

Supplementary Material 3: Nonpreregistered Bayesian Analyses

Angel V. Jimenez

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```
# DATASET
setwd("C:/Users/aj419/OneDrive - University of Exeter/2019/THESIS/CHAPTER 4 (tablets)/analyses/tablets_")
d<-read.csv("tablets_exp.csv")
# Gender as factor
d$GENDER <- ifelse((d$GENDER==1),"Male",
ifelse((d$GENDER==2),"female","other"))
d$GENDER <- as.factor(d$GENDER)
d$GENERATION <- ifelse((d$GENERATION=="F1"),1,
ifelse((d$GENERATION=="F2"),2,
ifelse((d$GENERATION=="F3"),3,
ifelse((d$GENERATION=="F4"),4, 60))))
d$GENDER <- as.factor(d$GENDER)
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').
```

NULL MODELS

```
# mo.0: fixed intercept model
mo.0<-brm(RECALL~1, data = d, family="poisson")

## Compiling the C++ model

## Start sampling

##
## SAMPLING FOR MODEL 'a6e1f398253bf16f87272bf3ae82b67e' 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: 0.332 seconds (Warm-up)
## Chain 1: 0.314 seconds (Sampling)
## Chain 1: 0.646 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'a6e1f398253bf16f87272bf3ae82b67e' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 0.457 seconds (Warm-up)
## Chain 2: 0.313 seconds (Sampling)
## Chain 2: 0.77 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'a6e1f398253bf16f87272bf3ae82b67e' 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)

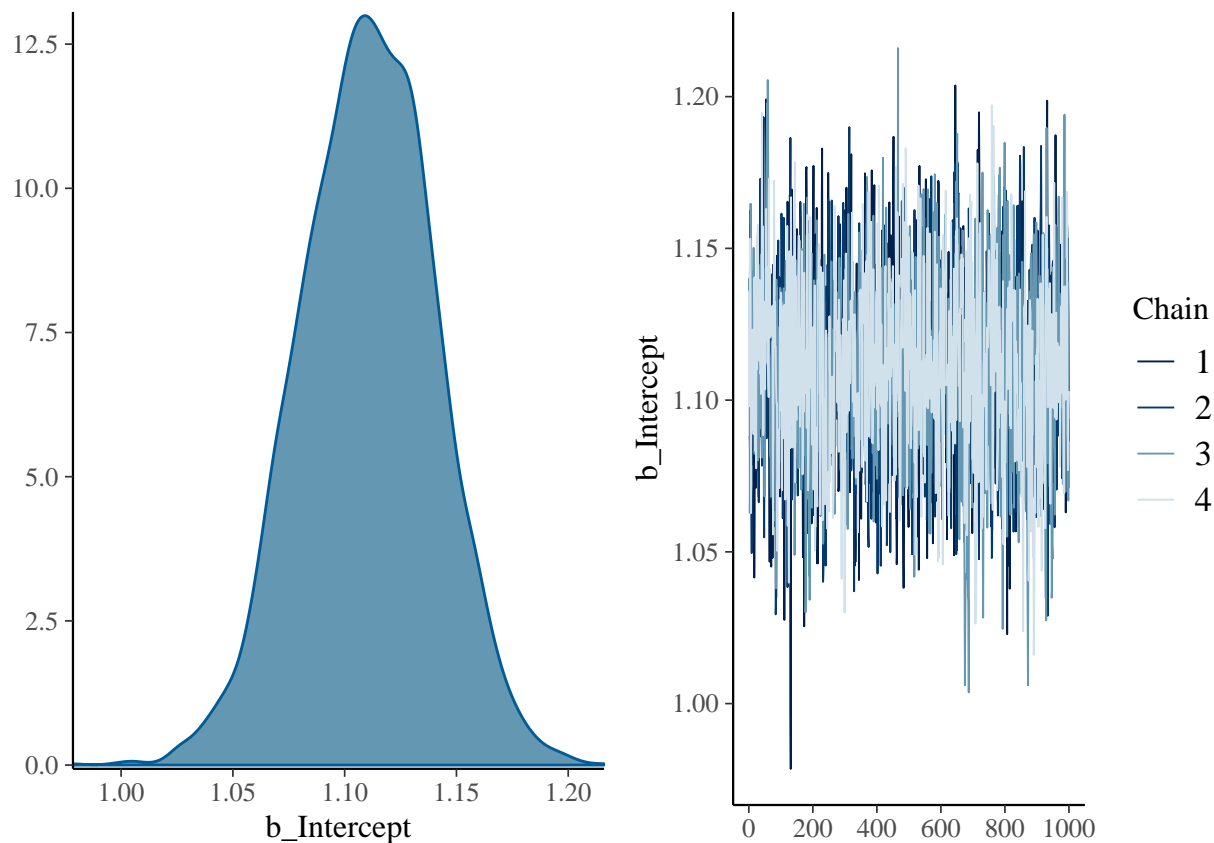
```

```

## Chain 3:
## Chain 3: Elapsed Time: 0.367 seconds (Warm-up)
## Chain 3:           0.42 seconds (Sampling)
## Chain 3:           0.787 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'a6e1f398253bf16f87272bf3ae82b67e' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 0.387 seconds (Warm-up)
## Chain 4:           0.343 seconds (Sampling)
## Chain 4:           0.73 seconds (Total)
## Chain 4:
mo.0<-add_criterion(mo.0, c("loo", "waic"))
summary(mo.0, prob=0.89)

