Models for Perceptual Difficulty Paper

Exp.2

Mixed effects logistic regression predicting redundant adjective use from fixed effects of redundant property, with random by-subject and by-item intercepts

going from high difficulty-material redundant(0) to low difficulty-color redundant(1) & no redundancy(0) to redundancy(1) –> should be positive

```
##
## high_difficulty  low_difficulty
##             357             335
```

```
##
##   0   1
## 519 173
```

```
##
##          boot_leather_green          bottle_glass_green
##                          42                          44
##        bottle_plastic_green           chair_metal_green
##                          38                          48
##          chair_metal_purple           cup_plastic_green
##                          44                          39
##         jacket_denim_purple          pitcher_metal_blue
##                          40                          45
##            plate_paper_blue plate_plastic_blue_original
##                          88                          46
##            spoon_wood_green            table_metal_blue
##                          45                          86
##           table_metal_green table_metal_silver_original
##                          44                          43
```

```
##
##    boot  bottle   chair     cup  jacket pitcher   plate   spoon   table
##      42      82      92      39      40      45     134      45     173
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: redundant ~ trialType + (1 | gameid) + (1 | targetName)
##    Data: targets
##
##      AIC      BIC   logLik deviance df.resid
##    524.1    542.2   -258.0    516.1      688
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8694 -0.3378 -0.1301  0.0246  6.4815
##
```

```
## Random effects:
##  Groups     Name        Variance Std.Dev.
##  gameid     (Intercept) 2.499    1.581
##  targetName (Intercept) 2.567    1.602
## Number of obs: 692, groups:  gameid, 51; targetName, 14
##
## Fixed effects:
##                          Estimate Std. Error z value Pr(>|z|)
## (Intercept)               -3.3724     0.6483  -5.202 1.97e-07 ***
## trialTypelow_difficulty    2.3235     0.6405   3.627 0.000286 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## trlTyplw_df -0.556
```

Exp.2 & Exp.3

Mixed effects linear regression predicting logRT to redundant adjective from fixed effects of redundant property –> to replicate the effect from Exp1

going from high difficulty(0) to low difficulty = material to color adjectives –> logRT decreases = should be negative

```
## boundary (singular) fit: see ?isSingular
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: logRT ~ trialType + (1 + trialType) + (1 | gameid) + (1 | targetName)
##    Data: tomodel
##
##      AIC      BIC   logLik deviance df.resid
##  -2665.7  -2643.0   1337.8  -2675.7      687
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.16142 -0.42629 -0.01786  0.38346  2.48590
##
## Random effects:
##  Groups     Name        Variance Std.Dev.
##  gameid     (Intercept) 0.000000 0.00000
##  targetName (Intercept) 0.001571 0.03964
##  Residual               0.001125 0.03355
## Number of obs: 692, groups:  gameid, 51; targetName, 14
##
## Fixed effects:
##                            Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                8.032863   0.010958  14.952305  733.09   <2e-16 ***
## trialTypelow_difficulty   -0.296520   0.004973 668.100212  -59.62   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
```

```
##             (Intr)
## trlTyplw_df -0.225
## convergence code: 0
## boundary (singular) fit: see ?isSingular
```

Mixed effects logistic regression predicting redundant adjective use from redundant property (color or material), RT to redundant adjective in context and their interaction

bigger RT = more perceptually difficulty = less redundant adjective use

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.142214 (tol = 0.002, component 1)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unide
##  - 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: redundant ~ trialType * MeanRT + (1 + trialType) + (1 | gameid) +
##     (1 | targetName)
##    Data: tomodel
##
##      AIC      BIC   logLik deviance df.resid
##    527.9    555.1   -257.9    515.9      686
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.9129 -0.3359 -0.1298  0.0238  6.5998
##
## Random effects:
##  Groups     Name        Variance Std.Dev.
##  gameid     (Intercept) 2.508    1.584
##  targetName (Intercept) 2.700    1.643
## Number of obs: 692, groups:  gameid, 51; targetName, 14
##
## Fixed effects:
##                                 Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    -3.046e+00  5.805e+00  -0.525    0.600
## trialTypelow_difficulty         6.555e+00  4.487e+00   1.461    0.144
## MeanRT                         -9.617e-05  1.815e-03  -0.053    0.958
## trialTypelow_difficulty:MeanRT -1.871e-03  2.485e-03  -0.753    0.451
##
## Correlation of Fixed Effects:
##             (Intr) trlTy_ MeanRT
## trlTyplw_df  0.764
## MeanRT      -0.993 -0.766
## trlTyp_:MRT -0.873 -0.976  0.869
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## convergence code: 0
## Model failed to converge with max|grad| = 0.142214 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
```

```
##  - Rescale variables?
## Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```

Same model with logRT as predictor

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

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: redundant ~ trialType * logRT + (1 + trialType) + (1 | gameid) +
##     (1 | targetName)
##    Data: tomodel
##
##      AIC      BIC   logLik deviance df.resid
##    527.9    555.1   -257.9    515.9      686
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.9121 -0.3364 -0.1295  0.0237  6.6302
##
## Random effects:
##  Groups     Name        Variance Std.Dev.
##  gameid     (Intercept) 2.510    1.584
##  targetName (Intercept) 2.708    1.646
## Number of obs: 692, groups:  gameid, 51; targetName, 14
##
## Fixed effects:
##                              Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   0.8677    40.4102   0.021    0.983
## trialTypelow_difficulty      32.9664    94.2761   0.350    0.727
## logRT                        -0.5241     5.0272  -0.104    0.917
## trialTypelow_difficulty:logRT  -3.9792    12.0732  -0.330    0.742
##
## Correlation of Fixed Effects:
##             (Intr) trlTy_ logRT
## trlTyplw_df -0.490
## logRT       -1.000  0.492
## trlTypl_:RT  0.477 -1.000 -0.479
## convergence code: 0
## Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```

Same model with perceptual difficulty difference score for each context (difference between RTs to target's sufficient and redundant feature)

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.016036 (tol = 0.002, component 1)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unide
##  - 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: redundant ~ diffPd + (1 + trialType) + (1 | gameid) + (1 | targetName)
##    Data: tomodel
##
##      AIC      BIC   logLik deviance df.resid
##    525.8    548.5   -257.9    515.8      687
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.9752 -0.3394 -0.1297  0.0236  6.9729
##
## Random effects:
##  Groups     Name        Variance Std.Dev.
##  gameid     (Intercept) 2.523    1.588
##  targetName (Intercept) 2.680    1.637
## Number of obs: 692, groups:  gameid, 51; targetName, 14
##
## Fixed effects:
##                           Estimate Std. Error z value Pr(>|z|)
## (Intercept)             -3.0201651  0.8142730  -3.709 0.000208 ***
## diffPd                   0.0004464  0.0006801   0.656 0.511586
## trialTypelow_difficulty  1.5202441  1.3666547   1.112 0.265973
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) diffPd
## diffPd       0.589
## trlTyplw_df -0.732 -0.875
## convergence code: 0
## Model failed to converge with max|grad| = 0.016036 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
## Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```