Procedural Learning 110320

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# Sample Size

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

# Descriptives Table

##   
## 1 2  
## DD 20 11  
## TYP 17 14

##   
## Table: Descriptives  
##   
## | | DD (N=31) | TYP (N=31) | p value|  
## |:--------------|:--------------:|:--------------:|-------:|  
## |Age | | | 0.848|  
## |- Mean (SD) | 26.35 (6.59) | 26.68 (6.58) | |  
## |IQ | | | 0.106|  
## |- Mean (SD) | 107.30 (14.84) | 113.68 (13.97) | |  
## |WID | | | < 0.001|  
## |- Mean (SD) | 89.44 (9.54) | 110.75 (7.40) | |  
## |WA | | | < 0.001|  
## |- Mean (SD) | 77.59 (9.71) | 102.46 (7.97) | |  
## |SWE | | | < 0.001|  
## |- Mean (SD) | 89.19 (9.19) | 110.25 (12.50) | |  
## |PDE | | | < 0.001|  
## |- Mean (SD) | 83.52 (8.19) | 106.54 (7.78) | |  
## |Vocabulary | | | 0.004|  
## |- Mean (SD) | 106.15 (10.02) | 113.93 (8.51) | |  
## |ORI | | | < 0.001|  
## |- Mean (SD) | 83.07 (15.40) | 107.11 (8.80) | |  
## |Elision | | | 0.005|  
## |- Mean (SD) | 8.22 (2.31) | 9.89 (1.91) | |  
## |Nonword | | | < 0.001|  
## |- Mean (SD) | 6.41 (1.69) | 8.89 (2.10) | |  
## |RAN\_2Set | | | < 0.001|  
## |- Mean (SD) | 102.04 (8.46) | 114.82 (8.94) | |  
## |DigitsForward | | | 0.930|  
## |- Mean (SD) | 11.37 (15.52) | 11.11 (2.64) | |  
## |DigitsBackward | | | 0.074|  
## |- Mean (SD) | 9.04 (2.56) | 10.36 (2.80) | |

# Demographics

##   
## DD TYP  
## 0 7 26  
## 1 19 1

##   
## DD TYP  
## 0 24 27  
## 1 2 0

##   
## DD TYP  
## 0 25 26  
## 1 1 1

## 'data.frame': 53 obs. of 12 variables:  
## $ read\_delay : Factor w/ 2 levels "0","1": 2 2 1 1 2 1 2 2 1 1 ...  
## $ lang\_delay : Factor w/ 2 levels "0","1": 2 1 1 1 1 1 1 1 1 1 ...  
## $ dyslexia : Factor w/ 2 levels "0","1": 2 2 1 1 2 1 2 2 1 1 ...  
## $ ADHD : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...  
## $ self\_ed : Factor w/ 5 levels "3","4","5","6",..: 2 2 3 3 3 3 3 3 3 3 ...  
## $ race\_white : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 1 2 ...  
## $ race\_AA : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 2 1 ...  
## $ race\_Asian : Factor w/ 1 level "0": 1 1 1 1 1 1 1 1 1 1 ...  
## $ race\_Hisp : Factor w/ 2 levels "0","1": 1 1 2 1 1 1 1 1 1 1 ...  
## $ race\_Native : Factor w/ 1 level "0": 1 1 1 1 1 1 1 1 1 1 ...  
## $ race\_Other\_PII: Factor w/ 1 level "0": 1 1 1 1 1 1 1 1 1 1 ...  
## $ Sex : Factor w/ 2 levels "1","2": 1 1 2 1 2 1 1 2 1 1 ...

##   
## Table: Adult Descriptives  
##   
## | | DD (N=26) | TYP (N=27) | p value|  
## |:-----------------|:-----------:|:-----------:|-------:|  
## |read\_delay | | | < 0.001|  
## |- 0 | 7 (26.9%) | 26 (96.3%) | |  
## |- 1 | 19 (73.1%) | 1 (3.7%) | |  
## |lang\_delay | | | 0.142|  
## |- 0 | 24 (92.3%) | 27 (100.0%) | |  
## |- 1 | 2 (7.7%) | 0 (0.0%) | |  
## |dyslexia | | | < 0.001|  
## |- 0 | 6 (23.1%) | 27 (100.0%) | |  
## |- 1 | 20 (76.9%) | 0 (0.0%) | |  
## |ADHD | | | 0.978|  
## |- 0 | 25 (96.2%) | 26 (96.3%) | |  
## |- 1 | 1 (3.8%) | 1 (3.7%) | |  
## |self\_ed | | | 0.181|  
## |- 3 | 1 (3.8%) | 0 (0.0%) | |  
## |- 4 | 2 (7.7%) | 0 (0.0%) | |  
## |- 5 | 7 (26.9%) | 12 (44.4%) | |  
## |- 6 | 14 (53.8%) | 10 (37.0%) | |  
## |- 7 | 2 (7.7%) | 5 (18.5%) | |  
## |race\_white | | | 0.646|  
## |- 0 | 4 (15.4%) | 3 (11.1%) | |  
## |- 1 | 22 (84.6%) | 24 (88.9%) | |  
## |race\_AA | | | 0.646|  
## |- 0 | 22 (84.6%) | 24 (88.9%) | |  
## |- 1 | 4 (15.4%) | 3 (11.1%) | |  
## |race\_Asian | | | 0.891|  
## |- 0 | 26 (100.0%) | 27 (100.0%) | |  
## |race\_Hisp | | | 0.322|  
## |- 0 | 26 (100.0%) | 26 (96.3%) | |  
## |- 1 | 0 (0.0%) | 1 (3.7%) | |  
## |race\_Native | | | 0.891|  
## |- 0 | 26 (100.0%) | 27 (100.0%) | |  
## |race\_Other\_PII | | | 0.891|  
## |- 0 | 26 (100.0%) | 27 (100.0%) | |  
## |household\_income | | | 0.204|  
## |- N-Miss | 1 | 1 | |  
## |- <30k | 6 (24.0%) | 3 (11.5%) | |  
## |- 30-60k | 11 (44.0%) | 9 (34.6%) | |  
## |- 60-100k | 4 (16.0%) | 3 (11.5%) | |  
## |- >100k | 4 (16.0%) | 11 (42.3%) | |  
## |Sex | | | 0.477|  
## |- 1 | 16 (61.5%) | 14 (51.9%) | |  
## |- 2 | 10 (38.5%) | 13 (48.1%) | |  
## |DadEd | | | |  
## |- Less7Grd | 0 (0.0%) | 0 (0.0%) | |  
## |- JuniorHigh | 0 (0.0%) | 0 (0.0%) | |  
## |- HighSchool | 1 (3.8%) | 0 (0.0%) | |  
## |- PartialCollege | 2 (7.7%) | 0 (0.0%) | |  
## |- College | 7 (26.9%) | 12 (44.4%) | |  
## |- Masters | 14 (53.8%) | 10 (37.0%) | |  
## |- Doctorate | 2 (7.7%) | 5 (18.5%) | |

# 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

## Analysis of Variance Table  
##   
## Response: rotarypursuit\_0\_2  
## Df Sum Sq Mean Sq F value Pr(>F)   
## Age 1 46.24 46.24 0.8964 0.348402   
## Sex 1 407.47 407.47 7.8996 0.007088 \*\*  
## Subgroup 1 7.51 7.51 0.1457 0.704342   
## Residuals 49 2527.46 51.58   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Parameter | Eta2 (partial) | 90% CI  
## -----------------------------------------  
## Age | 0.02 | [0.00, 0.12]  
## Sex | 0.14 | [0.02, 0.29]  
## Subgroup | 2.96e-03 | [0.00, 0.07]

