Procedural Learning 110320

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# Sample Size

##   
## Frequency table:  
## Subgroup  
## DD TYP   
## 31 31

# Rotary Pursuit

### RP Statstical Analysis by Trial

#### RP Baseline differences

* There is no significant group difference in baseline speed for RP.

##   
## Welch Two Sample t-test  
##   
## data: d$rotarypursuit\_0\_2 by d$Subgroup  
## t = -0.060585, df = 45.388, p-value = 0.952  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -4.38929 4.13288  
## sample estimates:  
## mean in group DD mean in group TYP   
## 26.53846 26.66667

#### RP Linear mixed-effect modeling

* model with trial and participant as random effects (controlling for age and sex)
* borderline significant effect trial x subgroup (fasrer learning in Dys)

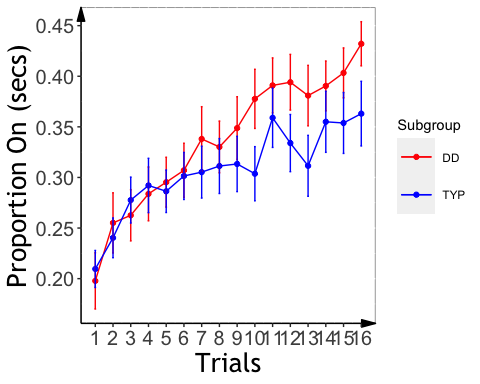
## refitting model(s) with ML (instead of REML)

## Data: rp2\_age\_gender\_iq  
## Models:  
## lmerrp1: prop\_on ~ Subgroup \* trial + background\_age + background\_sex +   
## lmerrp1: (1 | PartID)  
## lmerrp2: prop\_on ~ Subgroup \* trial + background\_age + background\_sex +   
## lmerrp2: (1 + trial | PartID)  
## npar AIC BIC logLik deviance Chisq Df Pr(>Chisq)   
## lmerrp1 8 -1864.4 -1826.5 940.21 -1880.4   
## lmerrp2 10 -2029.4 -1982.1 1024.72 -2049.4 169.02 2 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: prop\_on ~ Subgroup \* trial + background\_age + background\_sex +   
## (1 + trial | PartID)  
## Data: rp2\_age\_gender\_iq  
##   
## REML criterion at convergence: -2001.3  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.0400 -0.5959 0.0149 0.5949 3.5227   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## PartID (Intercept) 1.530e-02 0.123688   
## trial 6.755e-05 0.008219 -0.28  
## Residual 3.527e-03 0.059390   
## Number of obs: 844, groups: PartID, 53  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 0.2329960 0.0823771 49.9046011 2.828 0.00672 \*\*   
## SubgroupTYP 0.0105068 0.0354368 49.3633765 0.296 0.76810   
## trial 0.0123732 0.0017347 50.7865899 7.133 3.43e-09 \*\*\*  
## background\_age -0.0003613 0.0028760 48.9958367 -0.126 0.90053   
## background\_sex 0.0040717 0.0350641 48.9954644 0.116 0.90803   
## SubgroupTYP:trial -0.0045152 0.0024286 50.6576559 -1.859 0.06882 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) SbgTYP trial bckgrnd\_g bckgrnd\_s  
## SubgroupTYP -0.251   
## trial -0.100 0.232   
## backgrond\_g -0.768 0.115 0.000   
## backgrnd\_sx -0.317 -0.121 0.000 -0.290   
## SbgrpTYP:tr 0.071 -0.325 -0.714 0.000 0.000

#### RP Plot by trial

## `summarise()` has grouped output by 'Subgroup'. You can override using the `.groups` argument.



### RP Slope Analysis

#### ANCOVA on individual RP slopes

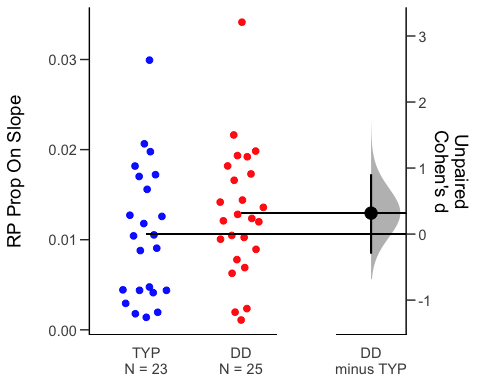
* Excluded negative slopes (n=5)
* No significant group effect on slope
* Should we control for IQ?

