

Memory likelihood

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The notebook looks at the likelihood of a cover memory, given that a memory was evoked by the original. We try to predict that given perceptual similarity and musical/emotional features.

Load the data.

Load just the features and similarity for song-wise analysis.

Does perceptual similarity predict the likelihood of a memory for the cover?

GLMM:

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: memory_cover ~ mean_sim + (1 | internal_id) + (1 | song_id)
## Data: data
##
##      AIC      BIC   logLik deviance df.resid
##  1515.3   1535.7   -753.7   1507.3     1209
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.6800 -0.7390  0.3728  0.7408  2.7992
##
## Random effects:
## Groups      Name      Variance Std.Dev.
## internal_id (Intercept) 1.0111   1.0055
## song_id      (Intercept) 0.1668   0.4085
## Number of obs: 1213, groups:  internal_id, 89; song_id, 50
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -0.19049    0.14755  -1.291    0.197
## mean_sim     0.42632    0.09156   4.656 3.22e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## mean_sim -0.065
```

Compute likelihood per song.

```
##
## Call:
## lm(formula = likelihood ~ mean_sim, data = data_by_song)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.26433 -0.10290  0.01765  0.09970  0.26042
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.50701     0.01901  26.676 < 2e-16 ***
## mean_sim      0.07835     0.01920   4.081 0.000169 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1344 on 48 degrees of freedom
## Multiple R-squared:  0.2576, Adjusted R-squared:  0.2421
## F-statistic: 16.65 on 1 and 48 DF,  p-value: 0.0001685
```

Features to memory likelihood

Tempo

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: memory_cover ~ tempo_difference + (1 | internal_id) + (1 | song_id)
## Data: data
##
##      AIC      BIC   logLik deviance df.resid
##  1523.4   1543.8   -757.7   1515.4     1209
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.4856 -0.7337  0.3929  0.7442  2.5102
##
## Random effects:
## Groups      Name                Variance Std.Dev.
## internal_id (Intercept) 0.9916     0.9958
## song_id      (Intercept) 0.2334     0.4831
## Number of obs: 1213, groups:  internal_id, 89; song_id, 50
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.1794     0.1514  -1.184  0.236224
## tempo_difference -0.3551     0.1044  -3.400  0.000673 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## temp_dffrnc 0.046
```

Timbre

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: memory_cover ~ mfccs_dist + (1 | internal_id) + (1 | song_id)
## Data: data
##
##      AIC      BIC   logLik deviance df.resid
##  1533.5   1553.9   -762.8   1525.5     1209
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.5748 -0.7269  0.3941  0.7423  2.3817
##
## Random effects:
## Groups      Name                Variance Std.Dev.
## internal_id (Intercept) 0.9823     0.9911
## song_id      (Intercept) 0.3255     0.5705
## Number of obs: 1213, groups:  internal_id, 89; song_id, 50
##
## Fixed effects:
```

```
##           Estimate Std. Error z value Pr(>|z|)
## (Intercept) -0.17086    0.15723  -1.087   0.277
## mfccs_dist  -0.09047    0.10548  -0.858   0.391
##
## Correlation of Fixed Effects:
##           (Intr)
## mfccs_dist 0.006
```

Key

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: memory_cover ~ key_difference + (1 | internal_id) + (1 | song_id)
## Data: data
##
##      AIC      BIC   logLik deviance df.resid
## 1533.9   1554.3   -763.0   1525.9     1209
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.5276 -0.7350  0.3948  0.7412  2.3018
##
## Random effects:
## Groups      Name      Variance Std.Dev.
## internal_id (Intercept) 0.9833   0.9916
## song_id      (Intercept) 0.3327   0.5768
## Number of obs: 1213, groups: internal_id, 89; song_id, 50
##
## Fixed effects:
##           Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -0.17197    0.15776  -1.090   0.276
## key_difference -0.06147    0.10954  -0.561   0.575
##
## Correlation of Fixed Effects:
##           (Intr)
## key_diffrenc 0.014
```

