Meta-analysis Manuscript Wrangling

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6/14/2021

Motivation and Hypotheses

Variability has been identified as important to organismal success and ecosystem dynamics (Vasseur et al 2014). To further understand the impacts of variability of performance, we conducted to analyses on data that explicitly accounted for acclimation (Acclimation model) and studies focuses solely on non-linear averaging (Non-linear averaging model).

H-Acclimation: If reared in fluctuating environments, when exposed to different thermal environments, organisms with larger fluctuation ranges will perform worse than those reared in constant environments. Additional covariates, such as age, size, and expsoure temperature will be correlated negative responses.

H-Non-linear averaging: Organisms will perform better in constant environments than fluctuating environments. Additional covariates, such as age, size, and large fluctuation range will be correlated negative responses.

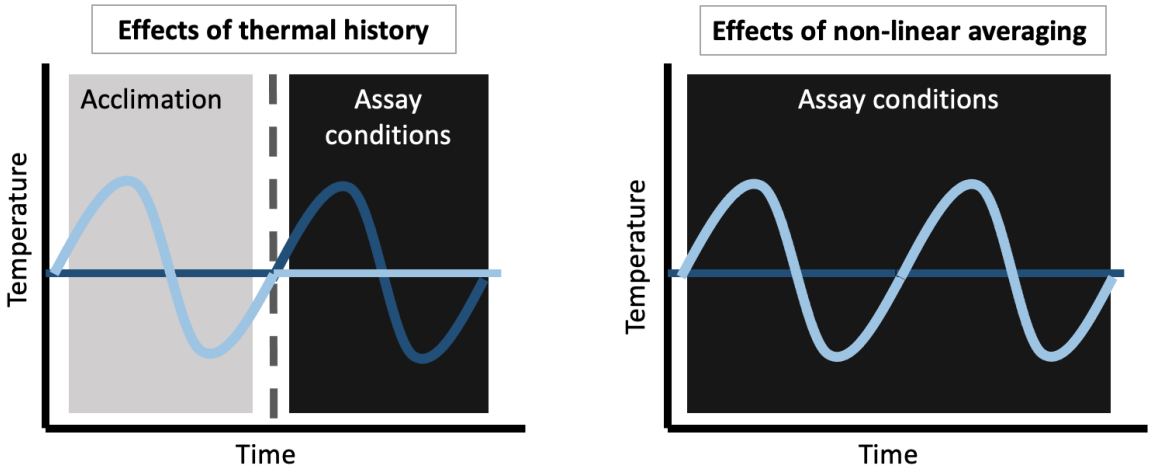


Figure 1: Conceptual figure demonstrating how acclimation and non-linear averaging account for different aspects of performance.

Acclimation Model

This data and analysis accounts for the temperatures at which organisms are reared and how their performance compares when exposed to different temperature. The results from this model has very similar results from the model I originally ran for my thesis...

Acclimation without modifiers

```
##
## Multivariate Meta-Analysis Model (k = 332; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed                              factor
## sigma^2.1  0.0000  0.0002     11     no                            study_id
## sigma^2.2  0.4731  0.6878     33     no               study_id/experiment_id
## sigma^2.3  0.2451  0.4951     61     no  study_id/experiment_id/response_id
##
## Test for Heterogeneity:
## Q(df = 331) = 3739.2101, p-val < .0001
##
## Model Results:
##
## estimate      se     zval    pval    ci.lb   ci.ub
##  -0.2197  0.1427  -1.5400  0.1236  -0.4994  0.0599
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Acclimation with modifiers

```
## Warning in rma.mv(yi, vi, data = dat_acclim_ES, mods = ~flux_range *
## mean_temp_reared + : Rows with NAs omitted from model fitting.

## Warning in rma.mv(yi, vi, data = dat_acclim_ES, mods = ~flux_range *
## mean_temp_reared + : Redundant predictors dropped from the model.

##
## Multivariate Meta-Analysis Model (k = 331; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed                              factor
## sigma^2.1  0.0000  0.0001     11     no                            study_id
## sigma^2.2  0.4698  0.6854     33     no               study_id/experiment_id
## sigma^2.3  0.2474  0.4974     60     no  study_id/experiment_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 324) = 3580.2892, p-val < .0001
##
## Test of Moderators (coefficients 2:7):
## QM(df = 6) = 127.0957, p-val < .0001
```