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ 1
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##           total post-warmup samples = 4000
##
## Population-Level Effects:
##           Estimate Est.Error l-89% CI u-89% CI Eff.Sample Rhat
## Intercept      1.11      0.03   1.06   1.16      1309 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(mo.0)

```



```
(loo.0<-loo(mo.0))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -744.0 12.4
## p_loo       1.0  0.1
## looic      1487.9 24.7
## -----
## 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.
```

```
# mo.0a: random intercept model with chain as a random effect
mo.0a<-brm(RECALL ~ 1 + (1|CHAIN), data = d, family = "poisson")
```

```
## Compiling the C++ model
## Start sampling
##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' 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: 2.736 seconds (Warm-up)
## Chain 1:                1.822 seconds (Sampling)
## Chain 1:                4.558 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 2.407 seconds (Warm-up)
## Chain 2:                1.785 seconds (Sampling)
## Chain 2:                4.192 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' 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: 2.342 seconds (Warm-up)
## Chain 3: 2.234 seconds (Sampling)
## Chain 3: 4.576 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' 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: 2.11 seconds (Warm-up)
## Chain 4: 1.47 seconds (Sampling)
## Chain 4: 3.58 seconds (Total)
## Chain 4:

## Warning: There were 1 transitions after warmup that exceeded the maximum treedepth. Increase max_treedepth.
## http://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded

## Warning: Examine the pairs() plot to diagnose sampling problems

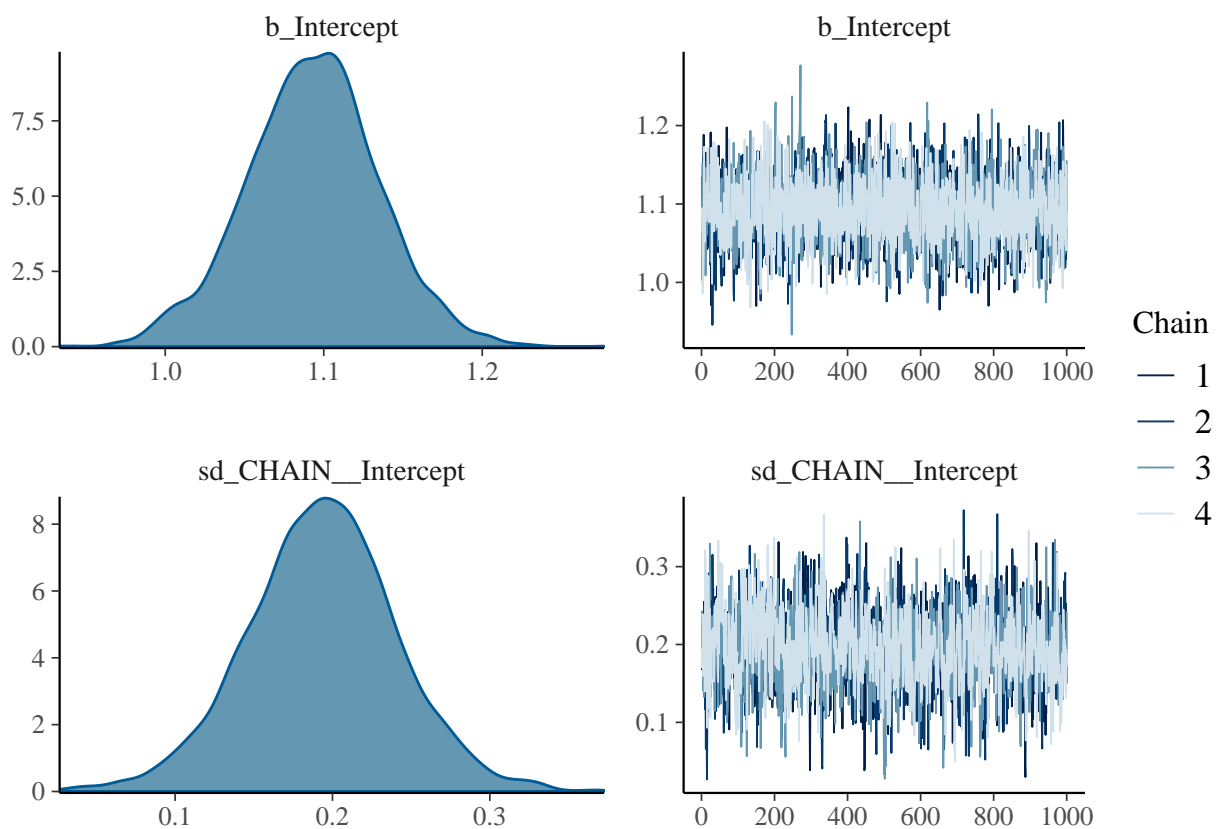
mo.0a<-add_criterion(mo.0a, c("loo", "waic"))
summary(mo.0a, prob=0.89)

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ 1 + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##

```