Voice type

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: memory_cover ~ voice_type_difference + (1 | internal_id) + (1 |
## song_id)
## Data: data
##
##      AIC      BIC   logLik deviance df.resid
## 1531.5   1551.9   -761.8   1523.5     1209
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.5427 -0.7370  0.3921  0.7474  2.2429
##
## Random effects:
## Groups      Name      Variance Std.Dev.
## internal_id (Intercept) 0.9833   0.9916
## song_id      (Intercept) 0.3327   0.5768
## voice_type_difference 0.0000   0.0000
```

```
## internal_id (Intercept) 0.9855 0.9927
## song_id (Intercept) 0.3087 0.5556
## Number of obs: 1213, groups: internal_id, 89; song_id, 50
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.1742    0.1563  -1.115    0.265
## voice_type_difference -0.1763    0.1066  -1.655    0.098 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## vc_typ_dffr 0.025
```

Valence

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial (logit)
## Formula: memory_cover ~ mean_valence_difference + (1 | internal_id) +
##          (1 | song_id)
## Data: data
##
##      AIC      BIC   logLik deviance df.resid
## 1534.1 1554.5 -763.0 1526.1 1209
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.5026 -0.7299  0.3927  0.7435  2.3155
##
## Random effects:
## Groups      Name      Variance Std.Dev.
## internal_id (Intercept) 0.9831 0.9915
## song_id (Intercept) 0.3315 0.5757
## Number of obs: 1213, groups: internal_id, 89; song_id, 50
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.1711    0.1577  -1.085    0.278
## mean_valence_difference 0.0434    0.1080  0.402    0.688
##
## Correlation of Fixed Effects:
##              (Intr)
## mn_vlnc_dff -0.003
```

Arousal

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial (logit)
## Formula: memory_cover ~ mean_arousal_difference + (1 | internal_id) +
##          (1 | song_id)
## Data: data
##
##      AIC      BIC   logLik deviance df.resid
```

```

##    1532.1    1552.5    -762.1    1524.1        1209
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.5199 -0.7348  0.3912  0.7367  2.2516
##
## Random effects:
##   Groups      Name      Variance Std.Dev.
## internal_id (Intercept) 0.9883   0.9942
## song_id      (Intercept) 0.3100   0.5568
## Number of obs: 1213, groups:  internal_id, 89; song_id, 50
##
## Fixed effects:
##
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -0.1749    0.1565  -1.118   0.264
## mean_arousal_difference -0.1566    0.1061  -1.476   0.140
##
## Correlation of Fixed Effects:
##              (Intr)
## mn_rsl_dffr 0.028

```

Features to memory likelihood (by song)

Tempo

```
##
## Call:
## lm(formula = likelihood ~ tempo_difference, data = data_by_song)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.28283 -0.09656  0.01553  0.08298  0.31880
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.50701    0.01998   25.381 < 2e-16 ***
## tempo_difference -0.06548    0.02018   -3.245  0.00214 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1413 on 48 degrees of freedom
## Multiple R-squared:  0.1799, Adjusted R-squared:  0.1628
## F-statistic: 10.53 on 1 and 48 DF,  p-value: 0.002143
```

Timbre

```
##
## Call:
## lm(formula = likelihood ~ mfccs_dist, data = data_by_song)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.35516 -0.10327  0.01744  0.11203  0.33635
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.50701    0.02189   23.16 <2e-16 ***
## mfccs_dist   -0.01879    0.02212   -0.85    0.4
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1548 on 48 degrees of freedom
## Multiple R-squared:  0.01482, Adjusted R-squared: -0.005707
## F-statistic: 0.7219 on 1 and 48 DF,  p-value: 0.3997
##
## Call:
## lm(formula = likelihood ~ key_difference, data = data_by_song)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.34026 -0.11438  0.00261  0.10407  0.35937
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.50701    0.02183   23.230 <2e-16 ***
## key_difference -0.02238    0.02205   -1.015    0.315
```