```
##
## Model Results:
##
##                              estimate      se     zval    pval    ci.lb
## intrcpt                        6.0093  1.3387   4.4889  <.0001   3.3855
## flux_range                    -0.4757  0.0991  -4.7983  <.0001  -0.6700
## mean_temp_reared              -0.2595  0.0440  -5.9001  <.0001  -0.3457
## exp_age                       -0.0836  0.3184  -0.2626  0.7929  -0.7078
## size                          -0.6691  0.4072  -1.6432  0.1003  -1.4671
## exposure_temp                  0.0032  0.0031   1.0098  0.3126  -0.0030
## flux_range:mean_temp_reared    0.0226  0.0044   5.1550  <.0001   0.0140
##                                ci.ub
## intrcpt                       8.6331  ***
## flux_range                   -0.2814  ***
## mean_temp_reared             -0.1733  ***
## exp_age                       0.5405
## size                          0.1290
## exposure_temp                 0.0093
## flux_range:mean_temp_reared   0.0312  ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Acclimation data split out by CT data and other thermal performance metrics

CT aggregated model

```
## Warning in rma.mv(yi, vi, data = CT_acclim_data, mods = ~flux_range *
## mean_temp_reared + : Redundant predictors dropped from the model.
```

```
##
## Multivariate Meta-Analysis Model (k = 158; method: REML)
##
## Variance Components:
##
##              estim    sqrt  nlvls  fixed                              factor
## sigma^2.1   0.9859  0.9929      8     no                            study_id
## sigma^2.2   0.0000  0.0004     22     no               study_id/experiment_id
## sigma^2.3  18.1941  4.2654     46     no  study_id/experiment_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 151) = 2659.6013, p-val < .0001
##
## Test of Moderators (coefficients 2:7):
## QM(df = 6) = 199.0077, p-val < .0001
##
## Model Results:
##
##                              estimate       se     zval    pval      ci.lb
## intrcpt                     -57.8913  44.0629  -1.3138  0.1889  -144.2531
## flux_range                    5.4642   4.3055   1.2691  0.2044    -2.9745
```

```
## mean_temp_reared               2.7042   2.1524   1.2563  0.2090    -1.5146
## exp_age                       -0.4234   1.8285  -0.2316  0.8169    -4.0071
## size                          -0.9591   2.6175  -0.3664  0.7141    -6.0893
## exposure_temp                  0.2290   0.0219  10.4818  <.0001     0.1862
## flux_range:mean_temp_reared   -0.2752   0.2153  -1.2787  0.2010    -0.6971
##                                ci.ub
## intrcpt                      28.4704
## flux_range                   13.9029
## mean_temp_reared              6.9229
## exp_age                       3.1603
## size                          4.1712
## exposure_temp                 0.2719  ***
## flux_range:mean_temp_reared   0.1467
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Remaining acclimation metrics model

```
## Warning in rma.mv(yi, vi, data = curve_acclim_data, mods = ~flux_range * : Rows
## with NAs omitted from model fitting.
```

```
## Warning in rma.mv(yi, vi, data = curve_acclim_data, mods = ~flux_range * :
## Redundant predictors dropped from the model.
```

```
##
## Multivariate Meta-Analysis Model (k = 203; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed                              factor
## sigma^2.1  0.0000  0.0000      8     no                            study_id
## sigma^2.2  0.0000  0.0002     21     no               study_id/experiment_id
## sigma^2.3  0.2158  0.4646     23     no  study_id/experiment_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 196) = 888.8163, p-val < .0001
##
## Test of Moderators (coefficients 2:7):
## QM(df = 6) = 43.4835, p-val < .0001
##
## Model Results:
##
##                              estimate      se     zval    pval    ci.lb
## intrcpt                        4.3351  1.6844   2.5737  0.0101   1.0338
## flux_range                    -0.2843  0.1575  -1.8048  0.0711  -0.5930
## mean_temp_reared              -0.1737  0.0698  -2.4900  0.0128  -0.3104
## exp_age                       -0.0660  0.3666  -0.1800  0.8571  -0.7844
## size                          -0.5917  0.3964  -1.4927  0.1355  -1.3686
## exposure_temp                 -0.0033  0.0042  -0.7819  0.4343  -0.0115
## flux_range:mean_temp_reared    0.0147  0.0067   2.1972  0.0280   0.0016
##                                ci.ub
## intrcpt                       7.6365  *
```

```
## flux_range                    0.0244  .
## mean_temp_reared             -0.0370  *
## exp_age                       0.6524
## size                          0.1852
## exposure_temp                 0.0049
## flux_range:mean_temp_reared   0.0278  *
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Effects of non-linear averaging

This uses the full dataset from my thesis (with more data from the additional search). Interesting that this time, mean temp is the only significant predictor?

