

# Advanced Analysis

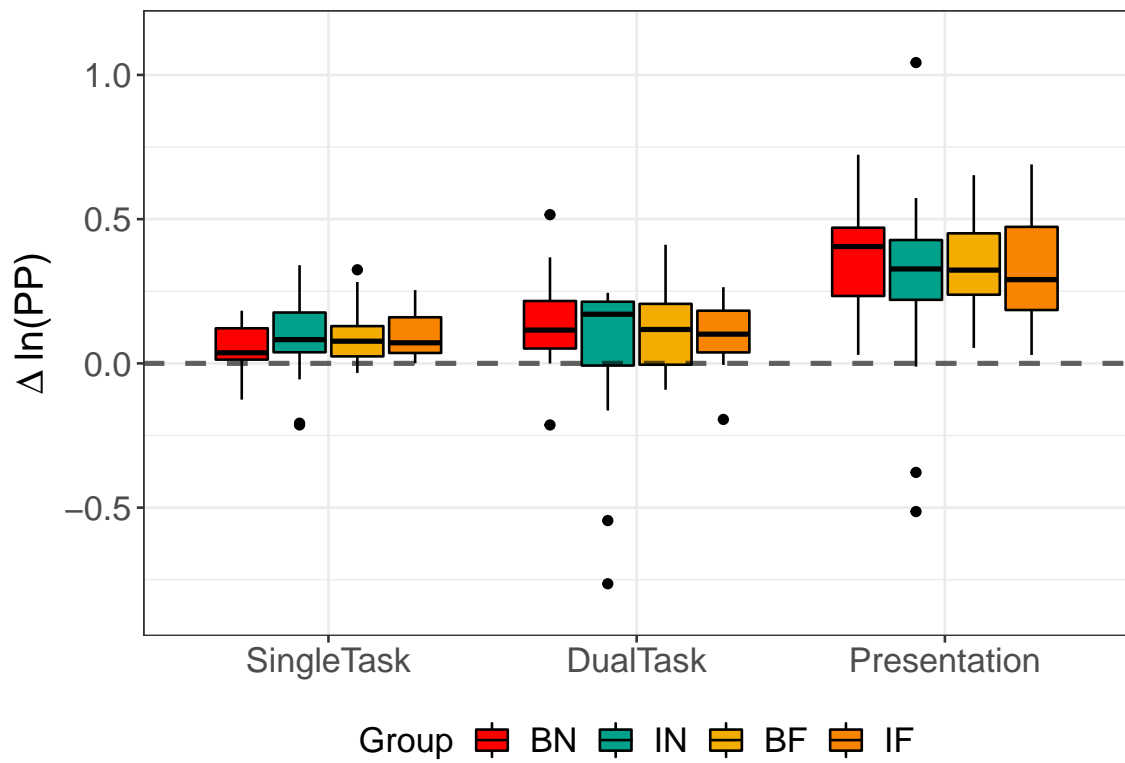
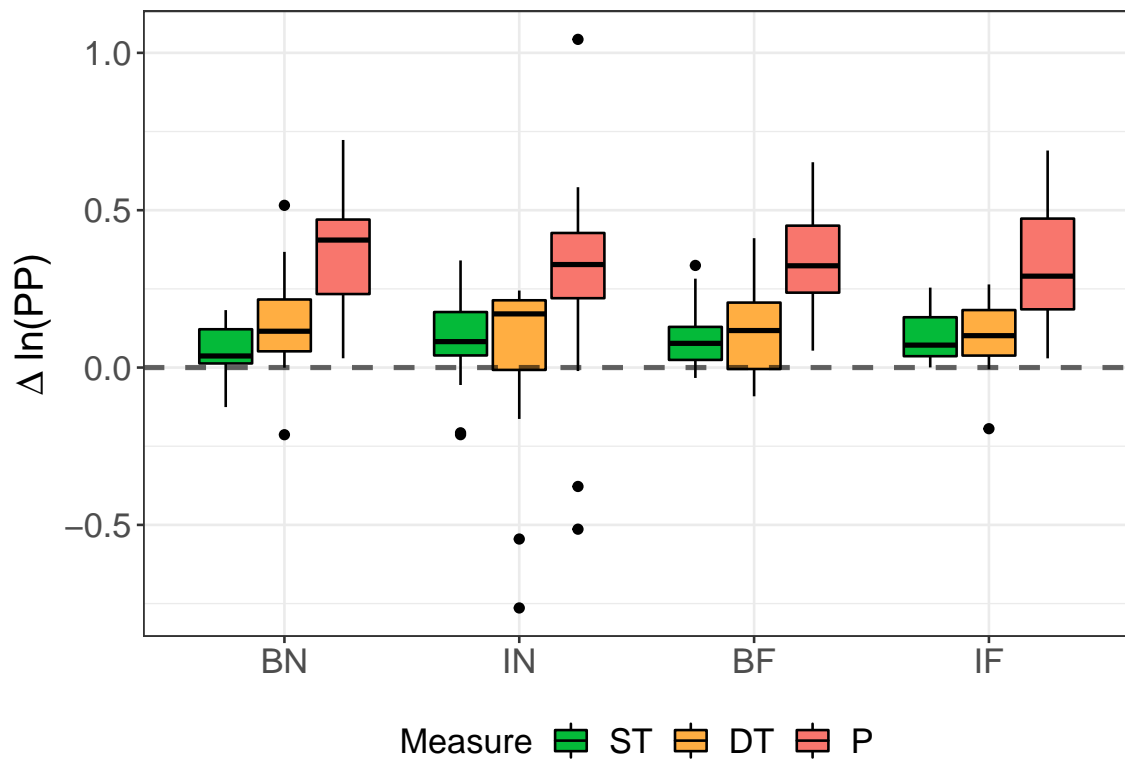
**PP, 4 Groups:**

## Stress Levels Across Activities

Our Linear Model:

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

```
## Linear mixed-effects model fit by REML
## Data: diff_df
##      AIC      BIC    logLik
## -178.948 -147.112  98.47402
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept) Residual
## StdDev:      0.138271 0.1254413
##
## Fixed effects: PP ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept)  0.10039584 0.04146835 192   2.421023  0.0164
## GroupIN      -0.04785667 0.05256399  62  -0.910446  0.3661
## GroupBF       0.00482909 0.05549157  62   0.087024  0.9309
## GroupIF      -0.00466546 0.05383780  62  -0.086658  0.9312
## ActivityB    -0.03929932 0.02194253 192  -1.791012  0.0749
## ActivityDT    0.01469432 0.02183652 192   0.672924  0.5018
## ActivityP     0.24369816 0.02205159 192  11.051272  0.0000
## Correlation:
##      (Intr) GropIN GropBF GropIF ActvtB ActvDT
## GroupIN    -0.708
## GroupBF    -0.670  0.529
## GroupIF    -0.690  0.545  0.516
## ActivityB  -0.258 -0.004 -0.004 -0.004
## ActivityDT -0.263  0.000  0.000  0.000  0.498
## ActivityP  -0.263  0.007  0.000  0.000  0.493  0.495
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -3.69297959 -0.40330059 -0.04953458  0.42425698  4.32262164
##
## Number of Observations: 261
## Number of Groups: 66
```

