Give Me Gestalt! Final Paper

Bayesian Analysis

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.2.1 --
```

```
## v ggplot2 3.1.1       v purrr   0.3.2
## v tibble  2.1.1       v dplyr   0.8.0.1
## v tidyr   0.8.3       v stringr 1.4.0
## v readr   1.3.1       v forcats 0.4.0
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(brms)
```

```
## Loading required package: Rcpp
```

```
## Loading 'brms' package (version 2.8.0). Useful instructions
## can be found by typing help('brms'). A more detailed introduction
## to the package is available through vignette('brms_overview').
```

```
library(ggplot2)
library(ggpubr)
```

```
## Loading required package: magrittr
```

```
##
## Attaching package: 'magrittr'
```

```
## The following object is masked from 'package:purrr':
##
##     set_names
```

```
## The following object is masked from 'package:tidyr':
##
##     extract
```

```
# read in the filtered csv results and select the columns needed for analysis
d = read_csv2("C:/Users/annik/Desktop/uni/4 Semester/Psycho Lab/HW/3/rotation-task-with-_babe-master/GiveMeGestalt_filtered_results.csv") %>%
  filter(trial_name %in% c("rating_scale_object", "rating_scale_like")) %>%
  select(submission_id, trial_name, response, picture_nr, artist)
```

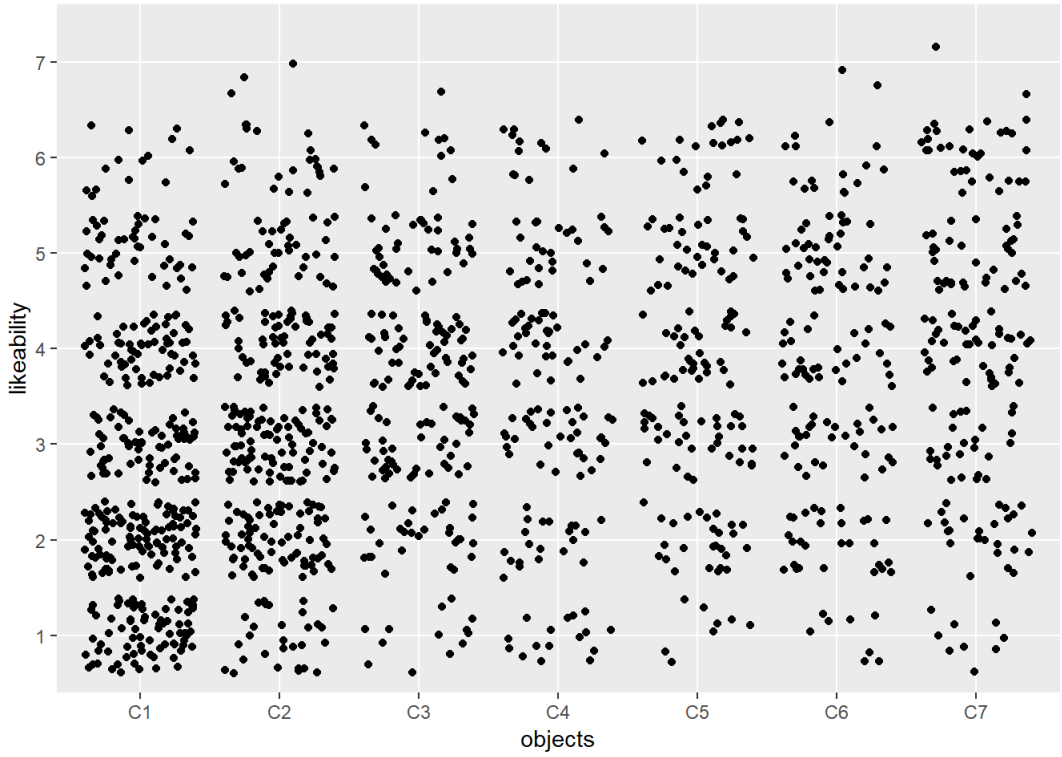
```
## Using ',' as decimal and '.' as grouping mark. Use read_delim() for more control.
```

```
## Warning: Missing column names filled in: 'X27' [27], 'X28' [28]
```

```
## Parsed with column specification:
## cols(
##   .default = col_character(),
##   submission_id = col_double(),
##   QUD = col_logical(),
##   RT = col_double(),
##   age = col_double(),
##   endTime = col_double(),
##   experiment_id = col_double(),
##   min_chars = col_double(),
##   picture_nr = col_double(),
##   startTime = col_double(),
##   timeSpent = col_number(),
##   trial_number = col_double(),
##   X27 = col_logical(),
##   X28 = col_double()
## )
```

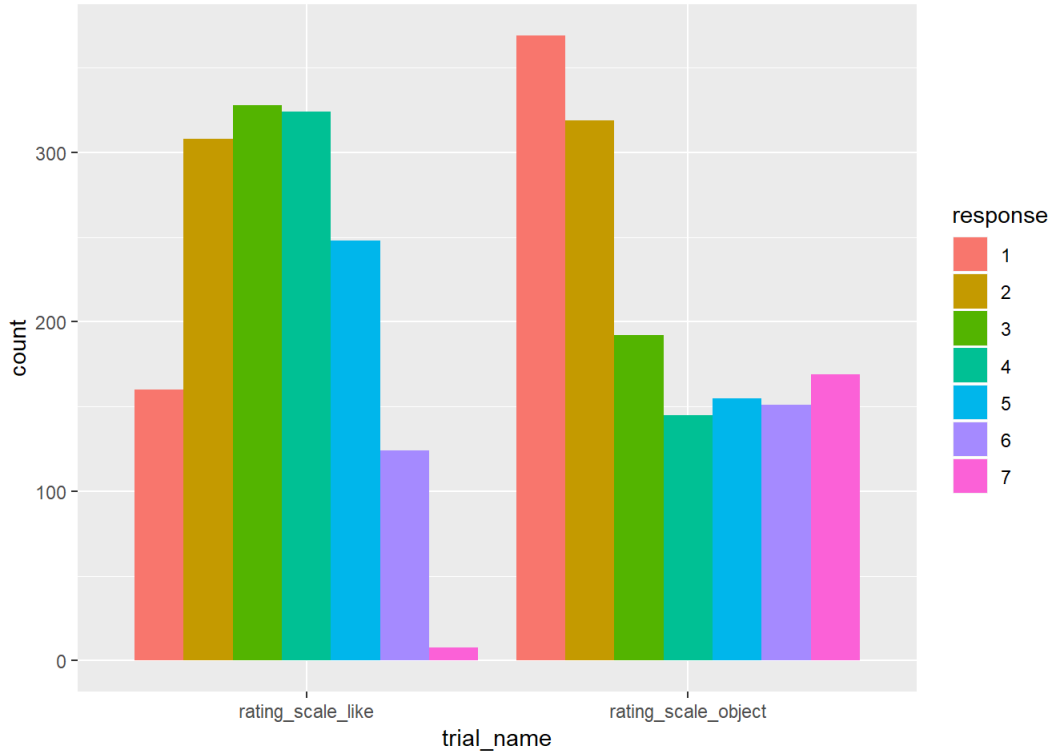
```
## See spec(...) for full column specifications.
```

