Advanced Analysis

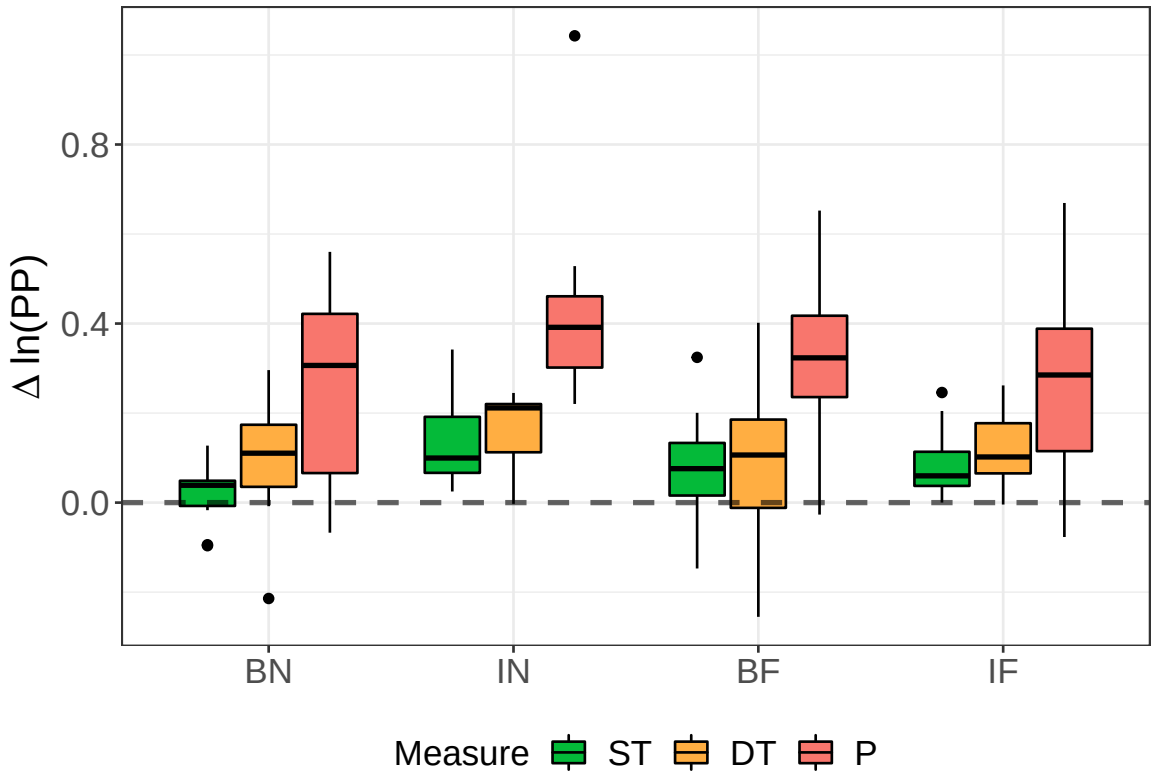
PP, 4 Groups:

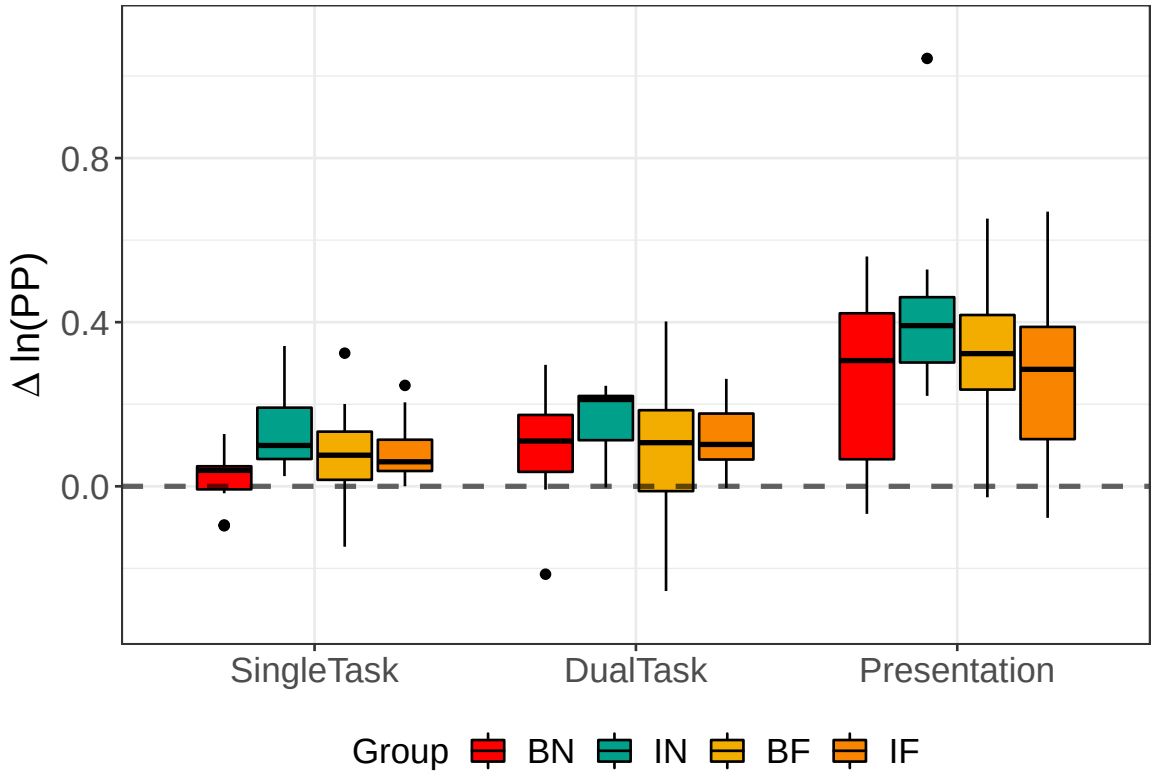
Stress Levels Across Activities

Our Linear Model:

$$\Delta ln(\bar{PP}) = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: diff_df
##         AIC       BIC   logLik
##   -219.3757 -189.4686 118.6879
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)  Residual
## StdDev:  0.06923459 0.1140393
##
## Fixed effects: PP ~ 1 + Group + Activity
##                   Value  Std.Error  DF   t-value p-value
## (Intercept)  0.03350620 0.03022111 155  1.108702  0.2693
## GroupIN      0.10999873 0.03690616  50  2.980498  0.0044
## GroupBF      0.04196743 0.03566506  50  1.176710  0.2449
## GroupIF      0.04172018 0.03566506  50  1.169777  0.2476
## ActivityB   -0.03194331 0.02219438 155 -1.439252  0.1521
## ActivityDT   0.03305760 0.02194687 155  1.506256  0.1340
## ActivityP    0.23906378 0.02219707 155 10.770063  0.0000
##  Correlation:
##             (Intr) GropIN GropBF GropIF ActvtB ActvDT
## GroupIN     -0.658
## GroupBF     -0.680  0.556
## GroupIF     -0.680  0.556  0.575
## ActivityB   -0.363  0.000  0.006  0.006
## ActivityDT -0.363  0.000  0.000  0.000  0.494
## ActivityP   -0.363  0.014  0.000  0.000  0.489  0.494
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -2.77346999 -0.41299424 -0.06356085  0.44133450  5.00521970
##
## Number of Observations: 212
## Number of Groups: 54
```


0.8
0.4
0.0
Δ ln(PP)
BN
IN
BF
IF
Measure
ST
DT
P

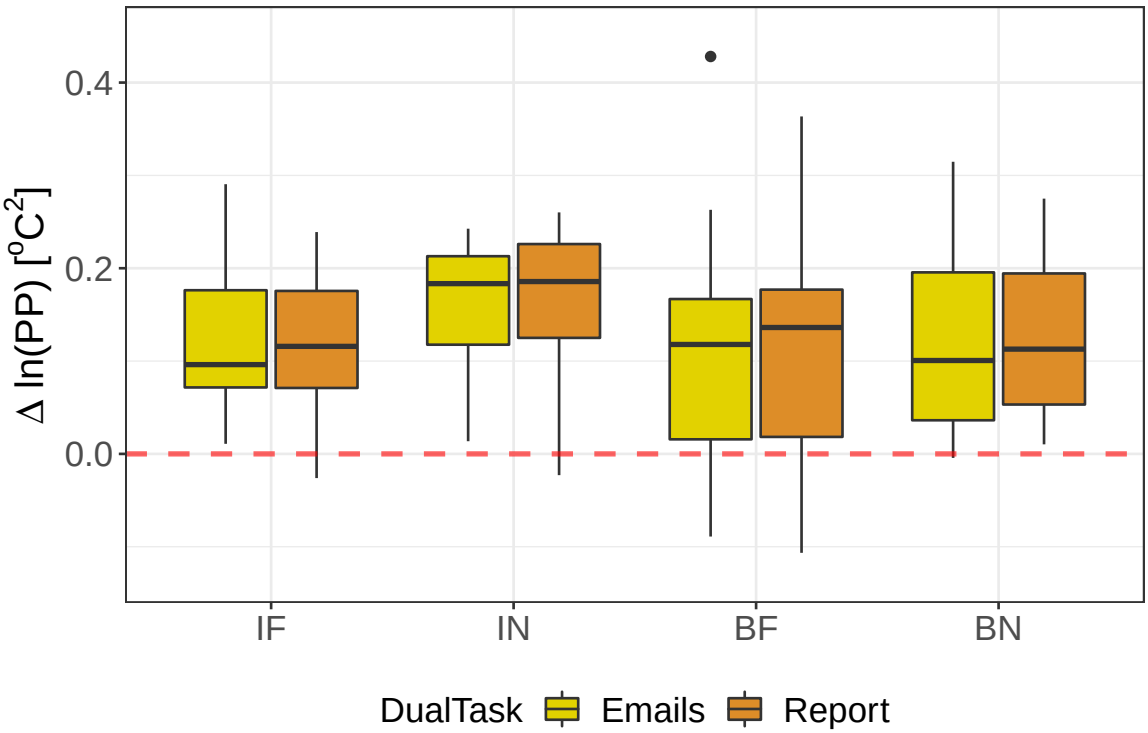

0.8
0.4
0.0
Δ ln(PP)
SingleTask
DualTask
Presentation
Group
BN
IN
BF
IF

Stress Levels for Dual Task

Our Linear Model:

$$\Delta ln(\bar{PP}) = 1 + Group + DualTask + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: total_df
##         AIC       BIC   logLik
##   -252.8742 -234.7083 133.4371
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)   Residual
## StdDev:  0.09587771 0.02557921
##
## Fixed effects: PP ~ 1 + Group + DualTask
##                       Value  Std.Error DF   t-value p-value
## (Intercept)     0.11956258 0.03095577 51  3.862368  0.0003
## GroupIN         0.03981772 0.04103964 48  0.970226  0.3368
## GroupBF        -0.00689396 0.04039735 48 -0.170654  0.8652
## GroupIF        -0.00155473 0.03983232 48 -0.039032  0.9690
## DualTaskReport  0.00420512 0.00501649 51  0.838259  0.4058
##  Correlation:
##                (Intr) GropIN GropBF GropIF
## GroupIN        -0.749
## GroupBF        -0.761  0.574
## GroupIF        -0.772  0.582  0.592
## DualTaskReport -0.081  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##          Min           Q1          Med           Q3          Max
## -1.991106566 -0.405986988  0.008940539  0.376651112  1.968142194
##
## Number of Observations: 104
## Number of Groups: 52
```



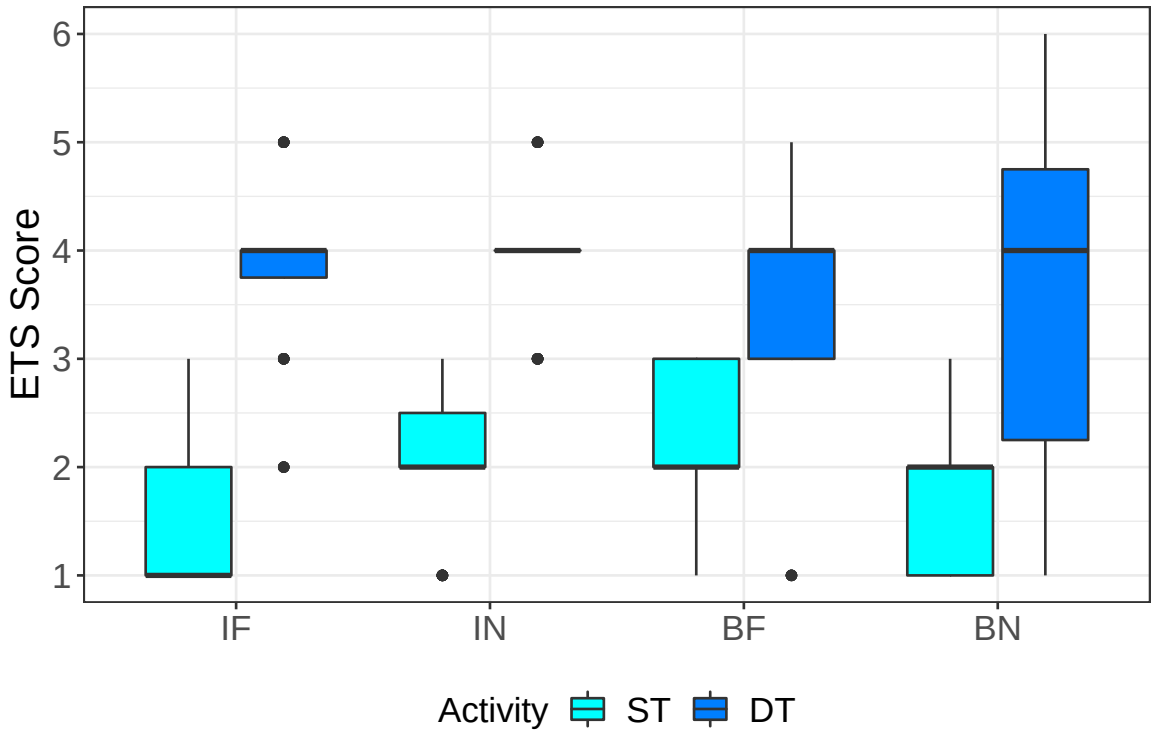

```
## Paired t-test
## For IF, p = 0.7289 > 0.05

## Paired t-test
## For IN, p = 0.4597 > 0.05

## Paired t-test
## For BF, p = 0.7362 > 0.05

## Paired t-test
## For BN, p = 0.8137 > 0.05
```

Linear Modelling for Writing Quality

Our Linear Model:

$$WritingQuality = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: full_df
##        AIC     BIC    logLik
##   810.1795 838.067 -398.0897
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)  Residual
## StdDev:   0.7331682 0.5461749
##
## Fixed effects: Score ~ 1 + Group + Activity
##                 Value Std.Error  DF  t-value p-value
## (Intercept) 1.6626368 0.2323115 349  7.15693  0.0000
## GroupIN     0.4103922 0.3029765  48  1.35453  0.1819
## GroupBF     0.4041443 0.3183103  48  1.26966  0.2103
## GroupIF     0.1191791 0.3086771  48  0.38610  0.7011
## ActivityDT  1.8606965 0.0544815 349 34.15284  0.0000
##  Correlation:
##             (Intr) GropIN GropBF GropIF
## GroupIN    -0.756
## GroupBF    -0.720  0.552
## GroupIF    -0.742  0.569  0.542
## ActivityDT -0.117  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -2.72406268 -0.71209023 -0.02949525  0.76273246  2.51363036
##
## Number of Observations: 402
## Number of Groups: 52
```



Activity	Group	n
ST	BN	42
ST	IN	59
ST	BF	48
ST	IF	52
DT	BN	42
DT	IN	59
DT	BF	48
DT	IF	52

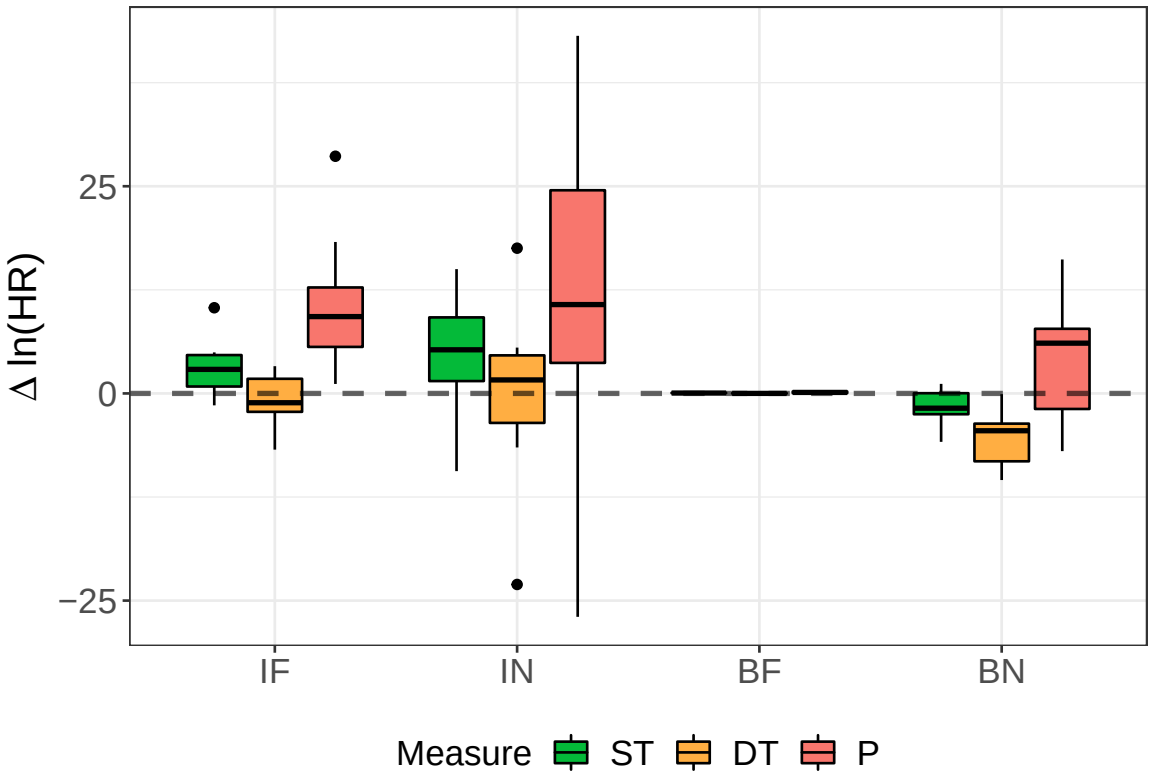
HR, 4 Groups:

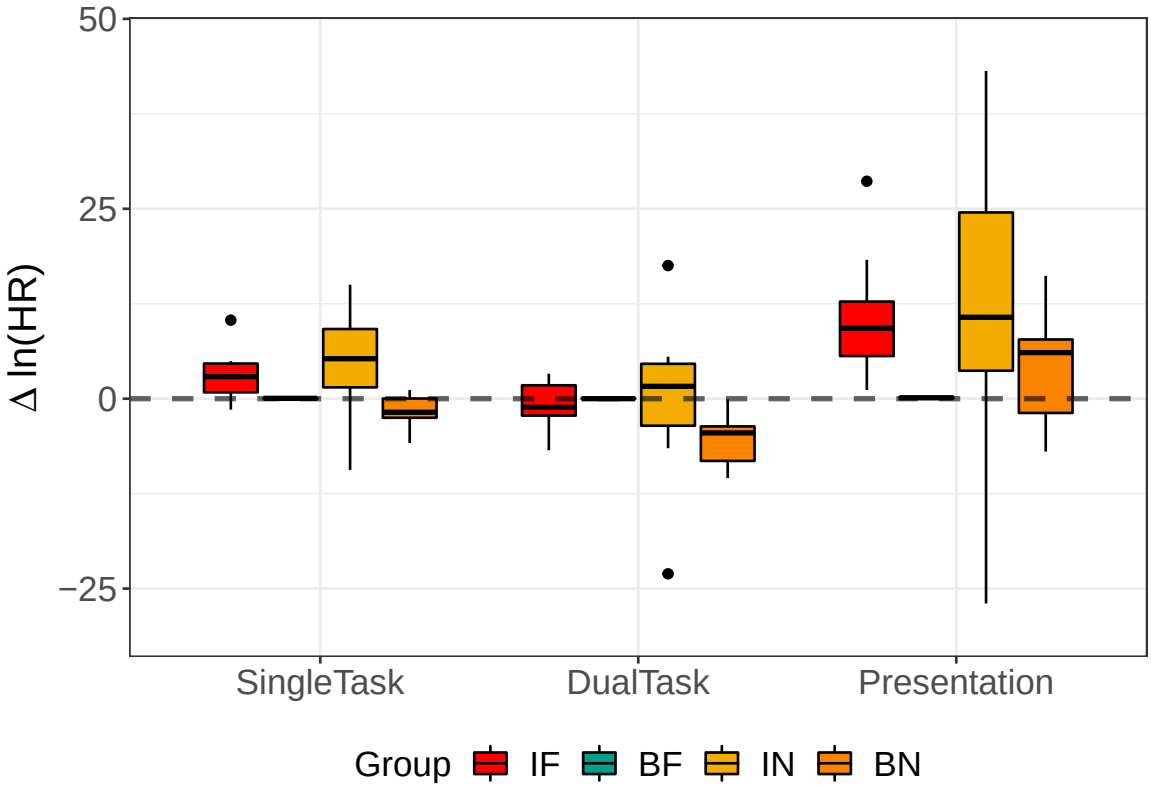
Stress Levels Across Activities

Our Linear Model:

$$\Delta \bar{HR} = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: diff_df
##        AIC      BIC    logLik
##   1167.934 1196.314 -574.9671
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept) Residual
## StdDev:    4.611047  5.27251
##
## Fixed effects: HR ~ 1 + Group + Activity
##                 Value Std.Error  DF   t-value p-value
## (Intercept) -0.460108  2.006015 130 -0.229364  0.8189
## GroupIN      4.116425  2.375528  43  1.732846  0.0903
## GroupBF      0.731044  2.371155  43  0.308307  0.7593
## GroupIF      3.855041  2.491648  43  1.547185  0.1291
## ActivityB   -2.385293  1.095374 130 -2.177606  0.0312
## ActivityDT  -2.921984  1.087636 130 -2.686547  0.0082
## ActivityP    4.902909  1.145331 130  4.280781  0.0000
##  Correlation:
##             (Intr) GropIN GropBF GropIF ActvtB ActvDT
## GroupIN     -0.754
## GroupBF     -0.754  0.638
## GroupIF     -0.719  0.607  0.609
## ActivityB   -0.272  0.000  0.000  0.008
## ActivityDT -0.271  0.000  0.000  0.000  0.496
## ActivityP   -0.248 -0.003 -0.014 -0.010  0.474  0.475
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -3.58925639 -0.50460601 -0.01629113  0.42226149  5.18860807
##
## Number of Observations: 180
## Number of Groups: 47
```


