

Final Project

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Contents

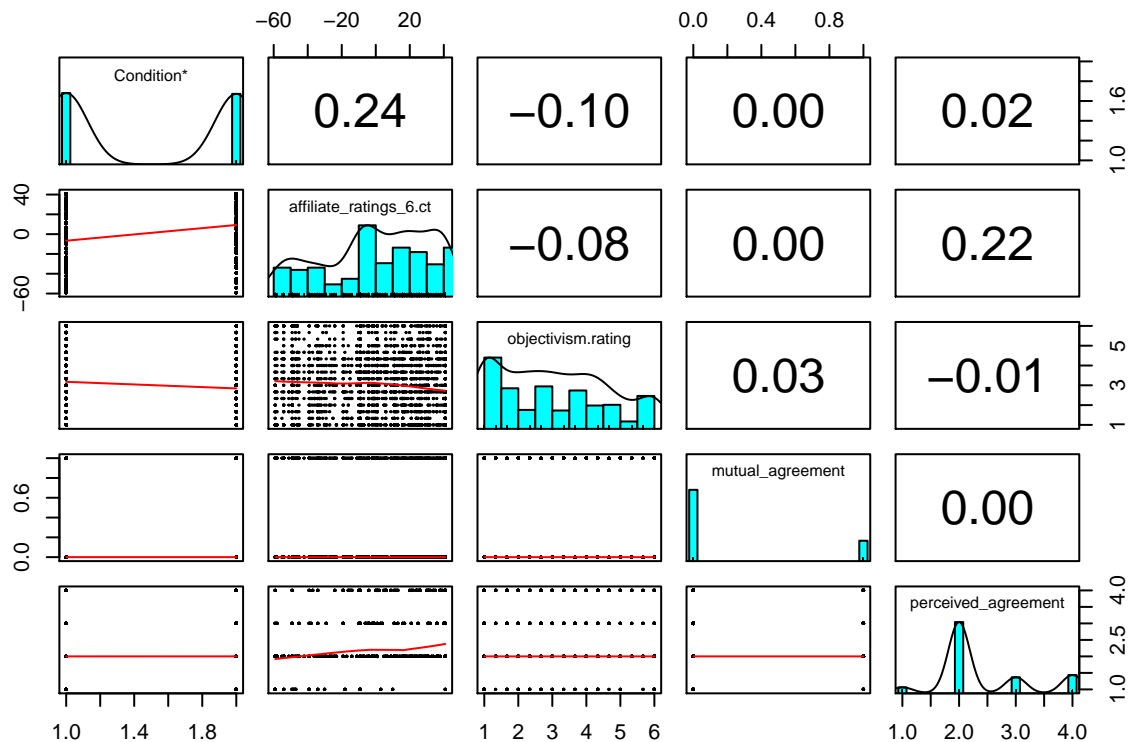
Load and examine data

```
## Warning: Missing column names filled in: 'X1' [1]
```

```
## Parsed with column specification:
```

```
## cols(
##   .default = col_double(),
##   Condition = col_character(),
##   gender = col_character(),
##   race = col_character()
## )
```

```
## See spec(...) for full column specifications.
```



Testing model assumptions

```
#Baseline model
m0 <- lmer(objectivism.rating ~ (1|statement) + (1|id), data = data)
vc_m0 <- as.data.frame(VarCorr(m0))
# ICC/Deff (person; cluster size = 9)
icc_person <- vc_m0$vcov[1] / sum(vc_m0$vcov)
# ICC (item; cluster size = 367)
icc_item <- vc_m0$vcov[2] / sum(vc_m0$vcov)
# ICC (person + item)
c("ICC(person + item)" = sum(vc_m0$vcov[1:2]) / sum(vc_m0$vcov)) #.40
```

ICC

```
## ICC(person + item)
##          0.404038
```

```
#ICC and design effect for person
c("ICC(person)" = icc_person,
  "Deff(person)" = (1 - icc_item) + (9 - 1) * icc_person)
```

```
## ICC(person) Deff(person)
##    0.3140867    3.4227419
```

```
#ICC and design effect for item
c("ICC(item)" = icc_item,
  "Deff(item)" = (1 - icc_person) + (367 - 1) * icc_item)
```