#### RP Realiability

## < table of extent 0 >

## Number of categories should be increased in order to count frequencies.

##   
## Reliability analysis   
## Call: psych::alpha(x = rp\_w)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd median\_r  
## 0.98 0.98 0.99 0.74 45 0.0045 0.32 0.12 0.76  
##   
## lower alpha upper 95% confidence boundaries  
## 0.97 0.98 0.99   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se var.r med.r  
## 1 0.98 0.98 0.99 0.75 44 0.0046 0.0096 0.77  
## 2 0.98 0.98 0.99 0.74 43 0.0046 0.0102 0.76  
## 3 0.98 0.98 0.99 0.74 44 0.0046 0.0090 0.76  
## 4 0.98 0.98 0.99 0.74 42 0.0047 0.0102 0.76  
## 5 0.98 0.98 0.99 0.73 41 0.0048 0.0109 0.76  
## 6 0.98 0.98 0.99 0.73 41 0.0048 0.0110 0.76  
## 7 0.98 0.98 0.99 0.73 40 0.0050 0.0111 0.75  
## 8 0.98 0.98 0.99 0.73 41 0.0049 0.0112 0.76  
## 9 0.98 0.98 0.99 0.73 40 0.0051 0.0107 0.74  
## 10 0.98 0.98 0.99 0.73 41 0.0050 0.0108 0.75  
## 11 0.98 0.98 0.99 0.73 41 0.0049 0.0103 0.76  
## 12 0.98 0.98 0.99 0.73 41 0.0049 0.0107 0.76  
## 13 0.98 0.98 0.99 0.74 42 0.0048 0.0101 0.76  
## 14 0.98 0.98 0.99 0.74 44 0.0047 0.0097 0.77  
## 15 0.98 0.98 0.99 0.74 43 0.0047 0.0097 0.77  
## 16 0.98 0.98 0.99 0.74 43 0.0047 0.0100 0.76  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## 1 53 0.79 0.80 0.79 0.77 0.20 0.12  
## 2 53 0.82 0.83 0.82 0.80 0.25 0.13  
## 3 53 0.80 0.81 0.80 0.77 0.27 0.12  
## 4 53 0.85 0.86 0.86 0.83 0.29 0.14  
## 5 53 0.90 0.90 0.89 0.88 0.29 0.12  
## 6 53 0.88 0.89 0.88 0.86 0.30 0.13  
## 7 53 0.92 0.92 0.92 0.91 0.32 0.15  
## 8 53 0.91 0.90 0.90 0.89 0.32 0.14  
## 9 53 0.94 0.94 0.94 0.93 0.33 0.15  
## 10 53 0.91 0.91 0.90 0.90 0.34 0.15  
## 11 53 0.90 0.90 0.89 0.89 0.37 0.15  
## 12 53 0.91 0.90 0.90 0.89 0.36 0.15  
## 13 53 0.87 0.86 0.86 0.85 0.35 0.16  
## 14 52 0.84 0.81 0.80 0.79 0.37 0.14  
## 15 52 0.86 0.83 0.83 0.81 0.38 0.14  
## 16 51 0.87 0.84 0.83 0.82 0.40 0.14

#### RP Linear mixed-effect modeling

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

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

## Data: rp2\_age\_gender\_iq  
## Models:  
## lmerrp1: prop\_on ~ Subgroup \* trial + Age + Sex + (1 | PartID)  
## lmerrp2: prop\_on ~ Subgroup \* trial + Age + Sex + kbit\_ss + (1 + trial |   
## lmerrp2: PartID)  
## npar AIC BIC logLik deviance Chisq Df Pr(>Chisq)   
## lmerrp1 8 -1864.4 -1826.5 940.21 -1880.4   
## lmerrp2 11 -2027.9 -1975.8 1024.94 -2049.9 169.46 3 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Type III Analysis of Variance Table with Satterthwaite's method  
## Sum Sq Mean Sq NumDF DenDF F value Pr(>F)   
## Subgroup 0.000067 0.000067 1 49.017 0.0190 0.89090   
## trial 0.244807 0.244807 1 50.655 69.4047 4.662e-11 \*\*\*  
## Age 0.000030 0.000030 1 48.000 0.0086 0.92655   
## Sex 0.000000 0.000000 1 48.000 0.0000 0.99742   
## kbit\_ss 0.001419 0.001419 1 48.000 0.4023 0.52891   
## Subgroup:trial 0.012195 0.012195 1 50.655 3.4574 0.06878 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Parameter | Eta2 (partial) | 90% CI  
## ----------------------------------------------  
## Subgroup | 3.88e-04 | [0.00, 0.00]  
## trial | 0.58 | [0.43, 0.68]  
## Age | 1.79e-04 | [0.00, 0.02]  
## Sex | 2.20e-07 | [0.00, 0.00]  
## kbit\_ss | 8.31e-03 | [0.00, 0.09]  
## Subgroup:trial | 0.06 | [0.00, 0.20]

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: prop\_on ~ Subgroup \* trial + Age + Sex + kbit\_ss + (1 + trial |   
## PartID)  
## Data: rp2\_age\_gender\_iq  
##   
## REML criterion at convergence: -1990.2  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.0401 -0.5988 0.0148 0.5950 3.5220   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## PartID (Intercept) 1.554e-02 0.124655   
## trial 6.755e-05 0.008219 -0.28  
## Residual 3.527e-03 0.059391   
## Number of obs: 844, groups: PartID, 53  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 0.1344299 0.1754027 48.2178654 0.766 0.4472   
## SubgroupTYP 0.0050628 0.0367203 49.0165204 0.138 0.8909   
## trial 0.0123738 0.0017346 50.7839872 7.133 3.42e-09 \*\*\*  
## Age 0.0002834 0.0030579 48.0003335 0.093 0.9265   
## Sex -0.0001167 0.0359017 47.9995692 -0.003 0.9974   
## kbit\_ss 0.0008163 0.0012870 48.0003992 0.634 0.5289   
## SubgroupTYP:trial -0.0045156 0.0024285 50.6550476 -1.859 0.0688 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) SbgTYP trial Age Sex kbt\_ss  
## SubgroupTYP 0.091   
## trial -0.048 0.228   
## Age -0.628 0.030 0.000   
## Sex 0.016 -0.072 0.000 -0.329   
## kbit\_ss -0.881 -0.235 0.000 0.323 -0.185   
## SbgrpTYP:tr 0.034 -0.319 -0.714 0.000 0.000 0.000

* within DD group

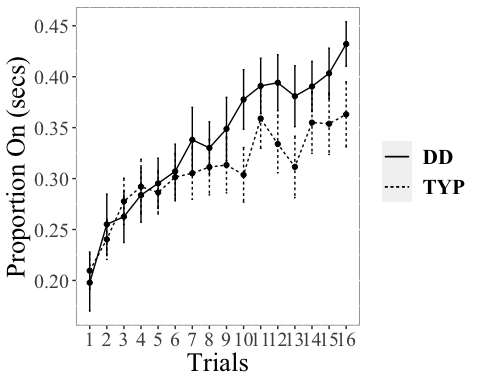
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: prop\_on ~ trial + Age + Sex + kbit\_ss + (1 + trial | PartID)  
## Data: rp2\_age\_gender\_iq[rp2\_age\_gender\_iq$Subgroup == "DD", ]  
##   
## REML criterion at convergence: -975.8  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.03577 -0.61458 -0.02929 0.59679 3.12439   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## PartID (Intercept) 2.130e-02 0.145933   
## trial 4.675e-05 0.006838 -0.56  
## Residual 3.480e-03 0.058988   
## Number of obs: 413, groups: PartID, 26  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) -0.262659 0.225811 22.176981 -1.163 0.2571   
## trial 0.012424 0.001484 24.342196 8.370 1.26e-08 \*\*\*  
## Age 0.002625 0.004141 21.919122 0.634 0.5326   
## Sex 0.052332 0.052152 21.850101 1.003 0.3266   
## kbit\_ss 0.003267 0.001707 21.892951 1.914 0.0688 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) trial Age Sex   
## trial -0.071   
## Age -0.557 -0.003   
## Sex -0.048 0.000 -0.315   
## kbit\_ss -0.860 -0.002 0.205 -0.145

