

# ABCD SL Analysis

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## Compute RT for VSL

- two groups are not different in target detection d-prime
- the DD group showed a significantly negative RT slope
- the TYP group showed a nonsignificantly negative RT slope
- Test the group difference in VSL

```
##
## Wilcoxon rank sum test with continuity correction
##
## data:  dprime by group
## W = 174.5, p-value = 0.5461
## alternative hypothesis: true location shift is not equal to 0
##
##
## Wilcoxon rank sum test
##
## data:  mean_rt by group
## W = 157, p-value = 0.3022
## alternative hypothesis: true location shift is not equal to 0
##
##
## One Sample t-test
##
## data:  subj_table$rt_slope[subj_table$group == "DD"]
## t = -2.6421, df = 16, p-value = 0.008877
## alternative hypothesis: true mean is less than 0
## 95 percent confidence interval:
##      -Inf -0.9116466
## sample estimates:
## mean of x
## -2.687647
##
##
## One Sample t-test
##
## data:  subj_table$rt_slope[subj_table$group == "TYP"]
## t = -0.83727, df = 22, p-value = 0.2057
## alternative hypothesis: true mean is less than 0
## 95 percent confidence interval:
##      -Inf 0.5534928
## sample estimates:
## mean of x
## -0.5266957
```

- VSL RT summary stats (mean +/- sd)

```
## # A tibble: 2 x 5
##   group count rt          slope          d_prime
##   <chr> <int> <chr>          <chr>          <chr>
## 1 DD      17 "475.36  $\pm$  70.75" "-2.69  $\pm$  4.19" "6.57  $\pm$  2.30"
## 2 TYP      23 "491.24  $\pm$  70.15" "-0.53  $\pm$  3.02" "7.44  $\pm$  1.63"
```

- The DD group had a faster RT acceleration than the TYP group tested by linear regression models

```
##
## Call:
## lm(formula = rt_col ~ reindex * group_cond, data = fam_trial_vsl)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -955.47  -61.12    3.55   67.06  312.66
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    509.8174    11.3636  44.864 < 2e-16 ***
## reindex         -3.0266     0.8014  -3.777 0.000169 ***
## group_condTYP   -11.3419    14.9059  -0.761 0.446907
## reindex:group_condTYP  2.4915     1.0492   2.375 0.017764 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 109.3 on 933 degrees of freedom
## Multiple R-squared:  0.02318,    Adjusted R-squared:  0.02004
## F-statistic: 7.381 on 3 and 933 DF,  p-value: 6.86e-05
##
## Call:
## lm(formula = rt_col ~ reindex * group_cond, data = fam_trial_vsl_scale)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.4363 -0.6037 -0.0520  0.5850  3.6945
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.294333   0.101298   2.906 0.00375 **
## reindex        -0.023750   0.007144  -3.325 0.00092 ***
## group_condTYP   -0.273308   0.132874  -2.057 0.03997 *
## reindex:group_condTYP  0.022062   0.009353   2.359 0.01853 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9747 on 933 degrees of freedom
## Multiple R-squared:  0.01179,    Adjusted R-squared:  0.008613
## F-statistic: 3.711 on 3 and 933 DF,  p-value: 0.01134
```

- marginal results with the raw RT data and significant results (same as linear regression) with the scaled data tested by lmer.

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: rt_col ~ group_cond * reindex + (1 | id) + (0 + reindex | id)
```

```

## Data: fam_trial_vsl
##
## REML criterion at convergence: 11110.8
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -9.7061 -0.4878 -0.0532  0.5078  3.9472
##
## Random effects:
##   Groups   Name                Variance Std.Dev.
##   id       (Intercept) 3229.282  56.827
##   id.1     reindex      7.157   2.675
##   Residual                    7345.982  85.709
## Number of obs: 937, groups: id, 40
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    509.3485    16.4184  46.2600   31.023 < 2e-16 ***
## group_condTYP   -11.2609    21.6141  45.9500   -0.521  0.60487
## reindex         -2.7352     0.9047  46.3700   -3.023  0.00406 **
## group_condTYP:reindex  2.1924     1.1882  45.7100    1.845  0.07150 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) gr_TYP reindx
## group_cndTYP -0.760
## reindex      -0.331  0.251
## grp_cndTYP:  0.252 -0.328 -0.761
##
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: rt_col ~ group_cond * reindex + (1 | id) + (0 + reindex | id)
## Data: fam_trial_vsl_scale
##
## REML criterion at convergence: 2632.2
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.5513 -0.6194 -0.0533  0.6002  3.7903
##
## Random effects:
##   Groups   Name                Variance Std.Dev.
##   id       (Intercept) 0.0000  0.0000
##   id.1     reindex      0.0000  0.0000
##   Residual                    0.9501  0.9747
## Number of obs: 937, groups: id, 40
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    0.294333    0.101298 933.000000    2.906  0.00375
## group_condTYP   -0.273308    0.132874 933.000000   -2.057  0.03997
## reindex         -0.023750    0.007144 933.000000   -3.325  0.00092
## group_condTYP:reindex  0.022062    0.009353 933.000000    2.359  0.01853