##   
## Call:  
## lm(formula = slopeProp\_On ~ background\_sex + background\_age +   
## kbit\_ss + Subgroup, data = d\_rp)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.0125922 -0.0045708 0.0000446 0.0043318 0.0214148   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -8.991e-03 1.150e-02 -0.782 0.4387   
## background\_sex 3.017e-03 2.158e-03 1.398 0.1692   
## background\_age 3.402e-04 1.882e-04 1.807 0.0777 .  
## kbit\_ss 7.887e-05 8.234e-05 0.958 0.3435   
## SubgroupTYP -2.174e-03 2.098e-03 -1.036 0.3059   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.006994 on 43 degrees of freedom  
## Multiple R-squared: 0.1689, Adjusted R-squared: 0.09155   
## F-statistic: 2.184 on 4 and 43 DF, p-value: 0.08681

## $`lsmeans of Subgroup`  
## Subgroup lsmean SE df lower.CL upper.CL  
## DD 0.0132 0.00144 43 0.01029 0.0161  
## TYP 0.0110 0.00151 43 0.00798 0.0141  
##   
## Results are averaged over the levels of: background\_sex   
## Confidence level used: 0.95   
##   
## $`pairwise differences of Subgroup`  
## 1 estimate SE df t.ratio p.value  
## DD - TYP 0.00217 0.0021 43 1.036 0.3059   
##   
## Results are averaged over the levels of: background\_sex

#### Plotting RP Slope Effects

## `summarise()` has grouped output by 'PartID'. You can override using the `.groups` argument.



# Mirror Tracing

### Statistical Analysis by Trial

#### Baseline differences on trial one

* No significant group differences on first trial

summary(lm(time~background\_age+background\_sex+kbit\_ss+Subgroup,data=me\_1))

##   
## Call:  
## lm(formula = time ~ background\_age + background\_sex + kbit\_ss +   
## Subgroup, data = me\_1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -114.54 -39.66 -10.16 18.22 626.00   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -3.28602 147.78880 -0.022 0.9824   
## background\_age 5.12614 2.61892 1.957 0.0564 .  
## background\_sex -51.24706 31.00940 -1.653 0.1052   
## kbit\_ss 0.01171 1.10010 0.011 0.9916   
## SubgroupTYP -2.50311 30.07316 -0.083 0.9340   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 101.5 on 46 degrees of freedom  
## (2 observations deleted due to missingness)  
## Multiple R-squared: 0.1054, Adjusted R-squared: 0.02756   
## F-statistic: 1.354 on 4 and 46 DF, p-value: 0.2645

summary(lm(time~background\_age+background\_sex+kbit\_ss+Subgroup,data=mt\_1))

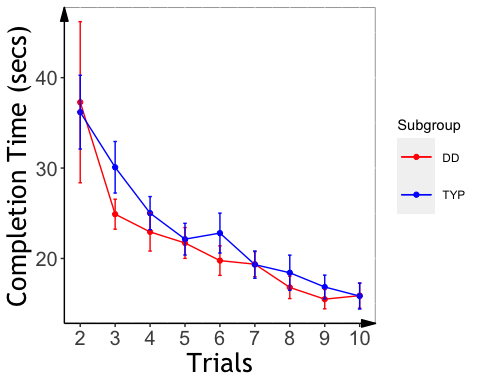
##   
## Call:  
## lm(formula = time ~ background\_age + background\_sex + kbit\_ss +   
## Subgroup, data = mt\_1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -114.54 -39.66 -10.16 18.22 626.00   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -3.28602 147.78880 -0.022 0.9824   
## background\_age 5.12614 2.61892 1.957 0.0564 .  
## background\_sex -51.24706 31.00940 -1.653 0.1052   
## kbit\_ss 0.01171 1.10010 0.011 0.9916   
## SubgroupTYP -2.50311 30.07316 -0.083 0.9340   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 101.5 on 46 degrees of freedom  
## (2 observations deleted due to missingness)  
## Multiple R-squared: 0.1054, Adjusted R-squared: 0.02756   
## F-statistic: 1.354 on 4 and 46 DF, p-value: 0.2645

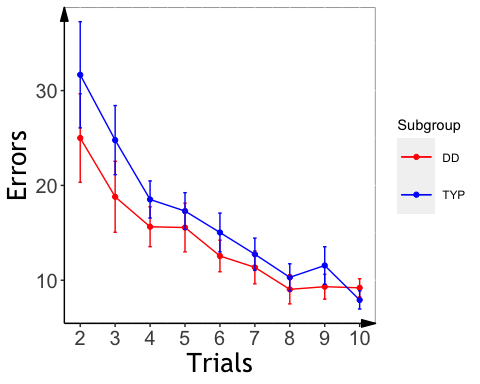
### Linear mixed modeling

* Filtered out first trial
* Main effect of trial, no significant effect of subgroup on time or error

## MT: Plot Time/Error by Trial

## `summarise()` has grouped output by 'Subgroup'. You can override using the `.groups` argument.  
## `summarise()` has grouped output by 'Subgroup'. You can override using the `.groups` argument.