* within TYP group

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: prop\_on ~ trial + Age + Sex + kbit\_ss + (1 + trial | PartID)  
## Data: rp2\_age\_gender\_iq[rp2\_age\_gender\_iq$Subgroup == "TYP", ]  
##   
## REML criterion at convergence: -1002.2  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -2.8501 -0.5530 0.0252 0.5843 3.4724   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## PartID (Intercept) 1.138e-02 0.106656   
## trial 8.615e-05 0.009282 -0.20  
## Residual 3.579e-03 0.059821   
## Number of obs: 431, groups: PartID, 27  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 4.631e-01 2.592e-01 2.302e+01 1.787 0.087194 .   
## trial 7.855e-03 1.893e-03 2.603e+01 4.150 0.000315 \*\*\*  
## Age 3.323e-05 4.158e-03 2.300e+01 0.008 0.993691   
## Sex -9.052e-03 4.439e-02 2.300e+01 -0.204 0.840210   
## kbit\_ss -1.835e-03 1.790e-03 2.300e+01 -1.025 0.316038   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) trial Age Sex   
## trial -0.022   
## Age -0.687 0.000   
## Sex 0.081 0.000 -0.355   
## kbit\_ss -0.921 0.000 0.459 -0.237

#### 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

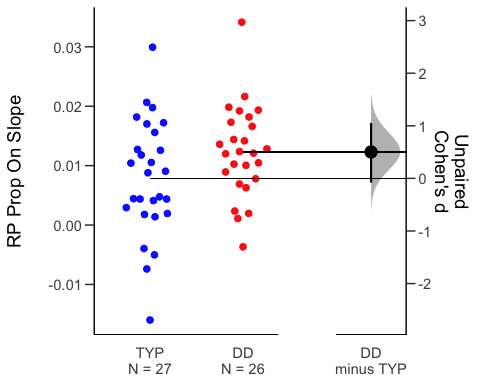
* No significant group effect on slope
* Should we control for IQ?

##   
## Call:  
## lm(formula = slopeProp\_On ~ Sex + Age + kbit\_ss + Subgroup, data = d\_rp)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.0259788 -0.0038423 -0.0003771 0.0049146 0.0231640   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.592e-04 1.301e-02 0.012 0.990   
## Sex 1.683e-04 2.666e-03 0.063 0.950   
## Age 2.571e-04 2.270e-04 1.133 0.263   
## kbit\_ss 4.696e-05 9.555e-05 0.491 0.625   
## SubgroupTYP -4.575e-03 2.584e-03 -1.770 0.083 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.009002 on 48 degrees of freedom  
## Multiple R-squared: 0.09045, Adjusted R-squared: 0.01466   
## F-statistic: 1.193 on 4 and 48 DF, p-value: 0.3258

## $`lsmeans of Subgroup`  
## Subgroup lsmean SE df lower.CL upper.CL  
## DD 0.01238 0.00182 48 0.00871 0.0161  
## TYP 0.00781 0.00177 48 0.00425 0.0114  
##   
## Results are averaged over the levels of: Sex   
## Confidence level used: 0.95   
##   
## $`pairwise differences of Subgroup`  
## 1 estimate SE df t.ratio p.value  
## DD - TYP 0.00457 0.00258 48 1.770 0.0830   
##   
## Results are averaged over the levels of: Sex

#### Plotting RP Slope Effects

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



# Mirror Tracing

#### RP Realiability

## Number of categories should be increased in order to count frequencies.

##   
## Reliability analysis   
## Call: psych::alpha(x = mt\_t\_w)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd median\_r  
## 0.56 0.92 0.96 0.52 11 0.058 33 66 0.62  
##   
## lower alpha upper 95% confidence boundaries  
## 0.44 0.56 0.67   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se var.r med.r  
## 1 0.80 0.93 0.95 0.60 13.6 0.043 0.035 0.64  
## 2 0.34 0.92 0.94 0.56 11.5 0.096 0.065 0.64  
## 3 0.53 0.91 0.96 0.52 9.8 0.056 0.076 0.64  
## 4 0.54 0.90 0.96 0.51 9.5 0.056 0.071 0.61  
## 5 0.54 0.90 0.95 0.51 9.3 0.057 0.068 0.59  
## 6 0.53 0.90 0.96 0.50 9.1 0.056 0.067 0.59  
## 7 0.54 0.90 0.95 0.49 8.7 0.057 0.061 0.59  
## 8 0.54 0.90 0.95 0.50 8.9 0.057 0.063 0.59  
## 9 0.55 0.90 0.96 0.51 9.5 0.058 0.070 0.61  
## 10 0.55 0.91 0.96 0.52 9.6 0.057 0.068 0.61  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## 1 51 0.99 0.38 0.37 0.50 59 102.9  
## 2 50 0.88 0.57 0.56 0.90 37 34.1  
## 3 51 0.84 0.76 0.73 0.43 28 12.4  
## 4 51 0.78 0.80 0.78 0.41 24 10.1  
## 5 51 0.78 0.83 0.81 0.41 22 8.8  
## 6 51 0.84 0.85 0.84 0.44 21 10.1  
## 7 51 0.85 0.90 0.91 0.46 19 7.4  
## 8 51 0.82 0.87 0.87 0.43 18 8.5  
## 9 51 0.78 0.80 0.78 0.43 16 6.2  
## 10 51 0.70 0.78 0.75 0.37 16 7.2

## Number of categories should be increased in order to count frequencies.

##   
## Reliability analysis   
## Call: psych::alpha(x = mt\_e\_w)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd median\_r  
## 0.68 0.91 0.93 0.5 10 0.056 22 32 0.54  
##   
## lower alpha upper 95% confidence boundaries  
## 0.58 0.68 0.79   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se var.r med.r  
## 1 0.86 0.92 0.93 0.56 11.6 0.026 0.013 0.56  
## 2 0.59 0.90 0.92 0.51 9.3 0.075 0.033 0.55  
## 3 0.62 0.90 0.92 0.49 8.6 0.062 0.031 0.53  
## 4 0.66 0.90 0.92 0.50 8.9 0.058 0.031 0.54  
## 5 0.66 0.90 0.93 0.51 9.4 0.058 0.031 0.55  
## 6 0.65 0.89 0.92 0.49 8.5 0.059 0.030 0.54  
## 7 0.66 0.89 0.92 0.48 8.4 0.058 0.027 0.53  
## 8 0.66 0.89 0.92 0.48 8.3 0.058 0.027 0.54  
## 9 0.66 0.90 0.92 0.49 8.8 0.059 0.029 0.54  
## 10 0.67 0.89 0.92 0.49 8.5 0.058 0.032 0.53  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## 1 53 0.90 0.44 0.36 0.38 46.2 64.0  
## 2 53 0.44 0.70 0.67 0.69 28.4 26.6  
## 3 52 0.77 0.80 0.78 0.60 21.9 19.1  
## 4 52 0.67 0.75 0.72 0.53 17.1 10.4  
## 5 52 0.63 0.69 0.64 0.48 16.5 11.5  
## 6 52 0.73 0.81 0.79 0.60 13.8 9.6  
## 7 52 0.71 0.82 0.82 0.57 12.1 8.8  
## 8 51 0.74 0.84 0.84 0.62 9.7 7.6  
## 9 52 0.70 0.77 0.76 0.58 10.5 8.7  
## 10 51 0.76 0.81 0.79 0.66 8.5 4.9

### Statistical Analysis by Trial

#### Baseline differences on trial one

* No significant group differences on first trial

mtri1<-lm(error~Age+Sex+kbit\_ss+Subgroup,data=me\_1)  
anova(mtri1)

## Analysis of Variance Table  
##   
## Response: error  
## Df Sum Sq Mean Sq F value Pr(>F)   
## Age 1 7078 7078.4 1.8757 0.17720   
## Sex 1 23286 23285.9 6.1706 0.01653 \*  
## kbit\_ss 1 313 313.2 0.0830 0.77453   
## Subgroup 1 1298 1298.4 0.3441 0.56024   
## Residuals 48 181137 3773.7   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

eta\_sq(mtri1)

## Parameter | Eta2 (partial) | 90% CI  
## -----------------------------------------  
## Age | 0.04 | [0.00, 0.16]  
## Sex | 0.11 | [0.01, 0.27]  
## kbit\_ss | 1.73e-03 | [0.00, 0.06]  
## Subgroup | 7.12e-03 | [0.00, 0.09]

t.test(error~Subgroup,data=me\_1)

##   
## Welch Two Sample t-test  
##   
## data: error by Subgroup  
## t = -0.05, df = 38.233, p-value = 0.9604  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -37.22546 35.43059  
## sample estimates:  
## mean in group DD mean in group TYP   
## 45.76923 46.66667

mtri2<-lm(time~Age+Sex+kbit\_ss+Subgroup,data=mt\_1)  
anova(mtri2)