```
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.19      0.05    0.12    0.27    1568 1.00
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept        1.09      0.04    1.03    1.16    2984 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(mo.0a)
```



```
(loo.0a<-loo(mo.0a))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo    -734.9 11.9
## p_loo        20.8  1.5
## looic       1469.9 23.8
## -----
## 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.
# mo.Ob: random intercept model with participant as a random effect
mo.Ob<-brm(RECALL ~ 1 + (1|PARTICIPANT), data = d, family = "poisson")

## Compiling the C++ model
## recompiling to avoid crashing R session
## Start sampling

##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' 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: 5.475 seconds (Warm-up)
## Chain 1:                15.154 seconds (Sampling)
## Chain 1:                20.629 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 5.983 seconds (Warm-up)
## Chain 2: 2.346 seconds (Sampling)
## Chain 2: 8.329 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' 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: 4.866 seconds (Warm-up)
## Chain 3: 2.839 seconds (Sampling)
## Chain 3: 7.705 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '1aa484be8b82844540f1147bab1dbc12' 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: 4.462 seconds (Warm-up)
## Chain 4: 2.007 seconds (Sampling)

```

```

## Chain 4:                6.469 seconds (Total)
## Chain 4:

## Warning: There were 48 transitions after warmup that exceeded the maximum treedepth. Increase max_tr
## http://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded

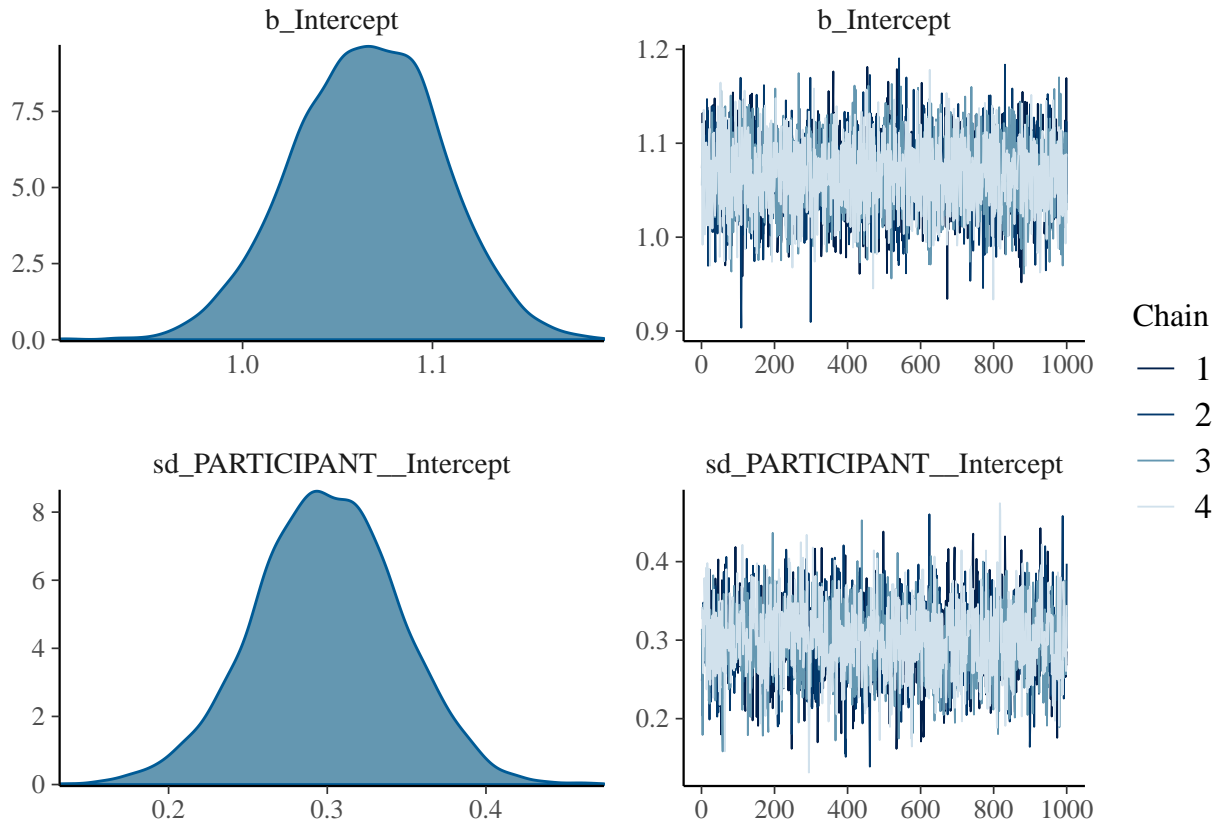
## Warning: Examine the pairs() plot to diagnose sampling problems

mo.0b<-add_criterion(mo.0b, c("loo", "waic"))
summary(mo.0b, prob=0.89)

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ 1 + (1 | PARTICIPANT)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~PARTICIPANT (Number of levels: 192)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.30      0.05    0.23    0.37      1660 1.00
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept       1.07      0.04    1.00    1.13      5012 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(mo.0b)

```