```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1543 on 48 degrees of freedom
## Multiple R-squared:  0.02102,    Adjusted R-squared:  0.000623
## F-statistic: 1.031 on 1 and 48 DF,  p-value: 0.3151
##
## Call:
## lm(formula = likelihood ~ voice_type_difference, data = data_by_song)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.32847 -0.10050  0.00597  0.09019  0.34443
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.50701    0.02145   23.64 <2e-16 ***
## voice_type_difference -0.03598    0.02167   -1.66   0.103
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1517 on 48 degrees of freedom
## Multiple R-squared:  0.05431,    Adjusted R-squared:  0.0346
## F-statistic: 2.756 on 1 and 48 DF,  p-value: 0.1034
##
## Call:
## lm(formula = likelihood ~ mean_valence_difference, data = data_by_song)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.35017 -0.11832  0.00361  0.09827  0.36567
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.50701    0.02200   23.042 <2e-16 ***
## mean_valence_difference 0.01082    0.02223    0.487   0.629
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1556 on 48 degrees of freedom
## Multiple R-squared:  0.004911,    Adjusted R-squared:  -0.01582
## F-statistic: 0.2369 on 1 and 48 DF,  p-value: 0.6287
##
## Call:
## lm(formula = likelihood ~ mean_arousal_difference, data = data_by_song)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.33772 -0.12244 -0.00733  0.11062  0.34819
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
```

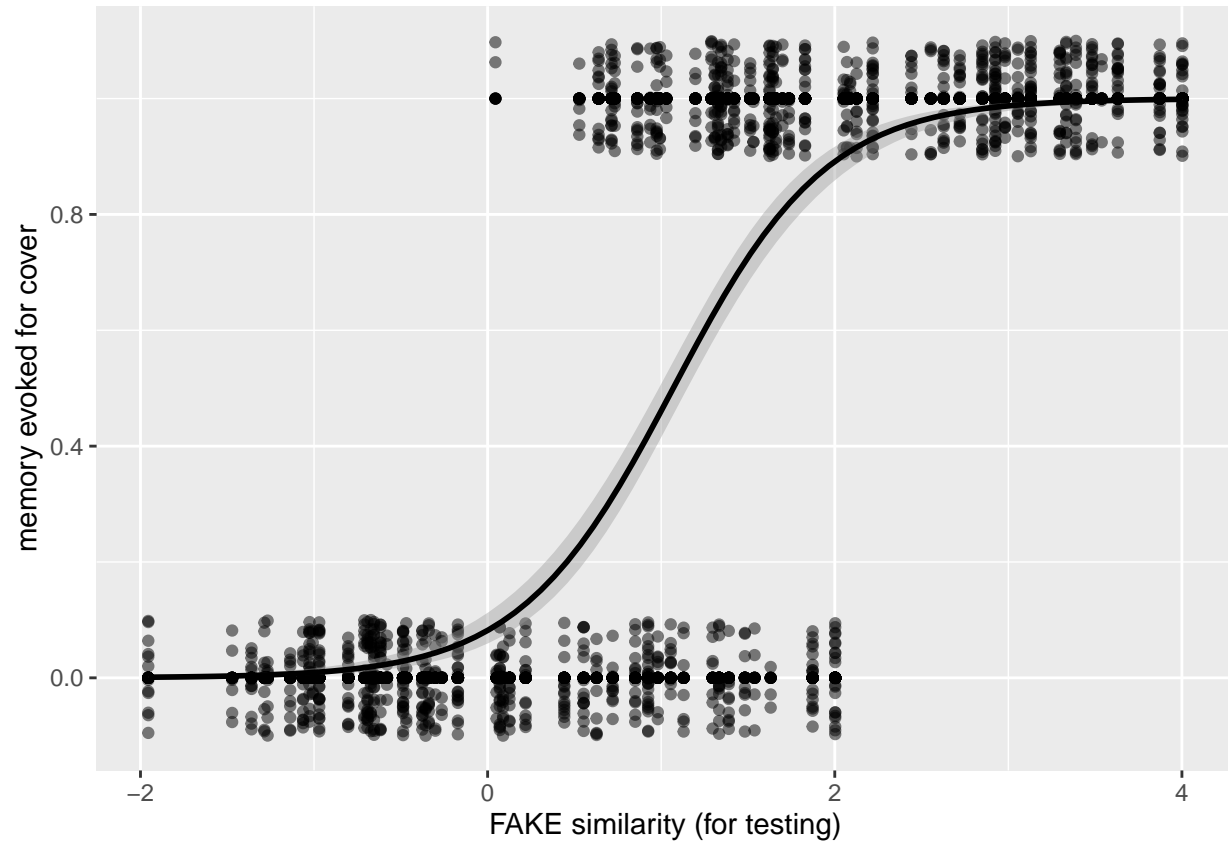
```