## Analysis of Variance Table  
##   
## Response: time  
## Df Sum Sq Mean Sq F value Pr(>F)   
## Age 1 26093 26093.5 2.5320 0.11841   
## Sex 1 29657 29657.3 2.8779 0.09656 .  
## kbit\_ss 1 2 1.6 0.0002 0.99024   
## Subgroup 1 71 71.4 0.0069 0.93403   
## Residuals 46 474046 10305.3   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

eta\_sq(mtri2)

## Parameter | Eta2 (partial) | 90% CI  
## -----------------------------------------  
## Age | 0.05 | [0.00, 0.19]  
## Sex | 0.06 | [0.00, 0.20]  
## kbit\_ss | 3.29e-06 | [0.00, 0.00]  
## Subgroup | 1.51e-04 | [0.00, 0.01]

t.test(time~Subgroup,data=mt\_1)

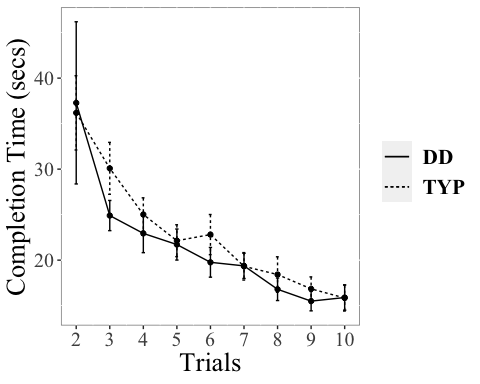
##   
## Welch Two Sample t-test  
##   
## data: time by Subgroup  
## t = 0.45986, df = 24.603, p-value = 0.6497  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -49.27009 77.56796  
## sample estimates:  
## mean in group DD mean in group TYP   
## 66.11042 51.96148

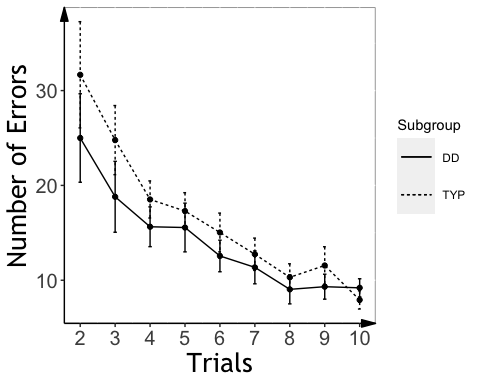
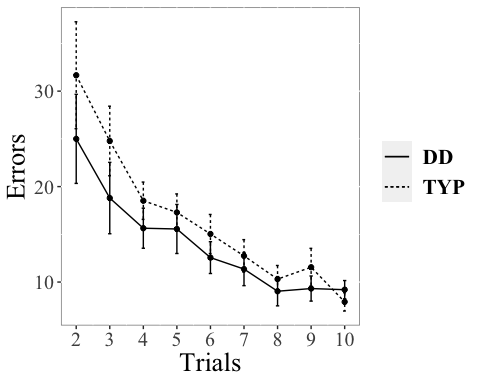
### Linear mixed modeling

* 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

## Final Sample

##   
## DD TYP   
## 26 27

##### MT 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=2)

##   
## Call:  
## lm(formula = slope\_mt ~ Age + Sex + kbit\_ss + Subgroup, data = d2,   
## na.action = na.exclude)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -5.0104 -0.5444 0.3169 1.0654 2.9428   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.9799541 2.3735390 -0.413 0.6816   
## Age -0.0558340 0.0433307 -1.289 0.2040   
## Sex 0.6157376 0.5037176 1.222 0.2278   
## kbit\_ss 0.0005472 0.0176373 0.031 0.9754   
## SubgroupTYP -0.8365620 0.4843214 -1.727 0.0908 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 1.633 on 46 degrees of freedom  
## (2 observations deleted due to missingness)  
## Multiple R-squared: 0.09558, Adjusted R-squared: 0.01694   
## F-statistic: 1.215 on 4 and 46 DF, p-value: 0.3173

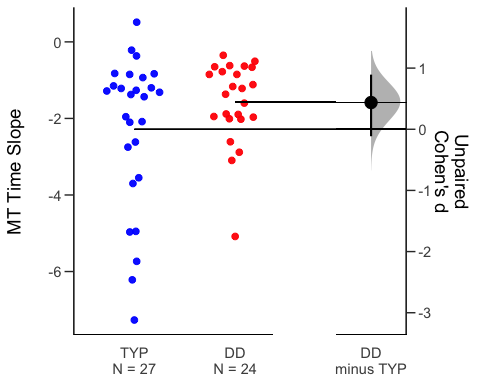
## $`lsmeans of Subgroup`  
## Subgroup lsmean SE df lower.CL upper.CL  
## DD -1.46 0.348 46 -2.16 -0.764  
## TYP -2.30 0.322 46 -2.95 -1.652  
##   
## Results are averaged over the levels of: Sex   
## Confidence level used: 0.95   
##   
## $`pairwise differences of Subgroup`  
## 1 estimate SE df t.ratio p.value  
## DD - TYP 0.837 0.484 46 1.727 0.0908   
##   
## Results are averaged over the levels of: Sex

##   
## Call:  
## lm(formula = slope\_me ~ Age + Sex + kbit\_ss + Subgroup, data = d2,   
## na.action = na.exclude)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -5.7769 -0.5177 0.5963 1.2224 4.1095   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.748891 3.114839 -0.240 0.8111   
## Age -0.063421 0.056864 -1.115 0.2705   
## Sex 0.866862 0.661038 1.311 0.1962   
## kbit\_ss -0.002293 0.023146 -0.099 0.9215   
## SubgroupTYP -1.125287 0.635584 -1.770 0.0833 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 2.143 on 46 degrees of freedom  
## (2 observations deleted due to missingness)  
## Multiple R-squared: 0.09668, Adjusted R-squared: 0.01813   
## F-statistic: 1.231 on 4 and 46 DF, p-value: 0.3109

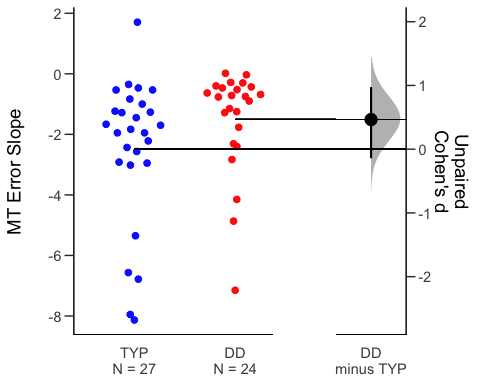
## $`lsmeans of Subgroup`  
## Subgroup lsmean SE df lower.CL upper.CL  
## DD -1.37 0.457 46 -2.29 -0.451  
## TYP -2.49 0.423 46 -3.35 -1.644  
##   
## Results are averaged over the levels of: Sex   
## Confidence level used: 0.95   
##   
## $`pairwise differences of Subgroup`  
## 1 estimate SE df t.ratio p.value  
## DD - TYP 1.13 0.636 46 1.770 0.0833   
##   
## Results are averaged over the levels of: 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

####Reliability#### Zhenghan, can you please calculate reliability on the SL data? I couldn’t figure out how to get clean item, I figured it would be faster for you :-)

# fam\_trial\_vsl  
# fam\_trial\_vsl\_scale  
# fam\_trial\_tsl  
# fam\_trial\_tsl\_scale  
#   
# sl1<-fam\_trial\_vsl%>%ungroup%>%select(PartID,rt\_col,trial)  
# sl2<-mt%>%ungroup%>%select(PartID,error,trial)  
#   
#   
# sl1\_w<- spread(sl1, trial, rt\_col)  
# mt\_e\_w<- spread(mt4, trial, error)  
# mt\_t\_w<-select(mt\_t\_w,-PartID)  
# mt\_e\_w<-select(mt\_e\_w,-PartID)  
# psych::alpha(sl1\_w)  
# psych::alpha(mt\_e\_w)