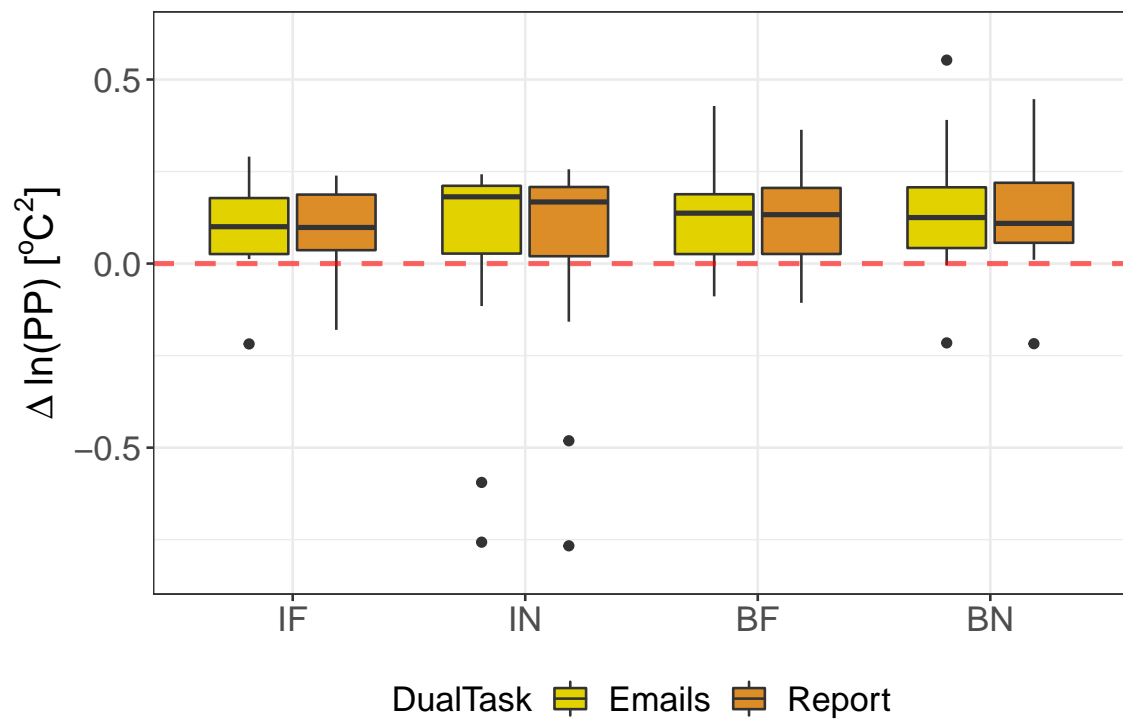


## Stress Levels for Dual Task

Our Linear Model:

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

```
## Linear mixed-effects model fit by REML
## Data: total_df
##      AIC      BIC    logLik
## -238.7776 -218.9794 126.3888
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept)  Residual
## StdDev:    0.1872633 0.02677144
##
## Fixed effects: PP ~ 1 + Group + DualTask
##              Value Std.Error DF   t-value p-value
## (Intercept)  0.14163189 0.04865428 64   2.9109850  0.0050
## GroupIN      -0.08806844 0.06500959 61  -1.3546992  0.1805
## GroupBF      -0.01400555 0.06994389 61  -0.2002397  0.8420
## GroupIF      -0.04123247 0.06667535 61  -0.6184065  0.5386
## DualTaskReport -0.00249349 0.00469602 64  -0.5309799  0.5973
## Correlation:
##      (Intr) GropIN GropBF GropIF
## GroupIN      -0.747
## GroupBF      -0.694  0.519
## GroupIF      -0.728  0.545  0.506
## DualTaskReport -0.048  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.383599e+00 -4.505942e-01 -1.059742e-05  3.762150e-01  2.069535e+00
##
## Number of Observations: 130
## Number of Groups: 65
```



```
## Paired t-test
## For IF, p = 0.674 > 0.05

## Paired t-test
## For IN, p = 0.744 > 0.05

## Paired t-test
## For BF, p = 0.4738 > 0.05

## Paired t-test
## For BN, p = 0.4718 > 0.05
```

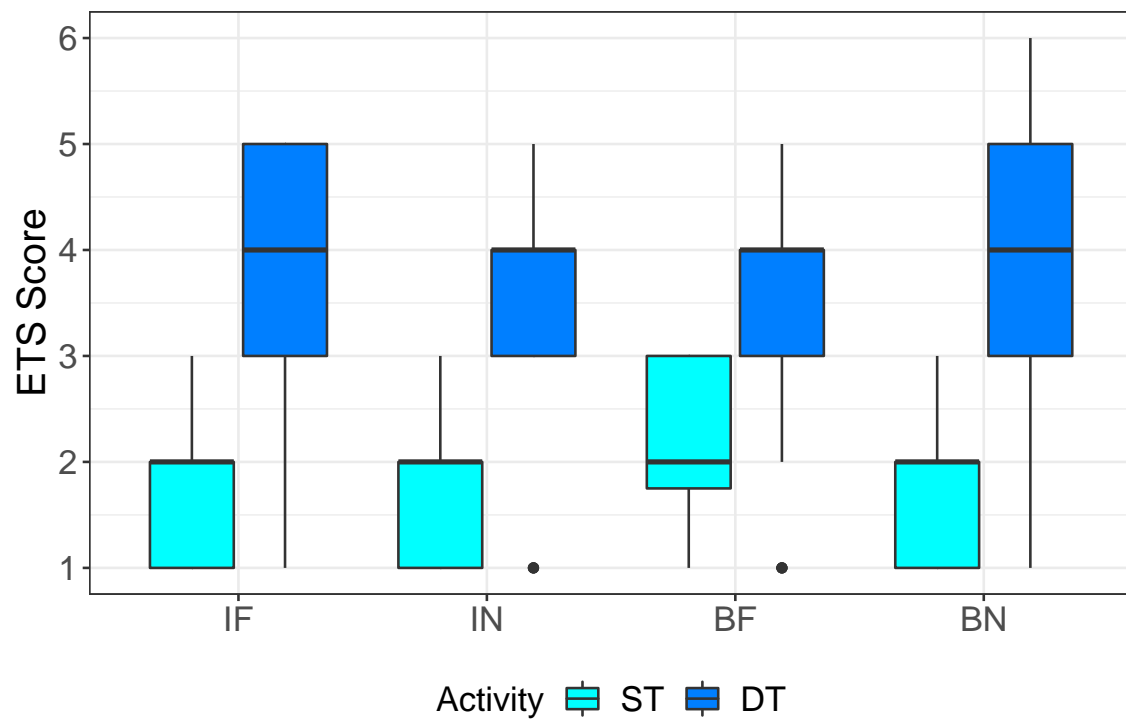
## Linear Modelling for Writing Quality

Our Linear Model:

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

---

```
## Linear mixed-effects model fit by REML
## Data: full_df
##      AIC      BIC    logLik
##  817.6827 844.9048 -401.8414
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept) Residual
## StdDev:   0.8037329 0.5812148
##
## Fixed effects: Score ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept) 1.9260910 0.21905259 300   8.792824  0.0000
## GroupIN      0.0692567 0.29079672  61   0.238162  0.8126
## GroupBF      0.0319413 0.31260930  61   0.102177  0.9190
## GroupIF      0.0897360 0.29848782  61   0.300635  0.7647
## ActivityDT   1.7431694 0.06076117 300  28.688871  0.0000
## Correlation:
##      (Intr) GropIN GropBF GropIF
## GroupIN   -0.739
## GroupBF   -0.687  0.518
## GroupIF   -0.720  0.542  0.504
## ActivityDT -0.139  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.55122903 -0.54685588 -0.02736085  0.45922973  2.18086539
##
## Number of Observations: 366
## Number of Groups: 65
```



Activity	Group	n
ST	BN	43
ST	IN	55
ST	BF	40
ST	IF	45
DT	BN	43
DT	IN	55
DT	BF	40
DT	IF	45



