

Effect spatial correlation on audiovisual integration stats analysis

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Unity judgment

```
# Data cleaning
rm(list = ls())
setwd("/Users/oliviaxujiang/Desktop/Github/SpatialCorrelation/Experiment_code/stats")
VE_ujdg_data = read_excel('VE_ujdg_trialByTrial_allSubj.xlsx')
VE_ujdg_data["ujdg"][VE_ujdg_data["ujdg"]==2] <- 0
```

GLMM as ordered factors

GLMM as numeric factors

```
class(VE_ujdg_data$disc) = "Numeric"
class(VE_ujdg_data$corr) = "Numeric"

GLMMmodel_AV1 <- glmer(ujdg ~ (scale(disc)+scale(disc^2))*
                      (scale(corr)+scale(corr^2)) + (1|subjID),
                      data = VE_ujdg_data, family='binomial',
                      control = glmerControl(optimizer='bobyqa'))

summary(GLMMmodel_AV1, corr = FALSE)

## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##   Family: binomial ( logit )
## Formula:
## ujdg ~ (scale(disc) + scale(disc^2)) * (scale(corr) + scale(corr^2)) +
##   (1 | subjID)
##   Data: VE_ujdg_data
## Control: glmerControl(optimizer = "bobyqa")
##
##           AIC          BIC    logLik deviance df.resid
##    8179.9    8249.3   -4080.0   8159.9     7590
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.5781 -0.6362 -0.2637  0.6529  4.1074
##
## Random effects:
##   Groups Name            Variance Std.Dev.
##   subjID (Intercept) 0.4665    0.683
## Number of obs: 7600, groups:  subjID, 9
##
## Fixed effects:
```

```
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -0.116094   0.229324  -0.506  0.61269
## scale(disc)       -0.082385   0.028520  -2.889  0.00387 **
## scale(disc^2)     -1.156832   0.029878 -38.719 < 2e-16 ***
## scale(corr)        0.081287   0.027407   2.966  0.00302 **
## scale(corr^2)      0.007676   0.027368   0.280  0.77911
## scale(disc):scale(corr) -0.006008  0.028539  -0.211  0.83326
## scale(disc):scale(corr^2) -0.008173  0.028520  -0.287  0.77445
## scale(disc^2):scale(corr) -0.005856  0.028561  -0.205  0.83754
## scale(disc^2):scale(corr^2) -0.006214  0.028525  -0.218  0.82755
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Anova(GLMMmodel_AV1)
```

```
## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: ujdg
##               Chisq Df Pr(>Chisq)
## scale(disc)         8.3747  1  0.003805 **
## scale(disc^2)      1499.4396  1 < 2.2e-16 ***
## scale(corr)         9.0853  1  0.002577 **
## scale(corr^2)        0.0988  1  0.753333
## scale(disc):scale(corr) 0.0443  1  0.833257
## scale(disc):scale(corr^2) 0.0821  1  0.774453
## scale(disc^2):scale(corr) 0.0420  1  0.837540
## scale(disc^2):scale(corr^2) 0.0475  1  0.827554
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
confint(GLMMmodel_AV1)
```

```
## Computing profile confidence intervals ...
```

```
##               2.5 %      97.5 %
## .sig01         0.45313681  1.18449763
## (Intercept)    -0.61811665  0.38591080
## scale(disc)     -0.13835221 -0.02653406
## scale(disc^2)   -1.21582413 -1.09869128
## scale(corr)      0.02761237  0.13506239
## scale(corr^2)   -0.04598339  0.06130821
## scale(disc):scale(corr) -0.06195925  0.04994376
## scale(disc):scale(corr^2) -0.06410021  0.04771717
## scale(disc^2):scale(corr) -0.06182184  0.05016612
## scale(disc^2):scale(corr^2) -0.06220817  0.04962669
```

Auditory ventriloquism effect

```
# Data cleaning
audVE_indvd_data <- VE_ujdg_data[, - c(6, 8)]
audVE_indvd_data <- audVE_indvd_data[complete.cases(audVE_indvd_data), ]
audVE_indvd_zeroDisc <- audVE_indvd_data[audVE_indvd_data$disc==0, ]
```