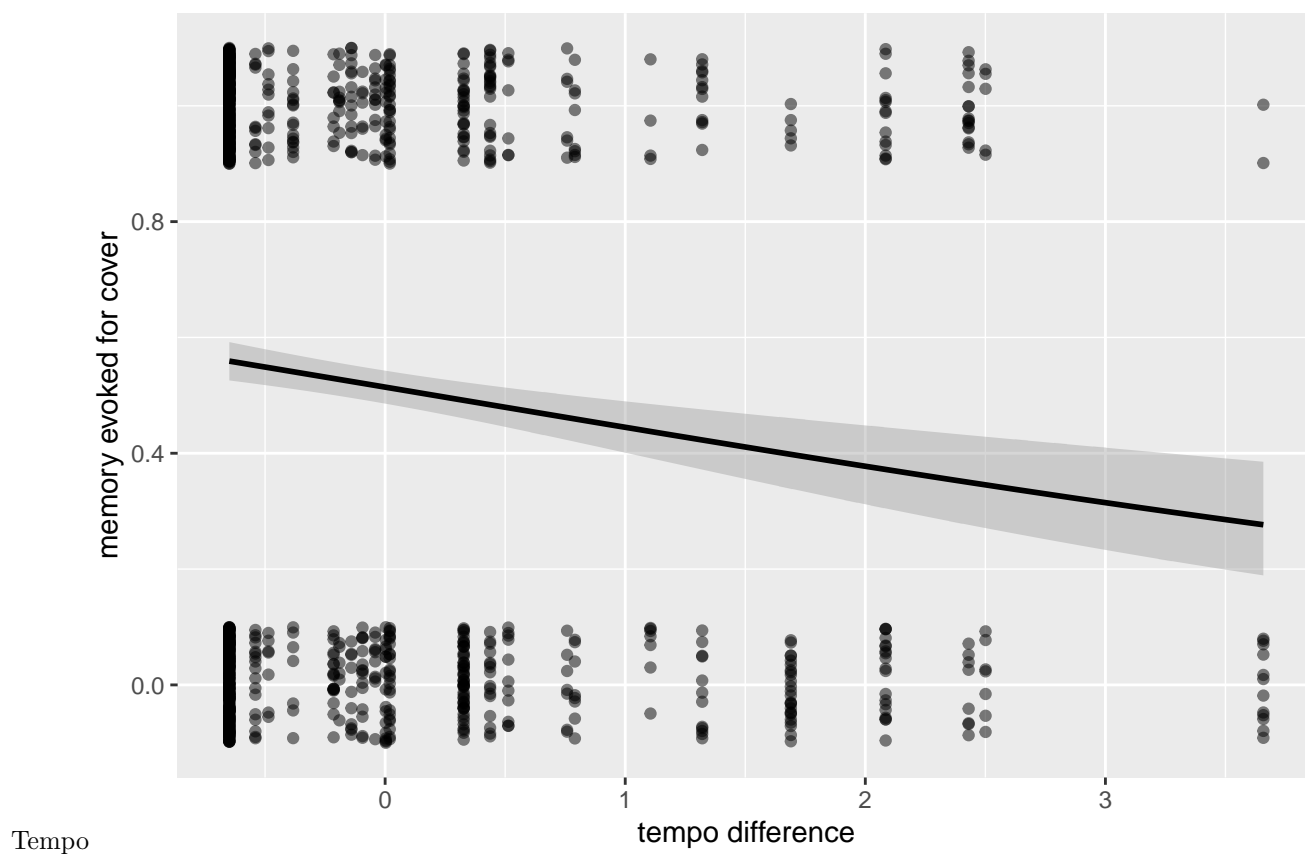
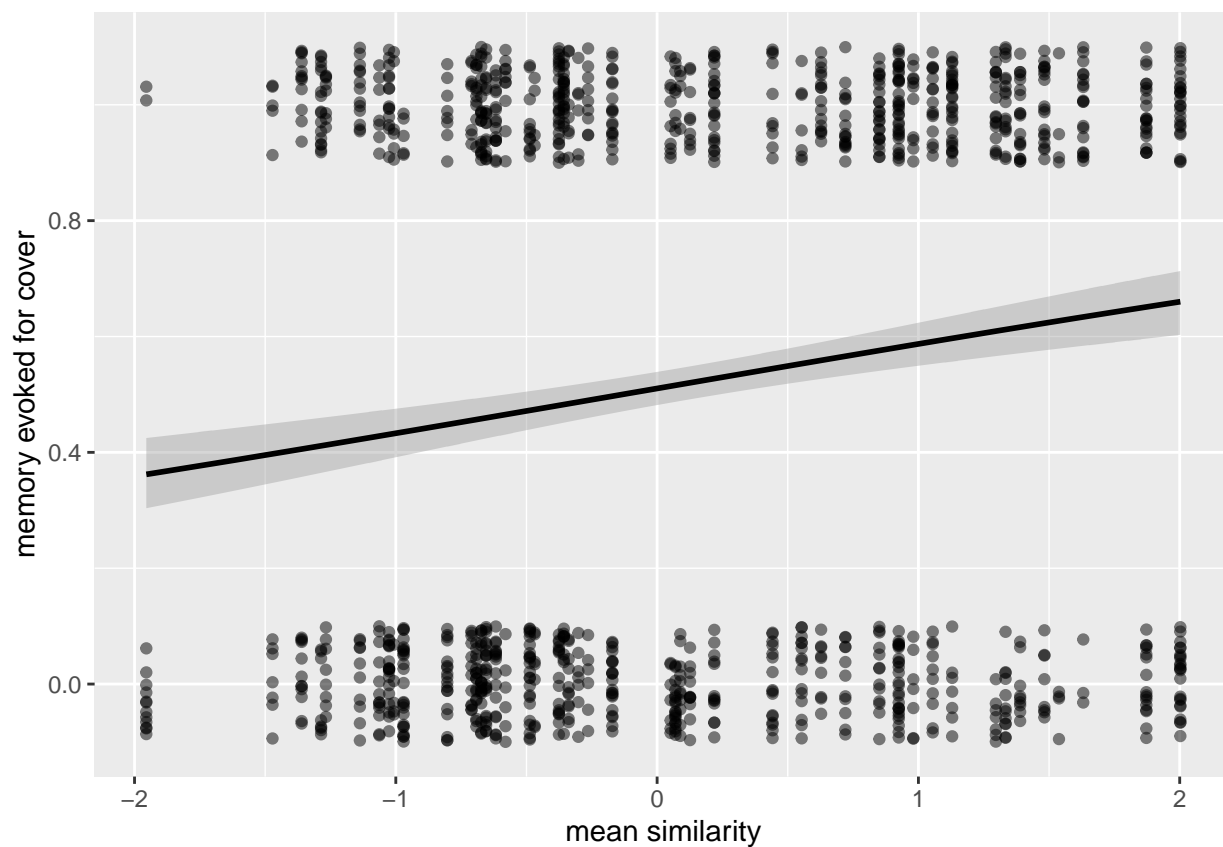
## (Intercept)          0.50701    0.02180  23.259   <2e-16 ***
## mean_arousal_difference -0.02363    0.02202  -1.073    0.289
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1541 on 48 degrees of freedom
## Multiple R-squared:  0.02344,    Adjusted R-squared:  0.003091
## F-statistic: 1.152 on 1 and 48 DF,  p-value: 0.2885