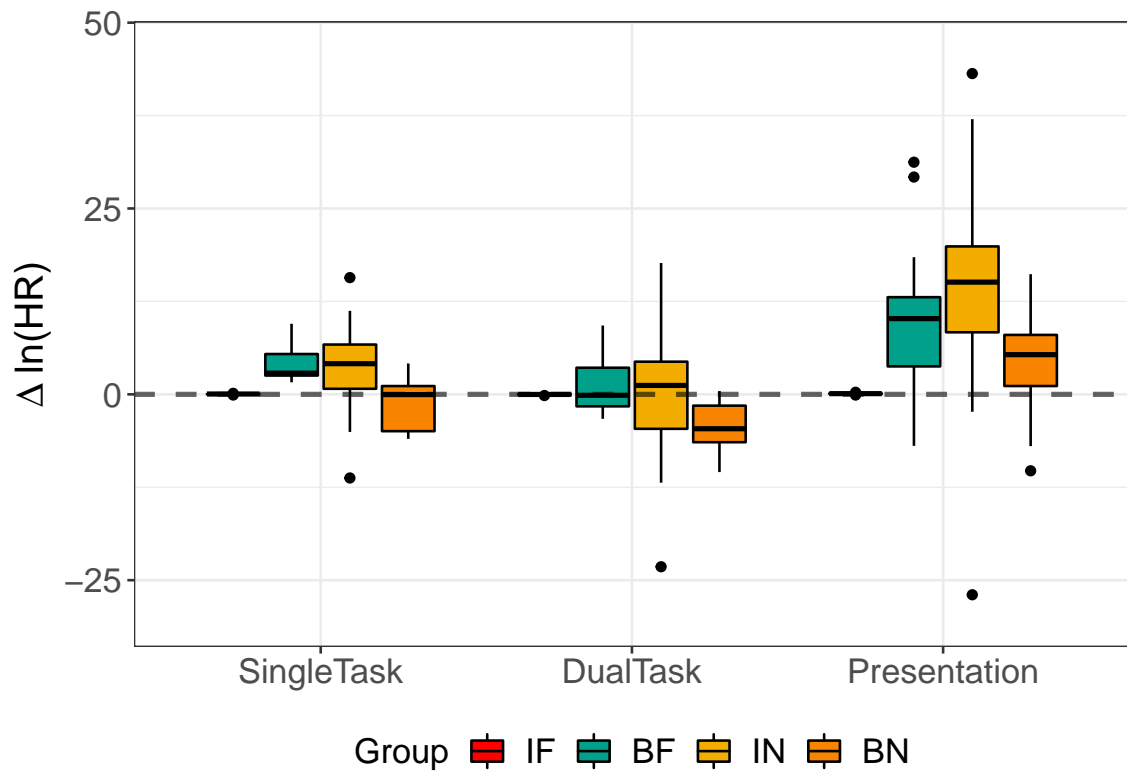
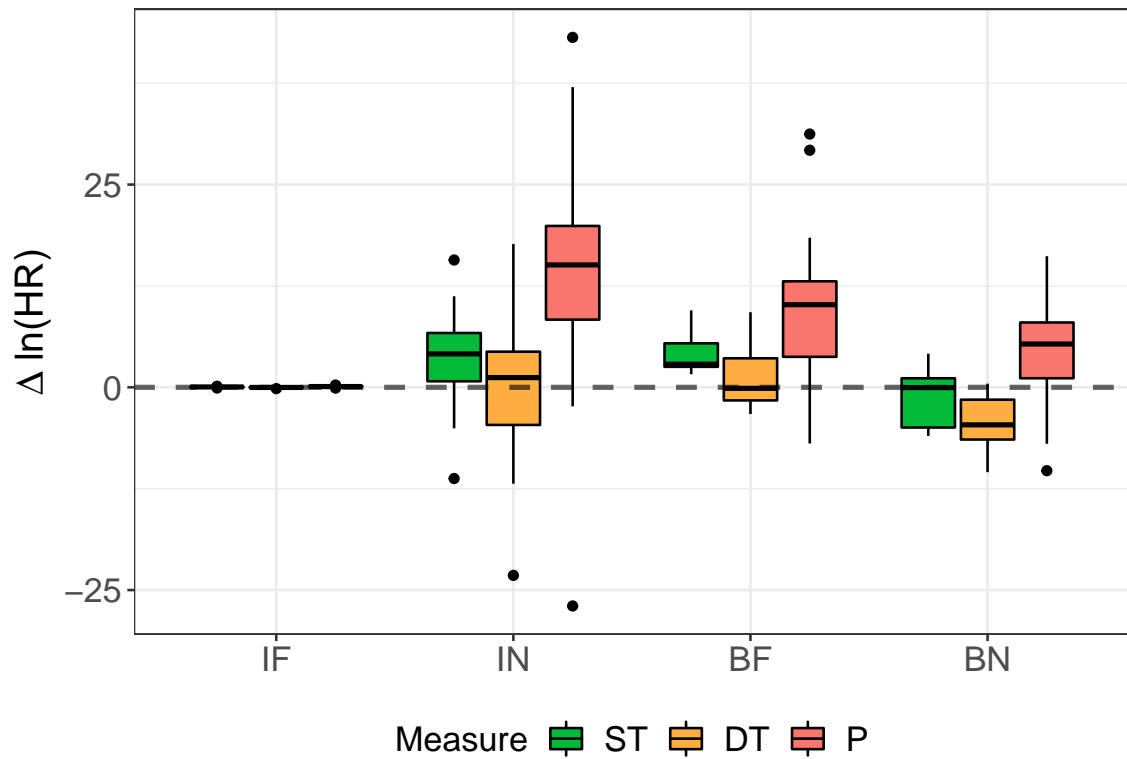
**HR, 4 Groups:**

## Stress Levels Across Activities

Our Linear Model:

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

```
## Linear mixed-effects model fit by REML
## Data: diff_df
##      AIC      BIC    logLik
## 1397.593 1427.544 -689.7966
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept) Residual
## StdDev:      4.7485 5.453409
##
## Fixed effects: HR ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept) -0.558257  1.652845 155 -0.337755  0.7360
## GroupIN      3.792501  2.060187  51  1.840853  0.0715
## GroupBF      5.188135  2.115775  51  2.452120  0.0177
## GroupIF      0.718798  2.201960  51  0.326435  0.7454
## ActivityB    -2.449953  1.045858 155 -2.342529  0.0204
## ActivityDT   -2.983310  1.039924 155 -2.868776  0.0047
## ActivityP     5.470081  1.078582 155  5.071547  0.0000
## Correlation:
##      (Intr) GropIN GropBF GropIF ActvtB ActvDT
## GroupIN    -0.687
## GroupBF    -0.666  0.535
## GroupIF    -0.640  0.514  0.501
## ActivityB  -0.315  0.005  0.000  0.000
## ActivityDT -0.315  0.000  0.000  0.000  0.497
## ActivityP  -0.299  0.003 -0.013 -0.006  0.479  0.482
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -3.46501284 -0.47250644  0.06466967  0.43791557  5.00418600
##
## Number of Observations: 213
## Number of Groups: 55
```

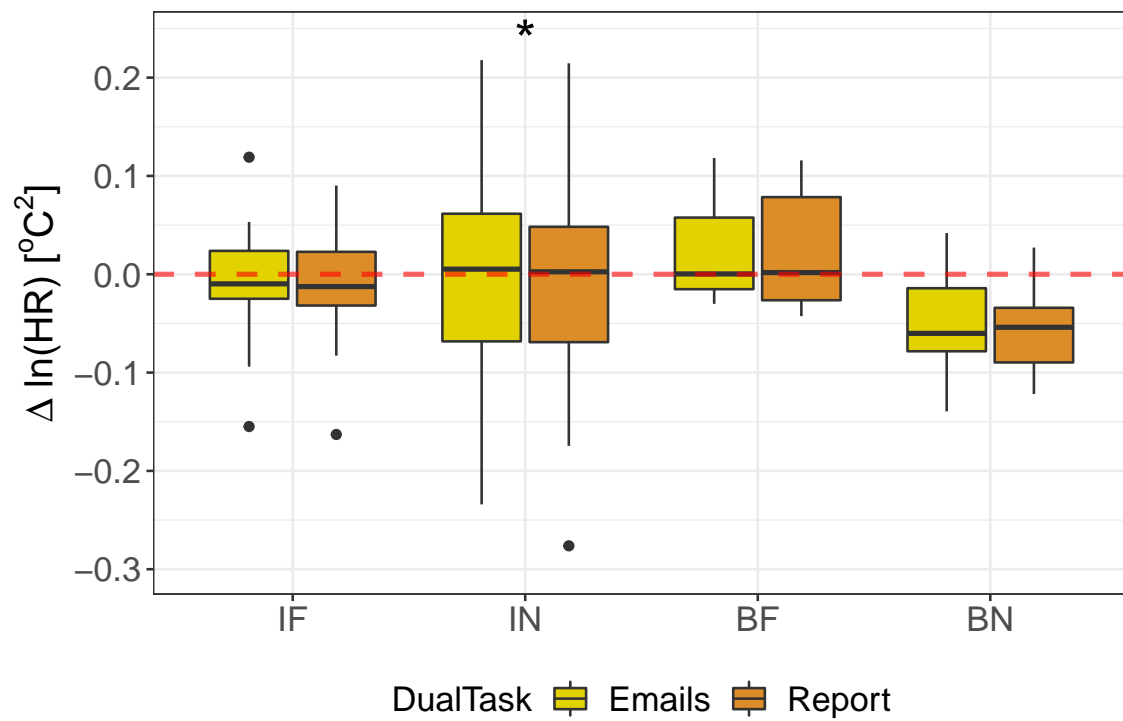


## Stress Levels for Dual Task

Our Linear Model:

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

```
## Linear mixed-effects model fit by REML
## Data: total_df
##      AIC      BIC    logLik
## -344.4591 -326.016 179.2295
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept)  Residual
## StdDev:  0.07447717 0.01528277
##
## Fixed effects: HR ~ 1 + Group + DualTask
##              Value Std.Error DF   t-value p-value
## (Intercept) -0.04759271 0.020924305 53 -2.274518  0.0270
## GroupIN      0.03980732 0.028100549 50  1.416603  0.1628
## GroupBF      0.07322944 0.029518263 50  2.480818  0.0165
## GroupIF      0.03915708 0.030126951 50  1.299736  0.1997
## DualTaskReport -0.00555952 0.002941171 53 -1.890241  0.0642
## Correlation:
##      (Intr) GropIN GropBF GropIF
## GroupIN      -0.741
## GroupBF      -0.705  0.525
## GroupIF      -0.691  0.515  0.490
## DualTaskReport -0.070  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.90592838 -0.38237059  0.04371162  0.38197252  2.07495035
##
## Number of Observations: 108
## Number of Groups: 54
```



```
## Paired t-test
## For IF, p = 0.4269 > 0.05

## Paired t-test
## For IN, p = 0.0397 < 0.05  *

## Paired t-test
## For BF, p = 0.8595 > 0.05

## Paired t-test
## For BN, p = 0.573 > 0.05
```

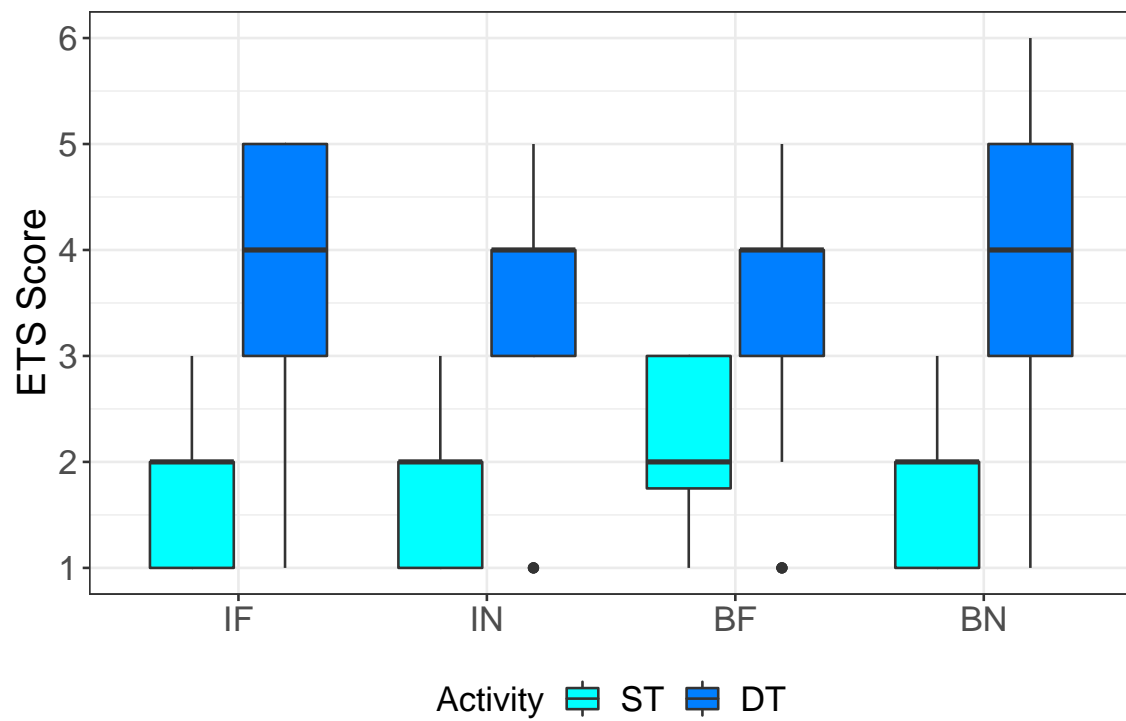
## Linear Modelling for Writing Quality

Our Linear Model:

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

---

```
## Linear mixed-effects model fit by REML
## Data: full_df
##      AIC      BIC    logLik
##  817.6827 844.9048 -401.8414
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept)  Residual
## StdDev:    0.8037329 0.5812148
##
## Fixed effects: Score ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept) 1.9260910 0.21905259 300   8.792824  0.0000
## GroupIN      0.0692567 0.29079672  61   0.238162  0.8126
## GroupBF      0.0319413 0.31260930  61   0.102177  0.9190
## GroupIF      0.0897360 0.29848782  61   0.300635  0.7647
## ActivityDT   1.7431694 0.06076117 300  28.688871  0.0000
## Correlation:
##      (Intr) GropIN GropBF GropIF
## GroupIN    -0.739
## GroupBF    -0.687  0.518
## GroupIF    -0.720  0.542  0.504
## ActivityDT -0.139  0.000  0.000  0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.55122903 -0.54685588 -0.02736085  0.45922973  2.18086539
##
## Number of Observations: 366
## Number of Groups: 65
```



Activity	Group	n
ST	BN	43
ST	IN	55
ST	BF	40
ST	IF	45
DT	BN	43
DT	IN	55
DT	BF	40
DT	IF	45