LMM as ordered factors

```
audVE_indvd_data$disc<-factor(audVE_indvd_data$disc, ordered=TRUE)
audVE_indvd_data$corr<-factor(audVE_indvd_data$corr, ordered=TRUE)
audVE_indvd_data$subjID<-factor(audVE_indvd_data$subjID, ordered=TRUE)
lmer_resultsAV <-lmer(audVE~ disc * corr + (1|subjID),
                     data=audVE_indvd_data)
summary(lmer_resultsAV)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: audVE ~ disc * corr + (1 | subjID)
## Data: audVE_indvd_data
##
## REML criterion at convergence: 25188.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -6.3921 -0.6331  0.0080  0.6266  8.2585
##
## Random effects:
## Groups Name Variance Std.Dev.
## subjID (Intercept) 2.393 1.547
## Residual 44.270 6.654
## Number of obs: 3800, groups: subjID, 9
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) -0.31460 0.52693 8.02318 -0.597 0.5669
## disc.L 13.33967 0.24107 3767.38077 55.336 <2e-16 ***
## disc.Q -0.10511 0.24155 3767.30665 -0.435 0.6635
## disc.C -2.55420 0.24204 3767.22526 -10.553 <2e-16 ***
## disc^4 0.38945 0.24254 3767.16141 1.606 0.1084
## corr.L 0.23543 0.24293 3767.11537 0.969 0.3325
## corr.Q 0.11454 0.24195 3767.87840 0.473 0.6360
## corr.C 0.10923 0.24224 3767.24978 0.451 0.6521
## corr^4 0.35599 0.24036 3767.62994 1.481 0.1387
## disc.L:corr.L -0.05681 0.54390 3767.32941 -0.104 0.9168
## disc.Q:corr.L 0.30910 0.54259 3767.32525 0.570 0.5689
## disc.C:corr.L -0.46382 0.54486 3767.29199 -0.851 0.3947
## disc^4:corr.L 0.75543 0.54210 3767.28755 1.394 0.1635
## disc.L:corr.Q -1.18209 0.53945 3767.53565 -2.191 0.0285 *
## disc.Q:corr.Q 0.64375 0.54088 3767.90397 1.190 0.2340
## disc.C:corr.Q 0.62087 0.54044 3767.32782 1.149 0.2507
## disc^4:corr.Q 0.17852 0.54196 3767.29457 0.329 0.7419
## disc.L:corr.C -0.59116 0.53961 3767.29814 -1.096 0.2734
## disc.Q:corr.C -0.72612 0.54047 3767.57534 -1.344 0.1792
## disc.C:corr.C 0.69576 0.54374 3767.37508 1.280 0.2008
## disc^4:corr.C 0.41813 0.54332 3767.39946 0.770 0.4416
## disc.L:corr^4 0.67610 0.53304 3767.41526 1.268 0.2047
## disc.Q:corr^4 0.81444 0.53726 3767.33194 1.516 0.1296
## disc.C:corr^4 -0.37519 0.53624 3767.48018 -0.700 0.4842
## disc^4:corr^4 -0.03207 0.54263 3767.46389 -0.059 0.9529
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##  
## Correlation matrix not shown by default, as p = 25 > 12.  
## Use print(x, correlation=TRUE) or  
##      vcov(x)          if you need it
```

```
Anova(lmer_resultsAV)
```

```
## Analysis of Deviance Table (Type II Wald chisquare tests)  
##  
## Response: audVE  
##              Chisq Df Pr(>Chisq)  
## disc        3185.0489 4    <2e-16 ***  
## corr         3.7169 4     0.4457  
## disc:corr    20.1817 16    0.2121  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
confint(lmer_resultsAV)
```

```
## Computing profile confidence intervals ...
```

```
##              2.5 %      97.5 %  
## .sig01        0.94541985  2.5496983  
## .sigma        6.48593597  6.7846080  
## (Intercept)  -1.40220588  0.7721681  
## disc.L       12.86837395 13.8105787  
## disc.Q       -0.57717171  0.3669136  
## disc.C       -3.02701145 -2.0810145  
## disc^4       -0.08450103  0.8634596  
## corr.L       -0.23947376  0.7100258  
## corr.Q       -0.35869920  0.5869609  
## corr.C       -0.36423961  0.5825414  
## corr^4       -0.11393764  0.8255246  
## disc.L:corr.L -1.11965902  1.0061721  
## disc.Q:corr.L -0.75078112  1.3699175  
## disc.C:corr.L -1.52854749  0.6010323  
## disc^4:corr.L -0.30367778  1.8151299  
## disc.L:corr.Q -2.23611078 -0.1276840  
## disc.Q:corr.Q -0.41391431  1.7001060  
## disc.C:corr.Q -0.43591287  1.6764218  
## disc^4:corr.Q -0.88025807  1.2380078  
## disc.L:corr.C -1.64620341  0.4628718  
## disc.Q:corr.C -1.78208329  0.3303286  
## disc.C:corr.C -0.36659095  1.7586010  
## disc^4:corr.C -0.64346706  1.4800955  
## disc.L:corr^4 -0.36646783  1.7169553  
## disc.Q:corr^4 -0.23540168  1.8644682  
## disc.C:corr^4 -1.42297223  0.6729164  
## disc^4:corr^4 -1.09194762  1.0289344
```