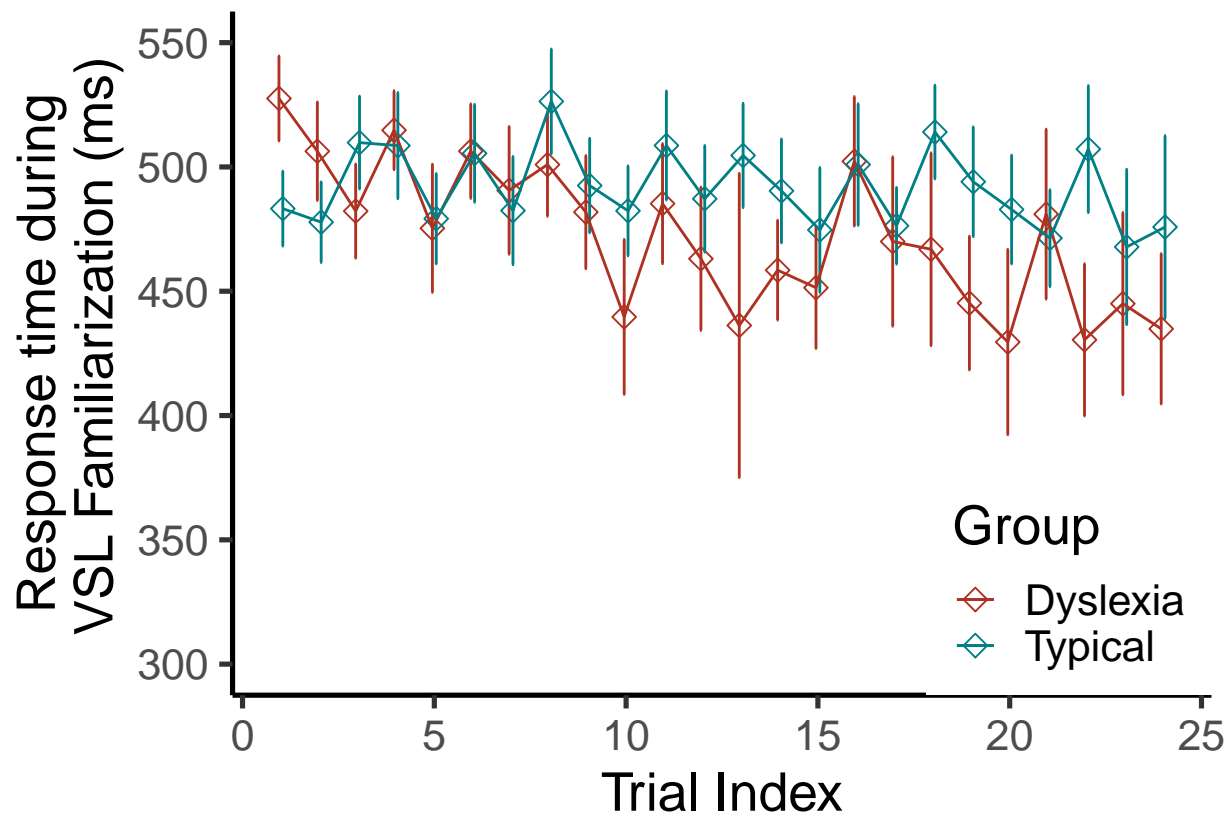
```

```
##
## (Intercept)          **
## group_condTYP        *
## reindex              ***
## group_condTYP:reindex *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) gr_TYP reindx
## grop_cndTYP -0.762
## reindex      -0.874  0.666
## grp_cndTYP:  0.668 -0.874 -0.764
```

## Plot of VSL RT

### RT as the function of Target repetition

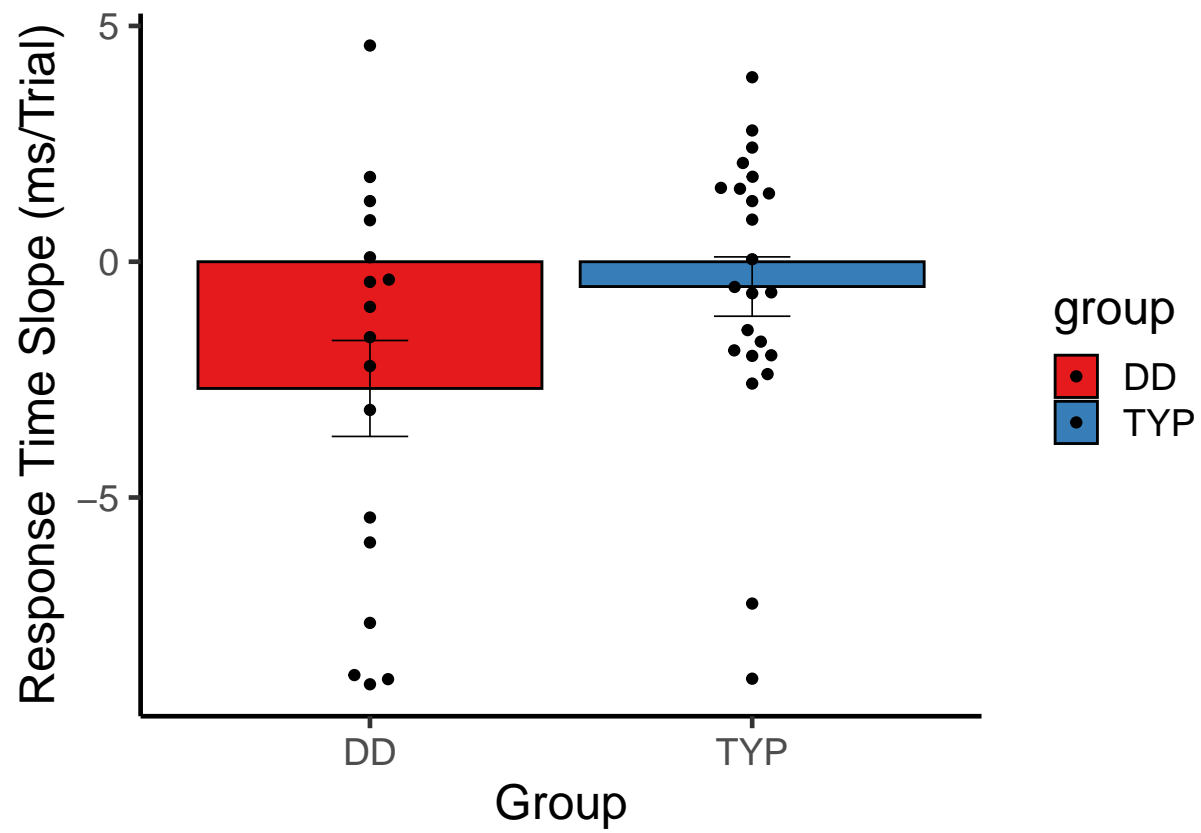
```
##      reindex      group_cond      mean_RT      sd_RT
## Min.   : 1.00    DD :24      Min.   :429.6    Min.   : 65.32
## 1st Qu.: 6.75    TYP:24      1st Qu.:469.5    1st Qu.: 87.90
## Median :12.50                Median :482.4    Median :102.38
## Mean   :12.50                Mean   :481.8    Mean   :107.31
## 3rd Qu.:18.25                3rd Qu.:502.8    3rd Qu.:120.30
## Max.   :24.00                Max.   :527.5    Max.   :252.06
##      length      se
## Min.   :14.00    Min.   :15.02
## 1st Qu.:16.75    1st Qu.:19.32
## Median :19.00    Median :21.86
## Mean   :19.52    Mean   :24.65
## 3rd Qu.:23.00    3rd Qu.:27.33
## Max.   :23.00    Max.   :61.13
```



plot mean RT slope across the two groups

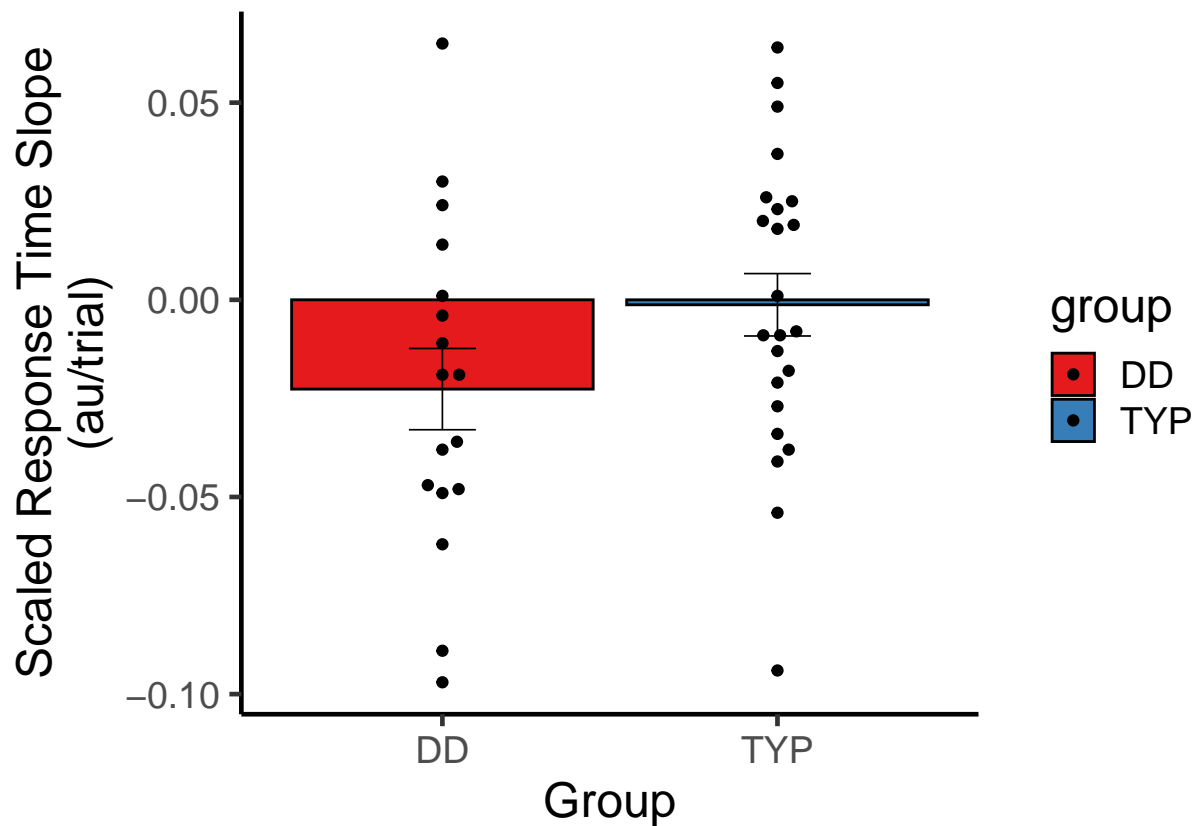
- mean RT slope