**PP, 2 Groups:**

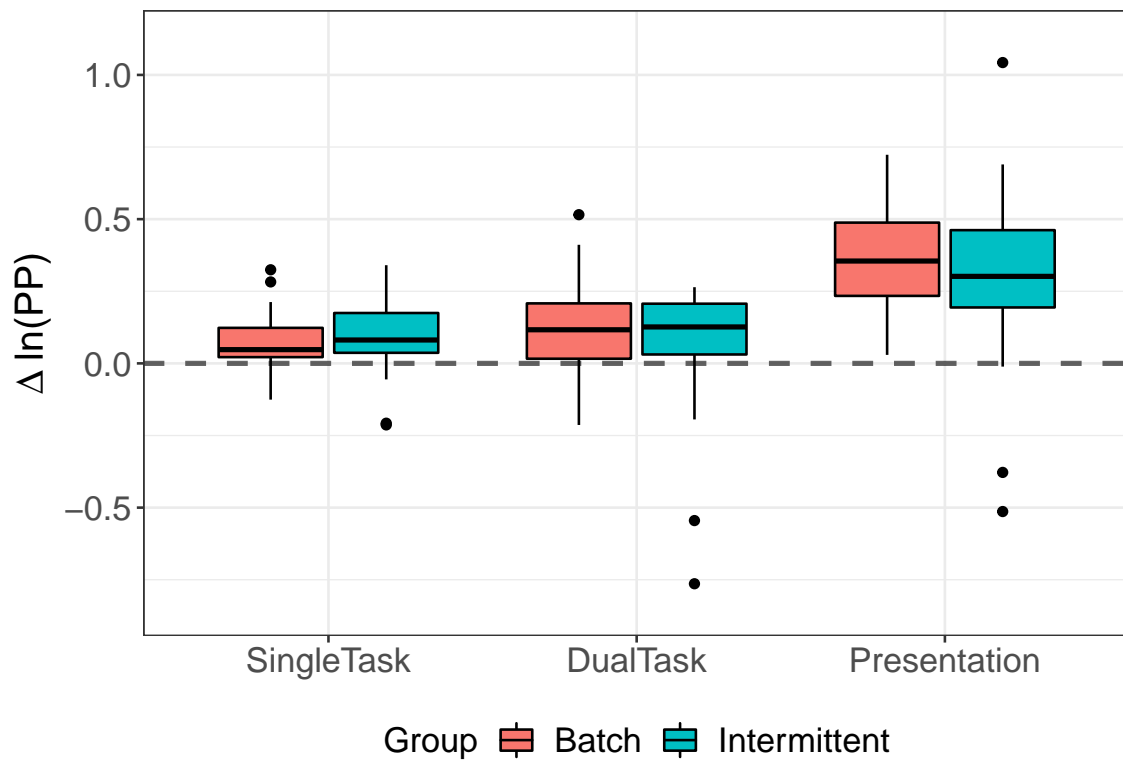
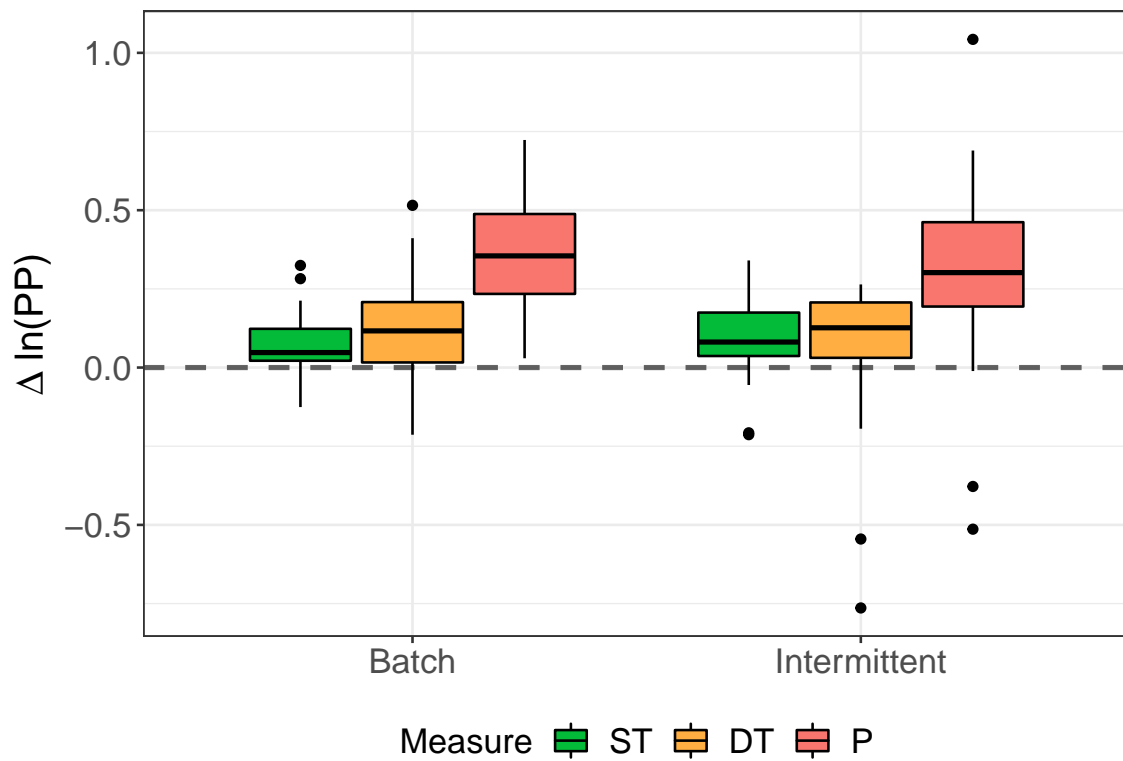


## Stress Levels Across Activities

Our Linear Model:

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

```
## Linear mixed-effects model fit by REML
## Data: diff_df
##      AIC      BIC    logLik
## -190.2974 -165.4812 102.1487
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept) Residual
## StdDev:   0.1366331 0.1254346
##
## Fixed effects: PP ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept)   0.10277792 0.03054843 192   3.364426  0.0009
## GroupIntermittent -0.02981584 0.03721068 64  -0.801271  0.4259
## ActivityB        -0.03929974 0.02194106 192  -1.791151  0.0748
## ActivityDT        0.01469432 0.02183537 192   0.672960  0.5018
## ActivityP        0.24382752 0.02204962 192  11.058130  0.0000
## Correlation:
##              (Intr) GrpInt ActvtB ActvDT
## GroupIntermittent -0.664
## ActivityB          -0.354 -0.003
## ActivityDT          -0.357  0.000  0.498
## ActivityP          -0.357  0.005  0.493  0.495
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -3.7336040 -0.4020245 -0.0522257  0.4340779  4.3003452
##
## Number of Observations: 261
## Number of Groups: 66
```

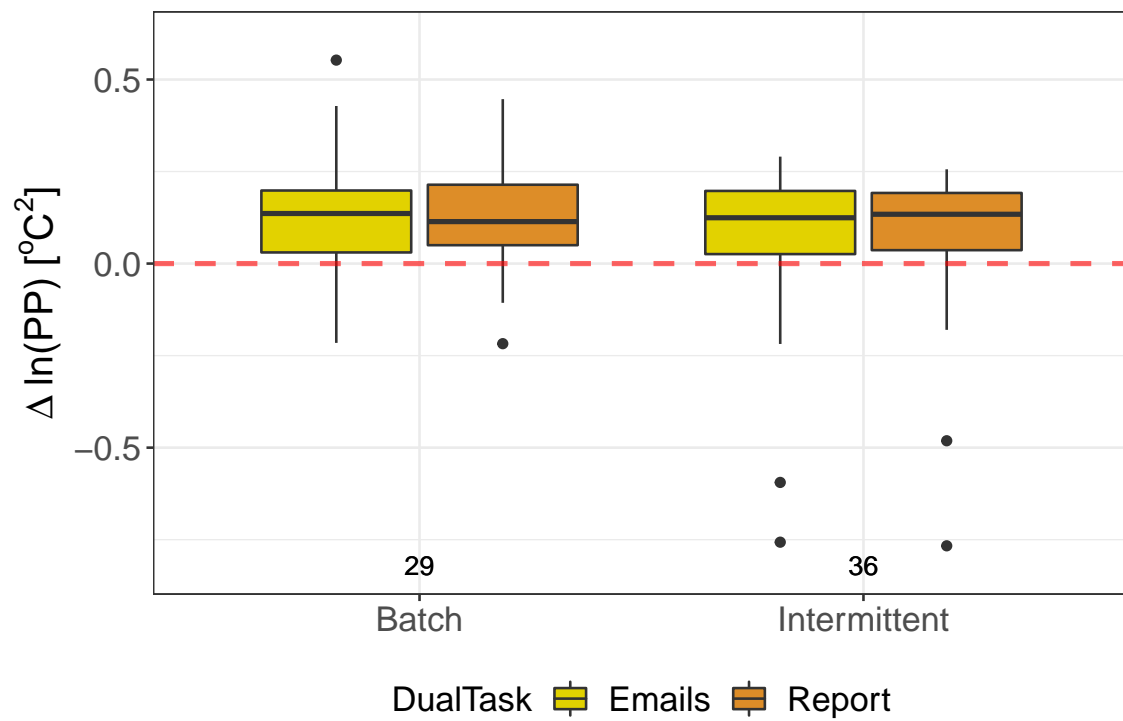


## Stress Levels for Dual Task

Our Linear Model:

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

```
## Linear mixed-effects model fit by REML
## Data: total_df
##      AIC      BIC    logLik
## -249.3766 -235.1557 129.6883
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept)  Residual
## StdDev:    0.1851428 0.02677144
##
## Fixed effects: PP ~ 1 + Group + DualTask
##              Value Std.Error DF   t-value p-value
## (Intercept)    0.13487059 0.03463907 64   3.893597  0.0002
## GroupIntermittent -0.05919015 0.04643780 63  -1.274612  0.2071
## DualTaskReport    -0.00249349 0.00469602 64  -0.530980  0.5973
## Correlation:
##              (Intr) GrpInt
## GroupIntermittent -0.742
## DualTaskReport    -0.068  0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.397230806 -0.449512451  0.006490064  0.371394466  2.075242947
##
## Number of Observations: 130
## Number of Groups: 65
```



```
## Paired t-test
## For Batch, p = 0.2975 > 0.05

## Paired t-test
## For Intermittent, p = 0.6066 > 0.05
```

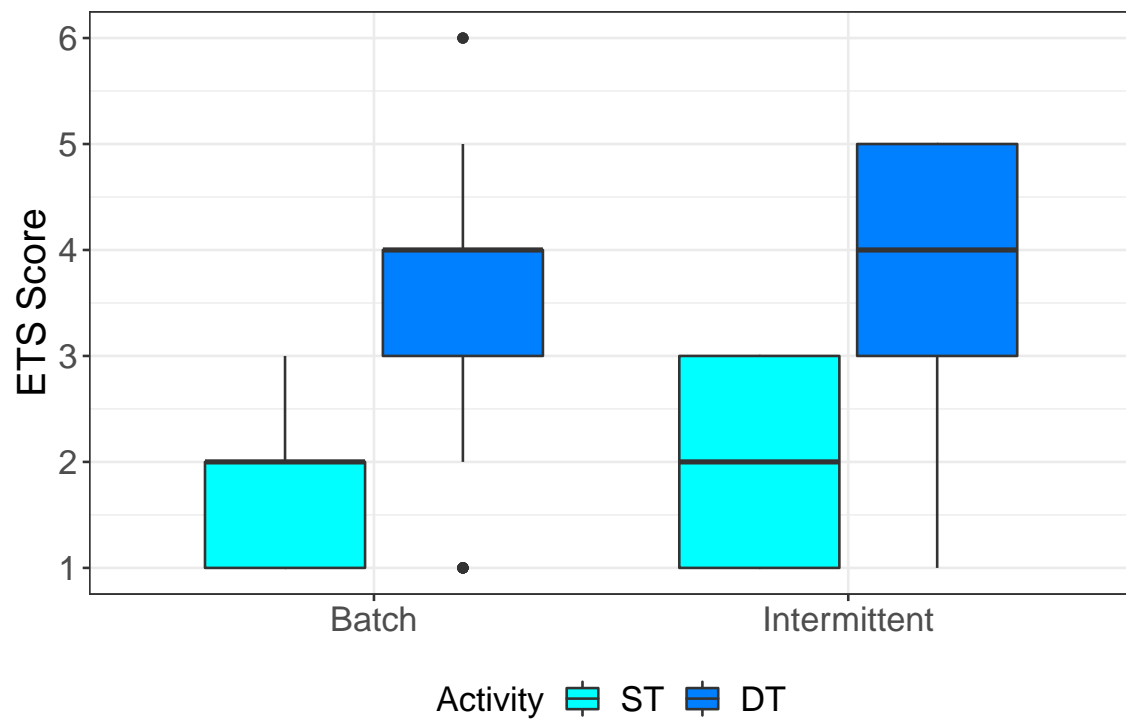
## Linear Modelling for Writing Quality

Our Linear Model:

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

---

```
## Linear mixed-effects model fit by REML
## Data: full_df
##      AIC      BIC    logLik
##  812.5732 832.0452 -401.2866
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept)  Residual
## StdDev:    0.7903461 0.5811993
##
## Fixed effects: Score ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept)   1.9645677 0.14548171 300 13.503881  0.000
## GroupIntermittent 0.0252212 0.20621865  63  0.122303  0.903
## ActivityDT       1.7431694 0.06075955 300 28.689636  0.000
## Correlation:
##              (Intr) GrpInt
## GroupIntermittent -0.675
## ActivityDT        -0.209  0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.55358078 -0.54490694 -0.02151113  0.44926958  2.16984967
##
## Number of Observations: 366
## Number of Groups: 65
```



Activity	Group	n
ST	Batch	98
ST	Intermittent	85
DT	Batch	98
DT	Intermittent	85

**HR, 2 Groups:**

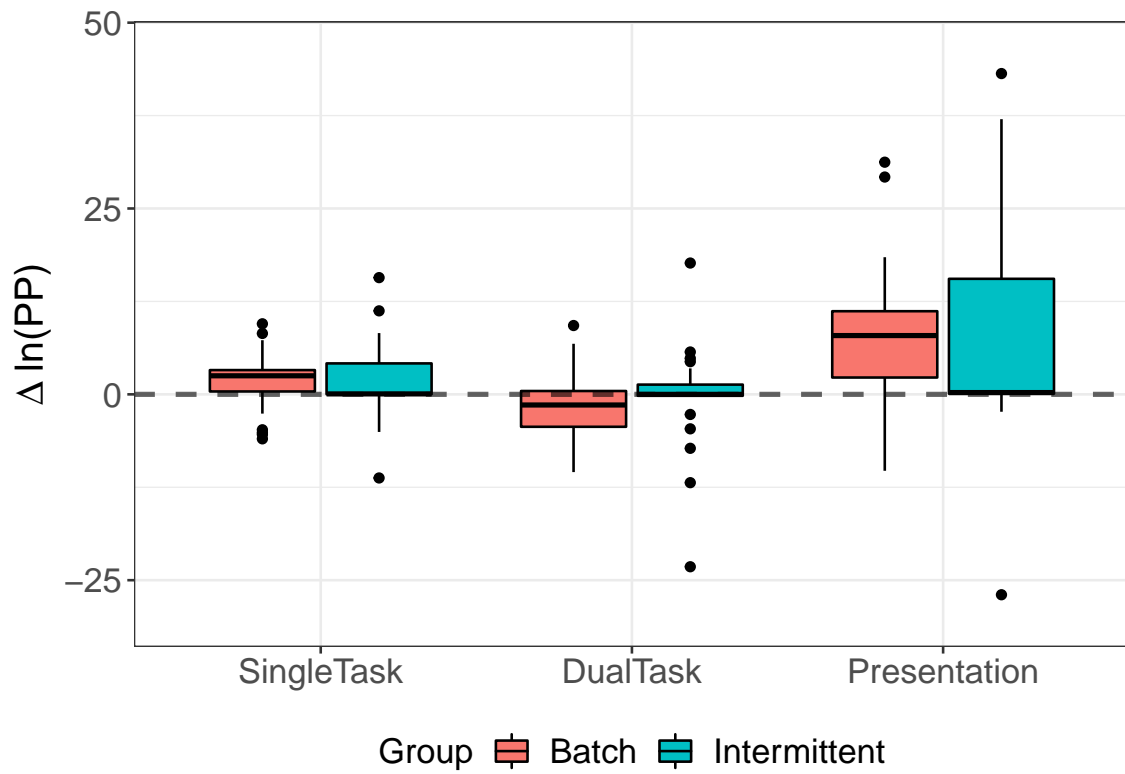
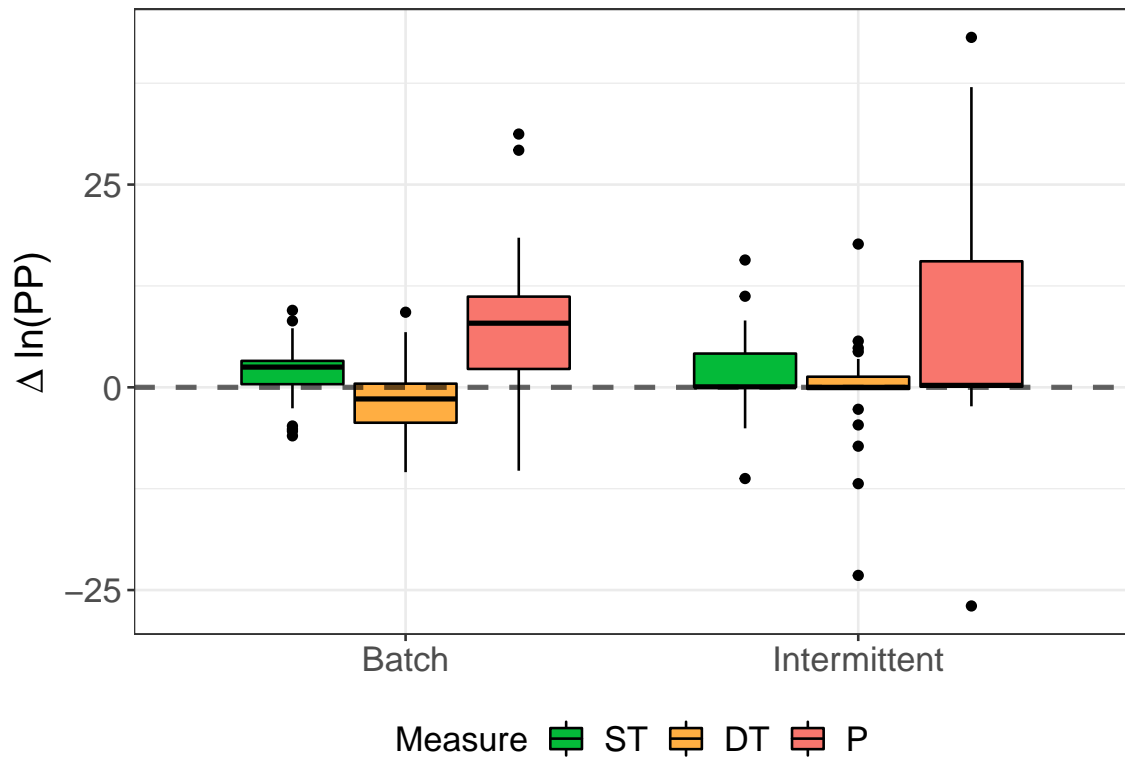
## Stress Levels Across Activities