* 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

# TSL Analysis

### RT by Trial Analysis

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

##   
## Welch Two Sample t-test  
##   
## data: subj\_table\_tsl\_usable$mean\_rt by subj\_table\_tsl\_usable$Subgroup  
## t = 1.5232, df = 25.85, p-value = 0.1399  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -18.3764 123.4250  
## sample estimates:  
## mean in group DD mean in group TYP   
## 408.5518 356.0275

* There is no significant group difference in detection accuracy for TSL

##   
## Welch Two Sample t-test  
##   
## data: hit\_rate by Subgroup  
## t = -1.3839, df = 29.986, p-value = 0.1766  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -0.27135406 0.05214772  
## sample estimates:  
## mean in group DD mean in group TYP   
## 0.5542857 0.6638889

* No RT effect of group or interaction tested either by lm or lmer

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ Age + Sex + kbit\_ss + reindex \* Subgroup + (1 + reindex |   
## PartID)  
## Data: fam\_tsl\_age\_gender\_iq  
##   
## REML criterion at convergence: 12675.7  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -2.0964 -0.7029 -0.1885 0.6753 2.6740   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## PartID (Intercept) 15630.83 125.023   
## reindex 15.93 3.991 -0.74  
## Residual 60788.67 246.554   
## Number of obs: 913, groups: PartID, 31  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)  
## (Intercept) 236.9372 219.1478 30.1461 1.081 0.288  
## Age 0.2308 3.6622 26.2782 0.063 0.950  
## Sex 31.0451 40.6802 26.3896 0.763 0.452  
## kbit\_ss 1.1763 1.6688 27.7586 0.705 0.487  
## reindex -0.2028 1.4839 29.7831 -0.137 0.892  
## SubgroupTYP -67.2181 60.8708 31.2198 -1.104 0.278  
## reindex:SubgroupTYP 0.2394 1.9209 28.4274 0.125 0.902  
##   
## Correlation of Fixed Effects:  
## (Intr) Age Sex kbt\_ss reindx SbgTYP  
## Age -0.712   
## Sex 0.220 -0.450   
## kbit\_ss -0.916 0.534 -0.373   
## reindex -0.158 0.002 0.011 -0.004   
## SubgroupTYP 0.170 -0.195 0.133 -0.341 0.569   
## rndx:SbgTYP 0.130 -0.008 -0.007 -0.004 -0.773 -0.737  
## optimizer (nloptwrap) convergence code: 0 (OK)  
## Model failed to converge with max|grad| = 0.00524202 (tol = 0.002, component 1)

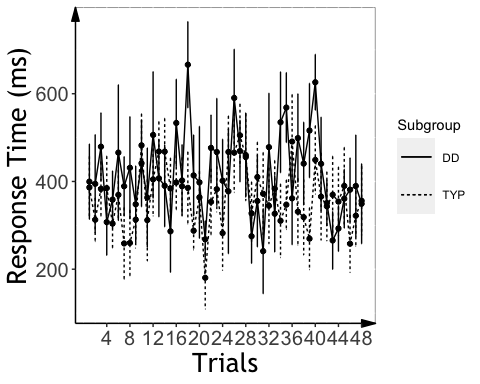
* ANCOVA with covariates (RT slope data) - no group effect

##   
## Call:  
## lm(formula = rt\_slope ~ Subgroup + Age + Sex + kbit\_ss, data = subj\_table\_tsl\_gender\_iq)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -11.311 -3.551 -0.118 3.925 9.623   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -6.32351 11.93682 -0.530 0.601  
## SubgroupTYP -0.18065 2.32406 -0.078 0.939  
## Age 0.20277 0.20659 0.981 0.335  
## Sex -3.58003 2.29134 -1.562 0.130  
## kbit\_ss 0.05700 0.09287 0.614 0.545  
##   
## Residual standard error: 5.417 on 26 degrees of freedom  
## (1 observation deleted due to missingness)  
## Multiple R-squared: 0.09178, Adjusted R-squared: -0.04794   
## F-statistic: 0.6569 on 4 and 26 DF, p-value: 0.6274

#### Plot of TSL RT

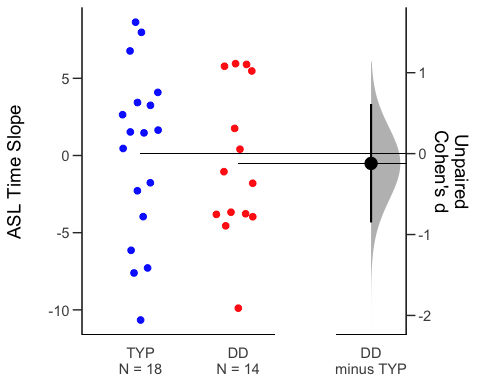
* RT as the function of Target repetition

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



### Plot ASL RT Slope

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



####VSL Slope Analysis

## # 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 $\\pm$ …

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

##   
## Welch Two Sample t-test  
##   
## data: subj\_table\_vsl$mean\_rt by subj\_table\_vsl$Subgroup  
## t = -0.7043, df = 34.466, p-value = 0.486  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -61.68091 29.91985  
## sample estimates:  
## mean in group DD mean in group TYP   
## 475.3603 491.2408

##   
## Welch Two Sample t-test  
##   
## data: subj\_table\_vsl$hit\_rate by subj\_table\_vsl$Subgroup  
## t = -1.5852, df = 21.679, p-value = 0.1274  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -0.060185457 0.008062695  
## sample estimates:  
## mean in group DD mean in group TYP   
## 0.9617647 0.9878261

* There is no significant group difference in target detection accuracy for VSL

##   
## Call:  
## lm(formula = dprime ~ Age + Sex + kbit\_ss + Subgroup, data = subj\_table\_vsl\_iq\_age)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -3.8717 0.4337 0.7642 1.3091 1.8101   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 6.890e+00 3.831e+00 1.798 0.0813 .  
## Age 2.091e-05 5.906e-02 0.000 0.9997   
## Sex -3.366e-01 6.996e-01 -0.481 0.6335   
## kbit\_ss 2.755e-03 2.911e-02 0.095 0.9252   
## SubgroupTYP 6.792e-01 7.294e-01 0.931 0.3585   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 2.009 on 33 degrees of freedom  
## (2 observations deleted due to missingness)  
## Multiple R-squared: 0.03667, Adjusted R-squared: -0.0801   
## F-statistic: 0.3141 on 4 and 33 DF, p-value: 0.8665

* The DD group had a faster RT acceleration than the TYP group (significant group x trial index interaction tested by lm and marginal interaction tested by lmer)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ Age + Sex + kbit\_ss + reindex \* Subgroup + (1 + reindex |   
## PartID)  
## Data: fam\_vsl\_age\_gender\_iq  
##   
## REML criterion at convergence: 10524.2  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -9.8278 -0.4930 -0.0449 0.4939 4.0270   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## PartID (Intercept) 3289.941 57.358   
## reindex 6.739 2.596 0.12  
## Residual 7130.657 84.443   
## Number of obs: 891, groups: PartID, 38  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 500.1099 124.8143 32.5935 4.007 0.000335 \*\*\*  
## Age 0.1431 1.9229 32.5132 0.074 0.941128   
## Sex 30.2208 22.8003 32.6476 1.325 0.194221   
## kbit\_ss -0.3433 0.9479 32.5216 -0.362 0.719592   
## reindex -2.5600 0.9120 36.7614 -2.807 0.007955 \*\*   
## SubgroupTYP -8.1461 24.4311 33.1008 -0.333 0.740912   
## reindex:SubgroupTYP 2.0993 1.1936 36.2279 1.759 0.087049 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) Age Sex kbt\_ss reindx SbgTYP  
## Age -0.619   
## Sex -0.042 -0.269   
## kbit\_ss -0.916 0.375 -0.119   
## reindex -0.036 -0.001 0.001 0.001   
## SubgroupTYP 0.293 -0.142 -0.077 -0.393 0.178   
## rndx:SbgTYP 0.028 0.001 -0.002 -0.001 -0.764 -0.231  
## optimizer (nloptwrap) convergence code: 0 (OK)  
## Model failed to converge with max|grad| = 0.00361062 (tol = 0.002, component 1)

* ANCOVA with covariates (from the slope data): marginal group effect.