```
# cast data into appropriate type
d_wide = spread(d, key = trial_name, value = response) %>%
  mutate(likeability = factor(rating_scale_like, ordered = T),
         objects = factor(paste0("C", rating_scale_object), ordered = T),
         artist = factor(artist),
         picture_nr = factor(picture_nr),
         submission_id = factor(submission_id),
         objects_forward = objects)
# inspect data
ggplot(d_wide, aes(x = objects, y= likeability)) + geom_jitter() + geom_smooth(method = "lm")
```

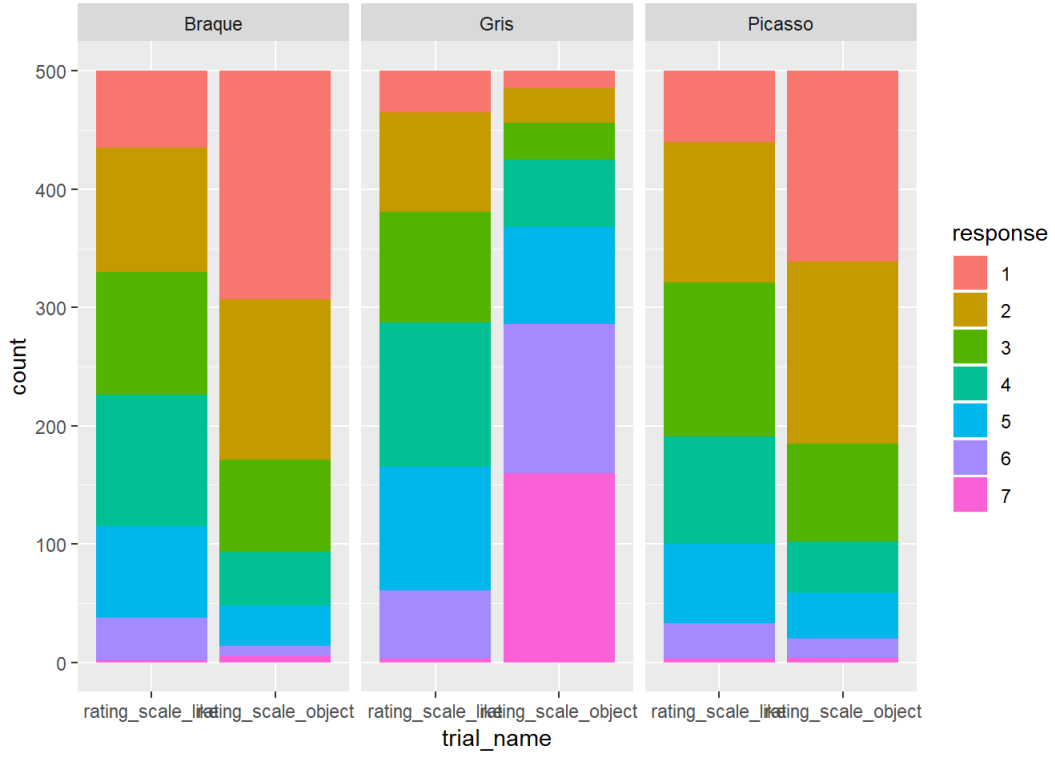


Visual display of the data

```
# absolute frequency of likeability and detecting objects
a <- ggplot(data=d)+
  geom_bar(mapping= aes(x = trial_name, fill = response), position = "dodge")
a
```




```
# absolute frequency of likeability and detecting objects regarding the artists
b <- ggplot(data=d)+
  geom_bar(mapping= aes(x = trial_name, fill = response))+
  facet_wrap(~artist)
b
```



Section 1:

the first three models treat the object-ratings as ordinal using the new brms monotonic models

Hierarchical model with only fixed effects

```
model_1 = brm(data = d_wide,
              formula = likeability ~ mo(objects),
              family=cumulative("logit")
)
```

```
## Compiling the C++ model
```

```
## Start sampling
```

```
##
## SAMPLING FOR MODEL '43fb6a6fcb32083957aa1b13fbc3d9fd' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.001 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 29.348 seconds (Warm-up)
## Chain 1:                17.187 seconds (Sampling)
## Chain 1:                46.535 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '43fb6a6fcb32083957aa1b13fbc3d9fd' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.001 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 31.959 seconds (Warm-up)
## Chain 2:                16.563 seconds (Sampling)
## Chain 2:                48.522 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '43fb6a6fcb32083957aa1b13fbc3d9fd' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 0 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
```

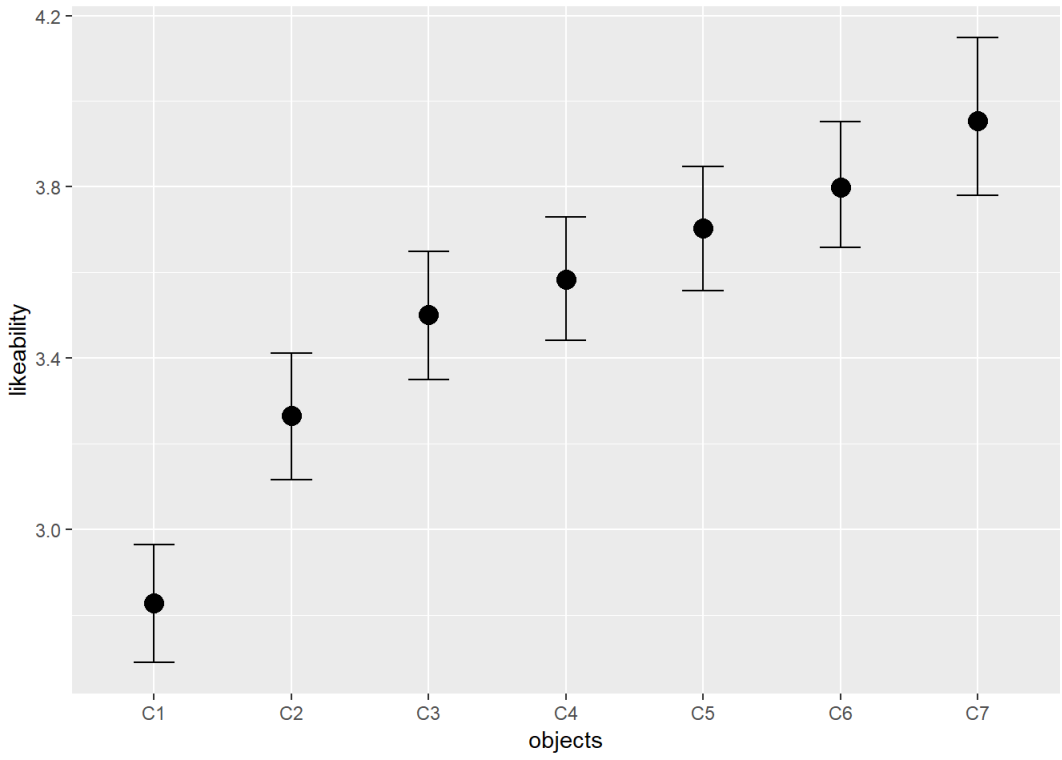
```
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 28.646 seconds (Warm-up)
## Chain 3:                20.776 seconds (Sampling)
## Chain 3:                49.422 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '43fb6a6fcb32083957aa1b13fbc3d9fd' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.001 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 35.343 seconds (Warm-up)
## Chain 4:                20.65 seconds (Sampling)
## Chain 4:                55.993 seconds (Total)
## Chain 4:
```