Δ ln(HR)
25
0
−25
IF
IN
BF
BN
Measure
ST
DT
P

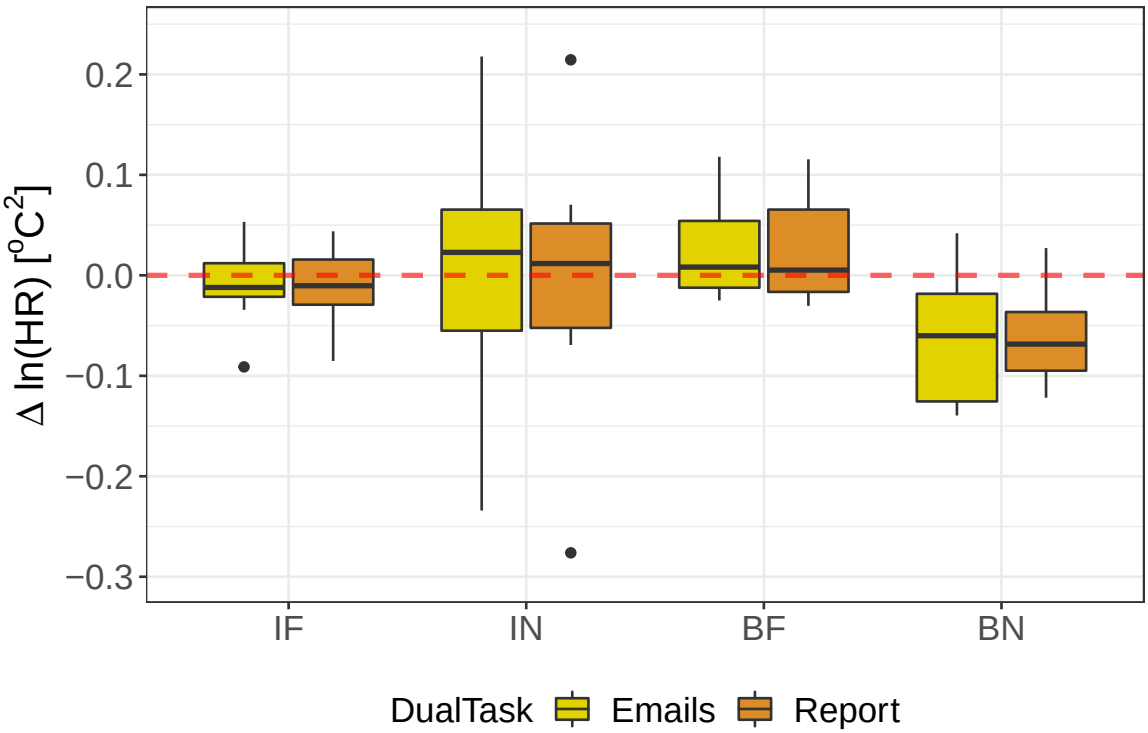

Δ ln(HR)
50
25
0
−25
SingleTask
DualTask
Presentation
Group
IF
BF
IN
BN

Stress Levels for Dual Task

Our Linear Model:

$$\Delta\bar{HR} = 1 + Group + DualTask + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: total_df
##         AIC       BIC   logLik
##   -312.3311 -294.7551 163.1655
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)   Residual
## StdDev:  0.06913645 0.01468389
##
## Fixed effects: HR ~ 1 + Group + DualTask
##                       Value   Std.Error DF    t-value p-value
## (Intercept)    -0.06062827 0.023352067 47 -2.5962698  0.0125
## GroupIN         0.06472257 0.029869574 44  2.1668393  0.0357
## GroupBF         0.08704844 0.029869574 44  2.9142846  0.0056
## GroupIF         0.05357653 0.031423010 44  1.7050094  0.0952
## DualTaskReport -0.00287140 0.002997337 47 -0.9579828  0.3430
##  Correlation:
##                (Intr) GropIN GropBF GropIF
## GroupIN        -0.779
## GroupBF        -0.779  0.609
## GroupIF        -0.740  0.579  0.579
## DualTaskReport -0.064  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##          Min           Q1          Med           Q3          Max
## -1.889191063 -0.417144413 -0.001957543  0.361793415  2.070980710
##
## Number of Observations: 96
## Number of Groups: 48
```



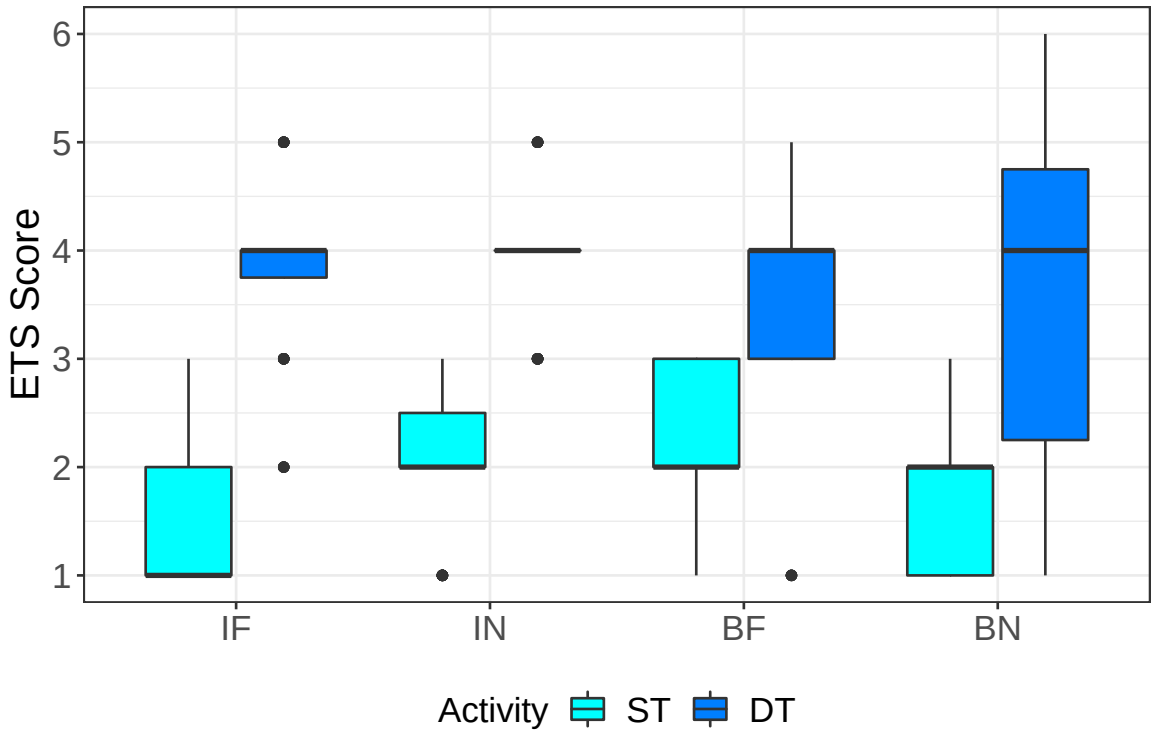

```
## Paired t-test
## For IF, p = 0.8626 > 0.05

## Paired t-test
## For IN, p = 0.1416 > 0.05

## Paired t-test
## For BF, p = 0.9277 > 0.05

## Paired t-test
## For BN, p = 0.7531 > 0.05
```

Linear Modelling for Writing Quality

Our Linear Model:

$$WritingQuality = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: full_df
##        AIC     BIC    logLik
##   810.1795 838.067 -398.0897
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)  Residual
## StdDev:   0.7331682 0.5461749
##
## Fixed effects: Score ~ 1 + Group + Activity
##                 Value Std.Error  DF  t-value p-value
## (Intercept) 1.6626368 0.2323115 349  7.15693  0.0000
## GroupIN     0.4103922 0.3029765  48  1.35453  0.1819
## GroupBF     0.4041443 0.3183103  48  1.26966  0.2103
## GroupIF     0.1191791 0.3086771  48  0.38610  0.7011
## ActivityDT  1.8606965 0.0544815 349 34.15284  0.0000
##  Correlation:
##             (Intr) GropIN GropBF GropIF
## GroupIN    -0.756
## GroupBF    -0.720  0.552
## GroupIF    -0.742  0.569  0.542
## ActivityDT -0.117  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -2.72406268 -0.71209023 -0.02949525  0.76273246  2.51363036
##
## Number of Observations: 402
## Number of Groups: 52
```



Activity	Group	n
ST	BN	42
ST	IN	59
ST	BF	48
ST	IF	52
DT	BN	42
DT	IN	59
DT	BF	48
DT	IF	52