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
## 1408.064 1431.427 -697.0319
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept) Residual
## StdDev:      5.107801 5.452549
##
## Fixed effects: HR ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept)   2.143937  1.285510 155   1.667771  0.0974
## GroupIntermittent -0.238614  1.568514  53  -0.152127  0.8797
## ActivityB        -2.454762  1.045728 155  -2.347419  0.0202
## ActivityDT        -2.983310  1.039760 155  -2.869229  0.0047
## ActivityP         5.491541  1.078591 155   5.091401  0.0000
## Correlation:
##              (Intr) GrpInt ActvtB ActvDT
## GroupIntermittent -0.621
## ActivityB          -0.404  0.004
## ActivityDT          -0.404  0.000  0.497
## ActivityP          -0.395  0.008  0.479  0.482
##
## Standardized Within-Group Residuals:
##              Min              Q1              Med              Q3              Max
## -3.307528856 -0.434774431  0.008940345  0.374207295  5.009845308
##
## Number of Observations: 213
## Number of Groups: 55
```



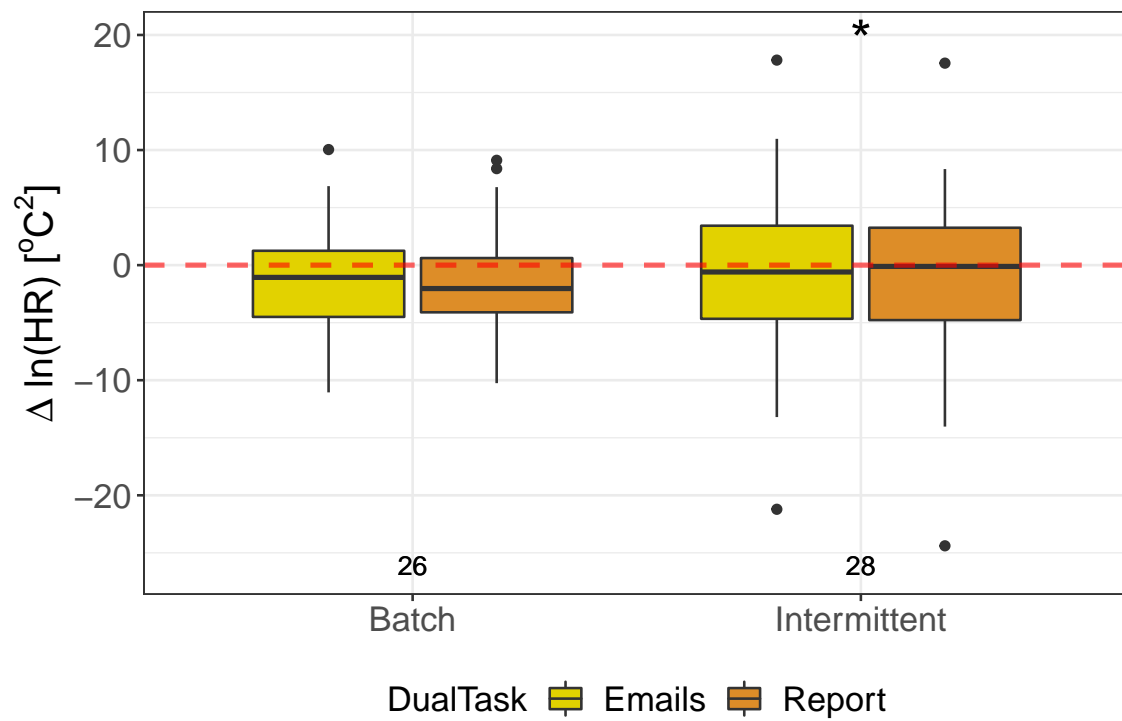


## Stress Levels for Dual Task

Our Linear Model:

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

```
## Linear mixed-effects model fit by REML
## Data: total_df
##      AIC      BIC    logLik
## 564.7997 578.0695 -277.3999
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept) Residual
## StdDev:      6.339725 1.169079
##
## Fixed effects: HR ~ 1 + Group + DualTask
##              Value Std.Error DF   t-value p-value
## (Intercept)  -0.9641354 1.2588841 53 -0.7658651 0.4472
## GroupIntermittent 0.0997138 1.7412561 52 0.0572655 0.9546
## DualTaskReport  -0.3896584 0.2249894 53 -1.7318966 0.0891
## Correlation:
##              (Intr) GrpInt
## GroupIntermittent -0.717
## DualTaskReport  -0.089 0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.08303345 -0.40857887 0.05106419 0.38434907 2.30886567
##
## Number of Observations: 108
## Number of Groups: 54
```