```
model_1
```

```
##  Family: cumulative
##   Links: mu = logit; disc = identity
## Formula: likeability ~ mo(objects)
##    Data: d_wide (Number of observations: 1500)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Population-Level Effects:
##              Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## Intercept[1]    -1.51      0.11    -1.72    -1.30       3155 1.00
## Intercept[2]    -0.12      0.10    -0.31     0.07       3922 1.00
## Intercept[3]     0.85      0.10     0.65     1.04       3925 1.00
## Intercept[4]     1.85      0.11     1.64     2.06       4137 1.00
## Intercept[5]     3.15      0.13     2.90     3.40       4578 1.00
## Intercept[6]     6.10      0.38     5.40     6.90       6009 1.00
## moobjects        1.41      0.15     1.11     1.71       4438 1.00
##
## Simplex Parameters:
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## moobjects1[1]     0.39      0.08     0.23     0.56       3226 1.00
## moobjects1[2]     0.21      0.09     0.03     0.41       2941 1.00
## moobjects1[3]     0.07      0.06     0.00     0.23       5419 1.00
## moobjects1[4]     0.10      0.07     0.01     0.27       6046 1.00
## moobjects1[5]     0.09      0.06     0.00     0.24       6448 1.00
## moobjects1[6]     0.13      0.08     0.01     0.30       5607 1.00
##
## Samples were drawn using sampling(NUTS). For each parameter, Eff.Sample
## is a crude measure of effective sample size, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
plot(marginal_effects(model_1), categorical = T)
```

```
## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.
```



Hierarchical model with by-item (pictures) and by-subject random intercepts

```
model_2 = brm(data = d_wide,
              formula = likeability ~ mo(objects) + (1 | picture_nr) + (1 | submission_id),
              family=cumulative("logit")
)
```

```
## Compiling the C++ model
```

```
## Start sampling
```

```
##
## SAMPLING FOR MODEL '73aac43371536bf55caf7bcba11bb5fb' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.002 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 20 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 52.765 seconds (Warm-up)
## Chain 1:                39.514 seconds (Sampling)
## Chain 1:                92.279 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '73aac43371536bf55caf7bcba11bb5fb' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.001 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 47.385 seconds (Warm-up)
## Chain 2:                40.453 seconds (Sampling)
## Chain 2:                87.838 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '73aac43371536bf55caf7bcba11bb5fb' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.002 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 20 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
```

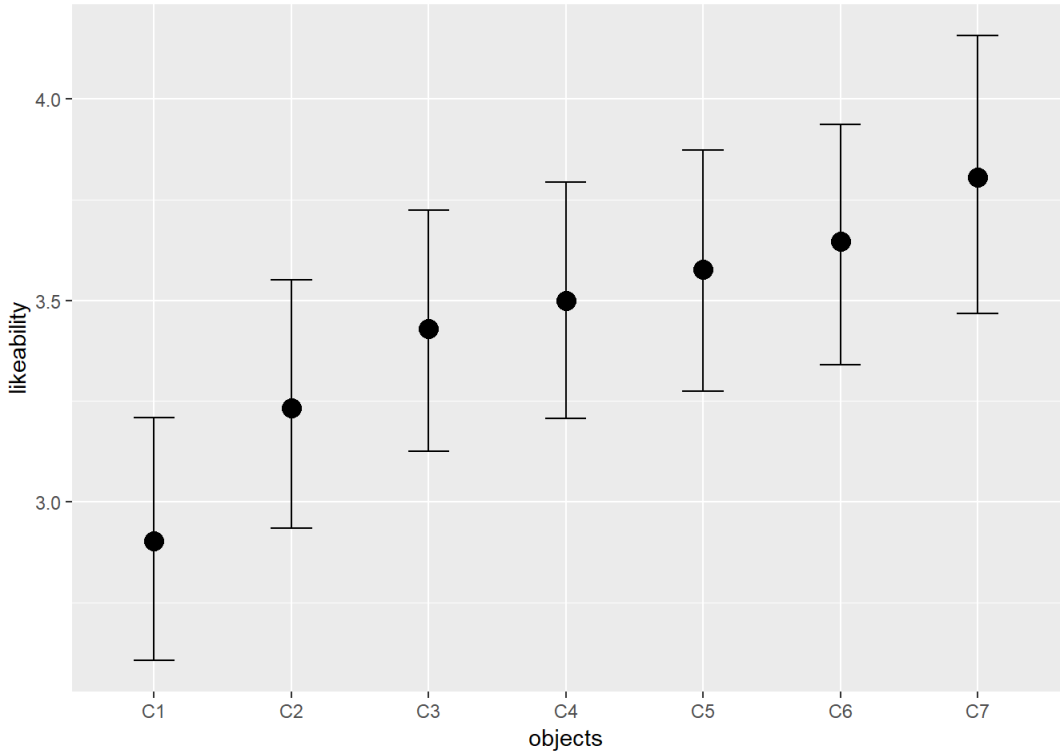
```
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 52.663 seconds (Warm-up)
## Chain 3:                48.386 seconds (Sampling)
## Chain 3:                101.049 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '73aac43371536bf55caf7bcba11bb5fb' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.001 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 48.839 seconds (Warm-up)
## Chain 4:                43.504 seconds (Sampling)
## Chain 4:                92.343 seconds (Total)
## Chain 4:
```

```
model_2
```

```
##  Family: cumulative
##   Links: mu = logit; disc = identity
## Formula: likeability ~ mo(objects) + (1 | picture_nr) + (1 | submission_id)
##    Data: d_wide (Number of observations: 1500)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~picture_nr (Number of levels: 30)
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## sd(Intercept)     0.46      0.09     0.31     0.66       1441 1.00
##
## ~submission_id (Number of levels: 50)
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## sd(Intercept)     1.21      0.14     0.97     1.51       1002 1.00
##
## Population-Level Effects:
##              Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## Intercept[1]    -2.14      0.25    -2.63    -1.65        943 1.00
## Intercept[2]    -0.34      0.24    -0.80     0.13        893 1.00
## Intercept[3]     0.90      0.24     0.44     1.36        905 1.01
## Intercept[4]     2.13      0.24     1.66     2.59        945 1.01
## Intercept[5]     3.59      0.25     3.10     4.07       1031 1.01
## Intercept[6]     6.66      0.44     5.82     7.53       2611 1.00
## moobjects        1.30      0.23     0.86     1.77       2693 1.00
##
## Simplex Parameters:
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## moobjects1[1]     0.38      0.11     0.18     0.59       4772 1.00
## moobjects1[2]     0.21      0.10     0.03     0.43       4717 1.00
## moobjects1[3]     0.08      0.06     0.00     0.23       5938 1.00
## moobjects1[4]     0.09      0.07     0.00     0.25       6427 1.00
## moobjects1[5]     0.07      0.06     0.00     0.22       6582 1.00
## moobjects1[6]     0.17      0.10     0.01     0.38       4977 1.00
##
## Samples were drawn using sampling(NUTS). For each parameter, Eff.Sample
## is a crude measure of effective sample size, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
plot(marginal_effects(model_2), categorical = T)
```