## Df Sum Sq Mean Sq F value Pr(>F)   
## Subgroup 1 39.9 39.86 3.015 0.0918 .  
## Age 1 25.3 25.33 1.916 0.1756   
## Sex 1 6.6 6.63 0.501 0.4839   
## kbit\_ss 1 1.9 1.92 0.145 0.7056   
## Residuals 33 436.3 13.22   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
## 2 observations deleted due to missingness

* within DYS group

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ Age + Sex + kbit\_ss + reindex + (1 + reindex | PartID)  
## Data: fam\_vsl\_age\_gender\_iq[fam\_vsl\_age\_gender\_iq$Subgroup == "DD", ]  
##   
## REML criterion at convergence: 4420.8  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -8.9709 -0.4611 -0.0675 0.5115 3.5553   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## PartID (Intercept) 1663.25 40.78   
## reindex 10.82 3.29 0.63  
## Residual 8572.13 92.59   
## Number of obs: 370, groups: PartID, 16  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 599.0846 139.5989 10.8654 4.291 0.00131 \*\*  
## Age -2.2613 2.4135 10.8741 -0.937 0.36914   
## Sex 25.8260 32.5764 11.0868 0.793 0.44454   
## kbit\_ss -0.6666 1.1345 10.8759 -0.588 0.56880   
## reindex -2.4994 1.0814 15.0738 -2.311 0.03537 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) Age Sex kbt\_ss  
## Age -0.401   
## Sex -0.161 -0.340   
## kbit\_ss -0.895 0.088 0.000   
## reindex -0.009 -0.003 0.005 0.005

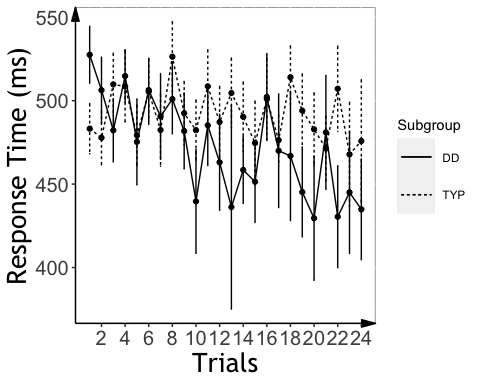
* within TYP group

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ Age + Sex + kbit\_ss + reindex + (1 + reindex | PartID)  
## Data: fam\_vsl\_age\_gender\_iq[fam\_vsl\_age\_gender\_iq$Subgroup == "TYP", ]  
##   
## REML criterion at convergence: 6068.3  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -9.5167 -0.4944 -0.0382 0.5059 4.3311   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## PartID (Intercept) 4758.361 68.98   
## reindex 3.961 1.99 -0.30  
## Residual 6115.586 78.20   
## Number of obs: 521, groups: PartID, 22  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)  
## (Intercept) 191.0802 223.8597 17.9898 0.854 0.405  
## Age 3.8891 3.0006 17.9444 1.296 0.211  
## Sex 38.2748 30.0364 17.9691 1.274 0.219  
## kbit\_ss 1.3382 1.5241 17.9491 0.878 0.392  
## reindex -0.4599 0.6525 21.0396 -0.705 0.489  
##   
## Correlation of Fixed Effects:  
## (Intr) Age Sex kbt\_ss  
## Age -0.753   
## Sex 0.044 -0.255   
## kbit\_ss -0.950 0.590 -0.194   
## reindex -0.035 0.000 0.001 0.000

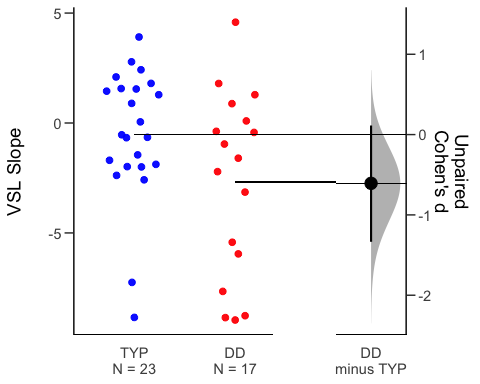
####Plot of VSL RT

* 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

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



#### Combine slope data of both tasks

#### Using scaled RT, check interactions between task and group.

* both lm and lmer models: task x trial interaction: visual task show faster acceleration across the two groups; task x trial x group interaction (marginal): group difference in slope is greater in VSL than ASL

## boundary (singular) fit: see ?isSingular

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]  
## Formula: rt\_col ~ Age + Sex + kbit\_ss + task \* reindex \* Subgroup + (1 +   
## task | PartID) + (task | reindex)  
## Data: all\_fam\_trials\_age\_gender\_iq  
##   
## REML criterion at convergence: 5113.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.5626 -0.6958 -0.1335 0.6735 3.7730   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## reindex (Intercept) 1.764e-02 1.328e-01   
## taskVisual 1.828e-02 1.352e-01 -0.99  
## PartID (Intercept) 9.443e-11 9.717e-06   
## taskVisual 1.382e-10 1.175e-05 -1.00  
## Residual 9.536e-01 9.765e-01   
## Number of obs: 1804, groups: reindex, 48; PartID, 39  
##   
## Fixed effects:  
## Estimate Std. Error df t value  
## (Intercept) 4.373e-02 2.983e-01 1.641e+03 0.147  
## Age 1.056e-04 4.379e-03 1.744e+03 0.024  
## Sex -2.553e-05 5.040e-02 1.744e+03 -0.001  
## kbit\_ss 7.455e-05 2.121e-03 1.746e+03 0.035  
## taskVisual 2.285e-01 1.532e-01 1.904e+02 1.492  
## reindex -2.190e-03 3.943e-03 2.027e+02 -0.555  
## SubgroupTYP -6.675e-02 1.345e-01 1.750e+03 -0.496  
## taskVisual:reindex -2.066e-02 8.387e-03 1.833e+02 -2.463  
## taskVisual:SubgroupTYP -2.146e-01 1.905e-01 1.741e+03 -1.126  
## reindex:SubgroupTYP 2.628e-03 4.723e-03 1.752e+03 0.556  
## taskVisual:reindex:SubgroupTYP 2.004e-02 1.073e-02 1.735e+03 1.868  
## Pr(>|t|)   
## (Intercept) 0.8835   
## Age 0.9808   
## Sex 0.9996   
## kbit\_ss 0.9720   
## taskVisual 0.1374   
## reindex 0.5792   
## SubgroupTYP 0.6197   
## taskVisual:reindex 0.0147 \*  
## taskVisual:SubgroupTYP 0.2602   
## reindex:SubgroupTYP 0.5780   
## taskVisual:reindex:SubgroupTYP 0.0620 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) Age Sex kbt\_ss tskVsl reindx SbgTYP tskVs: tV:STY  
## Age -0.638   
## Sex 0.063 -0.328   
## kbit\_ss -0.864 0.479 -0.240   
## taskVisual -0.262 -0.025 0.029 -0.011   
## reindex -0.317 0.006 0.005 -0.011 0.628   
## SubgroupTYP -0.120 -0.091 0.041 -0.172 0.531 0.628   
## tskVsl:rndx 0.155 -0.005 -0.003 -0.001 -0.823 -0.471 -0.294   
## tskVsl:STYP 0.188 0.012 -0.037 0.010 -0.749 -0.442 -0.687 0.630   
## rndx:SbgTYP 0.243 -0.017 -0.006 0.000 -0.459 -0.732 -0.849 0.344 0.600  
## tskVs::STYP -0.112 0.009 0.004 0.005 0.613 0.322 0.373 -0.757 -0.828  
## r:STYP  
## Age   
## Sex   
## kbit\_ss   
## taskVisual   
## reindex   
## SubgroupTYP   
## tskVsl:rndx   
## tskVsl:STYP   
## rndx:SbgTYP   
## tskVs::STYP -0.440  
## optimizer (nloptwrap) convergence code: 0 (OK)  
## boundary (singular) fit: see ?isSingular

* ANCOVA for interaction between task and group (no significant interaction)

##   
## Call:  
## lm(formula = rt\_slope\_scale ~ Subgroup \* task + Age + Sex + kbit\_ss,   
## data = all\_subj\_slope\_age\_gender\_iq)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.073496 -0.020347 -0.001736 0.020693 0.094612   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.0887526 0.0524796 -1.691 0.0965 .  
## SubgroupTYP -0.0046253 0.0132880 -0.348 0.7291   
## taskVisual -0.0176519 0.0128854 -1.370 0.1763   
## Age 0.0014840 0.0009127 1.626 0.1097   
## Sex -0.0097395 0.0100236 -0.972 0.3355   
## kbit\_ss 0.0006123 0.0004022 1.522 0.1337   
## SubgroupTYP:taskVisual 0.0157357 0.0171504 0.918 0.3629   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.03344 on 55 degrees of freedom  
## (2 observations deleted due to missingness)  
## Multiple R-squared: 0.1128, Adjusted R-squared: 0.01601   
## F-statistic: 1.165 on 6 and 55 DF, p-value: 0.3382

## 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"

#### ASL and VSL Accuracy

* both groups performed above chance for both tasks

##   
## One Sample t-test  
##   
## data: DD\_acc\_vsl$subj\_corr  
## 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$subj\_corr  
## 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$subj\_corr  
## 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$subj\_corr  
## 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

* generalized linear effect modeling within each task (both models failed to converge with IQ included, removing IQ from the covariates fix the issues)
* VSL, no group effect

## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unidentifiable: large eigenvalue ratio  
## - Rescale variables?