```
## Paired t-test
## For Batch, p = 0.6287 > 0.05

## Paired t-test
## For Intermittent, p = 0.0401 < 0.05 *
```

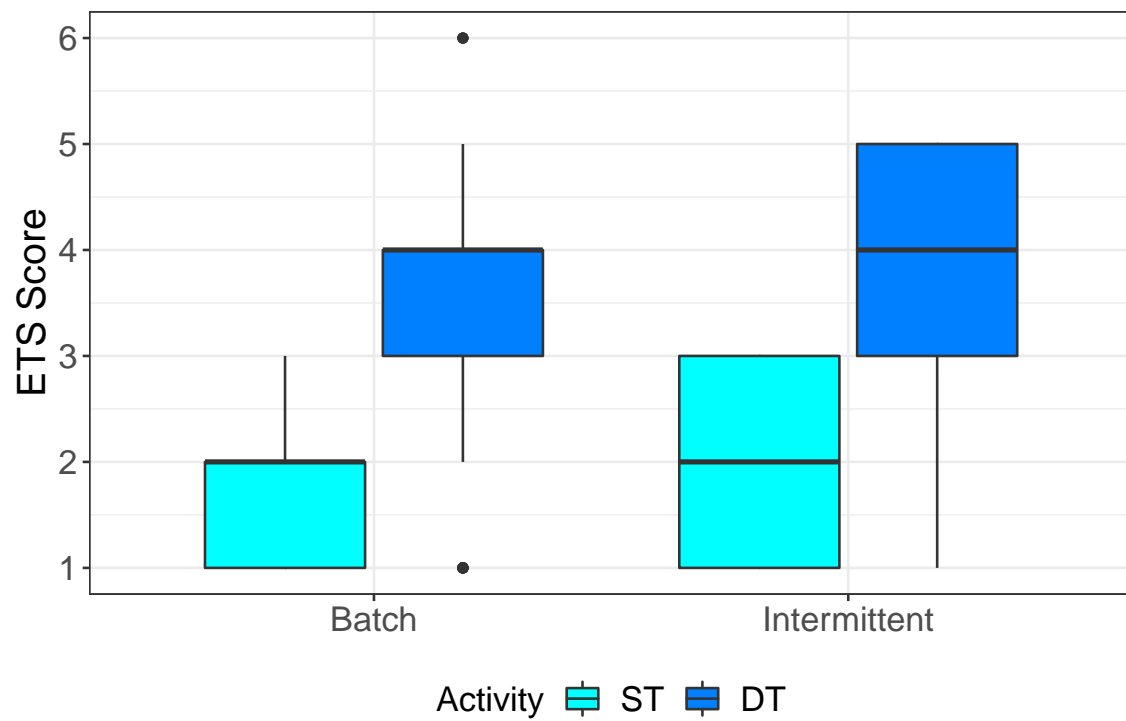
## Linear Modelling for Writing Quality

Our Linear Model:

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

---

```
## Linear mixed-effects model fit by REML
## Data: full_df
##      AIC      BIC    logLik
##  812.5732 832.0452 -401.2866
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept) Residual
## StdDev:   0.7903461 0.5811993
##
## Fixed effects: Score ~ 1 + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept)   1.9645677 0.14548171 300 13.503881  0.000
## GroupIntermittent 0.0252212 0.20621865  63  0.122303  0.903
## ActivityDT      1.7431694 0.06075955 300 28.689636  0.000
## Correlation:
##              (Intr) GrpInt
## GroupIntermittent -0.675
## ActivityDT        -0.209  0.000
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.55358078 -0.54490694 -0.02151113  0.44926958  2.16984967
##
## Number of Observations: 366
## Number of Groups: 65
```



Activity	Group	n
ST	Batch	98
ST	Intermittent	85
DT	Batch	98
DT	Intermittent	85

## Let's Get to 10 ★ 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
##   -97.37338 -74.68312 56.68669
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept)  Residual
## StdDev:    0.1160218 0.1047286
##
## Fixed effects: PP ~ 1 + ETSScore + Group + Activity
##              Value Std.Error DF   t-value p-value
## (Intercept)  0.07830843 0.04478419 65   1.7485732  0.0851
## ETSScore      0.00632252 0.01347347 65   0.4692574  0.6405
## GroupIN      -0.02413960 0.04745506 61  -0.5086834  0.6128
## GroupBF      -0.00071965 0.05114987 61  -0.0140695  0.9888
## GroupIF       0.00261483 0.04877144 61   0.0536139  0.9574
## ActivityDT    0.00308268 0.03020997 65   0.1020418  0.9190
## Correlation:
##      (Intr) ETSScr GropIN GropBF GropIF
## ETSScore   -0.573
## GroupIN    -0.584 -0.017
## GroupBF    -0.548 -0.006  0.520
## GroupIF    -0.565 -0.023  0.546  0.506
## ActivityDT  0.334 -0.797  0.014  0.005  0.018
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -4.25944641 -0.30605522 -0.01964231  0.33825689  2.33237928
##
## Number of Observations: 132
## Number of Groups: 65
```

## Hey! Let's ANOVA!

Our ANOVA Model:

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

---

```
##              Df Sum Sq Mean Sq F value Pr(>F)
## StressFactor    1 0.0059  0.00592   0.166  0.685
## IntermittentFactor 1 0.0548  0.05480   1.540  0.219
## Residuals      63 2.2425  0.03560

##  Tukey multiple comparisons of means
##    95% family-wise confidence level
##
## Fit: aov(formula = PP ~ 1 + StressFactor + IntermittentFactor, data = diff_df, na.action = na.omit)
##
## $StressFactor
##              diff              lwr              upr              p adj
## High-Low 0.01895161 -0.07390701 0.1118102 0.6847714
##
## $IntermittentFactor
##              diff              lwr              upr              p adj
## Intermittent-Non-Intermittent -0.05784808 -0.15105 0.03535383 0.2194568
```

## Now a Linear Model Very Close to the ANOVA One Above:

Our Linear Model:

$$\Delta \ln(\bar{PP}) = 1 + \text{StressIndicator} + \text{IntermittencyIndicator} + 1|\text{Subjects}$$

---

```
## Linear mixed-effects model fit by REML
## Data: diff_df
##      AIC      BIC  logLik
## -11.56681 -0.8511323 10.7834
##
## Random effects:
## Formula: ~1 | Subject
##      (Intercept)  Residual
## StdDev:    0.1766541 0.06624529
##
## Fixed effects: PP ~ 1 + StressFactor + IntermittentFactor
##                                     Value Std.Error DF   t-value
## (Intercept)                0.12437204 0.04155398 63  2.9930235
## StressFactorHigh            0.01735531 0.04648567 63  0.3733476
## IntermittentFactorIntermittent -0.05789242 0.04665752 63 -1.2407949
##                                     p-value
## (Intercept)                0.0039
## StressFactorHigh            0.7101
## IntermittentFactorIntermittent 0.2193
## Correlation:
##                                     (Intr) StrsFH
## StressFactorHigh                -0.559
## IntermittentFactorIntermittent -0.627  0.028
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.54542253 -0.12218771  0.03174836  0.21097440  0.72781883
##
## Number of Observations: 66
## Number of Groups: 66
```



## Hey! Let's ANOVA 2: With Interaction Effects

Our ANOVA Model:

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

---

```
##              Df Sum Sq Mean Sq F value Pr(>F)
## StressFactor      1 0.0059  0.00592    0.165   0.686
## IntermittentFactor  1 0.0548  0.05480    1.529   0.221
## StressFactor:IntermittentFactor  1 0.0203  0.02032    0.567   0.454
## Residuals        62 2.2222  0.03584

##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = PP ~ 1 + StressFactor * IntermittentFactor, data = diff_df, na.action = na.omit)
##
## $StressFactor
##           diff           lwr           upr           p adj
## High-Low 0.01895161 -0.0742573 0.1121605 0.6858197
##
## $IntermittentFactor
##           diff           lwr           upr           p adj
## Intermittent-Non-Intermittent -0.05784808 -0.1514016 0.03570542 0.2211031
##
## $`StressFactor:IntermittentFactor`
##           diff           lwr
## High:Non-Intermittent-Low:Non-Intermittent -0.02105726 -0.2035659
## Low:Intermittent-Low:Non-Intermittent      -0.09226156 -0.2648975
## High:Intermittent-Low:Non-Intermittent      -0.04279667 -0.2198561
## Low:Intermittent-High:Non-Intermittent      -0.07120430 -0.2438402
## High:Intermittent-High:Non-Intermittent     -0.02173941 -0.1987988
## High:Intermittent-Low:Intermittent          0.04946489 -0.1173997
##           upr           p adj
## High:Non-Intermittent-Low:Non-Intermittent 0.16145142 0.9900928
## Low:Intermittent-Low:Non-Intermittent      0.08037437 0.4974272
## High:Intermittent-Low:Non-Intermittent      0.13426276 0.9192577
## Low:Intermittent-High:Non-Intermittent      0.10143163 0.6975664
## High:Intermittent-High:Non-Intermittent     0.15532002 0.9881176
## High:Intermittent-Low:Intermittent         0.21632947 0.8620509
```