LMM as numeric factors

```
class(audVE_indvd_data$disc) = "Numeric"
class(audVE_indvd_data$corr) = "Numeric"
class(audVE_indvd_data$subjID) = "Numeric"
lmer_resultsAV1 <- lmer(audVE ~ (scale(disc)+scale(disc^2))*
                      (scale(corr)+scale(corr^2)) +
                      (1|subjID), data = audVE_indvd_data)
summary(lmer_resultsAV1,corr = FALSE)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## audVE ~ (scale(disc) + scale(disc^2)) * (scale(corr) + scale(corr^2)) +
## (1 | subjID)
## Data: audVE_indvd_data
##
## REML criterion at convergence: 25319.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -6.3299 -0.6544  0.0017  0.6529  7.9022
##
## Random effects:
## Groups   Name                Variance Std.Dev.
## subjID   (Intercept)         2.338    1.529
## Residual                    45.602    6.753
## Number of obs: 3800, groups: subjID, 9
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   -0.18000    0.52141    8.02489  -0.345    0.739
## scale(disc)     6.32196    0.56913  3783.30894  11.108 <2e-16
## scale(disc^2)  -0.34582    0.56915  3783.32888  -0.608    0.543
## scale(corr)    -0.07232    0.56282  3783.84469  -0.128    0.898
## scale(corr^2)   0.17682    0.56286  3783.89686   0.314    0.753
## scale(disc):scale(corr)  4.27654    2.92476  3783.93389   1.462    0.144
## scale(disc):scale(corr^2) -4.68354    2.93008  3783.85241  -1.598    0.110
## scale(disc^2):scale(corr) -3.17183    2.92398  3784.02292  -1.085    0.278
## scale(disc^2):scale(corr^2) 3.56190    2.92545  3783.92969   1.218    0.223
##
## (Intercept)
## scale(disc)          ***
## scale(disc^2)
## scale(corr)
## scale(corr^2)
## scale(disc):scale(corr)
## scale(disc):scale(corr^2)
## scale(disc^2):scale(corr)
## scale(disc^2):scale(corr^2)
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Anova(lmer_resultsAV1)
```

```
## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: audVE
##
```

	Chisq	Df	Pr(>Chisq)
scale(disc)	123.4204	1	<2e-16 ***
scale(disc^2)	0.3681	1	0.5440
scale(corr)	0.0175	1	0.8947
scale(corr^2)	0.0998	1	0.7521
scale(disc):scale(corr)	2.1380	1	0.1437
scale(disc):scale(corr^2)	2.5550	1	0.1099
scale(disc^2):scale(corr)	1.1767	1	0.2780
scale(disc^2):scale(corr^2)	1.4824	1	0.2234

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
confint(lmer_resultsAV1)
```

```
## Computing profile confidence intervals ...
```

	2.5 %	97.5 %
.sig01	0.9327331	2.5220283
.sigma	6.5967902	6.9005667
(Intercept)	-1.2563179	0.8954508
scale(disc)	5.2073561	7.4365166
scale(disc^2)	-1.4605075	0.7687202
scale(corr)	-1.1736742	1.0308140
scale(corr^2)	-0.9264875	1.2781754
scale(disc):scale(corr)	-1.4557661	10.0000288
scale(disc):scale(corr^2)	-10.4178715	1.0587371
scale(disc^2):scale(corr)	-8.8939025	2.5588196
scale(disc^2):scale(corr^2)	-2.1711528	9.2872968

At 0 discrepancy

```
lmer_resultsAV2 <- lmer(audVE ~ (scale(corr)+scale(corr^2)) +
                        (1|subjID), data = audVE_indvd_zeroDisc)
summary(lmer_resultsAV2,corr = FALSE)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: audVE ~ (scale(corr) + scale(corr^2)) + (1 | subjID)
## Data: audVE_indvd_zeroDisc
##
## REML criterion at convergence: 4534.2
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -8.8893 -0.5792  0.0586  0.6184  2.6581
##
```

```
## Random effects:
## Groups Name Variance Std.Dev.
## subjID (Intercept) 2.843 1.686
## Residual 23.658 4.864
## Number of obs: 752, groups: subjID, 9
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) -0.001669 0.589599 8.041281 -0.003 0.998
## scale(corr) 0.284091 0.177650 741.207274 1.599 0.110
## scale(corr^2) -0.066416 0.178582 742.714606 -0.372 0.710
```