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: corr ~ Age + Sex + kbit\_ss + Subgroup + (1 | PartID) + (1 | trial)  
## Data: vsl\_accuracy\_age\_gender\_iq  
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## AIC BIC logLik deviance df.resid   
## 1345.9 1381.6 -665.9 1331.9 1209   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.9653 -0.7900 0.3272 0.6713 1.9676   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 1.20050 1.0957   
## trial (Intercept) 0.04604 0.2146   
## Number of obs: 1216, groups: PartID, 38; trial, 32  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 2.9725567 2.3173467 1.283 0.1996   
## Age -0.0380614 0.0350052 -1.087 0.2769   
## Sex -0.7161461 0.4108970 -1.743 0.0814 .  
## kbit\_ss 0.0007701 0.0174371 0.044 0.9648   
## SubgroupTYP -0.1513840 0.4325556 -0.350 0.7264   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) Age Sex kbt\_ss  
## Age -0.640   
## Sex -0.043 -0.257   
## kbit\_ss -0.919 0.405 -0.120   
## SubgroupTYP 0.310 -0.154 -0.075 -0.407  
## optimizer (bobyqa) convergence code: 0 (OK)  
## Model is nearly unidentifiable: large eigenvalue ratio  
## - Rescale variables?

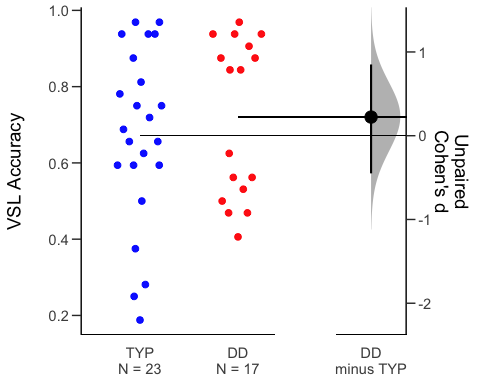
* Significant group effects for ASL (Typ>Dys)

## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unidentifiable: very large eigenvalue  
## - Rescale variables?;Model is nearly unidentifiable: large eigenvalue ratio  
## - Rescale variables?

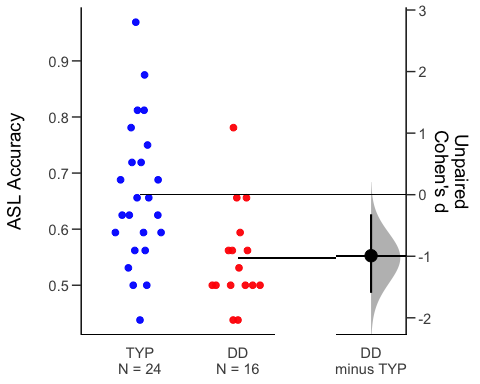
## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: corr ~ Age + Sex + kbit\_ss + Subgroup + (1 | PartID) + (1 | trial)  
## Data: tsl\_accuracy\_age\_gender\_iq  
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## AIC BIC logLik deviance df.resid   
## 1603.2 1638.9 -794.6 1589.2 1209   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -2.2337 -1.0917 0.6282 0.7892 1.3494   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## PartID (Intercept) 0.0537 0.2317   
## trial (Intercept) 0.1188 0.3447   
## Number of obs: 1216, groups: PartID, 38; trial, 32  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 1.078116 0.831254 1.297 0.19464   
## Age -0.026645 0.012850 -2.074 0.03812 \*   
## Sex 0.389298 0.154111 2.526 0.01153 \*   
## kbit\_ss -0.006777 0.006317 -1.073 0.28335   
## SubgroupTYP 0.478118 0.158999 3.007 0.00264 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) Age Sex kbt\_ss  
## Age -0.617   
## Sex -0.029 -0.286   
## kbit\_ss -0.914 0.378 -0.134   
## SubgroupTYP 0.292 -0.157 -0.022 -0.399  
## optimizer (bobyqa) convergence code: 0 (OK)  
## Model is nearly unidentifiable: very large eigenvalue  
## - Rescale variables?  
## Model is nearly unidentifiable: large eigenvalue ratio  
## - Rescale variables?

#### Plot VSL Accuracy

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

 #### Plot ASL Accuracy

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



#### Task by Group Interaction

* LME: main effect of task (visual > auditory); main effect of group (TYP > DD);

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: corr ~ task \* Subgroup + Age + Sex + (1 + task | PartID) + (1 |   
## trial)  
## Data: all\_accuracy\_age\_gender\_iq  
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## AIC BIC logLik deviance df.resid   
## 2956.8 3014.8 -1468.4 2936.8 2422   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.0109 -1.0438 0.4304 0.7543 1.8858   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## PartID (Intercept) 0.05991 0.2448   
## taskVisual 1.59200 1.2617 -0.39  
## trial (Intercept) 0.02892 0.1701   
## Number of obs: 2432, groups: PartID, 39; trial, 32  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 0.50152 0.32383 1.549 0.12145   
## taskVisual 0.94959 0.35048 2.709 0.00674 \*\*  
## SubgroupTYP 0.41899 0.14725 2.845 0.00444 \*\*  
## Age -0.02335 0.01094 -2.133 0.03290 \*   
## Sex 0.21885 0.14832 1.475 0.14008   
## taskVisual:SubgroupTYP -0.69996 0.45836 -1.527 0.12674   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) tskVsl SbgTYP Age Sex   
## taskVisual -0.149   
## SubgroupTYP -0.191 0.317   
## Age -0.718 -0.005 -0.016   
## Sex -0.439 0.014 -0.099 -0.201   
## tskVsl:STYP 0.110 -0.762 -0.413 0.009 -0.011

* ANCOVA: marginal effect of task (Visual > Auditory)

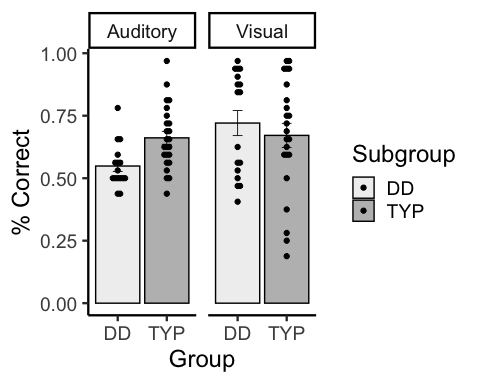
##   
## Call:  
## lm(formula = subj\_corr ~ task \* Subgroup + Age + Sex + kbit\_ss,   
## data = all\_acc\_table\_age\_gender\_iq)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.45843 -0.10014 -0.01138 0.13461 0.30679   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.745314 0.242726 3.071 0.00308 \*\*  
## taskVisual 0.148067 0.065136 2.273 0.02623 \*   
## SubgroupTYP 0.103796 0.062836 1.652 0.10324   
## Age -0.005876 0.003711 -1.583 0.11805   
## Sex -0.010505 0.044216 -0.238 0.81292   
## kbit\_ss -0.000315 0.001829 -0.172 0.86378   
## taskVisual:SubgroupTYP -0.130885 0.084472 -1.549 0.12598   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.1784 on 67 degrees of freedom  
## (4 observations deleted due to missingness)  
## Multiple R-squared: 0.1186, Adjusted R-squared: 0.03965   
## F-statistic: 1.502 on 6 and 67 DF, p-value: 0.1909