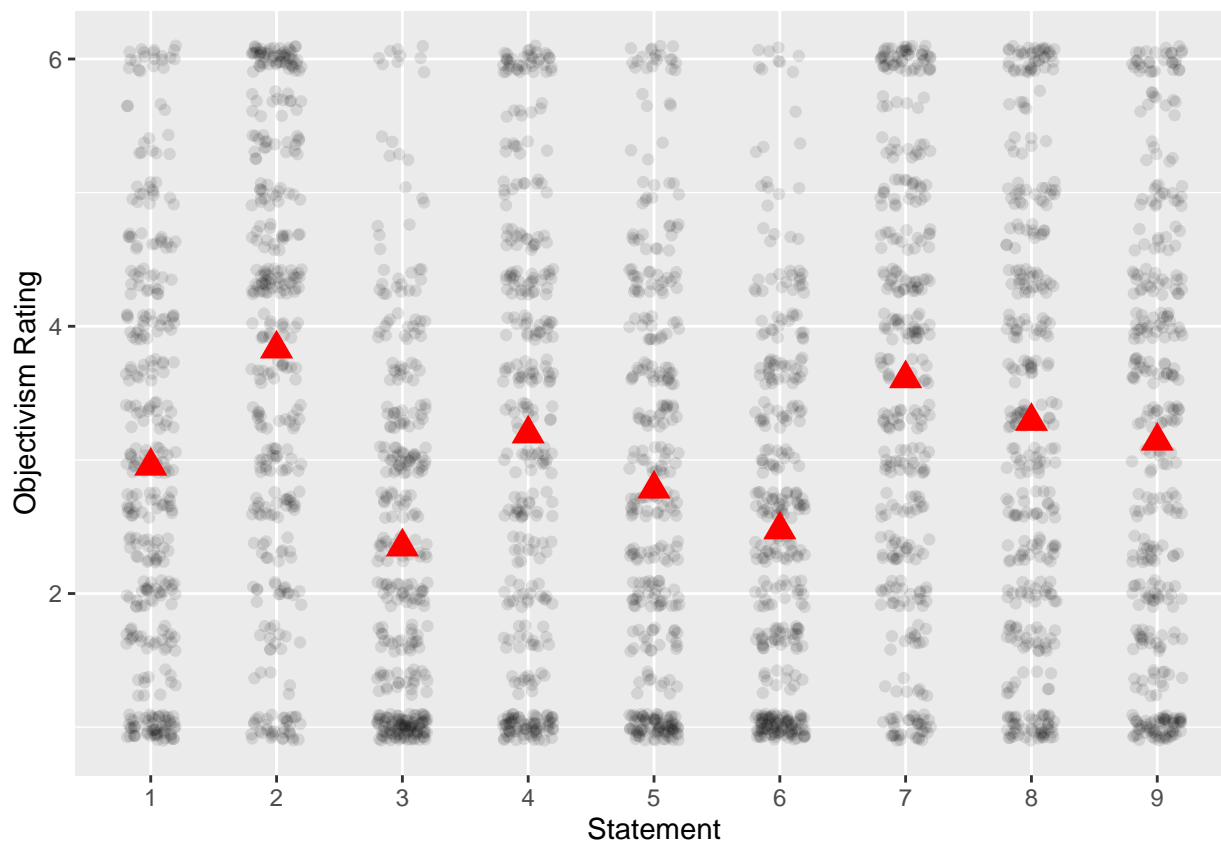
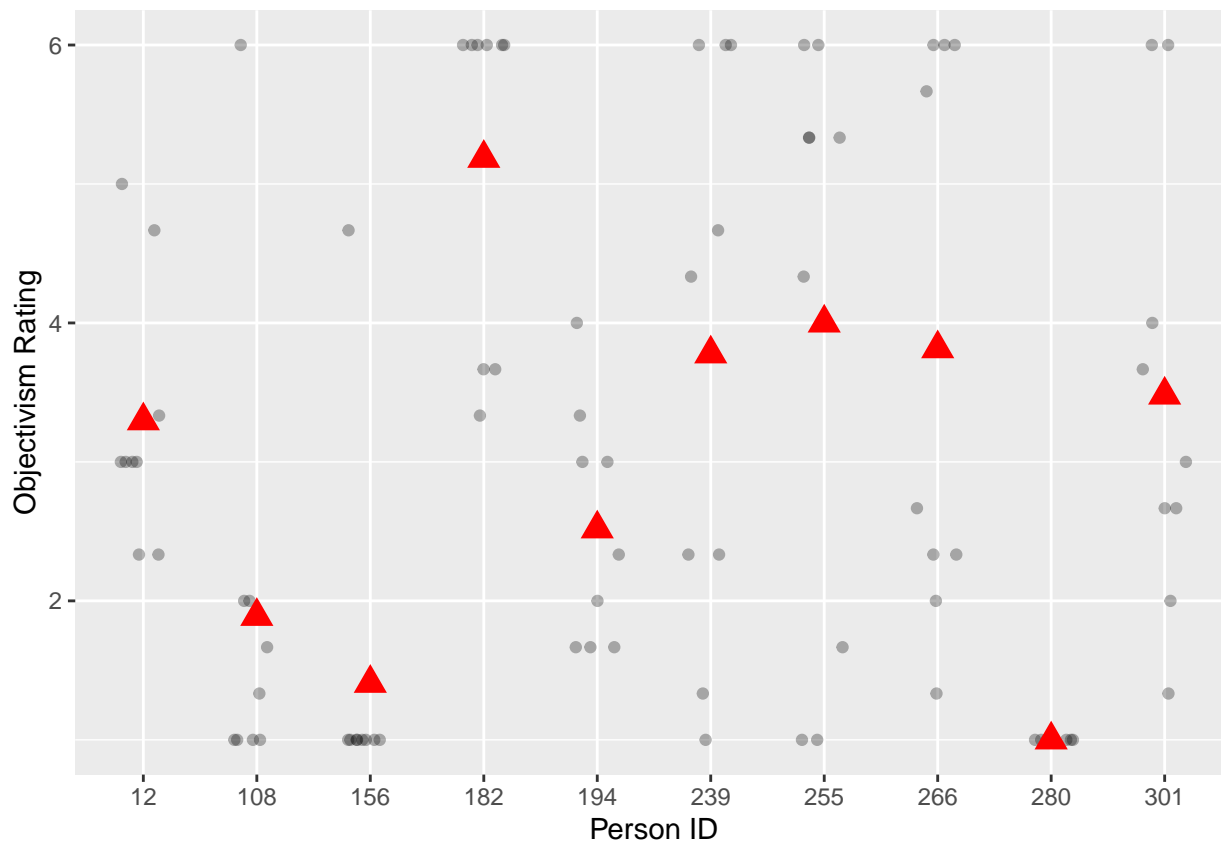
```
## ICC(item) Deff(item)
## 0.08995134 33.60810292
```