## No summary function supplied, defaulting to `mean\_se()`



- mean RT slope scaled

## No summary function supplied, defaulting to `mean\_se()`



## Compute RT for TSL

- The two groups are not different in the target detection task
- Neither group showed a significant negative RT slope.

```
##
## Wilcoxon rank sum test
##
## data: dprime by group
## W = 173, p-value = 0.6135
## alternative hypothesis: true location shift is not equal to 0
##
##
## Wilcoxon rank sum test
##
## data: mean_rt by group
## W = 231, p-value = 0.2915
## alternative hypothesis: true location shift is not equal to 0
##
##
## One Sample t-test
##
## data: subj_table$rt_slope[subj_table$group == "DD"]
## t = -0.40501, df = 15, p-value = 0.3456
## alternative hypothesis: true mean is less than 0
## 95 percent confidence interval:
##      -Inf 1.896363
```

```
## sample estimates:
## mean of x
## -0.56975
##
##
## One Sample t-test
##
## data: subj_table$rt_slope[subj_table$group == "TYP"]
## t = 1.2279, df = 23, p-value = 0.8841
## alternative hypothesis: true mean is less than 0
## 95 percent confidence interval:
##      -Inf 5.079512
## sample estimates:
## mean of x
## 2.120208
```

- TSL RT summary (mean +/- sd)