```
(loo.0b<-loo(mo.0b))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -717.7  8.8
## p_loo       43.7  2.5
## looic      1435.3 17.6
## -----
## Monte Carlo SE of elpd_loo is 0.2.
##
## Pareto k diagnostic values:
##               Count Pct.    Min. n_eff
## (-Inf, 0.5] (good)   376  97.9%    958
## (0.5, 0.7]  (ok)      8   2.1%    789
## (0.7, 1]    (bad)      0   0.0%    <NA>
## (1, Inf)    (very bad) 0   0.0%    <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
```

```
# mo.0c: random intercept model with participant nested within chain as random effects
mo.0c<-brm(RECALL ~ 1 + (1|CHAIN/PARTICIPANT), data = d, family = "poisson")
```

```
## Compiling the C++ model
## Start sampling
```

```

##
## SAMPLING FOR MODEL '36712e3252118ff2ee3f8a15bc6db496' 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: 7.339 seconds (Warm-up)
## Chain 1:                3.783 seconds (Sampling)
## Chain 1:                11.122 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '36712e3252118ff2ee3f8a15bc6db496' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 4.52 seconds (Warm-up)
## Chain 2:                5.368 seconds (Sampling)
## Chain 2:                9.888 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '36712e3252118ff2ee3f8a15bc6db496' 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: 5.606 seconds (Warm-up)
## Chain 3:           4.592 seconds (Sampling)
## Chain 3:           10.198 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '36712e3252118ff2ee3f8a15bc6db496' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 5.673 seconds (Warm-up)
## Chain 4:           4.079 seconds (Sampling)
## Chain 4:           9.752 seconds (Total)
## Chain 4:

## Warning: There were 2 divergent transitions after warmup. Increasing adapt_delta above 0.8 may help.
## http://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup
## Warning: Examine the pairs() plot to diagnose sampling problems
mo.0c<-add_criterion(mo.0c, c("loo", "waic"))
summary(mo.0c, prob=0.89)

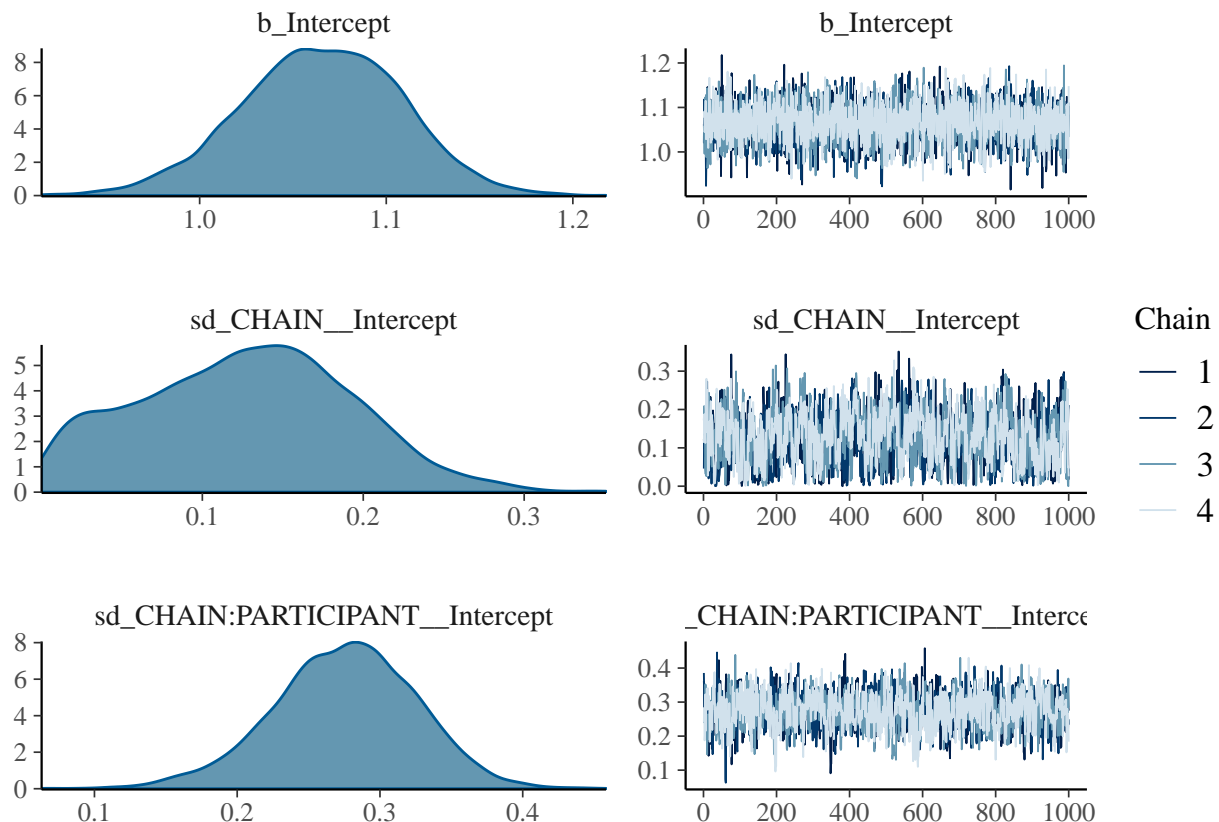
## Warning: There were 2 divergent transitions after warmup. Increasing adapt_delta above 0.8 may help.

```