ICC for **person** is .31, which means that 31% of the variance in objectivity rating was at the between-person level. The corresponding design effect was 3.42.

ICC for **item** is .09, meaning that 9% of the variance in objectivity rating was at the between-item level. The corresponding design effect was 33.61.

Since both design effects are larger than 1.1, we include both the person and item levels in our multilevel model.

Visualizing the Data The figure below shows the variation in objectivism rating at both the person and item levels.



Multilevel model

Model equations:

Repeated-Measure level (Lv 1):

$$\text{objectivism}_{j,k} = \beta_{j,k} + e_{jk}$$

Between-cell (Person \times Item) level (Lv 2):

$$\beta_{0(j,k)} = \gamma_{00} + \beta_{1j}\text{Condition} + \beta_{2k}\text{perceived_agreement} + u_{0j} + v_{0k}$$

Person level (Lv 2a) random slopes

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

Item level (Lv2b) random slopes

$$\beta_{2k} = \gamma_{20} + v_{2k}$$

Baseline model First, we fit a random-intercept model using condition at the person-level and perceived agreement at the item-level to predict objectivism ratings.

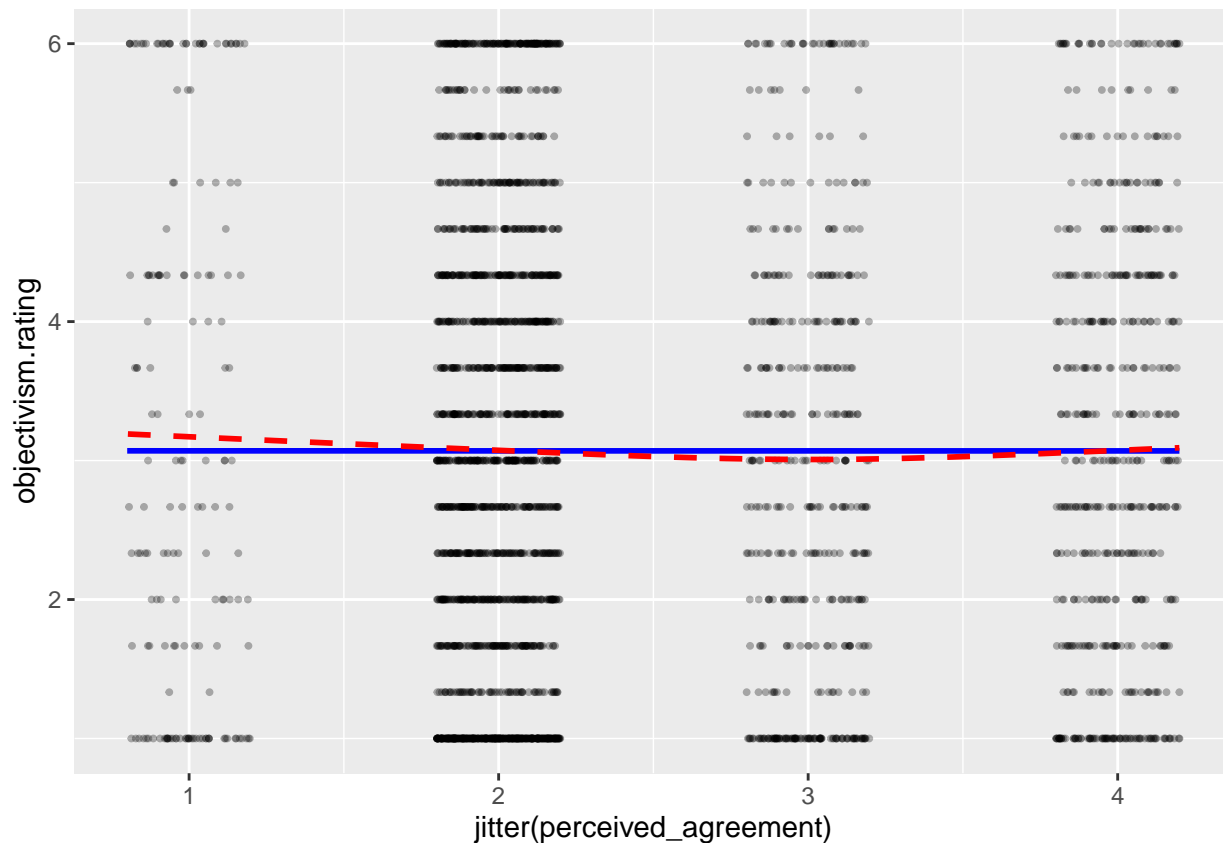
```
# Fit a linear growth model with no random slopes
m1 <- lmer(objectivism.rating ~ Condition + perceived_agreement + (1|statement) + (1|id), data = data)
summary(m1)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## objectivism.rating ~ Condition + perceived_agreement + (1 | statement) +
## (1 | id)
## Data: data
##
## REML criterion at convergence: 11083.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.8679 -0.6522 -0.0717  0.6353  3.8244
##
## Random effects:
##  Groups      Name              Variance Std.Dev.
##  id          (Intercept) 0.7961    0.8923
##  statement (Intercept) 0.2336    0.4833
##  Residual                1.5474    1.2440
## Number of obs: 3186, groups: id, 354; statement, 9
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    3.25821    0.23389  33.35489  13.930 1.85e-15 ***
## ConditionCOOPERATE WITH -0.31398    0.10460 351.00001  -3.002  0.00288 **
## perceived_agreement -0.01341    0.06350 351.00001  -0.211  0.83288
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) CCOOPW
## CCOOPERATEW -0.211
## prcvd_grmnt -0.653 -0.017
```

```
augment(m1) %>%
  ggplot(aes(x = jitter(perceived_agreement), y = objectivism.rating)) +
  geom_point(size = 0.7, alpha = 0.3) +
  geom_smooth(col = "blue", se = FALSE) + # blue line from data
  geom_smooth(aes(y = .fitted),
    col = "red",
    se = FALSE, linetype = "dashed"
  ) # red line from model
```

