# Project proposal: Is there post-error slowing in mice?

## Background / Introduction

In a perceptual decision task, noisy evidence is accumulated until a threshold is reached, that is, a decision occurs. However, our responses are not always correct, and adapting to an error is crucial for learning and survival. It is therefore assumed that the evidence accumulation process for each decision is dynamically updated based on choice history, among other things.

Post-error slowing (PES) refers to the phenomenon of reduced reaction time to a stimulus after an erroneous response. While PES itself has been reliably replicated in humans, there are conflicting findings to whether PES may lead to increased or decreased performance in the upcoming task [(Wessel, 2018)](https://www.zotero.org/google-docs/?sLf99i). Several theories try to determine why it may occur and how it works mechanistically [(see for example, Ceccarini & Castiello, 2018; Dames & Pfeuffer, 2021)](https://www.zotero.org/google-docs/?zAyRdD). An additional challenge seems to lie in the precise and unbiased measurement of PES [(Derrfuss et al., 2022)](https://www.zotero.org/google-docs/?PS9Yn0).

Based on the public data set "behavioural data" collected and released by the International Brain Laboratory (IBL; https://data.internationalbrainlab.org/) for a 2AFC perceptual decision making task in mice we want to investigate whether there is detectable difference in post-error versus post-correct response times which may replicate a PES phenomenon in mice. Furthermore, we aim to train both a GLM and classifier model to reliably predict reduced response times based on previous response, ITI duration, and signal contrast. Findings may add to and substantiate the idea of different internal states in mice which are thought to dynamically update the mice’s decision strategy throughout a multi-trial session [(Ashwood et al., 2022)](https://www.zotero.org/google-docs/?yb3pux).

## Hypothesis

In the trial after an incorrect response is recorded, there will be an increase in response time.

We believe that, given <input variables>, there is a reliable method to predict response times in subsequent trials.

<input variables> =

* ITI and/or Previous Trial Correct
* Signal contrast and location
* Response time and/or full trial time and/or time between start of trial and stimulus onset

## Methods

1. Normalize all variables
2. Check, using paired t-test, whether there is a significant difference in response times after correct vs incorrect responses.
3. Build GLM to predict response time, given variables of interest. We will use data from one lab.
   1. Analyze weights in order to determine importance placed on previous trial
4. Build a classifier to check for generalizability of data: Train on one lab, evaluate on the others.

Bonus: Update GLM to include more than one previous trial. This may cause us to modify our classifier as well.

## Expected Results

We expect that there will be a significant increase in response time following an incorrect trial. We believe that, given information from the previous trial, there will be a method to reliably predict response times.

## References

[Ashwood, Z. C., Roy, N. A., Stone, I. R., The International Brain Laboratory, Urai, A. E., Churchland, A. K., Pouget, A., & Pillow, J. W. (2022). Mice alternate between discrete strategies during perceptual decision-making. *Nature Neuroscience*, *25*(2), 201–212. https://doi.org/10.1038/s41593-021-01007-z](https://www.zotero.org/google-docs/?1cRvXW)

[Ceccarini, F., & Castiello, U. (2018). The grasping side of post-error slowing. *Cognition*, *179*, 1–13. https://doi.org/10.1016/j.cognition.2018.05.026](https://www.zotero.org/google-docs/?1cRvXW)

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[Derrfuss, J., Danielmeier, C., Klein, T. A., Fischer, A. G., & Ullsperger, M. (2022). Unbiased post-error slowing in interference tasks: A confound and a simple solution. *Behavior Research Methods*, *54*(3), 1416–1427. https://doi.org/10.3758/s13428-021-01673-8](https://www.zotero.org/google-docs/?1cRvXW)

[Wessel, J. R. (2018). An adaptive orienting theory of error processing. *Psychophysiology*, *55*(3), e13041. https://doi.org/10.1111/psyp.13041](https://www.zotero.org/google-docs/?1cRvXW)