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
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0553896 (tol = 0.002, component 1)
```

```
## 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 + (1 | gameid) + (1 | clickedobject)
##    Data: targets
##
##      AIC      BIC   logLik deviance df.resid
##    515.2    533.3   -253.6    507.2      688
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8722 -0.3427 -0.1206  0.0188  5.1311
##
## Random effects:
##  Groups        Name        Variance Std.Dev.
##  gameid        (Intercept) 2.547    1.596
##  clickedobject (Intercept) 2.731    1.653
## Number of obs: 692, groups:  gameid, 51; clickedobject, 9
##
## Fixed effects:
##                           Estimate Std. Error z value Pr(>|z|)
## (Intercept)             -2.798401   0.001362   -2055   <2e-16 ***
## trialTypelow_difficulty  1.775660   0.001319    1346   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## trlTyplw_df 0.000
## convergence code: 0
```

```
## Model failed to converge with max|grad| = 0.0553896 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

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 | gameid)
##    Data: tomodel
##
##      AIC      BIC   logLik deviance df.resid
##  -2235.8  -2217.7   1121.9  -2243.8      688
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.5579 -0.8234 -0.1270  0.4720  2.2162
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  gameid   (Intercept) 0.000000 0.00000
##  Residual             0.002287 0.04783
## Number of obs: 692, groups:  gameid, 51
##
## Fixed effects:
##                            Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                8.016115   0.002531 692.000000 3166.93   <2e-16 ***
## trialTypelow_difficulty  -0.259528   0.003638 692.000000  -71.34   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## trlTyplw_df -0.696
## 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| = 0.0544447 (tol = 0.002, component 1)
```

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

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: redundant ~ trialType * MeanRT + (1 | gameid) + (1 | clickedobject)
##    Data: tomodel
##
##      AIC      BIC   logLik deviance df.resid
##    518.2    545.4   -253.1    506.2      686
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.9694 -0.3492 -0.1253  0.0142  5.7159
##
## Random effects:
##  Groups        Name        Variance Std.Dev.
##  gameid        (Intercept) 2.613    1.617
##  clickedobject (Intercept) 3.219    1.794
## Number of obs: 692, groups:  gameid, 51; clickedobject, 9
##
## Fixed effects:
##                                Estimate Std. Error  z value Pr(>|z|)
## (Intercept)                   0.8692468  0.0013006  668.363  < 2e-16 ***
## trialTypelow_difficulty       3.3312362  0.0013010 2560.429  < 2e-16 ***
## MeanRT                       -0.0011423  0.0002337   -4.888 1.02e-06 ***
## trialTypelow_difficulty:MeanRT -0.0011401  0.0002130   -5.352 8.68e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) trlTy_ MeanRT
## trlTyplw_df  0.000
## MeanRT      -0.002  0.000
## trlTyp_:MRT -0.001 -0.003 -0.095
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## convergence code: 0
## Model failed to converge with max|grad| = 0.0544447 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

Same model with logRT as predictor

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0534617 (tol = 0.002, component 1)
```

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

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: redundant ~ trialType * logRT + (1 | gameid) + (1 | clickedobject)
##    Data: tomodel
```

```
##
##      AIC      BIC   logLik deviance df.resid
##    518.1    545.4   -253.1    506.1      686
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.9642 -0.3497 -0.1251  0.0141  5.7135
##
## Random effects:
##  Groups        Name        Variance Std.Dev.
##  gameid        (Intercept) 2.597    1.612
##  clickedobject (Intercept) 3.196    1.788
## Number of obs: 692, groups:  gameid, 51; clickedobject, 9
##
## Fixed effects:
##                                Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   25.965528   0.001323   19626   <2e-16 ***
## trialTypelow_difficulty       14.435908   0.001324   10907   <2e-16 ***
## logRT                         -3.563766   0.001324   -2692   <2e-16 ***
## trialTypelow_difficulty:logRT -1.791817   0.001328   -1350   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) trlTy_ logRT
## trlTyplw_df  0.000
## logRT        0.000  0.000
## trlTypl_:RT  0.000  0.000 -0.001
## convergence code: 0
## Model failed to converge with max|grad| = 0.0534617 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

Model comparison btw models with RT and logRT

```
## Data: tomodel
## Models:
## m2: redundant ~ trialType * MeanRT + (1 | gameid) + (1 | clickedobject)
## m3: redundant ~ trialType * logRT + (1 | gameid) + (1 | clickedobject)
##    npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## m2    6 518.17 545.40 -253.08   506.17
## m3    6 518.12 545.36 -253.06   506.12 0.0456  0  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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| = 0.0512862 (tol = 0.002, component 1)
```

```
## 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 ~ diffPd + (1 | gameid) + (1 | clickedobject)
##    Data: tomodel
##
##      AIC      BIC   logLik deviance df.resid
##    513.8    532.0   -252.9    505.8      688
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.1376 -0.3464 -0.1270  0.0153  6.0961
##
## Random effects:
##  Groups        Name        Variance Std.Dev.
##  gameid        (Intercept) 2.617    1.618
##  clickedobject (Intercept) 3.234    1.798
## Number of obs: 692, groups:  gameid, 51; clickedobject, 9
##
## Fixed effects:
##               Estimate Std. Error   z value Pr(>|z|)
## (Intercept) -1.9630496  0.0013808 -1421.680  < 2e-16 ***
## diffPd       0.0009601  0.0002894     3.318 0.000907 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##        (Intr)
## diffPd 0.000
## convergence code: 0
## Model failed to converge with max|grad| = 0.0512862 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

Model comparison btw models with logRT and perceptual difference score

```
## Data: tomodel
## Models:
## m4: redundant ~ diffPd + (1 | gameid) + (1 | clickedobject)
## m3: redundant ~ trialType * logRT + (1 | gameid) + (1 | clickedobject)
##    npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## m4    4 513.82 531.98 -252.91   505.82
## m3    6 518.12 545.36 -253.06   506.12     0  2          1
```