### Mirror Tracing Slopes

##   
## DD TYP   
## 26 27

##### MR Slope analysis

* A significant group effects for slope, with faster learning for Typ, even after controlling for age, sex, and IQ.
* Removed participants with slopes above zero (opposite learning pattern-N=1)

##   
## Call:  
## lm(formula = slope\_mt ~ background\_age + background\_sex + kbit\_ss +   
## Subgroup, data = d2, na.action = na.exclude)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.4333 -1.0219 -0.3748 0.8216 4.2997   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.182835 2.672474 0.068 0.9458   
## background\_age 0.080075 0.045937 1.743 0.0890 .  
## background\_sex -0.259482 0.524073 -0.495 0.6232   
## kbit\_ss -0.004151 0.019496 -0.213 0.8325   
## SubgroupTYP 1.273246 0.509948 2.497 0.0167 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 1.614 on 40 degrees of freedom  
## (8 observations deleted due to missingness)  
## Multiple R-squared: 0.1747, Adjusted R-squared: 0.09216   
## F-statistic: 2.117 on 4 and 40 DF, p-value: 0.09659

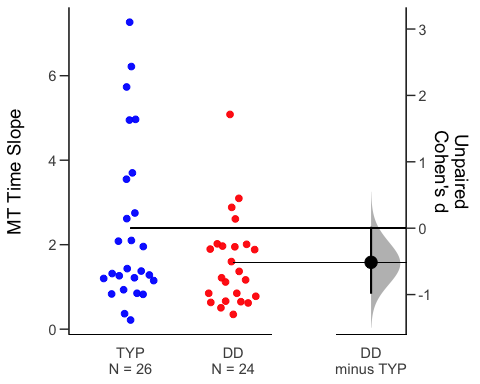
## $`lsmeans of Subgroup`  
## Subgroup lsmean SE df lower.CL upper.CL  
## DD 1.42 0.352 40 0.708 2.13  
## TYP 2.69 0.361 40 1.964 3.42  
##   
## Results are averaged over the levels of: background\_sex   
## Confidence level used: 0.95   
##   
## $`pairwise differences of Subgroup`  
## 1 estimate SE df t.ratio p.value  
## DD - TYP -1.27 0.51 40 -2.497 0.0167   
##   
## Results are averaged over the levels of: background\_sex

##   
## Call:  
## lm(formula = slope\_me ~ background\_age + background\_sex + kbit\_ss +   
## Subgroup, data = d2, na.action = na.exclude)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.6223 -1.2953 -0.6360 0.2702 5.2454   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -2.08422 3.49194 -0.597 0.5540   
## background\_age 0.10927 0.06002 1.820 0.0762 .  
## background\_sex -0.54470 0.68477 -0.795 0.4310   
## kbit\_ss 0.01256 0.02547 0.493 0.6248   
## SubgroupTYP 1.54459 0.66631 2.318 0.0256 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 2.109 on 40 degrees of freedom  
## (8 observations deleted due to missingness)  
## Multiple R-squared: 0.173, Adjusted R-squared: 0.09026   
## F-statistic: 2.091 on 4 and 40 DF, p-value: 0.09994

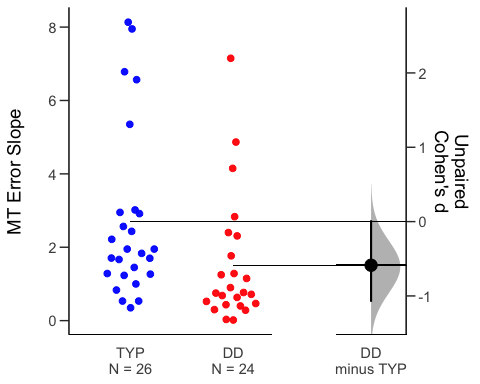
## $`lsmeans of Subgroup`  
## Subgroup lsmean SE df lower.CL upper.CL  
## DD 1.33 0.460 40 0.403 2.26  
## TYP 2.88 0.471 40 1.925 3.83  
##   
## Results are averaged over the levels of: background\_sex   
## Confidence level used: 0.95   
##   
## $`pairwise differences of Subgroup`  
## 1 estimate SE df t.ratio p.value  
## DD - TYP -1.54 0.666 40 -2.318 0.0256   
##   
## Results are averaged over the levels of: background\_sex

## MT: Plot Slope Effects

## `summarise()` has grouped output by 'PartID'. You can override using the `.groups` argument.



## `summarise()` has grouped output by 'PartID'. You can override using the `.groups` argument.



# Statistical Learning

##   
## Dyslexic Typical   
## 17 24

### Slope analyses

###ASL Slope Effects

## # A tibble: 2 x 6  
## Subgroup count rt slope d\_prime hits   
## \* <chr> <int> <chr> <chr> <chr> <chr>   
## 1 DD 17 "475.36 $\\pm$ 7… "-2.69 $\\pm$ … "6.57 $\\pm$ … "0.96 $\\pm$ …  
## 2 TYP 23 "491.24 $\\pm$ 7… "-0.53 $\\pm$ … "7.44 $\\pm$ … "0.99 $\\pm$ …

* 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  
## Subgroup count rt slope d\_prime hits   
## \* <chr> <int> <chr> <chr> <chr> <chr>   
## 1 DD 17 "475.36 $\\pm$ 7… "-2.69 $\\pm$ … "6.57 $\\pm$ … "0.96 $\\pm$ …  
## 2 TYP 23 "491.24 $\\pm$ 7… "-0.53 $\\pm$ … "7.44 $\\pm$ … "0.99 $\\pm$ …

* the two groups are not different in RT slope.