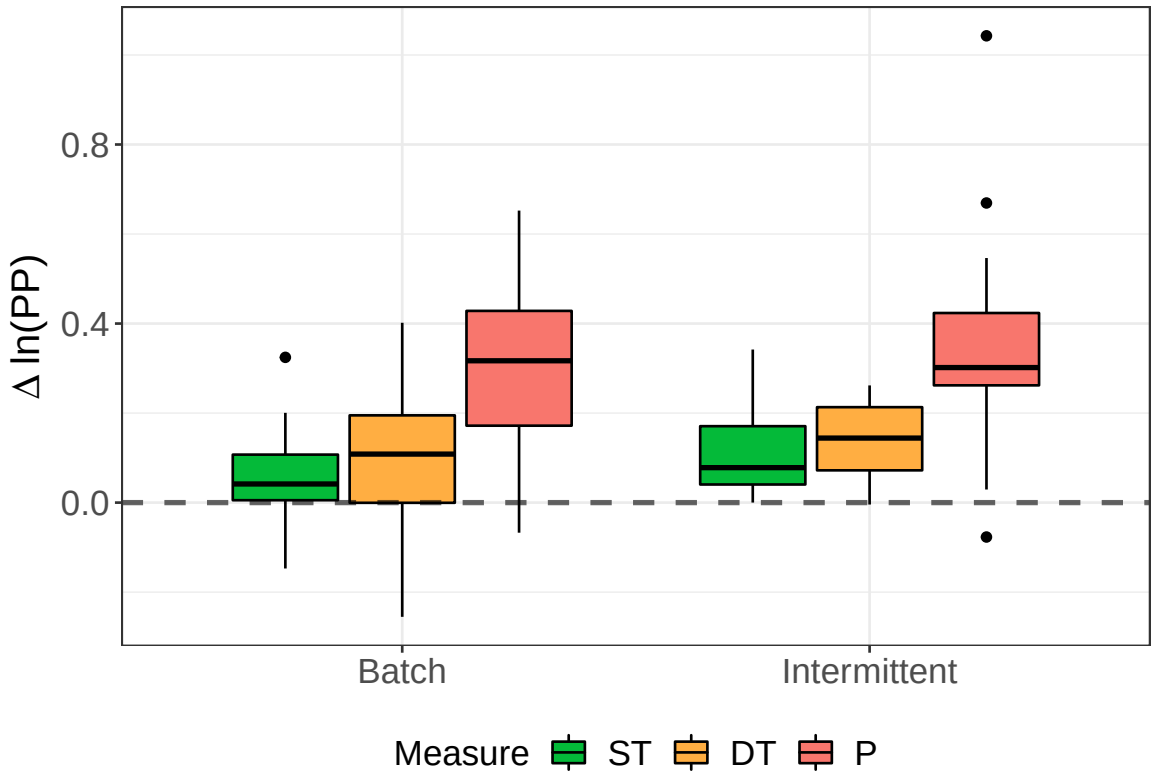
PP, 2 Groups:

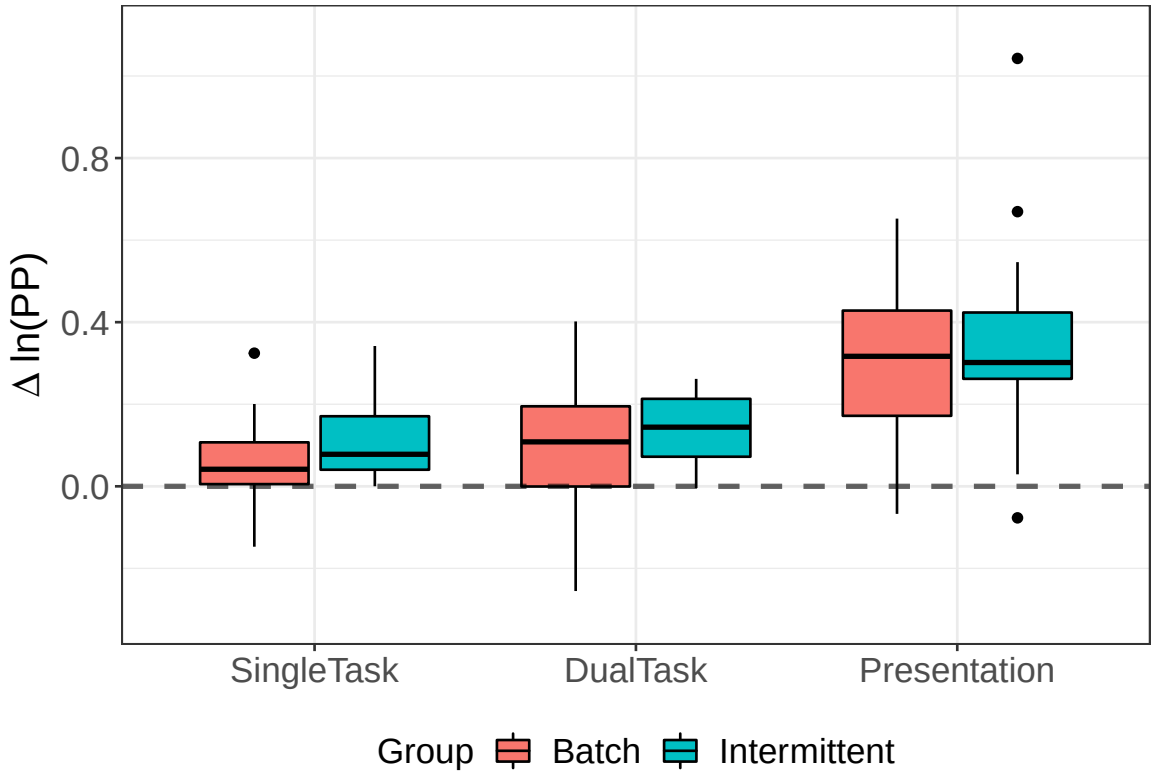
Stress Levels Across Activities

Our Linear Model:

$$\Delta ln(\bar{PP}) = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: diff_df
##         AIC       BIC   logLik
##   -227.8694 -204.5404 120.9347
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)  Residual
## StdDev:  0.07316607 0.1139673
##
## Fixed effects: PP ~ 1 + Group + Activity
##                         Value  Std.Error  DF   t-value p-value
## (Intercept)        0.05774154 0.02264046 155  2.550370  0.0117
## GroupIntermittent  0.04916390 0.02536104  52  1.938560  0.0580
## ActivityB         -0.03178522 0.02218139 155 -1.432968  0.1539
## ActivityDT         0.03305760 0.02193303 155  1.507207  0.1338
## ActivityP          0.23841041 0.02218239 155 10.747734  0.0000
##  Correlation:
##                   (Intr) GrpInt ActvtB ActvDT
## GroupIntermittent -0.581
## ActivityB         -0.479  0.000
## ActivityDT        -0.484  0.000  0.494
## ActivityP         -0.484  0.009  0.489  0.494
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -2.84125608 -0.39190599 -0.04318572  0.42510474  5.09963618
##
## Number of Observations: 212
## Number of Groups: 54
```


0.8
0.4
0.0
Δ ln(PP)
Batch
Intermittent
Measure
ST
DT
P

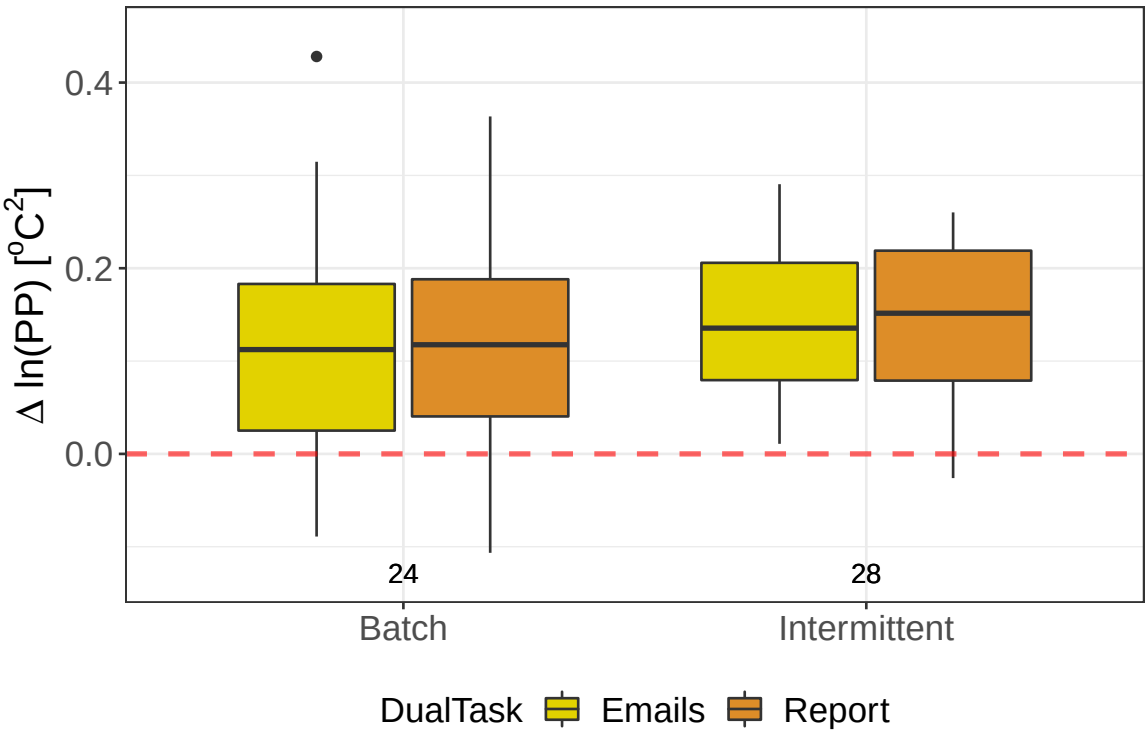

0.8
0.4
0.0
Δ ln(PP)
SingleTask
DualTask
Presentation
Group
Batch
Intermittent

Stress Levels for Dual Task

Our Linear Model:

$$\Delta ln(\bar{PP}) = 1 + Group + DualTask + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: total_df
##         AIC       BIC   logLik
##   -264.9355 -251.8599 137.4677
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)  Residual
## StdDev:  0.09516148 0.0255792
##
## Fixed effects: PP ~ 1 + Group + DualTask
##                         Value   Std.Error DF  t-value p-value
## (Intercept)       0.11554110 0.019930971 51 5.797063  0.0000
## GroupIntermittent 0.02167539 0.026945394 50 0.804419  0.4250
## DualTaskReport    0.00420512 0.005016494 51 0.838259  0.4058
##  Correlation:
##                   (Intr) GrpInt
## GroupIntermittent -0.728
## DualTaskReport    -0.126  0.000
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -1.99518962 -0.38860674  0.02238235  0.35390058  1.96405950
##
## Number of Observations: 104
## Number of Groups: 52
```