```
## # A tibble: 2 x 6
##   group count rt          slope      d_prime      hits
##   <chr> <int> <chr>          <chr>      <chr>      <chr>
## 1 DD      16 "400.34 $\\pm$ 1~ "-0.57 $\\pm$~ "1.07 $\\pm$ ~ "0.51 $\\pm$~
## 2 TYP      24 "372.78 $\\pm$ 8~ "2.12 $\\pm$ ~ "1.28 $\\pm$ ~ "0.54 $\\pm$~
```

- remove outliers who have hit rate lower than and equal to 0.25 (remaining participant: 14 DD and 18 TYP)
- participants removed from analysis: ABCD\_1705 ABCD\_1720 ABCD\_1747 ABCD\_1767 ABCD\_1783 ABCD\_1788 ABCD\_1709 ABCD\_1724

```
## # A tibble: 2 x 6
##   group count rt          slope      d_prime      hits
##   <chr> <int> <chr>          <chr>      <chr>      <chr>
## 1 DD      14 "408.55 $\\pm$ 1~ "-0.52 $\\pm$~ "1.15 $\\pm$ ~ "0.55 $\\pm$~
## 2 TYP      18 "356.03 $\\pm$ 8~ "0.12 $\\pm$ ~ "1.56 $\\pm$ ~ "0.66 $\\pm$~
```

- the two groups are not different in RT slope.

```
##
## Welch Two Sample t-test
##
## data: dprime by group
## t = -1.5595, df = 29.993, p-value = 0.1294
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.9410684 0.1261565
## sample estimates:
## mean in group DD mean in group TYP
##      1.152703      1.560159
##
## Welch Two Sample t-test
##
## data: rt_slope by group
## t = -0.34509, df = 29.433, p-value = 0.7325
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -4.428877 3.149384
```



```

## sample estimates:
## mean in group DD mean in group TYP
##      -0.5178571      0.1218889

##
## Call:
## lm(formula = rt_col ~ reindex * group_cond, data = fam_trial_tsl_usable)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -518.45 -206.05   -9.07   233.37   582.65
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      416.3073     27.5729   15.098 <2e-16 ***
## reindex           0.1412      0.9726    0.145  0.885
## group_condTYP     -53.7814     35.3733   -1.520  0.129
## reindex:group_condTYP -0.2229      1.2596   -0.177  0.860
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 265.7 on 941 degrees of freedom
## Multiple R-squared:  0.0118, Adjusted R-squared:  0.008652
## F-statistic: 3.746 on 3 and 941 DF, p-value: 0.0108

##
## Call:
## lm(formula = rt_col ~ reindex * group_cond, data = fam_trial_tsl_usable_s)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.2128 -0.7757 -0.2198  0.7533  3.2618
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.054084     0.102180    0.529  0.597
## reindex          -0.002201     0.003604   -0.611  0.541
## group_condTYP     -0.065300     0.131087   -0.498  0.619
## reindex:group_condTYP  0.002670     0.004668    0.572  0.568
##
## Residual standard error: 0.9848 on 941 degrees of freedom
## Multiple R-squared:  0.0004228, Adjusted R-squared:  -0.002764
## F-statistic: 0.1327 on 3 and 941 DF, p-value: 0.9406

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: rt_col ~ reindex * group_cond + (1 | id) + (0 + reindex | id)
## Data: fam_trial_tsl_usable
##
## REML criterion at convergence: 13150
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.1923 -0.7006 -0.1916  0.6837  2.6744
##

```

```

## Random effects:
##   Groups   Name      Variance Std.Dev.
##   id       (Intercept) 6440.088  80.250
##   id.1     reindex      5.037   2.244
##   Residual                62185.466 249.370
## Number of obs: 945, groups: id, 32
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      415.7086    33.9423   66.3100   12.247  <2e-16 ***
## reindex           -0.1611     1.1227   64.0100   -0.143    0.886
## group_condTYP     -57.8631    44.3086   60.4700   -1.306    0.197
## reindex:group_condTYP  0.1428     1.4586   59.4200    0.098    0.922
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) reindx gr_TYP
## reindex      -0.559
## grop_cndTYP  -0.766  0.428
## rndx:gr_TYP  0.430 -0.770 -0.545