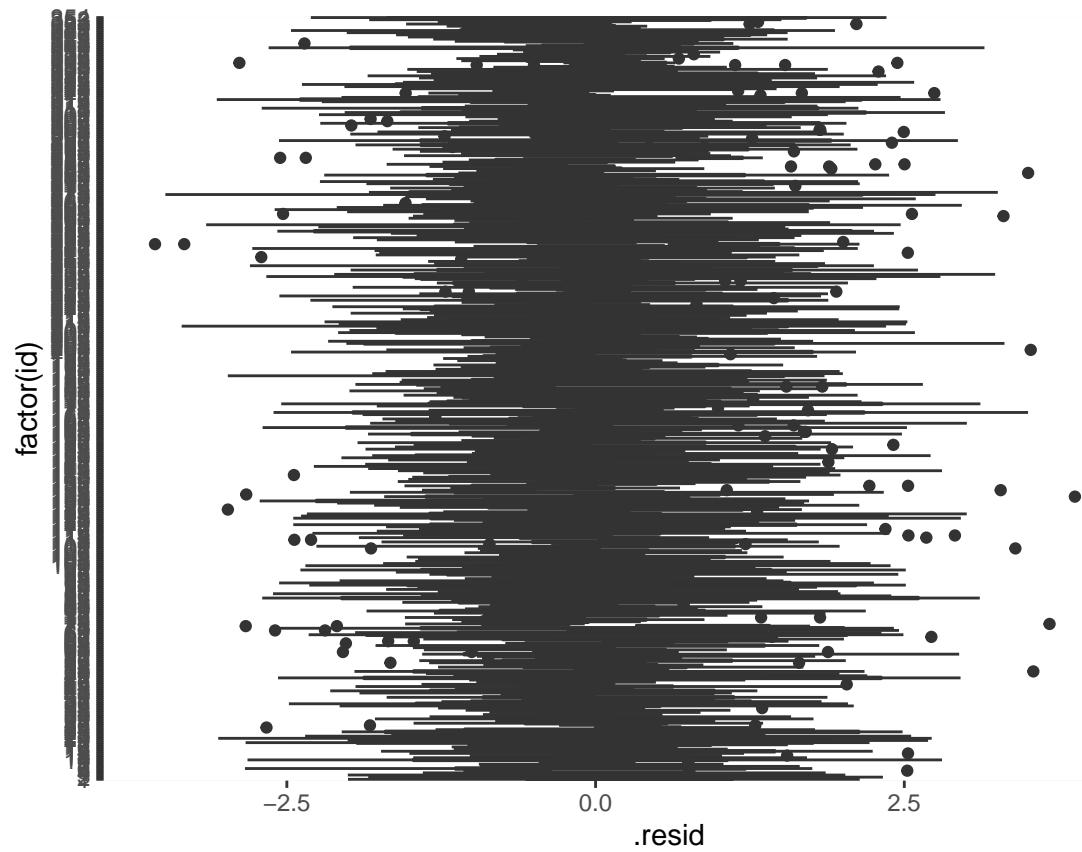
Linearity

```
## 'geom_smooth()' using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
## 'geom_smooth()' using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



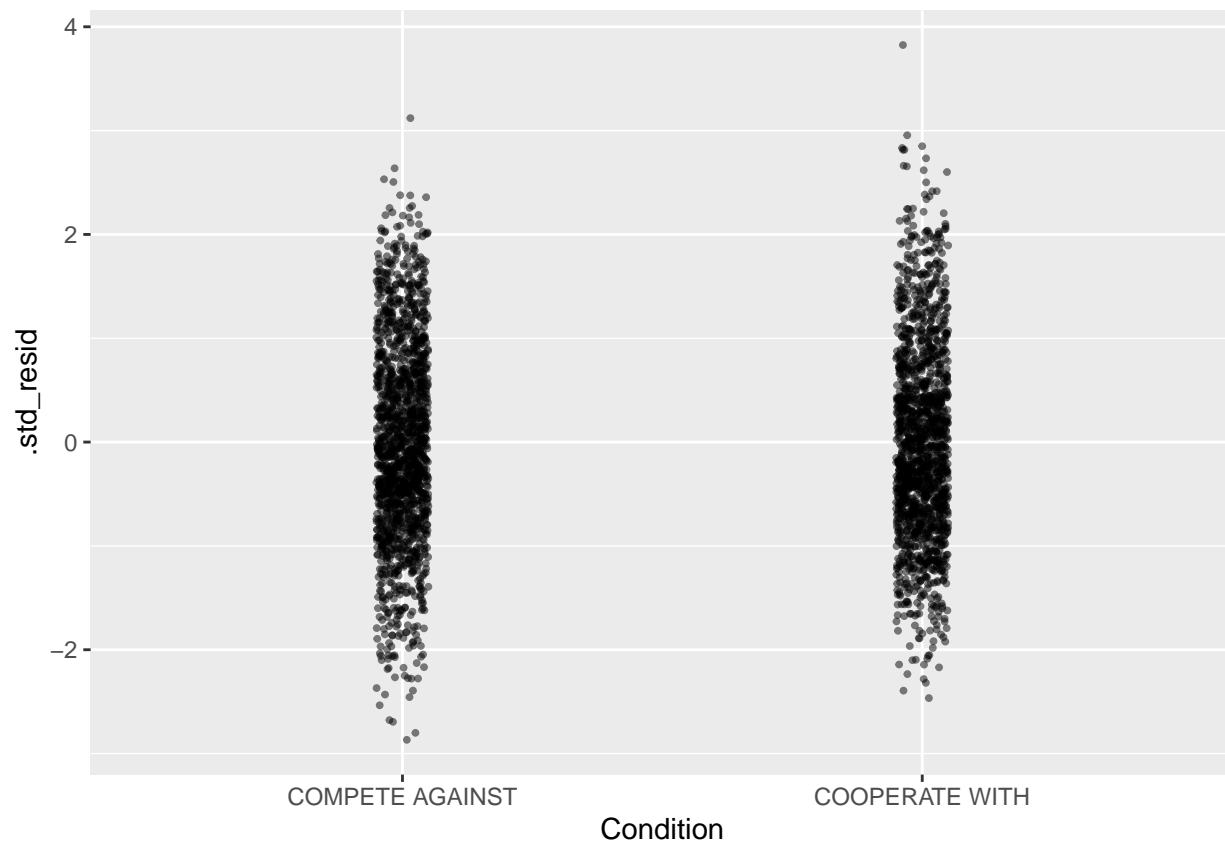
The marginal model plot above shows the outcome variable, objectivism rating, against the predictor perceived agreement. The lines are roughly similar to each other, so there is no need to include extra curvilinear terms.