```
## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.
```



Hierarchical model with by-subject random intercepts and fixed effect of artist

```
model_3 = brm(data = d_wide,
              formula = likeability ~ mo(objects) + artist + (1 | submission_id),
              family=cumulative("logit")
)
```

```
## Compiling the C++ model
```

```
## Start sampling
```

```
##
## SAMPLING FOR MODEL 'a84b2e54d20b4a8ad3940a14d75398f4' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.003 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 30 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 38.794 seconds (Warm-up)
## Chain 1:                49.487 seconds (Sampling)
## Chain 1:                88.281 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'a84b2e54d20b4a8ad3940a14d75398f4' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.004 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 40 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
```

```
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 37.601 seconds (Warm-up)
## Chain 2:                38.668 seconds (Sampling)
## Chain 2:                76.269 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'a84b2e54d20b4a8ad3940a14d75398f4' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.001 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 51.188 seconds (Warm-up)
## Chain 3:                56.319 seconds (Sampling)
## Chain 3:                107.507 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'a84b2e54d20b4a8ad3940a14d75398f4' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.003 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 30 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 63.762 seconds (Warm-up)
## Chain 4:                34.323 seconds (Sampling)
## Chain 4:                98.085 seconds (Total)
## Chain 4:
```

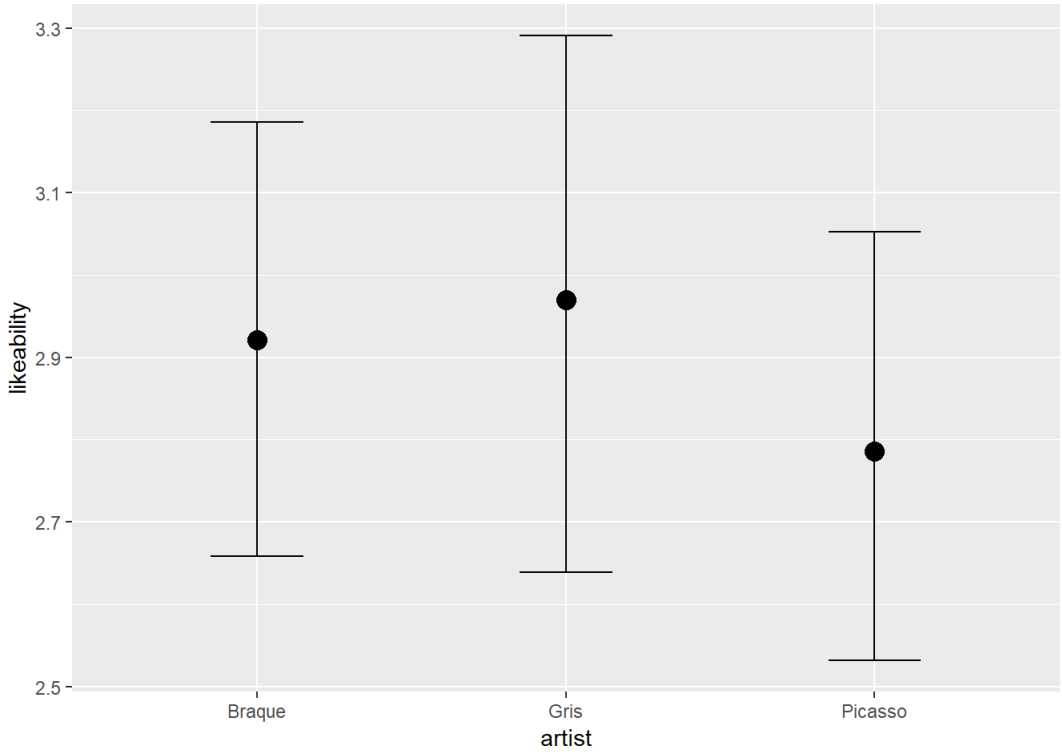
```
model_3
```

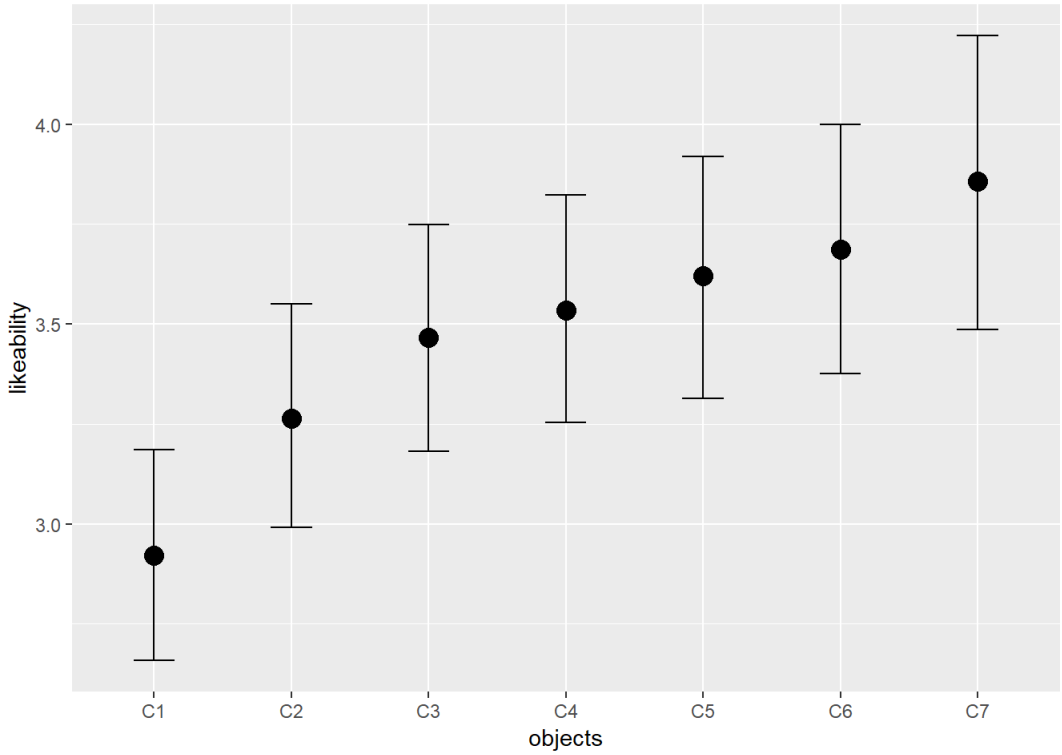
```
##  Family: cumulative
##   Links: mu = logit; disc = identity
## Formula: likeability ~ mo(objects) + artist + (1 | submission_id)
##    Data: d_wide (Number of observations: 1500)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~submission_id (Number of levels: 50)
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## sd(Intercept)     1.16      0.14     0.93     1.45        850 1.00
##
## Population-Level Effects:
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## Intercept[1]     -2.09      0.21    -2.50    -1.67        839 1.00
## Intercept[2]     -0.34      0.20    -0.73     0.06        848 1.00
## Intercept[3]      0.85      0.20     0.46     1.26        922 1.00
## Intercept[4]      2.04      0.21     1.64     2.45        889 1.00
## Intercept[5]      3.47      0.22     3.04     3.91       1079 1.00
## Intercept[6]      6.50      0.41     5.72     7.36       2502 1.00
## artistGris        0.07      0.15    -0.23     0.36       4024 1.00
## artistPicasso    -0.20      0.12    -0.43     0.03       4585 1.00
## moobjects         1.32      0.23     0.88     1.79       3374 1.00
##
## Simplex Parameters:
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## moobjects1[1]     0.38      0.11     0.17     0.59       4253 1.00
## moobjects1[2]     0.22      0.11     0.03     0.44       4209 1.00
## moobjects1[3]     0.07      0.06     0.00     0.22       4955 1.00
## moobjects1[4]     0.09      0.07     0.00     0.25       5191 1.00
## moobjects1[5]     0.07      0.06     0.00     0.22       5522 1.00
## moobjects1[6]     0.17      0.10     0.01     0.36       3874 1.00
##
## Samples were drawn using sampling(NUTS). For each parameter, Eff.Sample
## is a crude measure of effective sample size, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
plot(marginal_effects(model_3), categorical = T)
```