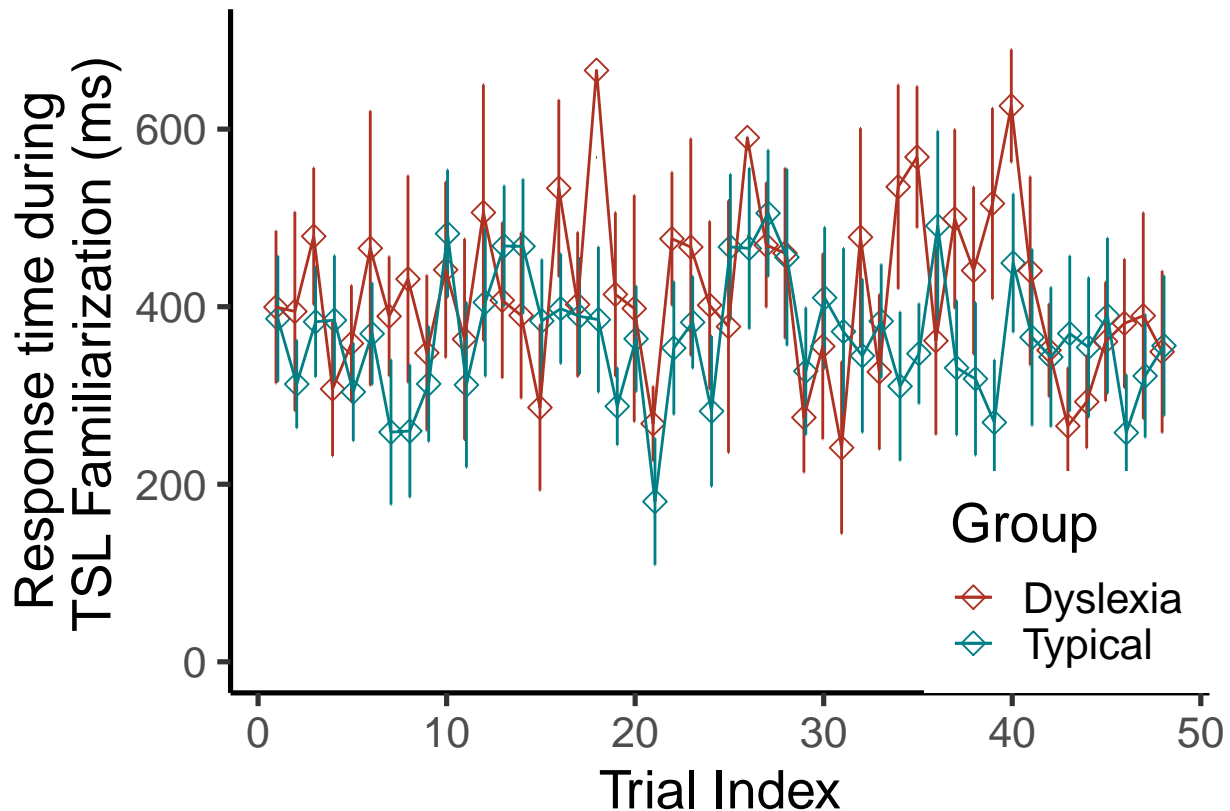
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: rt_col ~ reindex * group_cond + (1 | id) + (0 + reindex | id)
##   Data: fam_trial_tsl_usable_s
##
## REML criterion at convergence: 2676.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.2469 -0.7877 -0.2232  0.7649  3.3122
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   id       (Intercept) 0.0000   0.0000
##   id.1     reindex      0.0000   0.0000
##   Residual                0.9698   0.9848
## Number of obs: 945, groups: id, 32
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      0.054084   0.102180  941.000000    0.529    0.597
## reindex           -0.002201   0.003604  941.000000   -0.611    0.541
## group_condTYP     -0.065300   0.131087  941.000000   -0.498    0.619
## reindex:group_condTYP  0.002670   0.004668  941.000000    0.572    0.568
##
## Correlation of Fixed Effects:
##              (Intr) reindx gr_TYP
## reindex      -0.867
## grop_cndTYP  -0.779  0.675
## rndx:gr_TYP  0.669 -0.772 -0.866

```

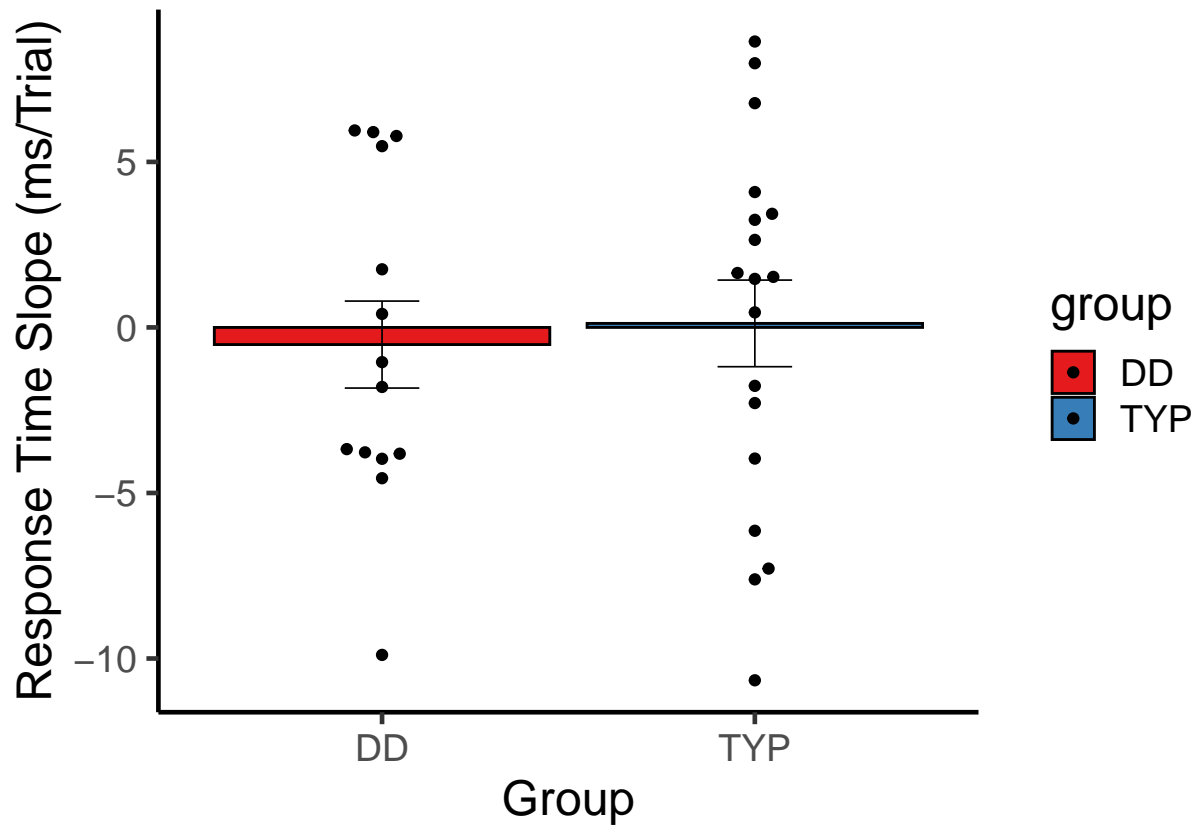
## Plot of TSL RT

RT as the function of Target repetition