```
## See http://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ 1 + (1 | CHAIN/PARTICIPANT)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##           total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.13      0.07    0.02    0.23      670 1.01
##
## ~CHAIN:PARTICIPANT (Number of levels: 192)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.28      0.05    0.19    0.35      918 1.00
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept        1.07      0.04    0.99    1.13     3430 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(mo.0c)
```



```

(loo.0c<-loo(mo.0c))

##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo    -717.2  9.0
## p_loo        44.3  2.6
## looic       1434.5 18.0
## -----
## Monte Carlo SE of elpd_loo is 0.2.
##
## Pareto k diagnostic values:
##
##           Count Pct.   Min. n_eff
## (-Inf, 0.5] (good)   380  99.0%   831
## (0.5, 0.7] (ok)      4    1.0%   430
## (0.7, 1] (bad)       0    0.0%   <NA>
## (1, Inf) (very bad)  0    0.0%   <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
# GENERATION MODELS
# Generation model with participant nested within chain as random effects
mo.1a<-brm(RECALL ~ mo(GENERATION) + (1|CHAIN/PARTICIPANT), data = d, family = "poisson")

## Compiling the C++ model
## Start sampling
##
## SAMPLING FOR MODEL '20033e31695d024353329b751274e3bd' 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: 9.201 seconds (Warm-up)
## Chain 1:                3.966 seconds (Sampling)
## Chain 1:                13.167 seconds (Total)
##

```

```

## SAMPLING FOR MODEL '20033e31695d024353329b751274e3bd' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 7.989 seconds (Warm-up)
## Chain 2:                4.29 seconds (Sampling)
## Chain 2:                12.279 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '20033e31695d024353329b751274e3bd' 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: 8.294 seconds (Warm-up)
## Chain 3:                4.087 seconds (Sampling)
## Chain 3:                12.381 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '20033e31695d024353329b751274e3bd' 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.

```



```

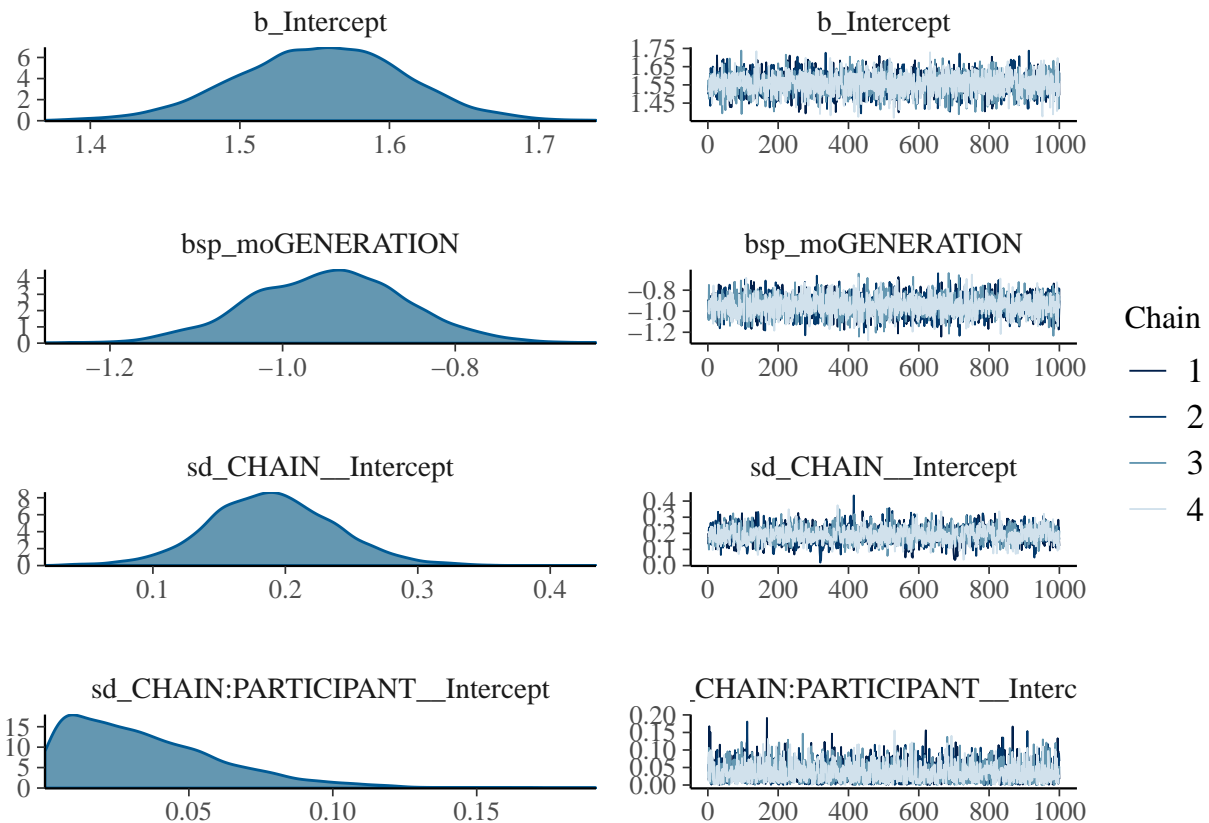
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%] (Warmup)
## Chain 4: Iteration:   200 / 2000 [ 10%] (Warmup)
## Chain 4: Iteration:   400 / 2000 [ 20%] (Warmup)
## Chain 4: Iteration:   600 / 2000 [ 30%] (Warmup)
## Chain 4: Iteration:   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: 9.994 seconds (Warm-up)
## Chain 4:           3.728 seconds (Sampling)
## Chain 4:           13.722 seconds (Total)
## Chain 4:

mo.1a<-add_criterion(mo.1a, c("loo", "waic"))
summary(mo.1a, prob=0.89)