```
Anova(lmer_resultsAV2)
```

```
## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: audVE
## Chisq Df Pr(>Chisq)
## scale(corr) 2.5573 1 0.1098
## scale(corr^2) 0.1383 1 0.7100
```

```
confint(lmer_resultsAV2)
```

```
## Computing profile confidence intervals ...
```

```
## 2.5 % 97.5 %
## .sig01 0.98403863 2.8252646
## .sigma 4.62048270 5.1151796
## (Intercept) -1.21956485 1.2133558
## scale(corr) -0.06437676 0.6319706
## scale(corr^2) -0.41594485 0.2840326
```

Visual ventriloquism effect

```
# Data cleaning
visVE_indvd_data <- VE_ujdg_data[, - c(6, 7)]
visVE_indvd_data <- visVE_indvd_data[complete.cases(visVE_indvd_data), ]
```

LMM as ordered factors

LMM as numeric factors

```
class(visVE_indvd_data$disc) = "Numeric"
class(visVE_indvd_data$corr) = "Numeric"
class(visVE_indvd_data$subjID) = "Numeric"
lmer_resultsAV4 <- lmer(visVE ~ (scale(disc)+scale(disc^2))*
  (scale(corr)+scale(corr^2)) +
  (1|subjID), data = visVE_indvd_data)
summary(lmer_resultsAV4, corr = FALSE)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
```

```
## lmerModLmerTest]
## Formula:
## visVE ~ (scale(disc) + scale(disc^2)) * (scale(corr) + scale(corr^2)) +
## (1 | subjID)
## Data: visVE_indvd_data
##
## REML criterion at convergence: 18142.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -9.8496 -0.4775  0.0112  0.4930  8.8777
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   subjID   (Intercept) 0.1336   0.3655
##   Residual                6.8807   2.6231
## Number of obs: 3800, groups: subjID, 9
##
## Fixed effects:
##
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    -0.01269    0.12910    8.06840  -0.098    0.924
## scale(disc)     -0.96662    0.21899  3783.76915  -4.414 1.04e-05
## scale(disc^2)     0.15652    0.21900  3783.82383   0.715    0.475
## scale(corr)      0.24502    0.22185  3785.03793   1.104    0.269
## scale(corr^2)    -0.20895    0.22186  3785.14282  -0.942    0.346
## scale(disc):scale(corr) -0.53738    1.14090  3785.21285  -0.471    0.638
## scale(disc):scale(corr^2) 0.57531    1.13888  3785.02159   0.505    0.613
## scale(disc^2):scale(corr) 0.23557    1.14140  3785.41437   0.206    0.837
## scale(disc^2):scale(corr^2) -0.21807    1.14082  3785.20479  -0.191    0.848
##
## (Intercept)
## scale(disc)          ***
## scale(disc^2)
## scale(corr)
## scale(corr^2)
## scale(disc):scale(corr)
## scale(disc):scale(corr^2)
## scale(disc^2):scale(corr)
## scale(disc^2):scale(corr^2)
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Anova(lmer_resultsAV4)
```

```
## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: visVE
##
##              Chisq Df Pr(>Chisq)
## scale(disc)    19.4860  1 1.013e-05 ***
## scale(disc^2)   0.5113  1   0.4746
## scale(corr)     1.2081  1   0.2717
## scale(corr^2)   0.8796  1   0.3483
## scale(disc):scale(corr) 0.2219  1   0.6376
## scale(disc):scale(corr^2) 0.2552  1   0.6134
```



```
## scale(disc^2):scale(corr)    0.0426  1    0.8365
## scale(disc^2):scale(corr^2) 0.0365  1    0.8484
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
confint(lmer_resultsAV4)
```

```
## Computing profile confidence intervals ...
```

```
##                2.5 %    97.5 %
## .sig01          0.2094673 0.6161298
## .sigma          2.5624357 2.6804327
## (Intercept)     -0.2790727 0.2535620
## scale(disc)      -1.3948944 -0.5370943
## scale(disc^2)    -0.2730218 0.5848106
## scale(corr)      -0.1901067 0.6788780
## scale(corr^2)    -0.6428281 0.2262155
## scale(disc):scale(corr) -2.7710707 1.6974998
## scale(disc):scale(corr^2) -1.6554325 2.8052404
## scale(disc^2):scale(corr) -2.0004260 2.4701132
## scale(disc^2):scale(corr^2) -2.4515482 2.0167118
```