```
##      reindex      group_cond      mean_RT      sd_RT      length
##  Min.   : 1.00      DD :48      Min.   :180.5      Min.   :132.7      Min.   : 5.0
##  1st Qu.:12.75      TYP:48      1st Qu.:340.3      1st Qu.:230.2      1st Qu.: 8.0
##  Median :24.50                      Median :383.8      Median :267.1      Median :11.0
##  Mean   :24.50                      Mean   :390.3      Mean   :262.4      Mean   :10.5
##  3rd Qu.:36.25                      3rd Qu.:450.8      3rd Qu.:297.6      3rd Qu.:13.0
##  Max.   :48.00                      Max.   :666.1      Max.   :378.5      Max.   :18.0
##      se
##  Min.   : 41.97
##  1st Qu.: 69.21
##  Median : 81.42
##  Mean   : 84.03
##  3rd Qu.: 96.09
##  Max.   :154.50
```

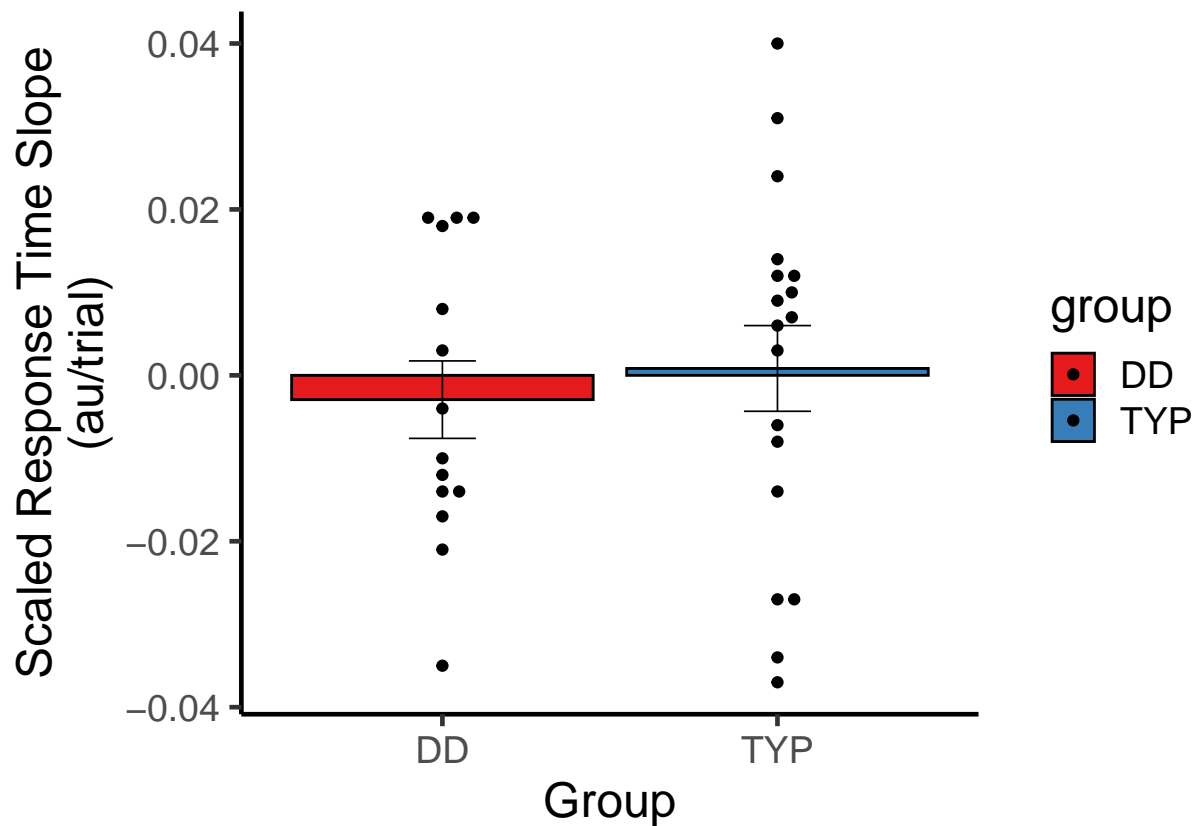


```
### plot mean RT slope across the two groups * mean RT slope
## Warning: Ignoring unknown parameters: fun.y, fun.ymin, fun.ymax
## No summary function supplied, defaulting to `mean_se()``
```



- mean RT slope scaled