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(GENERATION) + (1 | CHAIN/PARTICIPANT)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##           total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.19      0.05    0.12    0.27      1195 1.00
##
## ~CHAIN:PARTICIPANT (Number of levels: 192)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.04      0.03    0.00    0.08      3049 1.00
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept         1.55      0.06    1.47    1.64      4007 1.00
## moGENERATION      -0.95      0.09   -1.09   -0.80      5208 1.00
##
## Simplex Parameters:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moGENERATION1[1]    0.49      0.08    0.37    0.62      5555 1.00
## moGENERATION1[2]    0.25      0.10    0.10    0.42      5249 1.00
## moGENERATION1[3]    0.26      0.09    0.10    0.40      5089 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(mo.1a)
```



```
(loo.1a<-loo(mo.1a))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -656.0  7.2
## p_loo       13.0  0.8
## looic       1312.1 14.3
## -----
## 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.
# Generation model with chain as random effect
mo.1b<-brm(RECALL ~ mo(GENERATION) + (1|CHAIN), data = d, family = "poisson")

## Compiling the C++ model
## Start sampling
##
## SAMPLING FOR MODEL '15dadb01473dc5f46242496f5bd171b7' 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: 4.624 seconds (Warm-up)
## Chain 1:           4.114 seconds (Sampling)
## Chain 1:           8.738 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '15dadb01473dc5f46242496f5bd171b7' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 3.525 seconds (Warm-up)
## Chain 2:           2.189 seconds (Sampling)
## Chain 2:           5.714 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '15dadb01473dc5f46242496f5bd171b7' 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:

```

```

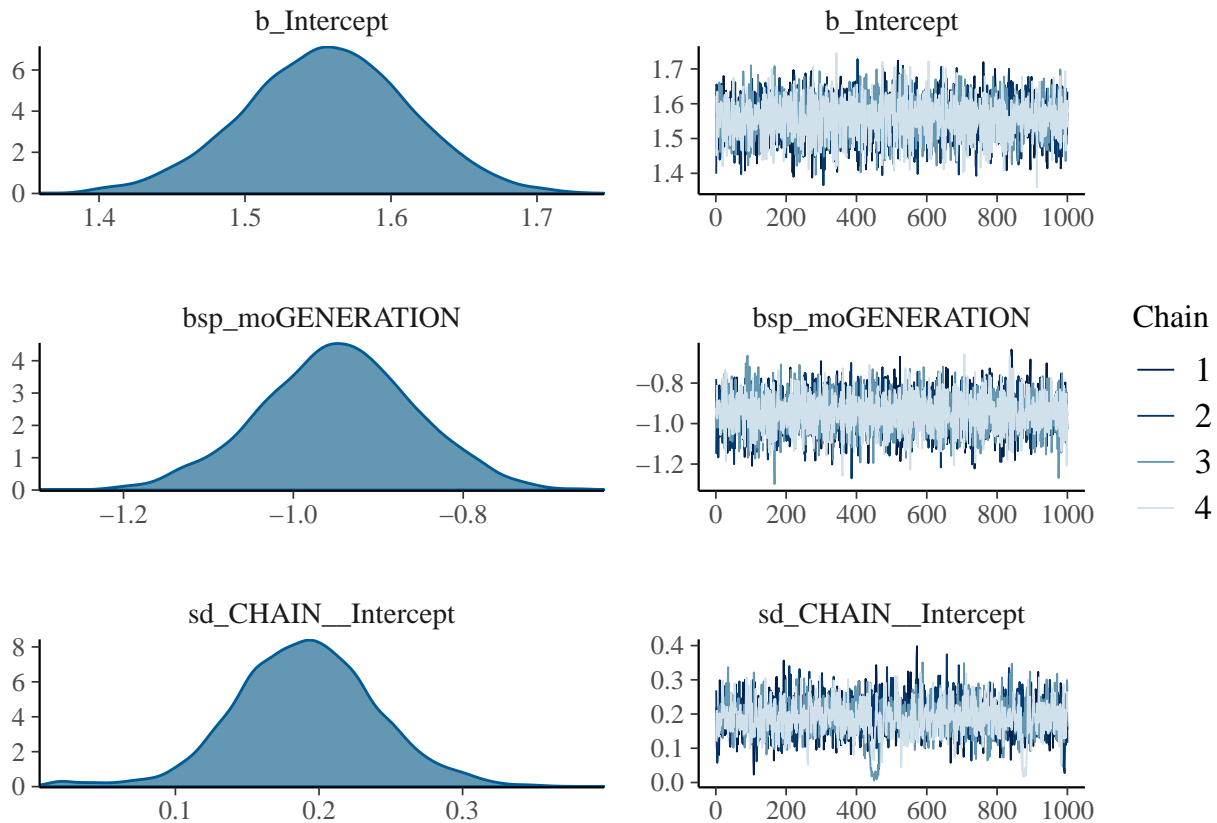
## Chain 3: Iteration:    1 / 2000 [ 0%] (Warmup)
## Chain 3: Iteration:   200 / 2000 [ 10%] (Warmup)
## Chain 3: Iteration:   400 / 2000 [ 20%] (Warmup)
## Chain 3: Iteration:   600 / 2000 [ 30%] (Warmup)
## Chain 3: Iteration:   800 / 2000 [ 40%] (Warmup)
## Chain 3: Iteration:  1000 / 2000 [ 50%] (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: 3.839 seconds (Warm-up)
## Chain 3:                2.369 seconds (Sampling)
## Chain 3:                6.208 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '15dadb01473dc5f46242496f5bd171b7' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 4.375 seconds (Warm-up)
## Chain 4:                2.709 seconds (Sampling)
## Chain 4:                7.084 seconds (Total)
## Chain 4:
mo.1b<-add_criterion(mo.1b, c("loo", "waic"))
summary(mo.1b, prob=0.89)

