**Notes on discussion of problems with P-values**

Problems Identified in the Papers

1. P-hacking
2. P-values don’t include direct information about effect sizes
3. P-values don’t provide information about future studies
4. P-values are not repeated unless a study is highly powered
5. P-values are used as a binary measure (statistically significant/not statistically significant) despite it being a continuous measure. [Ex. Is there a difference between p = 0.051 and p = 0.049?]
6. There is a general misinterpretation of what p-values mean. Often thought to be the probability that a null hypothesis is true. But that is not what it is.

Remedies to the identified problems

1. Document decisions made during data collection and analysis to increase transparency. Pre-registering designs and data collection are helpful. Documenting and justifying reasons for deviating from design in a transparent way (e.g., in code).
2. Present estimated effect sizes and confidence in addition to p-values.
3. (and 4). Take other information about the study and question into account before accepting results as scientifically valid. Be skeptical, but reasonable. Cross-reference scientific claims with known biological mechanisms and consistency with prior knowledge, especially mechanistically.
4. Think in continuous terms rather than discrete.
5. Be clear on what p-values tell you. Think about the plausibility of the hypothesis out of the context of the study.