```
## Warning: Ignoring unknown parameters: fun.y, fun.ymin, fun.ymax
## No summary function supplied, defaulting to `mean_se()``
```



Combine slope data of both tasks

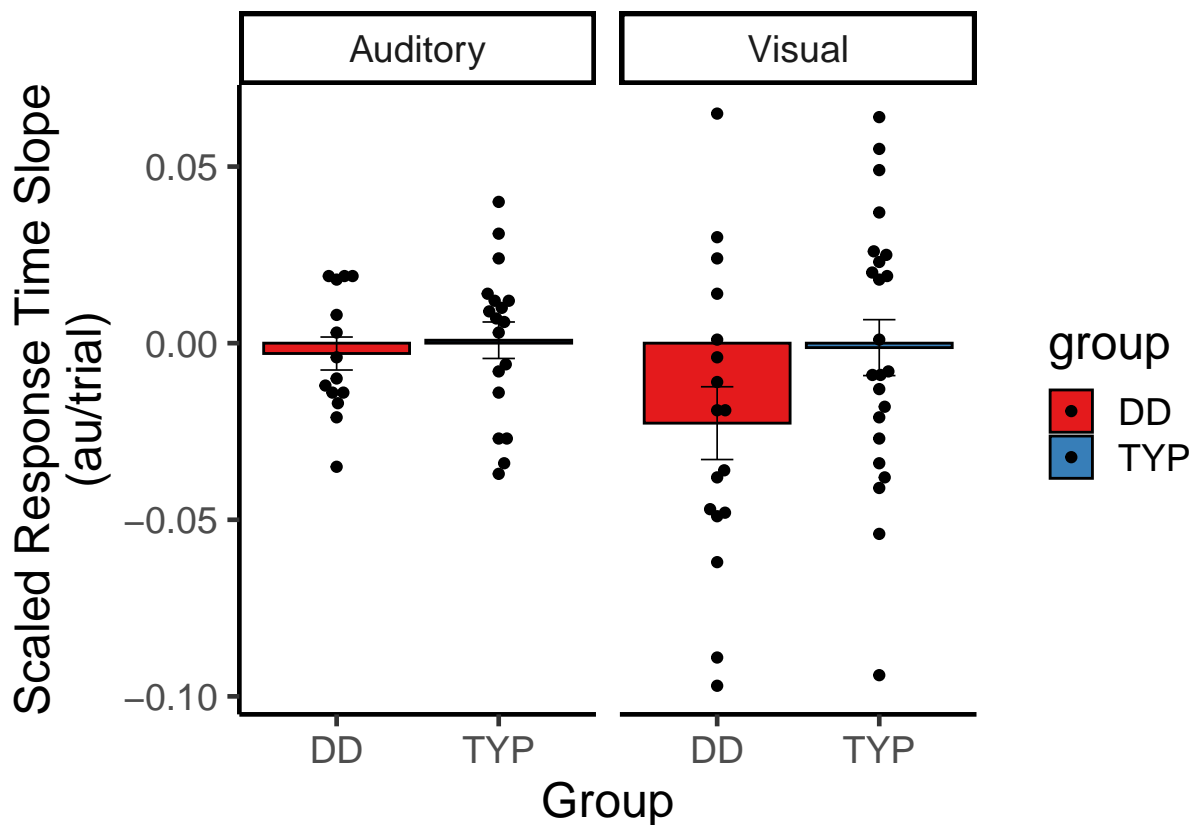
check interactions between task and group, using scaled RT: No interaction; anova showed marginal main effect of group (TYP is slower)

```
##
## Error: subj
##           Df  Sum Sq  Mean Sq F value Pr(>F)
## group      1 0.002526 0.0025258   2.681  0.112
## Residuals 29 0.027323 0.0009422
##
## Error: subj:task
##           Df  Sum Sq  Mean Sq F value Pr(>F)
## task       1 0.00243 0.002428   1.833  0.186
## task:group  1 0.00103 0.001030   0.778  0.385
## Residuals  29 0.03841 0.001324
##
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: rt_col ~ task * group_cond + (1 + task | id) + (1 | reindex)
## Data: all_fam_trials
##
## REML criterion at convergence: 5283.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.5299 -0.7082 -0.1188  0.6724  3.7965
##
```

```
## Random effects:
## Groups   Name      Variance Std.Dev.  Corr
## reindex  (Intercept) 5.895e-03 7.678e-02
## id       (Intercept) 0.000e+00 0.000e+00
##          taskVisual  1.583e-17 3.979e-09  NaN
## Residual                9.581e-01 9.788e-01
## Number of obs: 1882, groups: reindex, 48; id, 41
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   -1.602e-04  5.193e-02  6.381e+02  -0.003    0.998
## taskVisual     2.496e-03  7.160e-02  1.508e+03   0.035    0.972
## group_condTYP   3.455e-04  6.520e-02  1.859e+03   0.005    0.996
## taskVisual:group_condTYP -1.683e-04  9.195e-02  1.849e+03  -0.002    0.999
##
## Correlation of Fixed Effects:
##              (Intr) tskVsl gr_TYP
## taskVisual  -0.692
## grop_cndTYP -0.760  0.552
## tskVsl:_TYP  0.539 -0.763 -0.709
```

- plot both tasks (scaled RT)

```
## Warning: Ignoring unknown parameters: fun.y, fun.ymin, fun.ymax
## No summary function supplied, defaulting to `mean_se()`
## No summary function supplied, defaulting to `mean_se()`
```



## Compute accuracy

### Accuracy Data Summary (mean +/- sd)

```
## # A tibble: 4 x 4
## # Groups:   group [2]
##   group   task   count accuracy
##   <chr>   <chr>   <int> <chr>
## 1 Dyslexic Auditory    16 "0.55  $\pm$  0.09"
## 2 Dyslexic Visual     17 "0.72  $\pm$  0.21"
## 3 Typical  Auditory    24 "0.66  $\pm$  0.13"
## 4 Typical  Visual     23 "0.67  $\pm$  0.23"
```

### Look into group performance between Dyl and Typ

simple t test: both groups performed above chance for both tasks

```
##
## One Sample t-test
##
## data: DD_acc_vsl
## t = 4.3948, df = 16, p-value = 0.0002261
## alternative hypothesis: true mean is greater than 0.5
## 95 percent confidence interval:
##  0.6329919      Inf
## sample estimates:
## mean of x
##  0.7206471
##
## One Sample t-test
##
## data: DD_acc_tsl
## t = 2.1928, df = 15, p-value = 0.02225
## alternative hypothesis: true mean is greater than 0.5
## 95 percent confidence interval:
##  0.5097758      Inf
## sample estimates:
## mean of x
##  0.54875
##
## One Sample t-test
##
## data: TYP_acc_vsl
## t = 3.5474, df = 22, p-value = 0.0009032
## alternative hypothesis: true mean is greater than 0.5
## 95 percent confidence interval:
##  0.5883823      Inf
## sample estimates:
## mean of x
##  0.6713043
##
## One Sample t-test
##
```

```
## data: TYP_acc_tsl
## t = 6.2175, df = 23, p-value = 1.208e-06
## alternative hypothesis: true mean is greater than 0.5
## 95 percent confidence interval:
## 0.616952      Inf
## sample estimates:
## mean of x
## 0.6614583
```

anova: marginal main effect of task and marginal interaction between task and group