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(GENERATION) + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)

```

```
##               Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.19     0.05    0.12    0.27      855 1.00
##
## Population-Level Effects:
##               Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept        1.56     0.06    1.46    1.64      4501 1.00
## moGENERATION     -0.95     0.09   -1.10   -0.80      5266 1.00
##
## Simplex Parameters:
##               Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moGENERATION1[1]   0.49     0.08    0.37    0.61      4307 1.00
## moGENERATION1[2]   0.25     0.10    0.10    0.42      4863 1.00
## moGENERATION1[3]   0.26     0.09    0.10    0.40      4224 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).
```

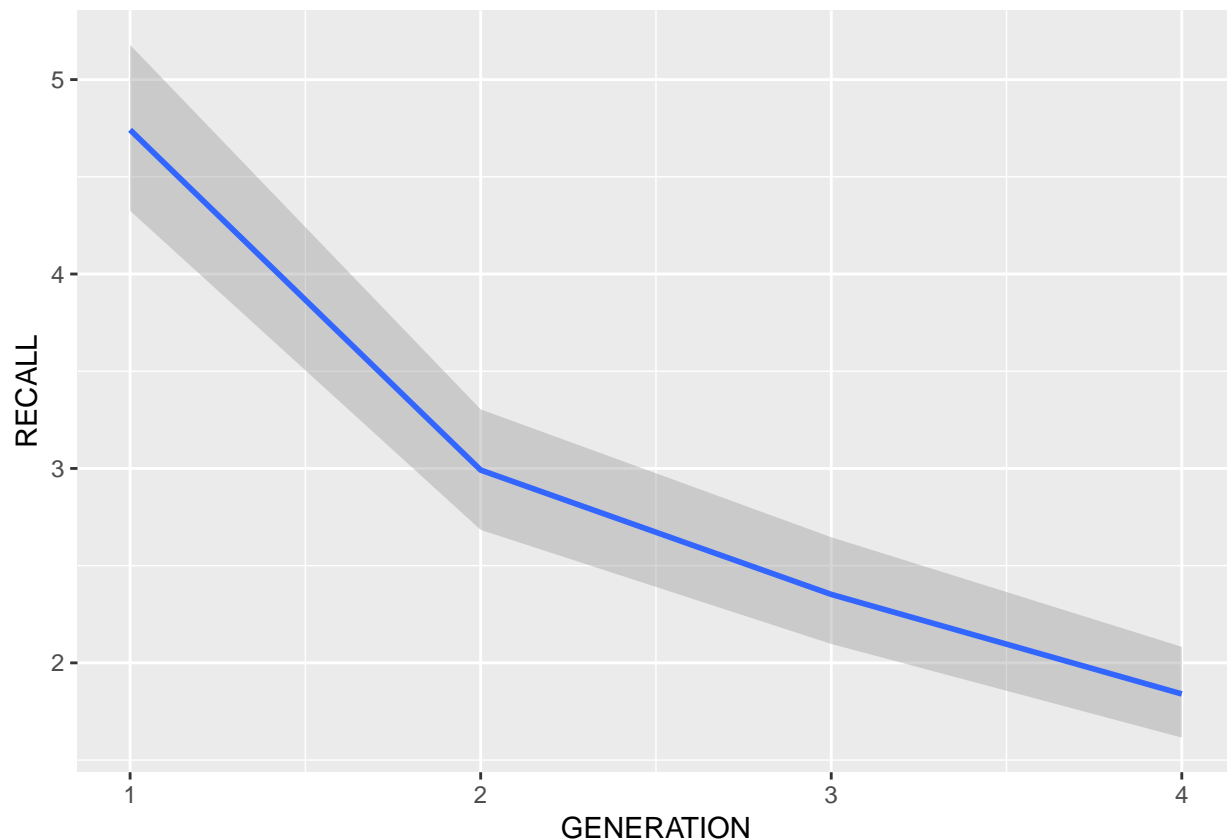
```
plot(mo.1b)
```