Non-linear averaging model with no modifiers

```
##
## Multivariate Meta-Analysis Model (k = 366; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed                                factor
## sigma^2.1  0.0000  0.0002     28     no                            study_id
## sigma^2.2  0.1769  0.4206     45     no               study_id/experiment_id
## sigma^2.3  0.6531  0.8081    100     no  study_id/experiment_id/response_id
##
## Test for Heterogeneity:
## Q(df = 365) = 6960.4343, p-val < .0001
##
## Model Results:
##
## estimate      se    zval    pval    ci.lb   ci.ub
##   0.1533  0.1119  1.3696  0.1708  -0.0661  0.3727
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Non-linear averaging model with modifiers

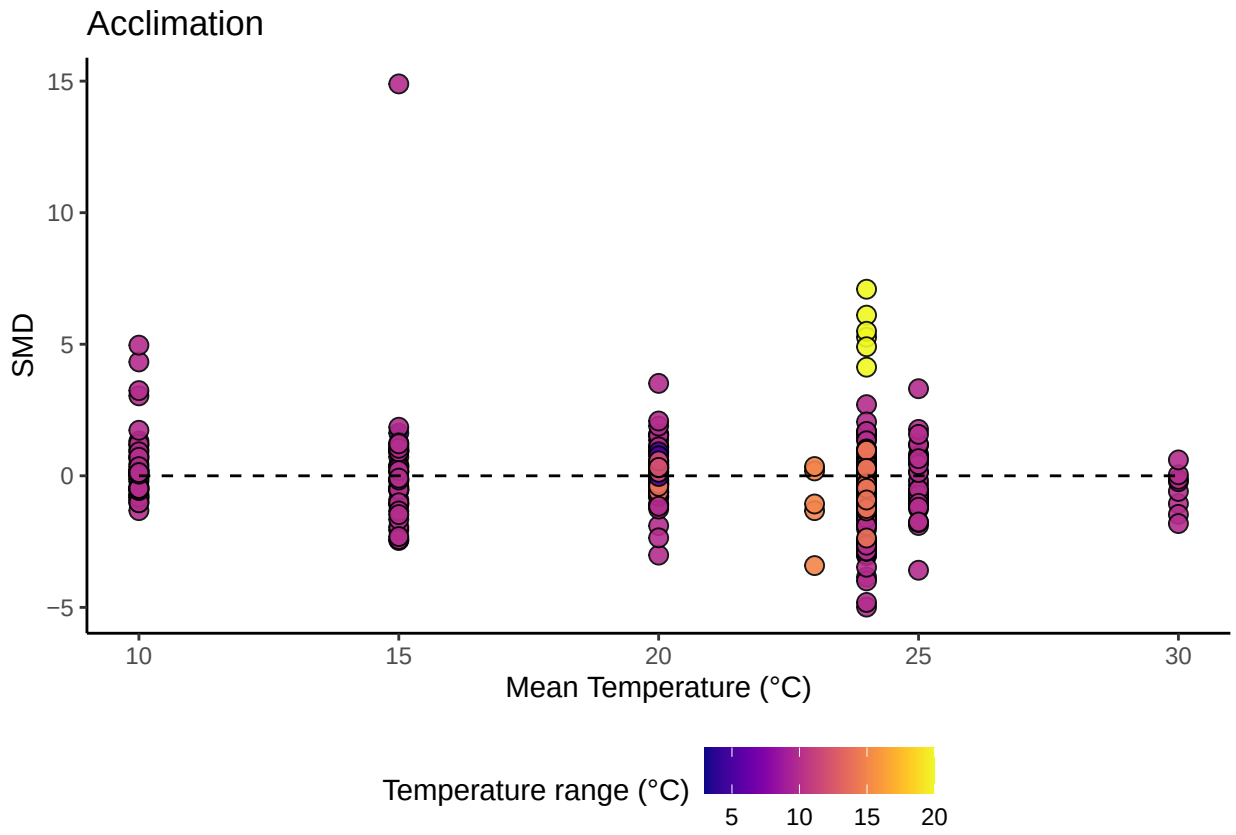
```
## Warning in rma.mv(yi, vi, data = dat_full_var_ES, mods = ~flux_range *
## mean_temp_constant + : Rows with NAs omitted from model fitting.