```
## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.

## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.
```





Section 2:

The following three models treat the object-ratings as interval-scale/ metric

Hierarchical model with only fixed effects

```
model_4 = brm(data = d_wide,
        formula = likeability ~ as.double(objects),
        family=cumulative("logit")
)
```

```
## Compiling the C++ model
```

```
## Start sampling
```

```
##
## SAMPLING FOR MODEL 'd9fe23fafc57c2777615d13508974caf' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.001 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 10.718 seconds (Warm-up)
## Chain 1:                11.135 seconds (Sampling)
## Chain 1:                21.853 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'd9fe23fafc57c2777615d13508974caf' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.001 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 10.971 seconds (Warm-up)
## Chain 2:                13.713 seconds (Sampling)
## Chain 2:                24.684 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'd9fe23fafc57c2777615d13508974caf' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.001 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 14.134 seconds (Warm-up)
## Chain 3:                10.511 seconds (Sampling)
```

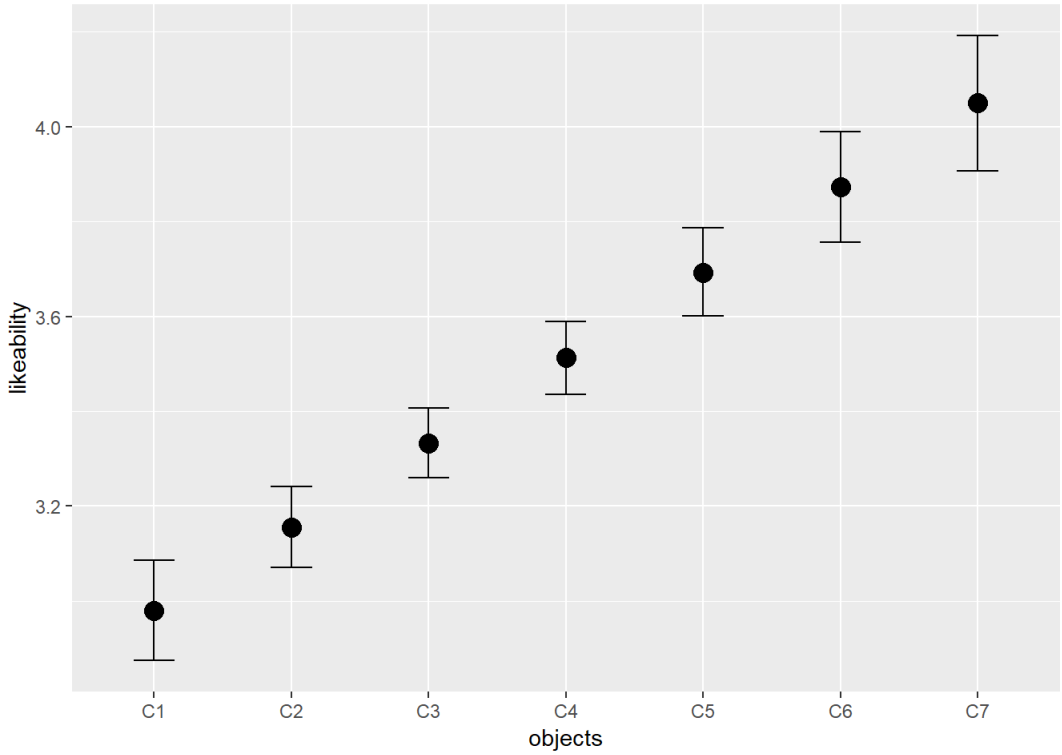
```
## Chain 3:                24.645 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'd9fe23fafc57c2777615d13508974caf' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.001 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 16.005 seconds (Warm-up)
## Chain 4:                14.275 seconds (Sampling)
## Chain 4:                30.28 seconds (Total)
## Chain 4:
```

```
model_4
```

```
##  Family: cumulative
##   Links: mu = logit; disc = identity
## Formula: likeability ~ as.double(objects)
##    Data: d_wide (Number of observations: 1500)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Population-Level Effects:
##                  Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## Intercept[1]        -1.47      0.11    -1.67    -1.26       3828 1.00
## Intercept[2]        -0.09      0.09    -0.26     0.09       4973 1.00
## Intercept[3]         0.87      0.09     0.69     1.04       4591 1.00
## Intercept[4]         1.87      0.10     1.67     2.06       4419 1.00
## Intercept[5]         3.17      0.13     2.92     3.42       4477 1.00
## Intercept[6]         6.13      0.38     5.46     6.93       4114 1.00
## as.doubleobjects     0.22      0.02     0.18     0.27       4342 1.00
##
## Samples were drawn using sampling(NUTS). For each parameter, Eff.Sample
## is a crude measure of effective sample size, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
plot(marginal_effects(model_4))
```

```
## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.
```



Hierarchical model with by-item (pictures) and by-subject random intercepts