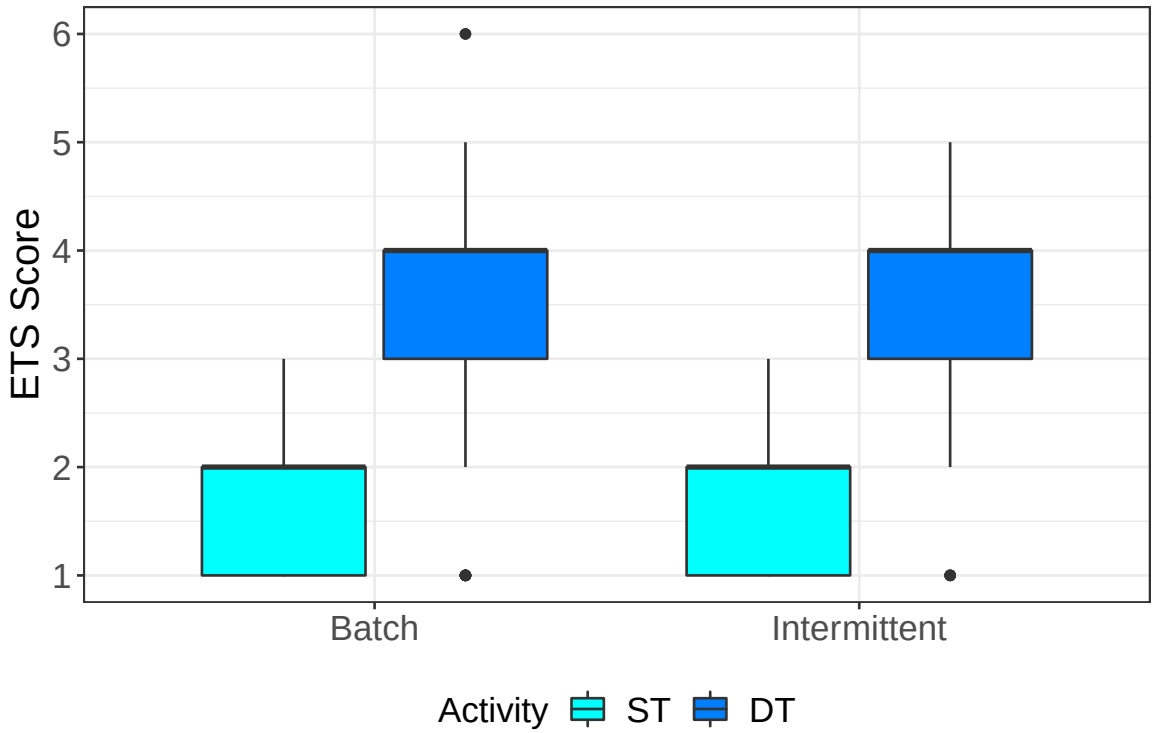

```
## Paired t-test
## For Batch, p = 0.6794 > 0.05

## Paired t-test
## For Intermittent, p = 0.4131 > 0.05
```

Linear Modelling for Writing Quality

Our Linear Model:

$$WritingQuality = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: full_df
##        AIC      BIC    logLik
##   807.7906 827.7354 -398.8953
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)  Residual
## StdDev:   0.7391994 0.5461542
##
## Fixed effects: Score ~ 1 + Group + Activity
##                       Value  Std.Error  DF  t-value p-value
## (Intercept)       1.9005566 0.15312544 349 12.41176  0.0000
## GroupIntermittent 0.0142147 0.21326940  50  0.06665  0.9471
## ActivityDT        1.8606965 0.05447939 349 34.15414  0.0000
##  Correlation:
##                   (Intr) GrpInt
## GroupIntermittent -0.695
## ActivityDT        -0.178  0.000
##
## Standardized Within-Group Residuals:
##          Min           Q1          Med           Q3          Max
## -2.745086656 -0.709704218 -0.008034864  0.747596171  2.492805001
##
## Number of Observations: 402
## Number of Groups: 52
```



Activity	Group	n
ST	Batch	101
ST	Intermittent	100
DT	Batch	101
DT	Intermittent	100

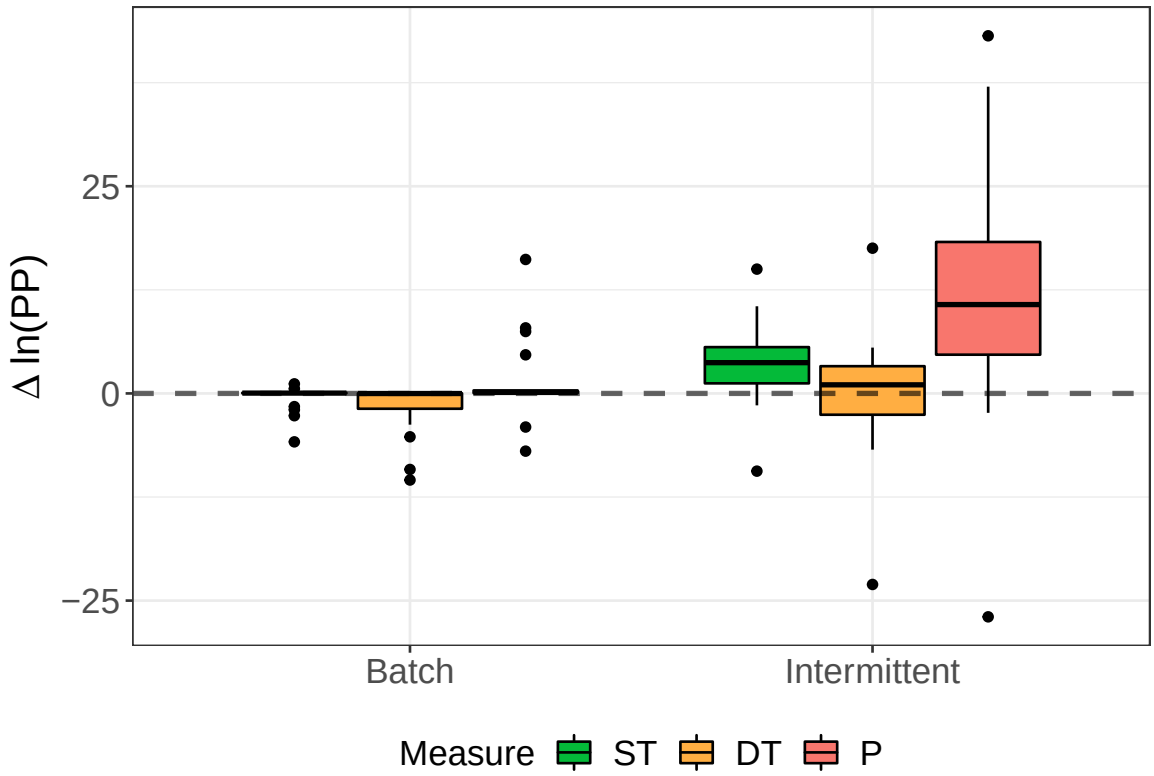
HR, 2 Groups:

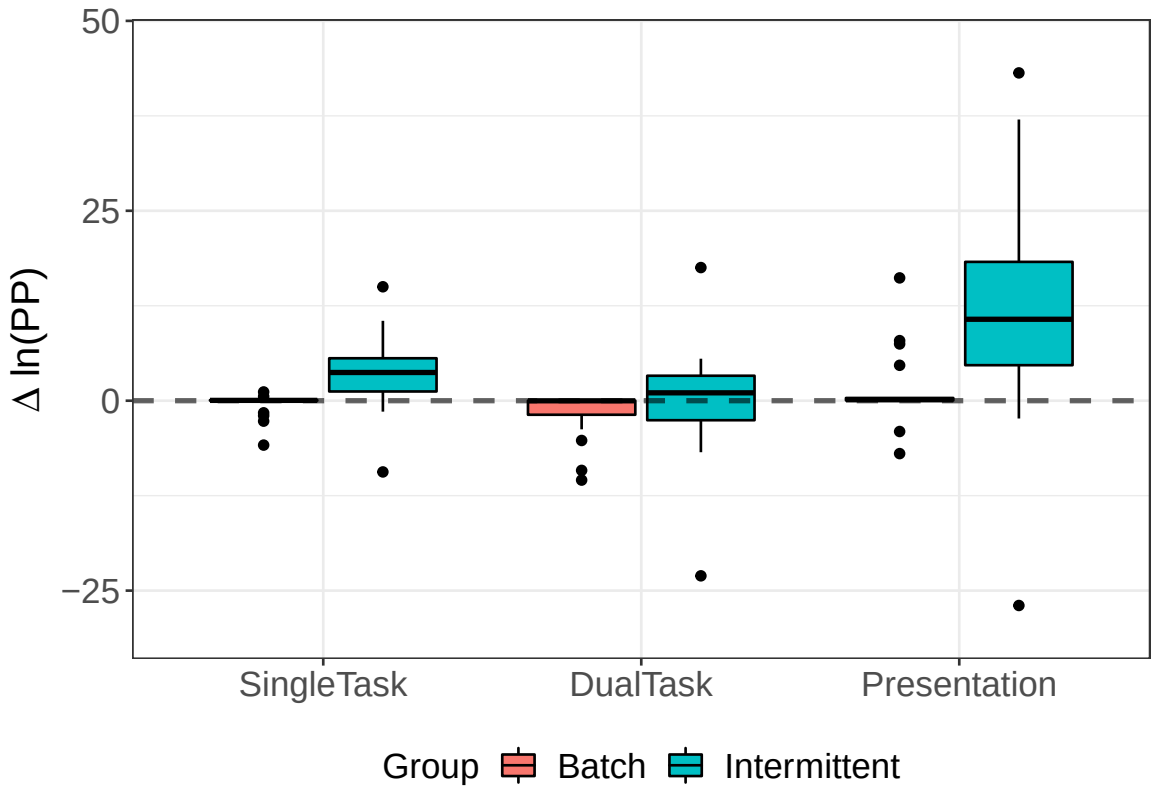
Stress Levels Across Activities

Our Linear Model:

$$\Delta\bar{H}R = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: diff_df
##        AIC      BIC   logLik
##   1170.946 1193.099 -578.473
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept) Residual
## StdDev:    4.481114 5.271894
##
## Fixed effects: HR ~ 1 + Group + Activity
##                       Value Std.Error  DF   t-value p-value
## (Intercept)        0.004958  1.296684 130  0.003824  0.9970
## GroupIntermittent  3.536476  1.530566  45  2.310567  0.0255
## ActivityB         -2.383440  1.095157 130 -2.176345  0.0313
## ActivityDT        -2.921984  1.087509 130 -2.686861  0.0082
## ActivityP          4.908475  1.144838 130  4.287485  0.0000
##  Correlation:
##                   (Intr) GrpInt ActvtB ActvDT
## GroupIntermittent -0.628
## ActivityB         -0.420  0.006
## ActivityDT        -0.419  0.000  0.497
## ActivityP         -0.401  0.004  0.475  0.475
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -3.62964871 -0.49214954 -0.01180449  0.43107110  5.21355141
##
## Number of Observations: 180
## Number of Groups: 47
```


Δ ln(PP)
25
0
−25
Batch
Intermittent
Measure
ST
DT
P

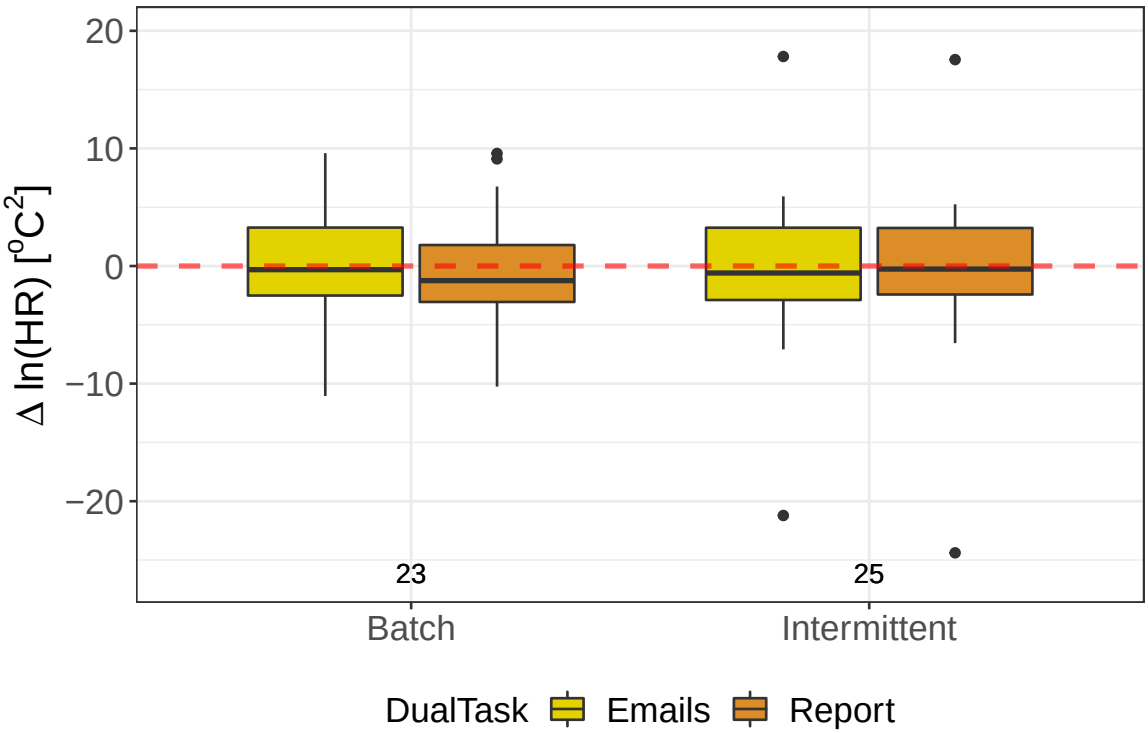

Δ ln(PP)
50
25
0
−25
SingleTask
DualTask
Presentation
Group
Batch
Intermittent

Stress Levels for Dual Task

Our Linear Model:

$$\Delta\bar{HR} = 1 + Group + DualTask + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: total_df
##        AIC      BIC    logLik
##   492.5249 505.1879 -241.2625
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept) Residual
## StdDev:    6.016257 1.111417
##
## Fixed effects: HR ~ 1 + Group + DualTask
##                        Value Std.Error DF    t-value p-value
## (Intercept)       -0.6280509 1.2702091 47 -0.4944468  0.6233
## GroupIntermittent  0.3254378 1.7530211 46  0.1856440  0.8535
## DualTaskReport    -0.1808579 0.2268671 47 -0.7971979  0.4293
##  Correlation:
##                   (Intr) GrpInt
## GroupIntermittent -0.719
## DualTaskReport    -0.089  0.000
##
## Standardized Within-Group Residuals:
##          Min           Q1          Med           Q3          Max
## -2.103401267 -0.397769399  0.007921389  0.384854891  2.328488769
##
## Number of Observations: 96
## Number of Groups: 48
```



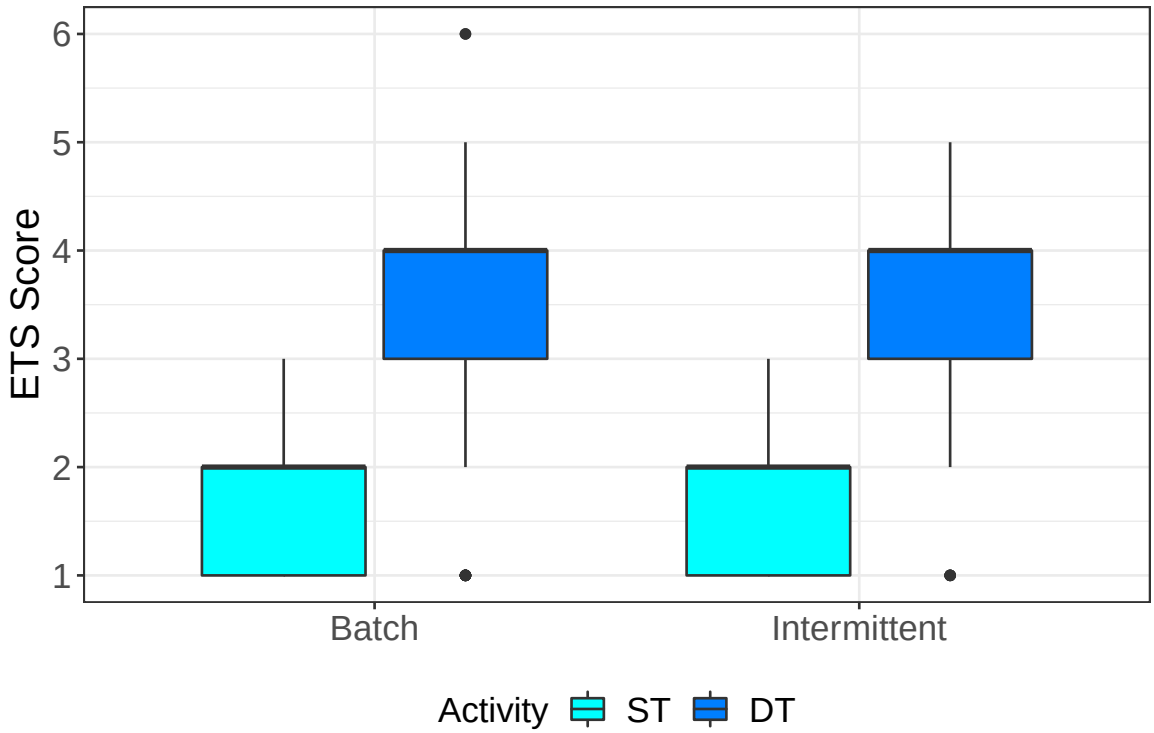

```
## Paired t-test
## For Batch, p = 0.8989 > 0.05

## Paired t-test
## For Intermittent, p = 0.2465 > 0.05
```

Linear Modelling for Writing Quality

Our Linear Model:

$$WritingQuality = 1 + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: full_df
##        AIC      BIC    logLik
##   807.7906 827.7354 -398.8953
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)  Residual
## StdDev:   0.7391994 0.5461542
##
## Fixed effects: Score ~ 1 + Group + Activity
##                       Value  Std.Error  DF  t-value p-value
## (Intercept)       1.9005566 0.15312544 349 12.41176  0.0000
## GroupIntermittent 0.0142147 0.21326940  50  0.06665  0.9471
## ActivityDT        1.8606965 0.05447939 349 34.15414  0.0000
##  Correlation:
##                   (Intr) GrpInt
## GroupIntermittent -0.695
## ActivityDT        -0.178  0.000
##
## Standardized Within-Group Residuals:
##          Min           Q1          Med           Q3          Max
## -2.745086656 -0.709704218 -0.008034864  0.747596171  2.492805001
##
## Number of Observations: 402
## Number of Groups: 52
```



Activity	Group	n
ST	Batch	101
ST	Intermittent	100
DT	Batch	101
DT	Intermittent	100

Let's Get to 10 $\star$ with Four Groups

Our Linear Model:

$$\Delta ln(\bar{PP}) = 1 + ETSScore + Group + Activity + 1|Subject$$

```
## Linear mixed-effects model fit by REML
##  Data: full_df
##         AIC       BIC   logLik
##   -154.7461 -134.7476 85.37305
##
## Random effects:
##  Formula: ~1 | Subject
##         (Intercept)   Residual
## StdDev:  0.07463008 0.05937426
##
## Fixed effects: PP ~ 1 + ETSScore + Group + Activity
##                   Value  Std.Error DF    t-value p-value
## (Intercept)  0.04186501 0.03148258 46  1.3297833  0.1901
## ETSScore    -0.00655483 0.01002662 46 -0.6537422  0.5165
## GroupIN      0.11266368 0.03658188 44  3.0797675  0.0036
## GroupBF      0.01148819 0.03715437 44  0.3092015  0.7586
## GroupIF      0.04180218 0.03610722 44  1.1577237  0.2532
## ActivityDT   0.03842069 0.02201797 46  1.7449701  0.0877
##  Correlation:
##             (Intr) ETSScr GropIN GropBF GropIF
## ETSScore    -0.472
## GroupIN     -0.554 -0.175
## GroupBF     -0.550 -0.162  0.568
## GroupIF     -0.612 -0.070  0.567  0.558
## ActivityDT  0.288 -0.835  0.146  0.135  0.059
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -2.08322159 -0.47832345  0.02317652  0.42044261  2.04384027
##
## Number of Observations: 96
## Number of Groups: 48
```

Hey! Let's ANOVA!

Our ANOVA Model:

$$\Delta ln(\bar{PP}) = 1 + StressFactor + IntermittentFactor$$

```
##                     Df Sum Sq  Mean Sq F value Pr(>F)
## StressFactor         1 0.0080 0.008006   0.585  0.448
## IntermittentFactor   1 0.0277 0.027693   2.024  0.161
## Residuals           51 0.6980 0.013685
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = PP ~ 1 + StressFactor + IntermittentFactor, data = diff_df, na.action = na.omi
##
## $StressFactor
##                  diff         lwr        upr     p adj
## High-Low -0.02450424 -0.08882211 0.03981363 0.4478784
##
## $IntermittentFactor
##                                       diff         lwr       upr     p adj
## Intermittent-Non-Intermittent 0.04528374 -0.01867976 0.1092472 0.1613176
```

Hey! Let's ANOVA 2: With Interaction Effects

Our ANOVA Model:

$$\Delta ln(\bar{PP}) = 1 + StressFactor + IntermittentFactor + StressFactor * IntermittentFactor$$

```
##                                 Df Sum Sq  Mean Sq F value Pr(>F)
## StressFactor                     1 0.0080 0.008006   0.580  0.450
## IntermittentFactor               1 0.0277 0.027693   2.006  0.163
## StressFactor:IntermittentFactor  1 0.0077 0.007663   0.555  0.460
## Residuals                       50 0.6903 0.013806
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = PP ~ 1 + StressFactor * IntermittentFactor, data = diff_df, na.action = na.omi
##
## $StressFactor
##                  diff         lwr        upr     p adj
## High-Low -0.02450424 -0.08913594 0.04012745 0.4499246
##
## $IntermittentFactor
##                                       diff         lwr       upr     p adj
## Intermittent-Non-Intermittent 0.04528374 -0.01899185 0.1095593 0.1632434
##
## $`StressFactor:IntermittentFactor`
##                                                      diff         lwr
## High:Non-Intermittent-Low:Non-Intermittent  0.002520434 -0.12143410
## Low:Intermittent-Low:Non-Intermittent       0.072132219 -0.05579275
## High:Intermittent-Low:Non-Intermittent      0.026614322 -0.09734021
## Low:Intermittent-High:Non-Intermittent      0.069611785 -0.04871401
## High:Intermittent-High:Non-Intermittent     0.024093888 -0.08992770
## High:Intermittent-Low:Intermittent         -0.045517897 -0.16384369
##                                                     upr     p adj
## High:Non-Intermittent-Low:Non-Intermittent 0.12647497 0.9999425
## Low:Intermittent-Low:Non-Intermittent      0.20005718 0.4460204
## High:Intermittent-Low:Non-Intermittent     0.15056885 0.9403670
## Low:Intermittent-High:Non-Intermittent     0.18793758 0.4084248
## High:Intermittent-High:Non-Intermittent    0.13811547 0.9429316
## High:Intermittent-Low:Intermittent         0.07280789 0.7372276
```