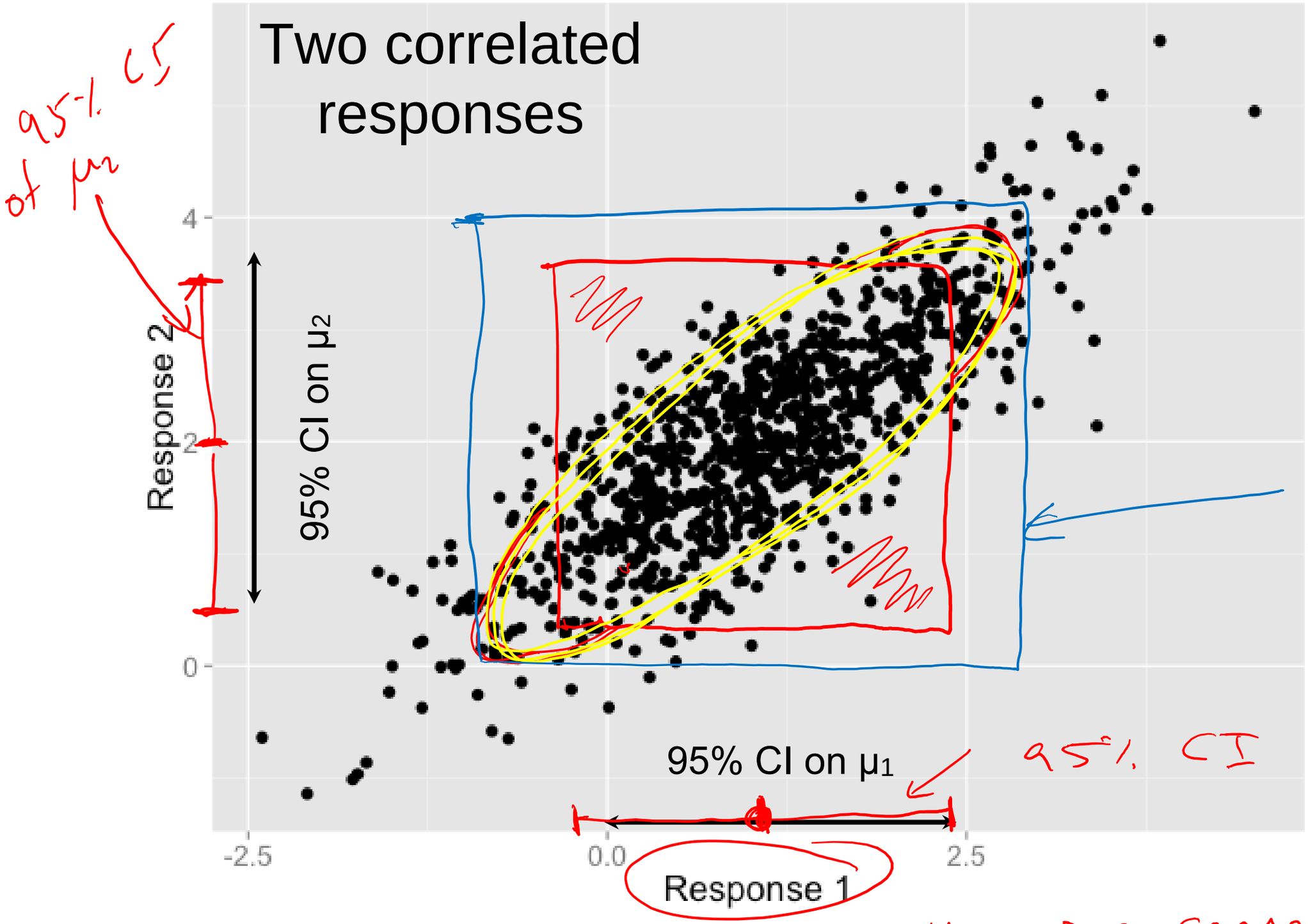
In general, if the questions of interest can be answered with several summaries of the multivariate response that are not strongly correlated, separate univariate analyses is an appropriate way to proceed.

Draw in a point that would be your guess for the location of the mean ($\mu_{Response2}$, $\mu_{Response1}$)



Now, draw a region around that point, that you would be fairly confident the mean will lie in.

The problem with separate univariate analyses



Hotelling's T^2

An ellipse is hard to compute and hard to present.

Hotelling's T^2 adjustment adjusts the univariate confidence intervals to conservatively approximate the ellipse.

Hotelling's T^2 statistic provides an joint test for both parameters at once.