```
model_5 = brm(data = d_wide,
        formula = likeability ~ as.double(objects) + (1 | picture_nr) + (1 | submission_id),
        family=cumulative("logit")
)
```

```
## Compiling the C++ model
```

```
## Start sampling
```

```
##
## SAMPLING FOR MODEL 'ef9da17aa5dc87bf80d86915ebda8075' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.001 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 34.442 seconds (Warm-up)
## Chain 1:                23.605 seconds (Sampling)
## Chain 1:                58.047 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'ef9da17aa5dc87bf80d86915ebda8075' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.001 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
```

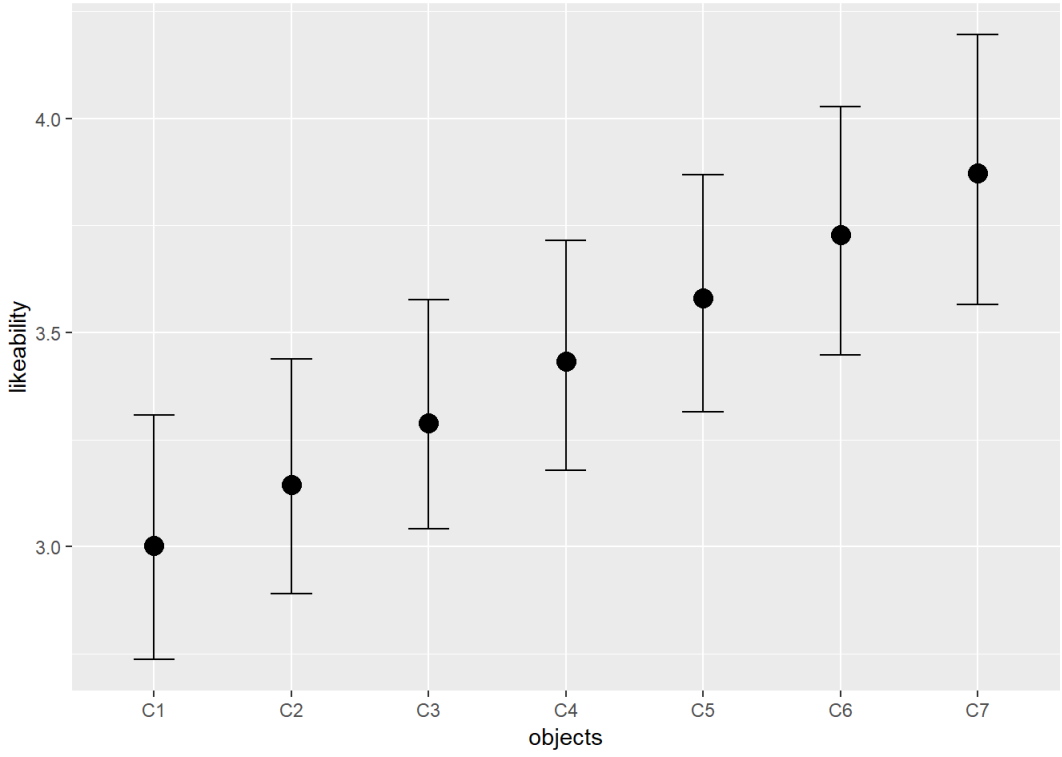
```
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 40.449 seconds (Warm-up)
## Chain 2:                48.695 seconds (Sampling)
## Chain 2:                89.144 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'ef9da17aa5dc87bf80d86915ebda8075' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.001 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 33.399 seconds (Warm-up)
## Chain 3:                23.757 seconds (Sampling)
## Chain 3:                57.156 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'ef9da17aa5dc87bf80d86915ebda8075' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.001 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 31.373 seconds (Warm-up)
## Chain 4:                29.579 seconds (Sampling)
## Chain 4:                60.952 seconds (Total)
## Chain 4:
```

```
model_5
```

```
##  Family: cumulative
##   Links: mu = logit; disc = identity
## Formula: likeability ~ as.double(objects) + (1 | picture_nr) + (1 | submission_id)
##    Data: d_wide (Number of observations: 1500)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~picture_nr (Number of levels: 30)
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## sd(Intercept)     0.45      0.08     0.31     0.63       1399 1.00
##
## ~submission_id (Number of levels: 50)
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## sd(Intercept)     1.21      0.14     0.97     1.51        643 1.00
##
## Population-Level Effects:
##                  Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## Intercept[1]        -2.07      0.25    -2.57    -1.60        698 1.00
## Intercept[2]        -0.29      0.23    -0.76     0.15        644 1.00
## Intercept[3]         0.94      0.24     0.47     1.38        630 1.00
## Intercept[4]         2.17      0.24     1.68     2.64        663 1.00
## Intercept[5]         3.64      0.26     3.12     4.12        745 1.00
## Intercept[6]         6.71      0.44     5.90     7.58       1499 1.00
## as.doubleobjects     0.21      0.04     0.14     0.28       2207 1.00
##
## Samples were drawn using sampling(NUTS). For each parameter, Eff.Sample
## is a crude measure of effective sample size, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
plot(marginal_effects(model_5))
```

```
## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.
```



Hierarchical model with by-subject random intercepts and fixed effect of artist

```
model_6 = brm(data = d_wide,
        formula = likeability ~ as.double(objects) + artist + (1 | submission_id),
        family=cumulative("logit")
)
```

```
## Compiling the C++ model
```

```
## Start sampling
```

```
##
## SAMPLING FOR MODEL '1b726ff50c235e73d05586071a94906d' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 0 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 25.727 seconds (Warm-up)
## Chain 1:                23.468 seconds (Sampling)
## Chain 1:                49.195 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '1b726ff50c235e73d05586071a94906d' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.002 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 20 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 38.263 seconds (Warm-up)
## Chain 2:                17.78 seconds (Sampling)
## Chain 2:                56.043 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '1b726ff50c235e73d05586071a94906d' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.001 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
```