#### Plot 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>

## 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

##   
## Correlation method: 'pearson'  
## Missing treated using: 'pairwise.complete.obs'

## term slope\_me slope\_mt slopeProp\_On vis\_slope\_scale  
## 1 IQ -.04 -.01 -.05 .14  
## 2 WID -.18 -.18 -.06 .19  
## 3 WA -.29 -.32 .00 .15  
## 4 Vocabulary -.18 -.12 .06 .02  
## 5 Elision -.24 -.17 .05 .12  
## 6 Nonword -.06 -.03 -.19 -.01  
## 7 RAN\_Objects .07 -.00 -.03 -.01  
## 8 RAN\_2Set -.05 -.10 -.25 .23  
## 9 DigitsForward .01 .04 -.07 .32  
## 10 DigitsBackward .06 -.02 .08 .21  
## aud\_slope\_scale aud\_fam\_rt vis\_fam\_rt  
## 1 .04 .07 -.01  
## 2 .04 -.16 .07  
## 3 .11 -.18 .13  
## 4 -.07 -.15 -.11  
## 5 .04 .09 -.33  
## 6 .14 -.25 .07  
## 7 -.20 -.11 -.14  
## 8 -.39 .24 .07  
## 9 -.09 -.36 -.03  
## 10 .03 .03 -.11

## slopeProp\_On slope\_mt slope\_me vis\_slope\_scale aud\_slope\_scale  
## slopeProp\_On 1.00 -0.33 -0.22 0.19 -0.06  
## slope\_mt -0.33 1.00 0.82 0.04 -0.14  
## slope\_me -0.22 0.82 1.00 0.00 -0.02  
## vis\_slope\_scale 0.19 0.04 0.00 1.00 -0.23  
## aud\_slope\_scale -0.06 -0.14 -0.02 -0.23 1.00  
## aud\_fam\_rt -0.20 0.18 0.24 -0.17 -0.14  
## vis\_fam\_rt 0.13 0.03 0.23 0.42 0.11  
## aud\_fam\_rt vis\_fam\_rt  
## slopeProp\_On -0.20 0.13  
## slope\_mt 0.18 0.03  
## slope\_me 0.24 0.23  
## vis\_slope\_scale -0.17 0.42  
## aud\_slope\_scale -0.14 0.11  
## aud\_fam\_rt 1.00 -0.10  
## vis\_fam\_rt -0.10 1.00

## slopeProp\_On slope\_mt slope\_me vis\_slope\_scale  
## slopeProp\_On " 1.000 " "-0.286\* " "-0.248 " " 0.195 "   
## slope\_mt "-0.286\* " " 1.000 " " 0.797\*\*\*" " 0.067 "   
## slope\_me "-0.248 " " 0.797\*\*\*" " 1.000 " " 0.035 "   
## vis\_slope\_scale " 0.195 " " 0.067 " " 0.035 " " 1.000 "   
## aud\_slope\_scale "-0.061 " "-0.129 " "-0.023 " "-0.182 "   
## aud\_fam\_rt "-0.204 " " 0.179 " " 0.235 " "-0.197 "   
## vis\_fam\_rt " 0.043 " "-0.041 " " 0.187 " " 0.381\* "   
## aud\_slope\_scale aud\_fam\_rt vis\_fam\_rt   
## slopeProp\_On "-0.061 " "-0.204 " " 0.043 "  
## slope\_mt "-0.129 " " 0.179 " "-0.041 "  
## slope\_me "-0.023 " " 0.235 " " 0.187 "  
## vis\_slope\_scale "-0.182 " "-0.197 " " 0.381\* "  
## aud\_slope\_scale " 1.000 " "-0.137 " " 0.133 "  
## aud\_fam\_rt "-0.137 " " 1.000 " "-0.100 "  
## vis\_fam\_rt " 0.133 " "-0.100 " " 1.000 "

### Dys only

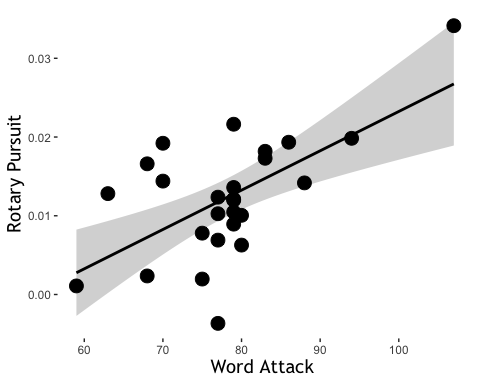
* both the rotary pursuit and ASL accuracy/RT are related to reading
* RP performance is associated with better reading

##   
## Correlation method: 'pearson'  
## Missing treated using: 'pairwise.complete.obs'

## term slope\_me slope\_mt slopeProp\_On vis\_slope\_scale  
## 1 IQ -.07 .11 .07 -.07  
## 2 WID -.11 -.16 .58 -.31  
## 3 WA .01 -.08 .61 -.23  
## 4 Vocabulary .07 .09 .21 -.15  
## 5 Elision -.23 -.08 .20 -.30  
## 6 Nonword .08 .27 -.26 -.01  
## 7 RAN\_Objects .42 .47 .08 -.48  
## 8 RAN\_2Set -.12 -.27 .08 -.18  
## 9 DigitsForward .01 .11 -.07 .52  
## 10 DigitsBackward .07 -.03 .65 -.04  
## 11 aud\_fam\_rt -.27 -.39 -.20 -.35  
## 12 vis\_fam\_rt .25 -.11 .00 .48  
## aud\_slope\_scale  
## 1 .19  
## 2 -.00  
## 3 -.43  
## 4 -.25  
## 5 .01  
## 6 -.27  
## 7 -.38  
## 8 -.67  
## 9 -.20  
## 10 .19  
## 11 -.24  
## 12 .15

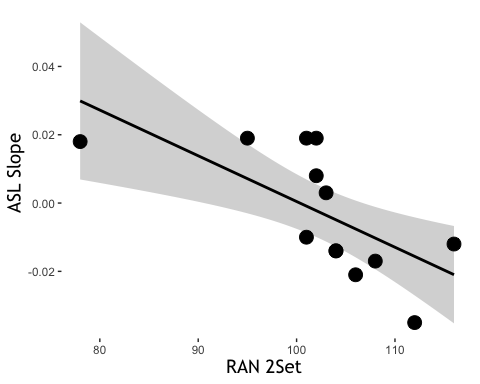
## Warning: Removed 5 rows containing non-finite values (stat\_smooth).

## Warning: Removed 5 rows containing missing values (geom\_point).



## Warning: Removed 18 rows containing non-finite values (stat\_smooth).

## Warning: Removed 18 rows containing missing values (geom\_point).



### Typ only

* better VSL is related to worse reading

##   
## Correlation method: 'pearson'  
## Missing treated using: 'pairwise.complete.obs'

## term slope\_me slope\_mt slopeProp\_On vis\_slope\_scale  
## 1 IQ .11 .04 -.01 .15  
## 2 WID .07 .05 -.08 .14  
## 3 WA -.33 -.40 .16 -.20  
## 4 Vocabulary -.23 -.11 .17 -.14  
## 5 Elision -.13 -.11 .12 .26  
## 6 Nonword .09 .06 .04 -.30  
## 7 RAN\_Objects .03 -.07 .05 .15  
## 8 RAN\_2Set .25 .18 -.29 .37  
## 9 DigitsForward .03 -.13 -.22 -.08  
## 10 DigitsBackward .20 .09 -.19 .18  
## 11 aud\_fam\_rt .36 .28 -.19 .07  
## 12 vis\_fam\_rt .28 .04 .05 .25  
## aud\_slope\_scale  
## 1 -.13  
## 2 -.10  
## 3 .24  
## 4 -.08  
## 5 .00  
## 6 .33  
## 7 -.15  
## 8 -.42  
## 9 .30  
## 10 -.11  
## 11 -.04  
## 12 .10