```
##
## Error: subj
##           Df Sum Sq Mean Sq F value Pr(>F)
## group      1 0.0222 0.02218   0.754  0.391
## Residuals 37 1.0889 0.02943
##
## Error: subj:task
##           Df Sum Sq Mean Sq F value Pr(>F)
## task       1 0.1086 0.10864   3.221 0.0809 .
## task:group 1 0.1088 0.10877   3.225 0.0807 .
## Residuals 37 1.2480 0.03373
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

generalized linear effect modeling: main effect of task (visual > auditory); main effect of group (TYP > DD); marginal interaction between task and group

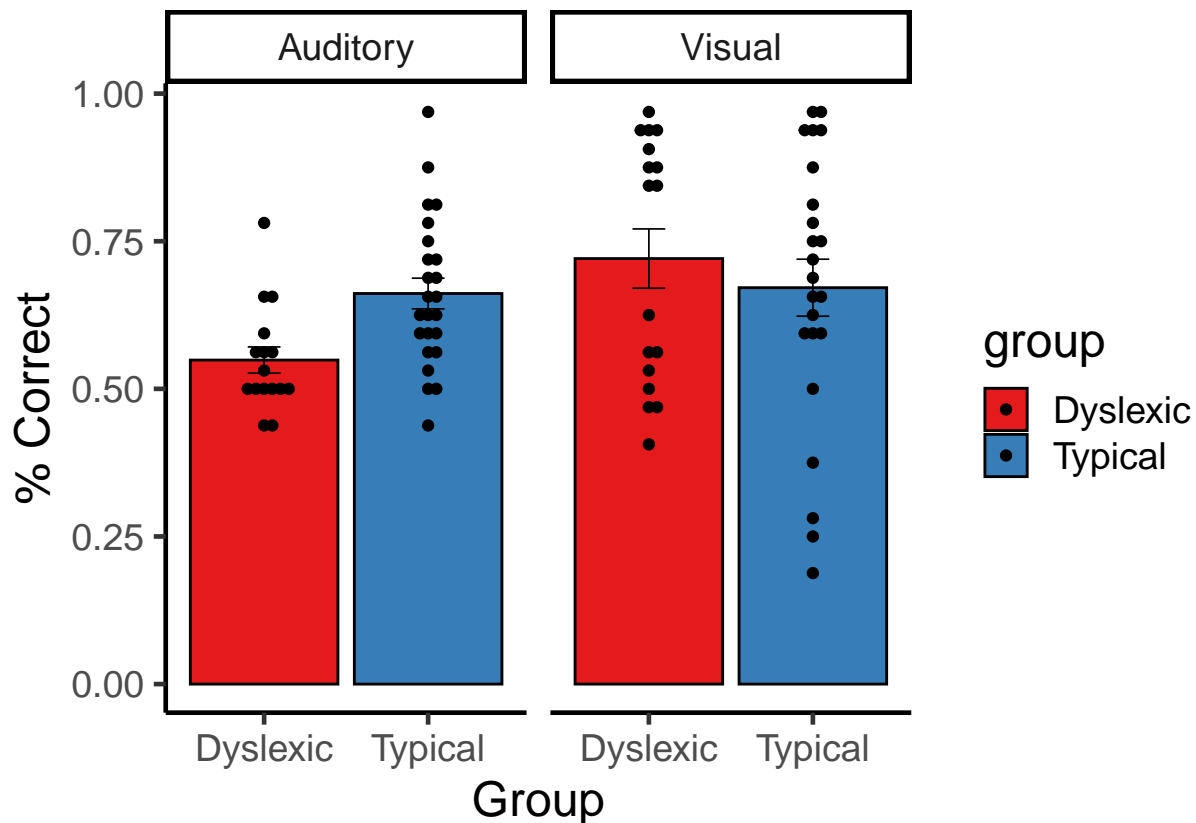
```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: corr ~ task * group + (1 + task | subj) + (1 | trial)
## Data: all_accuracy
##
##      AIC      BIC   logLik deviance df.resid
## 3091.9   3138.6 -1537.9   3075.9     2552
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.8869 -1.0408  0.4311  0.7491  1.8645
##
## Random effects:
## Groups Name          Variance Std.Dev. Corr
## subj   (Intercept) 0.10879   0.3298
##         taskVisual 1.54476   1.2429  -0.38
## trial  (Intercept) 0.02172   0.1474
## Number of obs: 2560, groups:  subj, 41; trial, 32
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    0.2007    0.1248   1.608  0.10785
## taskVisual     1.0186    0.3365   3.027  0.00247 **
## groupTYP       0.4928    0.1597   3.086  0.00203 **
## taskVisual:groupTYP -0.7947    0.4412  -1.801  0.07164 .
## ---
```



```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) tskVsl grpTYP
## taskVisual  -0.418
## groupTYP    -0.746  0.327
## tskVsl:grpTYP  0.319 -0.760 -0.427
```

plot the accuracy by group and task

```
## Warning: Ignoring unknown parameters: fun.y, fun.ymin, fun.ymax
## No summary function supplied, defaulting to `mean_se()`
## No summary function supplied, defaulting to `mean_se()`
```



A t-test to compare between Dylexia and Typical group

In tsl

```
##
## Welch Two Sample t-test
##
## data: DD_acc_tsl and TYP_acc_tsl
## t = -3.297, df = 37.874, p-value = 0.00213
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.18192006 -0.04349661
## sample estimates:
```

```
## mean of x mean of y
## 0.5487500 0.6614583
```

## In vsl

```
##
## Welch Two Sample t-test
##
## data: DD_acc_vsl and TYP_acc_vsl
## t = 0.70832, df = 36.548, p-value = 0.4832
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.09186351 0.19054893
## sample estimates:
## mean of x mean of y
## 0.7206471 0.6713043
```