

# LMM considerations

## One factor rm ANOVA, categorical fixed effect

Model works fine with random intercept only:

```
# lmer model, random intercept
model1 <- lmer(measure ~ situation + (1|id),df1)
summary(model1)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: measure ~ situation + (1 | id)
## Data: df1
##
## REML criterion at convergence: 73.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.92330 -0.49814  0.05354  0.51792  1.54811
##
## Random effects:
## Groups   Name                Variance Std.Dev.
## id       (Intercept)  0.1627     0.4034
## Residual                    0.1237     0.3517
## Number of obs: 48, groups: id, 32
##
## Fixed effects:
##              Estimate Std. Error    df t value Pr(>|t|)
## (Intercept)  1.21798     0.10055 41.36437  12.114 3.45e-15 ***
## situation2   0.09838     0.11339 18.12464   0.868  0.397
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## situation2 -0.471
```

Adding a random slope makes it unidentifiable

```
# lmer model, random intercept + random slope
model2 <- lmer(measure ~ situation + (1+situation|id),df1)
```

```
## Error: number of observations (=48) <= number of random effects (=64) for term (1 + situation | id);
```

## Continuous predictor (fixed effect) works

Adding a random slope works when the predictor is continuous

```
model3 <- lmer(delta_distance ~ acceleration_s + (1+acceleration_s|id),df2) #standardized predictor nee
summary(model3)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: delta_distance ~ acceleration_s + (1 + acceleration_s | id)
## Data: df2
##
## REML criterion at convergence: 1304.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.68947 -0.40064  0.02119  0.40142  1.80638
##
## Random effects:
## Groups   Name                Variance Std.Dev. Corr
## id      (Intercept)          7637.8   87.39
##          acceleration_s      685.5    26.18   0.64
## Residual                    1349.5    36.74
## Number of obs: 118, groups: id, 39
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    405.917    14.500   38.379   28.00  <2e-16 ***
## acceleration_s  165.635     5.729   32.585   28.91  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## accelertn_s  0.476
```

## two factor mixed anova

### model, random intercept

Random intercept only works:

```
model4 <- lmer(dv ~ group*stage+(1|id),df3)
summary(model4)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: dv ~ group * stage + (1 | id)
## Data: df3
##
## REML criterion at convergence: 309.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.8639 -0.4909 -0.1308  0.3467  4.4436
##
## Random effects:
## Groups   Name                Variance Std.Dev.
## id      (Intercept)    0.4347    0.6593
```

```
## Residual          0.3205    0.5661
## Number of obs: 141, groups: id, 36
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    2.1133    0.2527  86.6249   8.364 9.25e-13 ***
## group2         -1.1729    0.3209  80.6371  -3.655 0.000457 ***
## stage2         -0.6031    0.2898  96.3018  -2.081 0.040080 *
## stage3         -0.8985    0.2831  97.2365  -3.174 0.002013 **
## stage4         -1.0456    0.2476  96.4297  -4.223 5.46e-05 ***
## stage5         -0.4726    0.2574  96.1694  -1.836 0.069457 .
## stage6         -0.9400    0.2668  97.8314  -3.523 0.000650 ***
## group2:stage2    0.3424    0.3722  96.5480   0.920 0.359858
## group2:stage3    0.4927    0.3894  97.3911   1.265 0.208743
## group2:stage4    0.7411    0.3313  96.5682   2.237 0.027569 *
## group2:stage5    0.3342    0.3218  95.7638   1.039 0.301570
## group2:stage6    0.7345    0.3314  96.9035   2.217 0.028990 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) group2 stage2 stage3 stage4 stage5 stage6 grp2:2 grp2:3
## group2      -0.787
## stage2      -0.455  0.359
## stage3      -0.490  0.386  0.392
## stage4      -0.565  0.445  0.483  0.493
## stage5      -0.538  0.423  0.450  0.483  0.561
## stage6      -0.528  0.415  0.409  0.497  0.538  0.512
## group2:stg2  0.355 -0.433 -0.779 -0.305 -0.376 -0.351 -0.319
## group2:stg3  0.356 -0.428 -0.285 -0.727 -0.359 -0.351 -0.361  0.354
## group2:stg4  0.422 -0.507 -0.361 -0.369 -0.747 -0.419 -0.402  0.429  0.415
## group2:stg5  0.430 -0.519 -0.360 -0.387 -0.448 -0.800 -0.409  0.433  0.430
## group2:stg6  0.425 -0.510 -0.329 -0.400 -0.433 -0.412 -0.805  0.403  0.437
##      grp2:4 grp2:5
## group2
## stage2
## stage3
## stage4
## stage5
## stage6
## group2:stg2
## group2:stg3
## group2:stg4
## group2:stg5  0.515
## group2:stg6  0.493  0.506
```

## model, random intercept + random slope per factor

This model is already unidentifiable

```
model15 <- lmer(dv ~ group*stage+(1+group|id)+(1+stage|id),df3)
```

```
## Error: number of observations (=141) <= number of random effects (=216) for term (1 + stage | id); tl
```

```
#maximum model? random slope for interaction Also unidentifiable
```

```
model6 <- lmer(dv ~ group*stage+(group*stage|id),df3)
```

```
## Error: number of observations (=141) <= number of random effects (=432) for term (group * stage | id)
```