##   
## Welch Two Sample t-test  
##   
## data: dprime by Subgroup  
## t = -1.3305, df = 27.27, p-value = 0.1944  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -2.2095266 0.4707495  
## sample estimates:  
## mean in group DD mean in group TYP   
## 6.566801 7.436190

##   
## Welch Two Sample t-test  
##   
## data: rt\_slope by Subgroup  
## t = -1.8068, df = 27.638, p-value = 0.0817  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -4.6123799 0.2904771  
## sample estimates:  
## mean in group DD mean in group TYP   
## -2.6876471 -0.5266957

##   
## Call:  
## lm(formula = rt\_col ~ reindex \* Subgroup, data = fam\_trial\_tsl\_usable)  
##   
## 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 \*\*\*  
## SubgroupTYP -11.3419 14.9059 -0.761 0.446907   
## reindex:SubgroupTYP 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 \* Subgroup, data = fam\_trial\_tsl\_usable\_s)  
##   
## 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 \*\*\*  
## SubgroupTYP -0.273308 0.132874 -2.057 0.03997 \*   
## reindex:SubgroupTYP 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

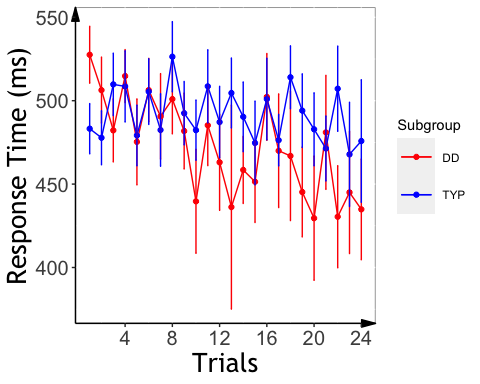
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ reindex \* Subgroup + (1 | PartID) + (0 + reindex | PartID)  
## Data: fam\_trial\_tsl\_usable  
##   
## REML criterion at convergence: 11110.8  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -9.7061 -0.4878 -0.0532 0.5078 3.9472   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 3229.342 56.827   
## PartID.1 reindex 7.157 2.675   
## Residual 7345.975 85.709   
## Number of obs: 937, groups: PartID, 40  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 509.3485 16.4185 46.2616 31.023 < 2e-16 \*\*\*  
## reindex -2.7352 0.9047 46.3653 -3.023 0.00406 \*\*   
## SubgroupTYP -11.2609 21.6142 45.9442 -0.521 0.60487   
## reindex:SubgroupTYP 2.1924 1.1882 45.7058 1.845 0.07150 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) reindx SbgTYP  
## reindex -0.331   
## SubgroupTYP -0.760 0.251   
## rndx:SbgTYP 0.252 -0.761 -0.328

## boundary (singular) fit: see ?isSingular

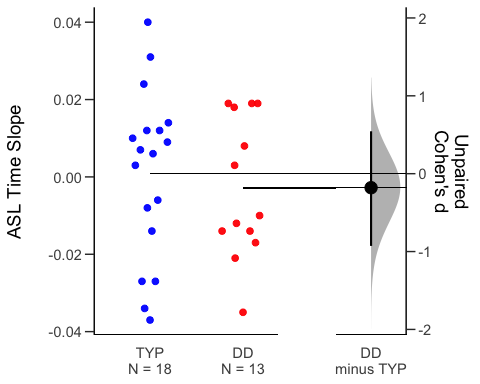
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ reindex \* Subgroup + (1 | PartID) + (0 + reindex | PartID)  
## Data: fam\_trial\_tsl\_usable\_s  
##   
## REML criterion at convergence: 2632.2  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.5513 -0.6194 -0.0533 0.6002 3.7903   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 0.0000 0.0000   
## PartID.1 reindex 0.0000 0.0000   
## Residual 0.9501 0.9747   
## Number of obs: 937, groups: PartID, 40  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 0.294333 0.101298 933.000000 2.906 0.00375 \*\*   
## reindex -0.023750 0.007144 933.000000 -3.325 0.00092 \*\*\*  
## SubgroupTYP -0.273308 0.132874 933.000000 -2.057 0.03997 \*   
## reindex:SubgroupTYP 0.022062 0.009353 933.000000 2.359 0.01853 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) reindx SbgTYP  
## reindex -0.874   
## SubgroupTYP -0.762 0.666   
## rndx:SbgTYP 0.668 -0.764 -0.874  
## optimizer (nloptwrap) convergence code: 0 (OK)  
## boundary (singular) fit: see ?isSingular

##Plot of TSL RT ### RT as the function of Target repetition

## `summarise()` has grouped output by 'Subgroup'. You can override using the `.groups` argument.

 ### plot Scaled RT slope across the two groups \* mean RT slope

## `summarise()` has grouped output by 'PartID'. You can override using the `.groups` argument.



##VSL Slope Analysis

## # A tibble: 2 x 5  
## Subgroup 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 \* Subgroup, 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 \*\*\*  
## SubgroupTYP -11.3419 14.9059 -0.761 0.446907   
## reindex:SubgroupTYP 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 \* Subgroup, 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 \*\*\*  
## SubgroupTYP -0.273308 0.132874 -2.057 0.03997 \*   
## reindex:SubgroupTYP 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.