```
augment(m1) %>%
  ggplot(aes(x = factor(id), y = .resid)) +
  geom_boxplot() +
  coord_flip()
```



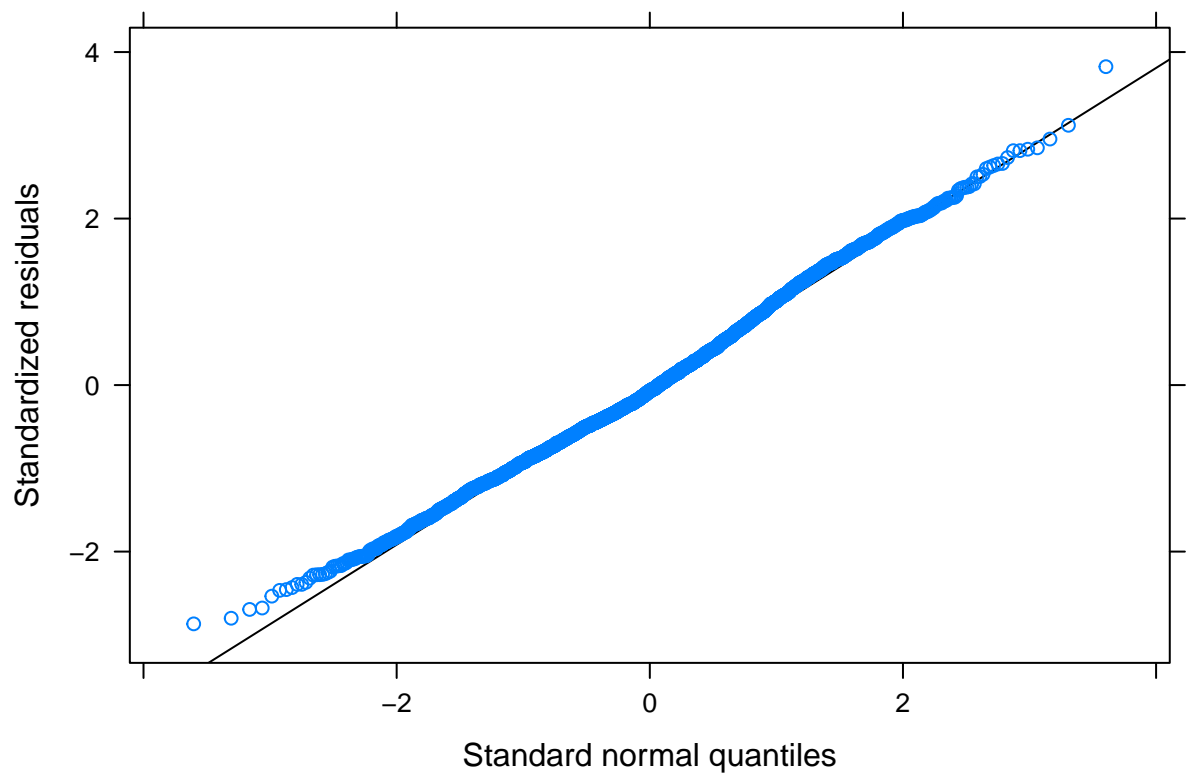
Homogeneity of variance