##
## Multivariate Meta-Analysis Model (k = 359; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed                                factor
## sigma^2.1  0.0464  0.2154     27     no                            study_id
## sigma^2.2  0.3284  0.5731     44     no               study_id/experiment_id
```

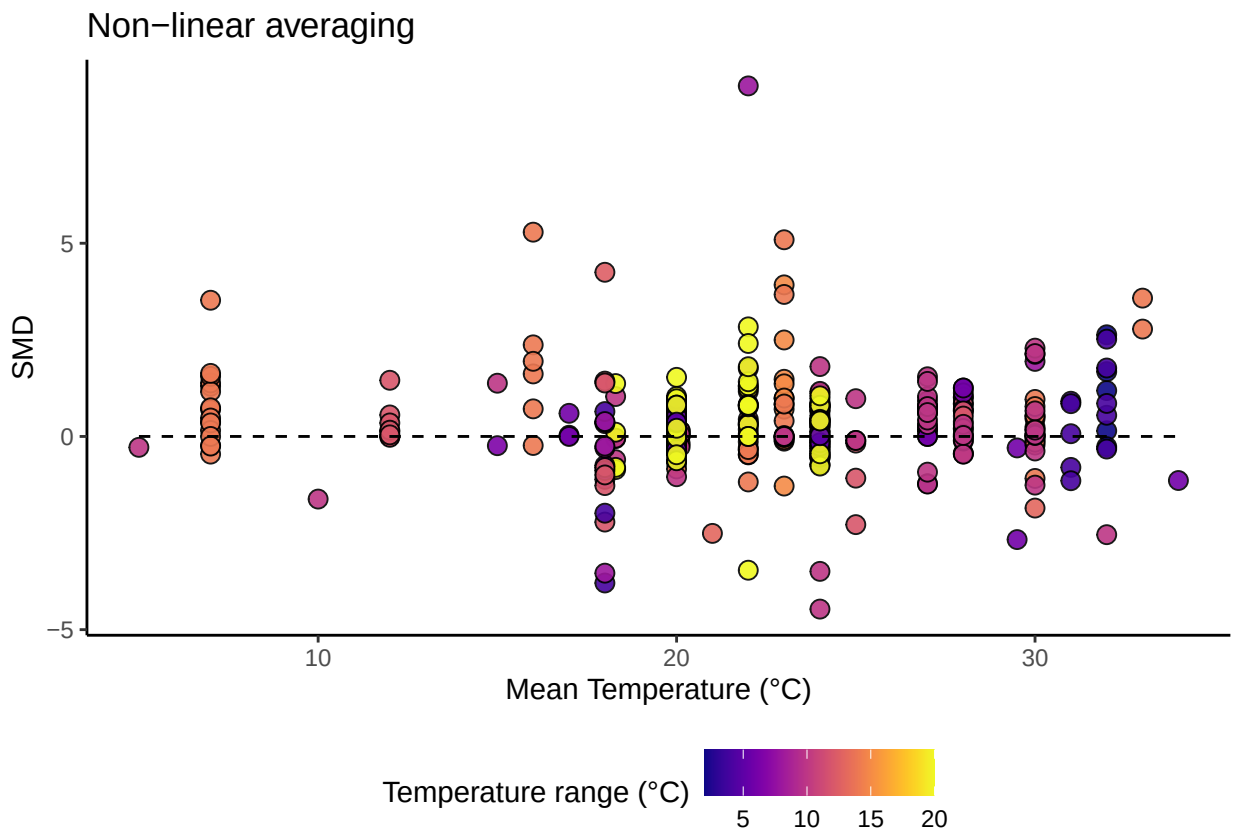
```
## sigma^2.3  0.4578  0.6766     98     no  study_id/experiment_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 352) = 6377.2072, p-val < .0001
##
## Test of Moderators (coefficients 2:7):
## QM(df = 6) = 97.4285, p-val < .0001
##
## Model Results:
##
##                               estimate      se     zval    pval    ci.lb
## intrcpt                         1.3702  0.4645   2.9495  0.0032   0.4597
## flux_range                     -0.0209  0.0223  -0.9399  0.3473  -0.0646
## mean_temp_constant             -0.0466  0.0129  -3.6196  0.0003  -0.0719
## exp_age                         0.0706  0.0737   0.9580  0.3381  -0.0738
## size                           -0.1461  0.2205  -0.6626  0.5076  -0.5783
## org_level                      -0.2797  0.2824  -0.9905  0.3220  -0.8331
## flux_range:mean_temp_constant   0.0012  0.0010   1.2001  0.2301  -0.0008
##                                 ci.ub
## intrcpt                        2.2806   **
## flux_range                     0.0227
## mean_temp_constant            -0.0214  ***
## exp_age                        0.2150
## size                           0.2861
## org_level                      0.2738
## flux_range:mean_temp_constant  0.0031
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figures

```
## Warning: Ignoring unknown parameters: width, height
```




```
## Warning: Ignoring unknown parameters: width, height
```


Non−linear averaging
SMD
5
0
−5
10
20
30
Mean Temperature (°C)
Temperature range (°C)
5
10
15
20