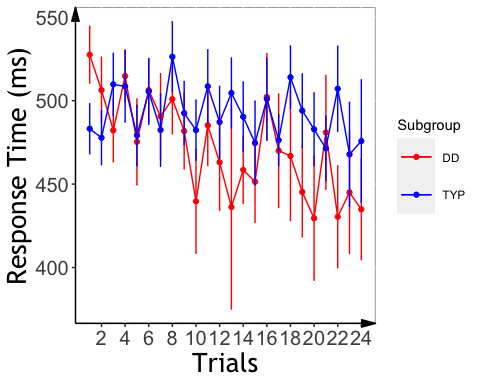
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ Subgroup \* reindex + (1 | PartID) + (0 + reindex | PartID)  
## Data: fam\_trial\_vsl  
##   
## REML criterion at convergence: 11110.8  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -9.7061 -0.4878 -0.0532 0.5078 3.9472   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 3229.342 56.827   
## PartID.1 reindex 7.157 2.675   
## Residual 7345.975 85.709   
## Number of obs: 937, groups: PartID, 40  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 509.3485 16.4185 46.2616 31.023 < 2e-16 \*\*\*  
## SubgroupTYP -11.2609 21.6142 45.9442 -0.521 0.60487   
## reindex -2.7352 0.9047 46.3653 -3.023 0.00406 \*\*   
## SubgroupTYP:reindex 2.1924 1.1882 45.7058 1.845 0.07150 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) SbgTYP reindx  
## SubgroupTYP -0.760   
## reindex -0.331 0.251   
## SbgrpTYP:rn 0.252 -0.328 -0.761

## boundary (singular) fit: see ?isSingular

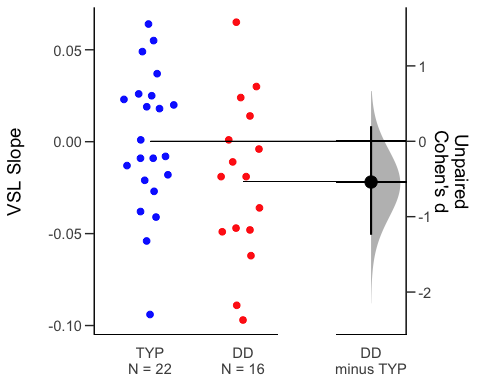
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ Subgroup \* reindex + (1 | PartID) + (0 + reindex | PartID)  
## Data: fam\_trial\_vsl\_scale  
##   
## REML criterion at convergence: 2632.2  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.5513 -0.6194 -0.0533 0.6002 3.7903   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 0.0000 0.0000   
## PartID.1 reindex 0.0000 0.0000   
## Residual 0.9501 0.9747   
## Number of obs: 937, groups: PartID, 40  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 0.294333 0.101298 933.000000 2.906 0.00375 \*\*   
## SubgroupTYP -0.273308 0.132874 933.000000 -2.057 0.03997 \*   
## reindex -0.023750 0.007144 933.000000 -3.325 0.00092 \*\*\*  
## SubgroupTYP:reindex 0.022062 0.009353 933.000000 2.359 0.01853 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) SbgTYP reindx  
## SubgroupTYP -0.762   
## reindex -0.874 0.666   
## SbgrpTYP:rn 0.668 -0.874 -0.764  
## optimizer (nloptwrap) convergence code: 0 (OK)  
## boundary (singular) fit: see ?isSingular

##Plot of VSL RT ### RT as the function of Target repetition

## `summarise()` has grouped output by 'Subgroup'. You can override using the `.groups` argument.

 ### plot mean RT slope across the two groups \* mean RT slope

## `summarise()` has grouped output by 'PartID'. You can override using the `.groups` argument.



## 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  
## Subgroup 1 0.006385 0.006385  
##   
## Error: subj:task  
## Df Sum Sq Mean Sq  
## task 1 3.641e-34 3.641e-34  
##   
## Error: Within  
## Df Sum Sq Mean Sq F value Pr(>F)   
## task 1 0.00000 0.000000 0.000 1.00000   
## Subgroup 1 0.00388 0.003884 2.704 0.10443   
## mean\_rt 1 0.01493 0.014929 10.393 0.00189 \*\*  
## task:Subgroup 1 0.00000 0.000000 0.000 1.00000   
## Residuals 73 0.10486 0.001436   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## boundary (singular) fit: see ?isSingular

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ task \* Subgroup + (1 + task | PartID) + (1 | reindex)  
## Data: all\_fam\_trials  
##   
## REML criterion at convergence: 5240.9  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.5825 -0.6122 -0.0554 0.5624 3.8323   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## PartID (Intercept) 0.000e+00 0.000e+00   
## taskVisual 5.418e-10 2.328e-05 NaN  
## reindex (Intercept) 1.786e-02 1.336e-01   
## Residual 9.422e-01 9.707e-01   
## Number of obs: 1874, groups: PartID, 40; reindex, 24  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)  
## (Intercept) -1.222e-03 5.611e-02 1.424e+02 -0.022 0.983  
## taskVisual -1.439e-12 6.933e-02 1.847e+03 0.000 1.000  
## SubgroupTYP 1.142e-03 6.429e-02 1.848e+03 0.018 0.986  
## taskVisual:SubgroupTYP 1.070e-12 9.091e-02 1.847e+03 0.000 1.000  
##   
## Correlation of Fixed Effects:  
## (Intr) tskVsl SbgTYP  
## taskVisual -0.618   
## SubgroupTYP -0.667 0.539   
## tskVsl:STYP 0.471 -0.763 -0.707  
## optimizer (nloptwrap) convergence code: 0 (OK)  
## boundary (singular) fit: see ?isSingular

### Mean RT sanity check

No significant differences in RT for either task.