```
augment(m1) %>%
  mutate(.std_resid = resid(m1, scaled = TRUE)) %>%
  ggplot(aes(x = Condition, y = .std_resid)) +
  # use `geom_jitter` for discrete predictor
  geom_jitter(size = 0.7, alpha = 0.5, width = 0.05)
```



Here, we see that most of the standardized residuals are between -3 and 3, so there are not a lot of outliers. Also, the variability of the residuals looks roughly similar across clusters.

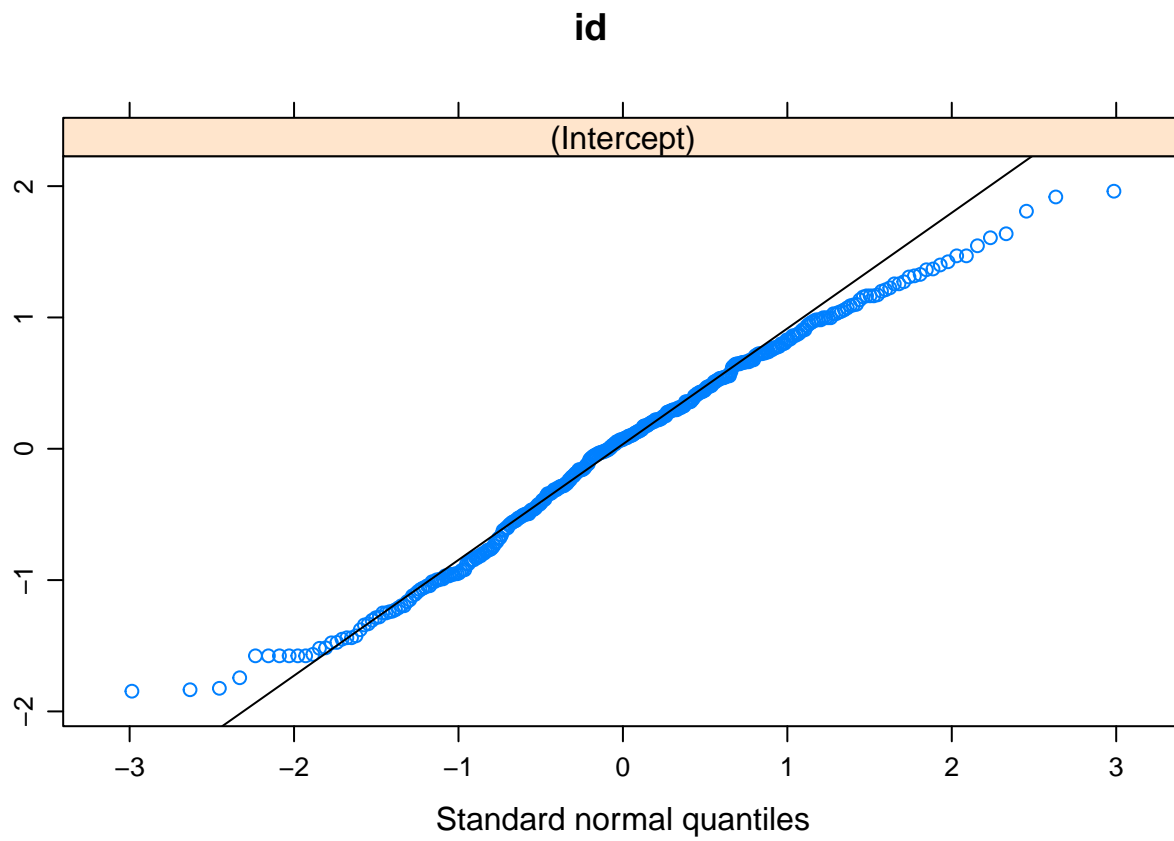
```
library(lattice) # need this package to use the built-in functions
qqmath(m1) # just use the `qqmath()` function on the fitted model
```



Normality

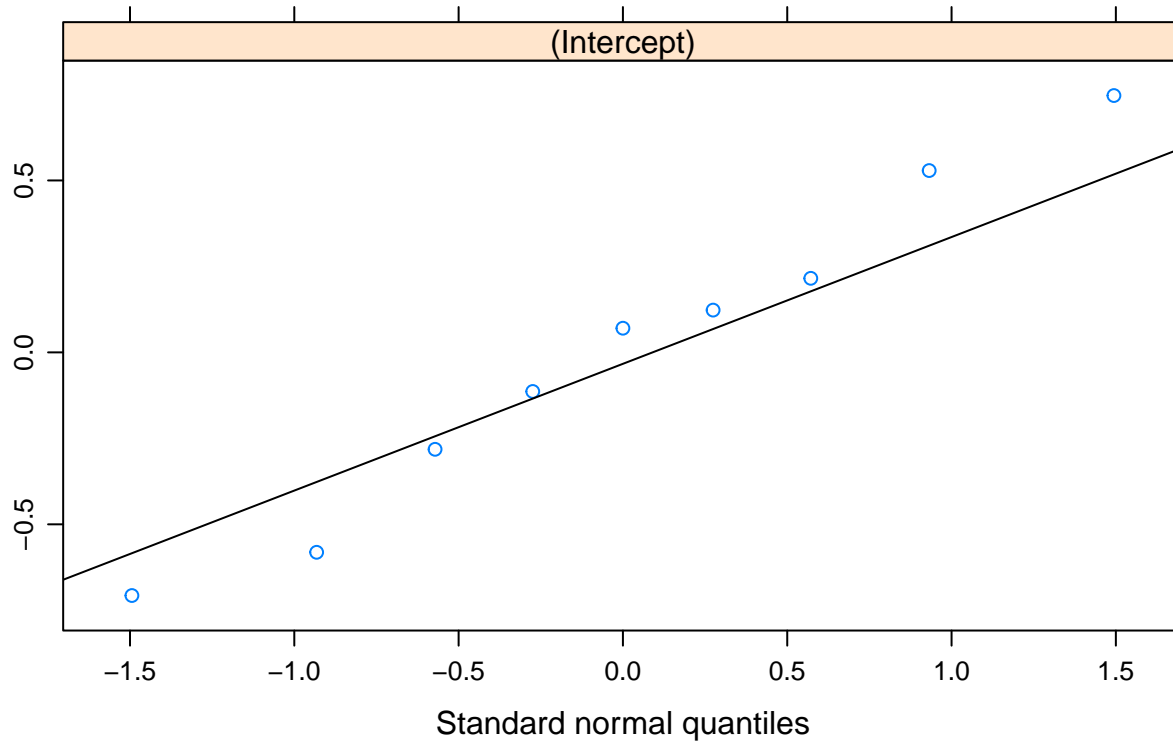
```
qqmath(ranef(m1, condVar = FALSE),  
  panel = function(x) {  
    panel.qqmath(x)  
    panel.qqmathline(x)  
  })
```