```
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 26.018 seconds (Warm-up)
## Chain 3:                18.125 seconds (Sampling)
## Chain 3:                44.143 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '1b726ff50c235e73d05586071a94906d' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0.001 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 10 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 23.593 seconds (Warm-up)
## Chain 4:                16.334 seconds (Sampling)
## Chain 4:                39.927 seconds (Total)
## Chain 4:
```

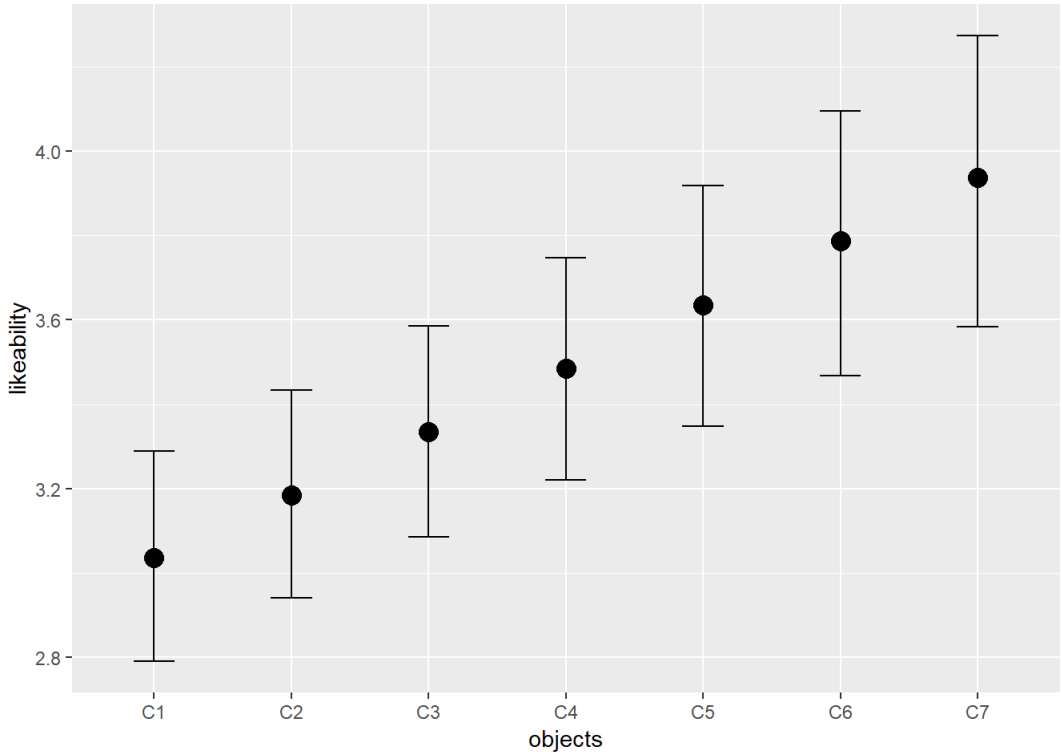
```
model_6
```

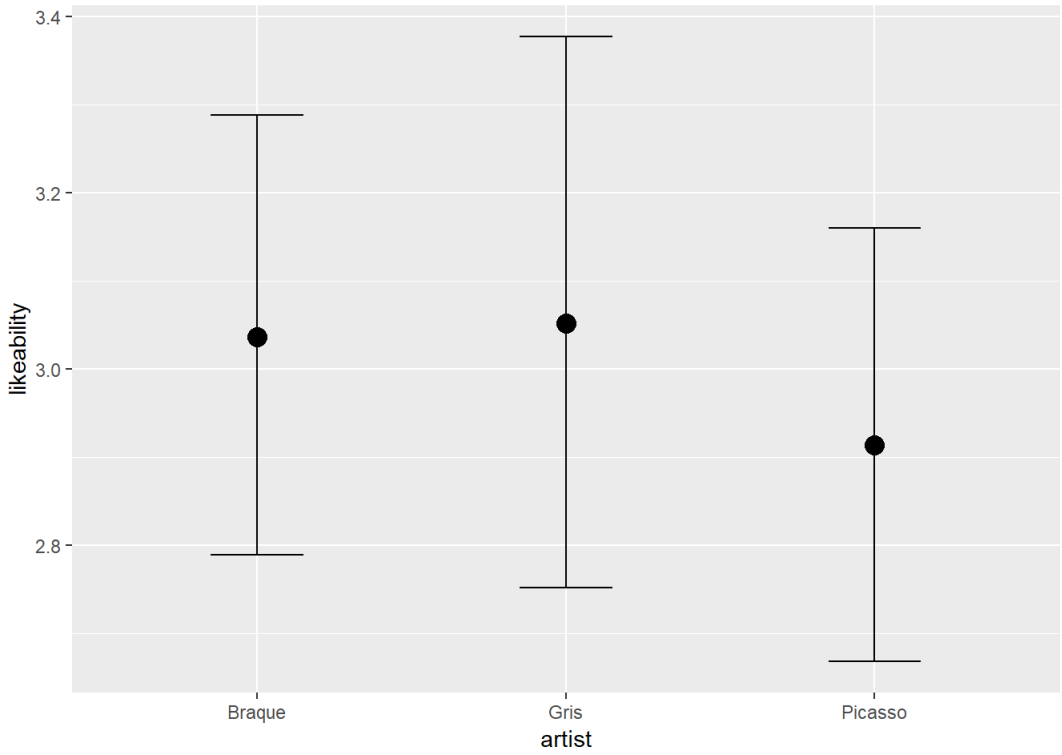
```
##  Family: cumulative
##   Links: mu = logit; disc = identity
## Formula: likeability ~ as.double(objects) + artist + (1 | submission_id)
##    Data: d_wide (Number of observations: 1500)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~submission_id (Number of levels: 50)
##               Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## sd(Intercept)     1.16      0.13     0.93     1.45        742 1.00
##
## Population-Level Effects:
##                  Estimate Est.Error l-95% CI u-95% CI Eff.Sample Rhat
## Intercept[1]        -2.03      0.21    -2.45    -1.62        547 1.00
## Intercept[2]        -0.30      0.20    -0.69     0.09        523 1.00
## Intercept[3]         0.89      0.20     0.50     1.29        542 1.00
## Intercept[4]         2.08      0.20     1.68     2.49        570 1.00
## Intercept[5]         3.50      0.22     3.08     3.94        662 1.00
## Intercept[6]         6.53      0.41     5.77     7.38       1573 1.00
## as.doubleobjects     0.21      0.04     0.14     0.28       2564 1.00
## artistGris           0.02      0.16    -0.27     0.34       2369 1.00
## artistPicasso       -0.18      0.12    -0.41     0.04       3902 1.00
##
## Samples were drawn using sampling(NUTS). For each parameter, Eff.Sample
## is a crude measure of effective sample size, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
plot(marginal_effects(model_6))
```

```
## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.

## Warning: Predictions are treated as continuous variables in
## 'marginal_effects' by default, which is likely invalid for ordinal
## families. Please set 'categorical' to TRUE.
```





Model comparison

```
loo <- loo(model_1, model_2, model_3, model_4, model_5, model_6)
```

```
## Warning: Passing multiple brmsfit objects to 'loo' and related methods is
## deprecated. Please see ?loo.brmsfit for the recommended workflow.
```