## Analysis of Variance Table  
##   
## Response: aud\_fam\_rt  
## Df Sum Sq Mean Sq F value Pr(>F)  
## background\_age 1 0 0.0 0.0000 0.9984  
## background\_sex 1 14523 14523.4 1.6219 0.2137  
## Subgroup 1 14248 14248.2 1.5911 0.2180  
## Residuals 27 241777 8954.7

## Analysis of Variance Table  
##   
## Response: vis\_fam\_rt  
## Df Sum Sq Mean Sq F value Pr(>F)  
## background\_age 1 6080 6079.7 1.2305 0.2751  
## background\_sex 1 12178 12178.2 2.4649 0.1257  
## Subgroup 1 1555 1555.3 0.3148 0.5784  
## Residuals 34 167984 4940.7

# SL accuracy analysis

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

## `summarise()` has grouped output by 'Subgroup'. You can override using the `.groups` argument.

## # A tibble: 4 x 4  
## # Groups: Subgroup [2]  
## Subgroup task count accuracy   
## <chr> <chr> <int> <chr>   
## 1 DD Auditory 16 "0.55 $\\pm$ 0.09"  
## 2 DD Visual 17 "0.72 $\\pm$ 0.21"  
## 3 TYP Auditory 24 "0.66 $\\pm$ 0.13"  
## 4 TYP 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 = 4.3588, df = 32, p-value = 6.328e-05  
## alternative hypothesis: true mean is greater than 0.5  
## 95 percent confidence interval:  
## 0.5839456 Inf  
## sample estimates:  
## mean of x   
## 0.637303

##   
## 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 = 6.2033, df = 46, p-value = 7.173e-08  
## alternative hypothesis: true mean is greater than 0.5  
## 95 percent confidence interval:  
## 0.6212808 Inf  
## sample estimates:  
## mean of x   
## 0.6662766

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

##   
## Error: PartID  
## Df Sum Sq Mean Sq F value Pr(>F)  
## Subgroup 1 0.0222 0.02218 0.754 0.391  
## Residuals 37 1.0889 0.02943   
##   
## Error: PartID:task  
## Df Sum Sq Mean Sq F value Pr(>F)   
## task 1 0.1086 0.10864 3.221 0.0809 .  
## task:Subgroup 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

### 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 = -0.7005, df = 69.698, p-value = 0.4859  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -0.11147176 0.05352463  
## sample estimates:  
## mean of x mean of y   
## 0.6373030 0.6662766

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

### 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 \* Subgroup + (1 + task | PartID) + (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   
## PartID (Intercept) 0.10879 0.3298   
## taskVisual 1.54473 1.2429 -0.38  
## trial (Intercept) 0.02172 0.1474   
## Number of obs: 2560, groups: PartID, 41; trial, 32  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 0.2007 0.1248 1.608 0.10786   
## taskVisual 1.0186 0.3366 3.026 0.00248 \*\*  
## SubgroupTYP 0.4928 0.1597 3.086 0.00203 \*\*  
## taskVisual:SubgroupTYP -0.7948 0.4412 -1.801 0.07166 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) tskVsl SbgTYP  
## taskVisual -0.418   
## SubgroupTYP -0.746 0.327   
## tskVsl:STYP 0.319 -0.760 -0.427

### generalized linear effect modeling within each task

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: corr ~ Subgroup + (1 | PartID) + (1 | trial)  
## Data: vsl\_accuracy  
##   
## AIC BIC logLik deviance df.resid   
## 1403.8 1424.5 -697.9 1395.8 1276   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.7675 -0.7647 0.3292 0.6507 1.9013   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 1.35302 1.1632   
## trial (Intercept) 0.03695 0.1922   
## Number of obs: 1280, groups: PartID, 40; trial, 32  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 1.2235 0.3079 3.974 7.07e-05 \*\*\*  
## SubgroupTYP -0.3011 0.4011 -0.751 0.453   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr)  
## SubgroupTYP -0.754

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: corr ~ Subgroup + (1 | PartID) + (1 | trial)  
## Data: tsl\_accuracy  
##   
## AIC BIC logLik deviance df.resid   
## 1678.4 1699.0 -835.2 1670.4 1276   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -2.0581 -1.0900 0.6127 0.7869 1.2218   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 0.1176 0.3429   
## trial (Intercept) 0.1248 0.3533   
## Number of obs: 1280, groups: PartID, 40; trial, 32  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 0.2075 0.1398 1.484 0.13788   
## SubgroupTYP 0.5037 0.1636 3.079 0.00208 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr)  
## SubgroupTYP -0.682