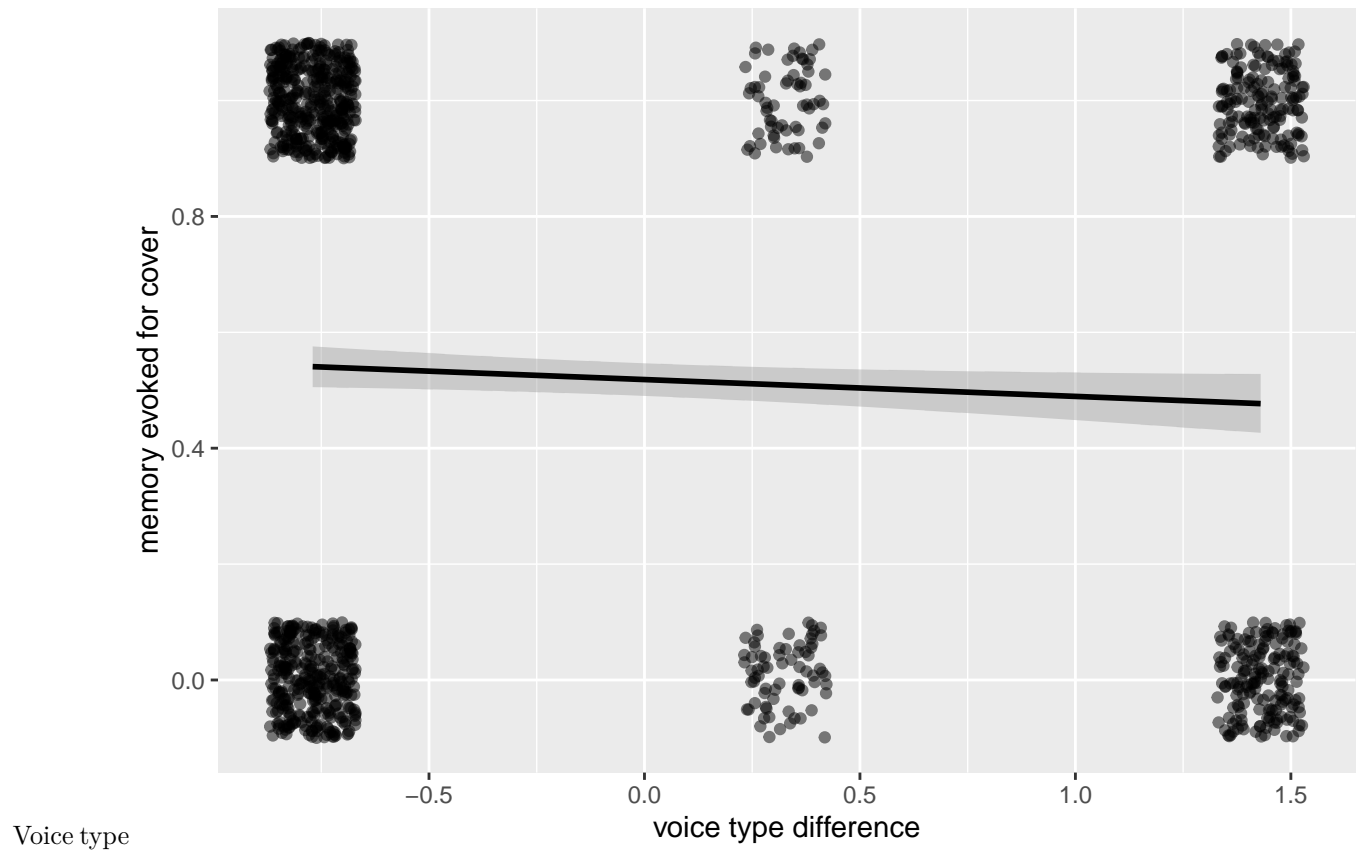
```

Visualizations

GLMMs







OLMs

