Effect spatial correlation on audiovisual integration stats analysis

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Unity judgment

```
# Data cleaning
rm(list = ls())
setwd("/Users/oliviaxujiaming/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
```