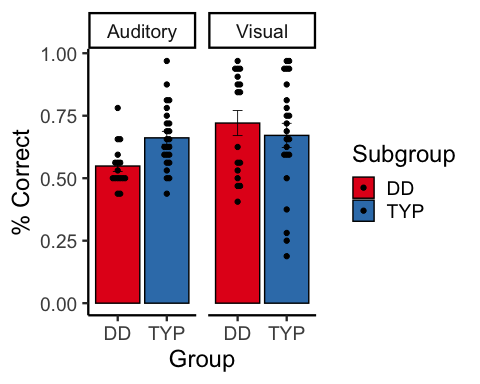
## plot the accuracy by group and task

## # A tibble: 2 x 10  
## task term group1 group2 null.value estimate conf.low conf.high p.adj  
## \* <chr> <chr> <chr> <chr> <dbl> <dbl> <dbl> <dbl> <dbl>  
## 1 Audi… Subg… DD TYP 0 0.113 0.0384 0.187 0.00391  
## 2 Visu… Subg… DD TYP 0 -0.0493 -0.193 0.0941 0.491   
## # … with 1 more variable: p.adj.signif <chr>

## alternative plots

## 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()`

 # Cross-task correlations

###Everyone

## kbit\_ss\_2 gort\_ori\_ss\_2 ctopp\_nonword\_raw\_2  
## kbit\_ss\_2   
## gort\_ori\_ss\_2 0.25\*   
## ctopp\_nonword\_raw\_2 0.17 0.48\*\*\*\*   
## ctopp\_elision\_raw\_2 0.47\*\*\* 0.42\*\*\* 0.15   
## ctopp\_blending\_raw\_2 0.26\* 0.42\*\*\* 0.24\*   
## wais\_dsb\_ss\_2 0.51\*\*\*\* 0.43\*\*\* 0.26\*   
## slopeProp\_On -0.05 -0.05 -0.19   
## slope\_mt -0.01 0.19 0.00   
## slope\_me 0.07 0.31\* 0.13   
## vis\_slope\_scale 0.14 0.28\* 0.09   
## aud\_slope\_scale 0.04 -0.09 0.07   
## vis\_acc 0.06 0.06 0.20   
## aud\_acc 0.12 0.38\*\* 0.17   
## quicksin\_snr\_loss\_2 -0.12 -0.59\*\*\*\* -0.37\*\*   
## ctopp\_elision\_raw\_2 ctopp\_blending\_raw\_2 wais\_dsb\_ss\_2  
## kbit\_ss\_2   
## gort\_ori\_ss\_2   
## ctopp\_nonword\_raw\_2   
## ctopp\_elision\_raw\_2   
## ctopp\_blending\_raw\_2 0.56\*\*\*\*   
## wais\_dsb\_ss\_2 0.42\*\*\* 0.41\*\*\*   
## slopeProp\_On 0.08 0.06 0.08   
## slope\_mt 0.18 0.13 0.03   
## slope\_me 0.28\* 0.19 0.05   
## vis\_slope\_scale 0.09 -0.26 0.21   
## aud\_slope\_scale 0.07 0.00 0.03   
## vis\_acc 0.19 0.17 0.00   
## aud\_acc 0.19 0.24 0.26   
## quicksin\_snr\_loss\_2 -0.17 -0.35\*\* -0.13   
## slopeProp\_On slope\_mt slope\_me vis\_slope\_scale  
## kbit\_ss\_2   
## gort\_ori\_ss\_2   
## ctopp\_nonword\_raw\_2   
## ctopp\_elision\_raw\_2   
## ctopp\_blending\_raw\_2   
## wais\_dsb\_ss\_2   
## slopeProp\_On   
## slope\_mt 0.28\*   
## slope\_me 0.16 0.81\*\*\*\*   
## vis\_slope\_scale 0.19 -0.04 -0.02   
## aud\_slope\_scale -0.06 0.13 0.02 -0.18   
## vis\_acc -0.18 -0.17 0.04 -0.35\*   
## aud\_acc 0.20 0.06 0.11 0.07   
## quicksin\_snr\_loss\_2 -0.07 -0.09 -0.18 -0.08   
## aud\_slope\_scale vis\_acc aud\_acc  
## kbit\_ss\_2   
## gort\_ori\_ss\_2   
## ctopp\_nonword\_raw\_2   
## ctopp\_elision\_raw\_2   
## ctopp\_blending\_raw\_2   
## wais\_dsb\_ss\_2   
## slopeProp\_On   
## slope\_mt   
## slope\_me   
## vis\_slope\_scale   
## aud\_slope\_scale   
## vis\_acc 0.08   
## aud\_acc -0.16 -0.12   
## quicksin\_snr\_loss\_2 -0.02 -0.02 -0.23