```
## $id
```

```
##  
## $statement
```

statement



In the Q-Q plots above, we see the residuals roughly follow the 45-degree line, so normality does not appear to be an issue.

```
msummary_mixed <- function(models, output = "default", coef_map = NULL, ...) {
  if (is.null(coef_map)) {
    if (!"list" %in% class(models)) {
      models <- list(models)
    }
    for (model in models) {
      coef_map <- union(coef_map, tidy(model)$term)
    }
    ranef_index <- grep("^sd|cor)_", x = coef_map)
    coef_map <- c(coef_map[-ranef_index], coef_map[ranef_index])
    names(coef_map) <- coef_map
  } else {
    ranef_index <- grep("^sd|cor)_", x = names(coef_map))
  }
  rows <- data.frame(term = c("Fixed Effects", "Random Effects"))
  rows <- cbind(rows, rbind(
    rep("", length(models)),
    rep("", length(models))
  ))
  length_fes <- length(coef_map) - length(ranef_index)
  if ("statistic" %in% names(list(...)) && is.null(list(...)$statistic)) {
    attr(rows, "position") <- c(1, (length_fes + 1))
  }
}
```

	random-intercept	model 1
Fixed Effects		
(Intercept)	3.070 (0.170)	3.258 (0.234)
ConditionCOOPERATE WITH		−0.314 (0.105)
perceived-agreement		−0.013 (0.064)
Random Effects		
sd-(Intercept)	0.483	0.483
	0.483	0.892
	0.903	0.483
	0.903	0.892
sd-Observation	1.244	1.244
AIC	11 094.3	11 095.6
BIC	11 118.6	11 132.0
Log.Lik.	−5543.146	−5541.819
REMLcrit	11 086.292	11 083.637

```

} else {
  attr(rows, "position") <- c(1, (length_fes + 1) * 2)
}
if (output == "latex" || knitr::is_latex_output()) {
  coef_map <- gsub("_", "-", coef_map)
}
modelsummary::msummary(models,
  output = output, coef_map = coef_map,
  add_rows = rows, ...
)
}

msummary_mixed(list("random-intercept" = m0,
  "model 1" = m1))

```

Summary table

Testing random slopes We then test random slopes for Condition at the person level and for perceived agreement at the person level

```

# Fit a linear growth model with random slope= of time
m1.rs1 <- lmer(objectivism.rating ~ Condition + perceived_agreement + (Condition|statement) + (1|id), data = data,
  control = lmerControl()
)

m1.rs2 <- lmer(objectivism.rating ~ Condition + perceived_agreement + (perceived_agreement|statement) + (1|id), data = data,
  control = lmerControl()
)

#test
ranova(m1.rs1)

```

```
## ANOVA-like table for random-effects: Single term deletions
##
## Model:
## objectivism.rating ~ Condition + perceived_agreement + (Condition | statement) + (1 | id)
##
##          npar  logLik   AIC    LRT Df Pr(>Chisq)
## <none>          8 -5541.8 11100
## Condition in (Condition | statement)    6 -5541.8 11096    0.04  2    0.9801
## (1 | id)          7 -5894.7 11803 705.84  1    <2e-16
##
## <none>
## Condition in (Condition | statement)
## (1 | id)          ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ranova(m1.rs2)
```

```
## ANOVA-like table for random-effects: Single term deletions
##
## Model:
## objectivism.rating ~ Condition + perceived_agreement + (perceived_agreement | statement) + (1 | id)
##
##          npar  logLik   AIC
## <none>          8 -5541.7 11100
## perceived_agreement in (perceived_agreement | statement)    6 -5541.8 11096
## (1 | id)          7 -5894.7 11803
##
##          LRT Df Pr(>Chisq)
## <none>
## perceived_agreement in (perceived_agreement | statement)    0.16  2    0.9236
## (1 | id)          705.88  1    <2e-16
##
## <none>
## perceived_agreement in (perceived_agreement | statement)
## (1 | id)          ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Neither the random slopes for Condition nor 'perceived_agreement' were significant.