```
loo
```

```
## Output of model 'model_1':
##
## Computed from 4000 by 1500 log-likelihood matrix
##
##          Estimate   SE
## elpd_loo  -2592.9 17.9
## p_loo         9.6  0.4
## looic      5185.8 35.8
## ------
## Monte Carlo SE of elpd_loo is 0.0.
##
## All Pareto k estimates are good (k < 0.5).
## See help('pareto-k-diagnostic') for details.
##
## Output of model 'model_2':
##
## Computed from 4000 by 1500 log-likelihood matrix
##
##          Estimate   SE
## elpd_loo  -2356.2 24.8
## p_loo        80.2  2.0
## looic      4712.5 49.6
## ------
## Monte Carlo SE of elpd_loo is 0.2.
##
## All Pareto k estimates are good (k < 0.5).
## See help('pareto-k-diagnostic') for details.
##
## Output of model 'model_3':
##
## Computed from 4000 by 1500 log-likelihood matrix
##
##          Estimate   SE
## elpd_loo  -2386.4 24.1
## p_loo        60.2  1.5
## looic      4772.8 48.2
## ------
## Monte Carlo SE of elpd_loo is 0.1.
##
## All Pareto k estimates are good (k < 0.5).
## See help('pareto-k-diagnostic') for details.
##
## Output of model 'model_4':
##
## Computed from 4000 by 1500 log-likelihood matrix
##
##          Estimate   SE
## elpd_loo  -2597.6 17.7
## p_loo         7.1  0.4
## looic      5195.2 35.3
## ------
## Monte Carlo SE of elpd_loo is 0.0.
##
## All Pareto k estimates are good (k < 0.5).
## See help('pareto-k-diagnostic') for details.
##
## Output of model 'model_5':
##
## Computed from 4000 by 1500 log-likelihood matrix
##
##          Estimate   SE
## elpd_loo  -2360.2 24.6
## p_loo        78.3  1.9
## looic      4720.3 49.2
## ------
## Monte Carlo SE of elpd_loo is 0.2.
##
## All Pareto k estimates are good (k < 0.5).
## See help('pareto-k-diagnostic') for details.
##
```

```
##
## Output of model 'model_6':
##
## Computed from 4000 by 1500 log-likelihood matrix
##
##          Estimate   SE
## elpd_loo  -2390.1 24.0
## p_loo        57.9  1.4
## looic      4780.1 47.9
## ------
## Monte Carlo SE of elpd_loo is 0.1.
##
## All Pareto k estimates are good (k < 0.5).
## See help('pareto-k-diagnostic') for details.
##
## Model comparisons:
##         elpd_diff se_diff
## model_2    0.0       0.0
## model_5   -3.9       2.5
## model_3  -30.1       7.7
## model_6  -33.8       8.1
## model_1 -236.7      20.7
## model_4 -241.4      20.9
```

Frequentist Analysis: Pearson correlation

```
data <- read_csv2("GiveMeGestalt_filtered_results.csv")
```

```
## Using ',' as decimal and '.' as grouping mark. Use read_delim() for more control.
```

```
## Warning: Missing column names filled in: 'X27' [27], 'X28' [28]
```

```
## Parsed with column specification:
## cols(
##   .default = col_character(),
##   submission_id = col_double(),
##   QUD = col_logical(),
##   RT = col_double(),
##   age = col_double(),
##   endTime = col_double(),
##   experiment_id = col_double(),
##   min_chars = col_double(),
##   picture_nr = col_double(),
##   startTime = col_double(),
##   timeSpent = col_number(),
##   trial_number = col_double(),
##   X27 = col_logical(),
##   X28 = col_double()
## )
```

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

Data formatting

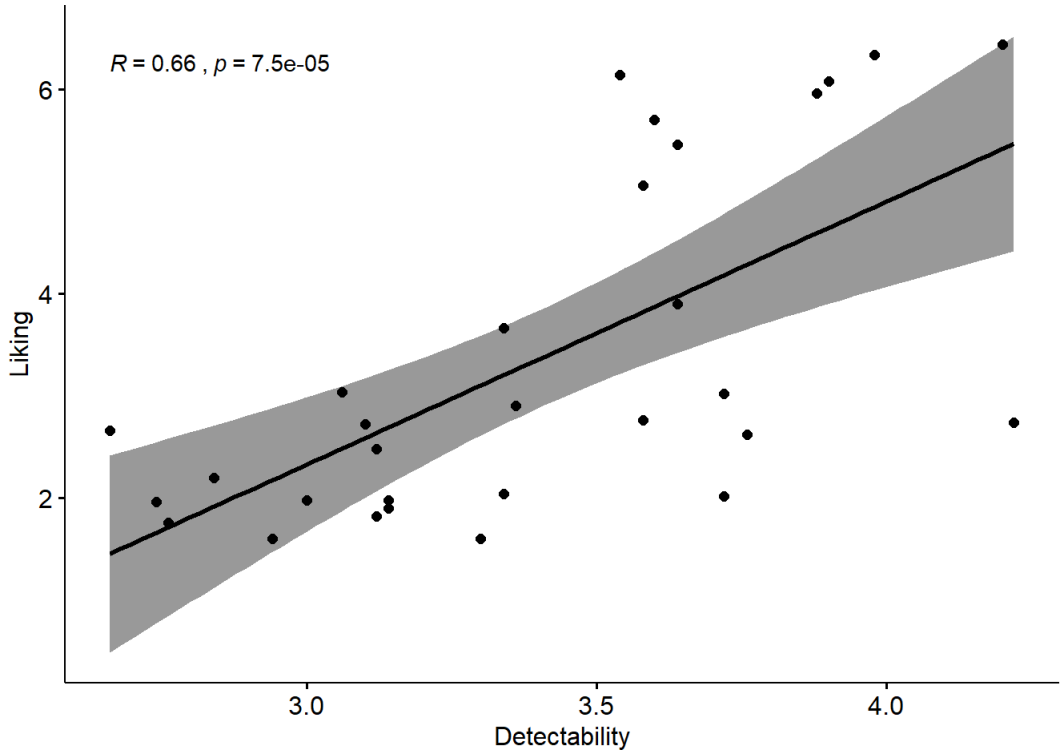
```
data_temp <- as_tibble(data) %>% mutate(response = as.integer(response))
```

```
## Warning: NAs durch Umwandlung erzeugt
```

```
x <- filter(data_temp, trial_name == 'rating_scale_like') %>%
  select(c('response', 'picture_nr'))%>%
  group_by(picture_nr) %>%
  summarise(response = mean(response))
y <- filter(data_temp, trial_name == 'rating_scale_object') %>%
  select(c('response', 'picture_nr')) %>%
  group_by(picture_nr) %>%
  summarise(response = mean(response))
data_formatted <- merge(x,y, by = 'picture_nr')
```

Correlation test and regression graph

```
ggscatter(data_formatted, x = "response.x", y = "response.y",
          add = "reg.line", conf.int = TRUE,
          cor.coef = TRUE, cor.method = "pearson",
          xlab = "Detectability", ylab = "Liking")
```




```
res <- cor.test(data_formatted$response.x, data_formatted$response.y,
                    method = "pearson")
res
```

```
##
##  Pearson's product-moment correlation
##
## data:  data_formatted$response.x and data_formatted$response.y
## t = 4.6356, df = 28, p-value = 7.508e-05
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.3916580 0.8236774
## sample estimates:
##       cor
## 0.6589481
```

```
# extract the p.value
res$p.value
```

```
## [1] 7.508036e-05
```

```
# extract the correlation coefficient
res$estimate
```

```
##       cor
## 0.6589481
```

```
# the amount of variance explained
res$estimate^2
```

```
##       cor
## 0.4342126
```