###Dys only both the rotary pursuit and ASL accuracy/RT are related to reading

## kbit\_ss\_2 gort\_ori\_ss\_2 wrmt\_id\_ss\_2 wrmt\_wa\_ss\_2 towre\_sw\_ss\_2  
## kbit\_ss\_2   
## gort\_ori\_ss\_2 0.06   
## wrmt\_id\_ss\_2 0.18 0.41\*   
## wrmt\_wa\_ss\_2 0.08 0.22 0.67\*\*\*\*   
## towre\_sw\_ss\_2 -0.10 0.52\*\* 0.40\* 0.07   
## towre\_pde\_ss\_2 0.03 0.29 0.28 0.58\*\*\* 0.46\*\*   
## slopeProp\_On 0.07 0.26 0.58\*\* 0.61\*\*\* -0.08   
## slope\_mt -0.11 0.08 0.16 0.08 0.25   
## slope\_me 0.07 0.13 0.11 -0.01 0.18   
## aud\_acc -0.26 0.13 0.41 0.50\* 0.14   
## vis\_acc 0.11 0.17 -0.31 -0.22 0.00   
## aud\_slope\_scale 0.19 -0.38 0.00 -0.43 -0.14   
## vis\_slope\_scale -0.07 0.05 -0.31 -0.23 -0.25   
## towre\_pde\_ss\_2 slopeProp\_On slope\_mt slope\_me aud\_acc  
## kbit\_ss\_2   
## gort\_ori\_ss\_2   
## wrmt\_id\_ss\_2   
## wrmt\_wa\_ss\_2   
## towre\_sw\_ss\_2   
## towre\_pde\_ss\_2   
## slopeProp\_On 0.09   
## slope\_mt -0.01 0.03   
## slope\_me -0.13 -0.07 0.74\*\*\*\*   
## aud\_acc 0.33 0.22 -0.38 -0.25   
## vis\_acc 0.20 -0.20 -0.59\*\* -0.03 -0.08   
## aud\_slope\_scale -0.50\* 0.08 0.17 0.05 0.07   
## vis\_slope\_scale -0.28 0.27 0.00 -0.01 -0.22   
## vis\_acc aud\_slope\_scale  
## kbit\_ss\_2   
## gort\_ori\_ss\_2   
## wrmt\_id\_ss\_2   
## wrmt\_wa\_ss\_2   
## towre\_sw\_ss\_2   
## towre\_pde\_ss\_2   
## slopeProp\_On   
## slope\_mt   
## slope\_me   
## aud\_acc   
## vis\_acc   
## aud\_slope\_scale -0.16   
## vis\_slope\_scale -0.28 0.16

###Typ only better VSL is related to worse reading…

## kbit\_ss\_2 gort\_ori\_ss\_2 wrmt\_id\_ss\_2 wrmt\_wa\_ss\_2 towre\_sw\_ss\_2  
## kbit\_ss\_2   
## gort\_ori\_ss\_2 0.30   
## wrmt\_id\_ss\_2 0.16 0.38\*   
## wrmt\_wa\_ss\_2 -0.04 0.11 -0.04   
## towre\_sw\_ss\_2 0.12 0.43\* 0.15 0.17   
## towre\_pde\_ss\_2 0.14 0.69\*\*\*\* 0.38\* 0.12 0.44\*   
## slopeProp\_On -0.01 0.10 -0.08 0.16 -0.11   
## slope\_mt -0.11 -0.03 0.01 0.36\* 0.08   
## slope\_me -0.10 0.23 0.12 0.29 0.09   
## aud\_acc 0.08 0.19 0.29 0.02 0.26   
## vis\_acc 0.10 0.23 0.11 0.01 -0.12   
## aud\_slope\_scale -0.13 -0.05 -0.10 0.24 -0.29   
## vis\_slope\_scale 0.15 0.30 0.14 -0.20 0.27   
## towre\_pde\_ss\_2 slopeProp\_On slope\_mt slope\_me aud\_acc  
## kbit\_ss\_2   
## gort\_ori\_ss\_2   
## wrmt\_id\_ss\_2   
## wrmt\_wa\_ss\_2   
## towre\_sw\_ss\_2   
## towre\_pde\_ss\_2   
## slopeProp\_On -0.20   
## slope\_mt -0.22 0.48\*\*   
## slope\_me -0.10 0.39\* 0.83\*\*\*\*   
## aud\_acc -0.01 0.16 -0.04 0.02   
## vis\_acc 0.11 -0.16 -0.05 0.11 -0.12   
## aud\_slope\_scale 0.04 -0.13 0.08 -0.05 -0.36   
## vis\_slope\_scale 0.51\*\* 0.15 -0.23 -0.21 0.08   
## vis\_acc aud\_slope\_scale  
## kbit\_ss\_2   
## gort\_ori\_ss\_2   
## wrmt\_id\_ss\_2   
## wrmt\_wa\_ss\_2   
## towre\_sw\_ss\_2   
## towre\_pde\_ss\_2   
## slopeProp\_On   
## slope\_mt   
## slope\_me   
## aud\_acc   
## vis\_acc   
## aud\_slope\_scale 0.25   
## vis\_slope\_scale -0.36\* -0.48\*