```
(loo.1b<-loo(mo.1b))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##               Estimate   SE
## elpd_loo      -655.5   7.2
```

```
## p_loo      12.3  0.8
## looic      1311.1 14.3
## -----
## 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.
marginal_effects(mo.1b, probs = c(0.055, 0.945))
```



```
# View model
mo.2a<-brm(RECALL ~ VIEW + mo(GENERATION) + (1|CHAIN), data = d, family = "poisson")

## Compiling the C++ model
## Start sampling
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' 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: 5.857 seconds (Warm-up)
## Chain 1: 3.301 seconds (Sampling)
## Chain 1: 9.158 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 4.728 seconds (Warm-up)
## Chain 2: 2.284 seconds (Sampling)
## Chain 2: 7.012 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' 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: 4.028 seconds (Warm-up)
## Chain 3: 2.333 seconds (Sampling)
## Chain 3: 6.361 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' 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: 3.995 seconds (Warm-up)
## Chain 4: 2.32 seconds (Sampling)
## Chain 4: 6.315 seconds (Total)
## Chain 4:

```

```

mo.2a<-add_criterion(mo.2a, c("loo", "waic"))
summary(mo.2a)

```

```

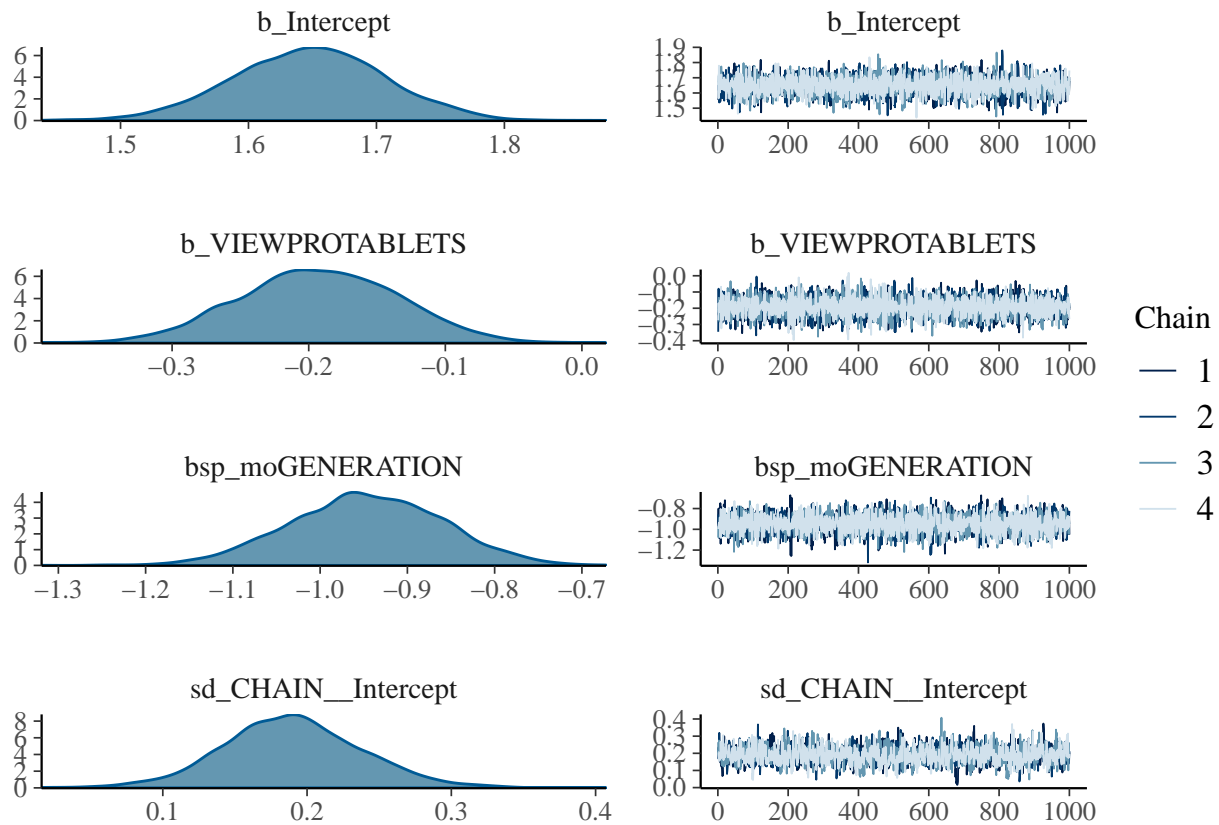
## Family: poisson
## Links: mu = log
## Formula: RECALL ~ VIEW + mo(GENERATION) + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
## Estimate Est.Error 1-95% CI u-95% CI Eff.Sample Rhat
## sd(Intercept) 0.19 0.05 0.10 0.29 1648 1.00
##
## Population-Level Effects:
## Estimate Est.Error 1-95% CI u-95% CI Eff.Sample Rhat
## Intercept 1.65 0.06 1.53 1.76 5201 1.00
## VIEWPROTABLETS -0.19 0.06 -0.31 -0.08 7496 1.00

```

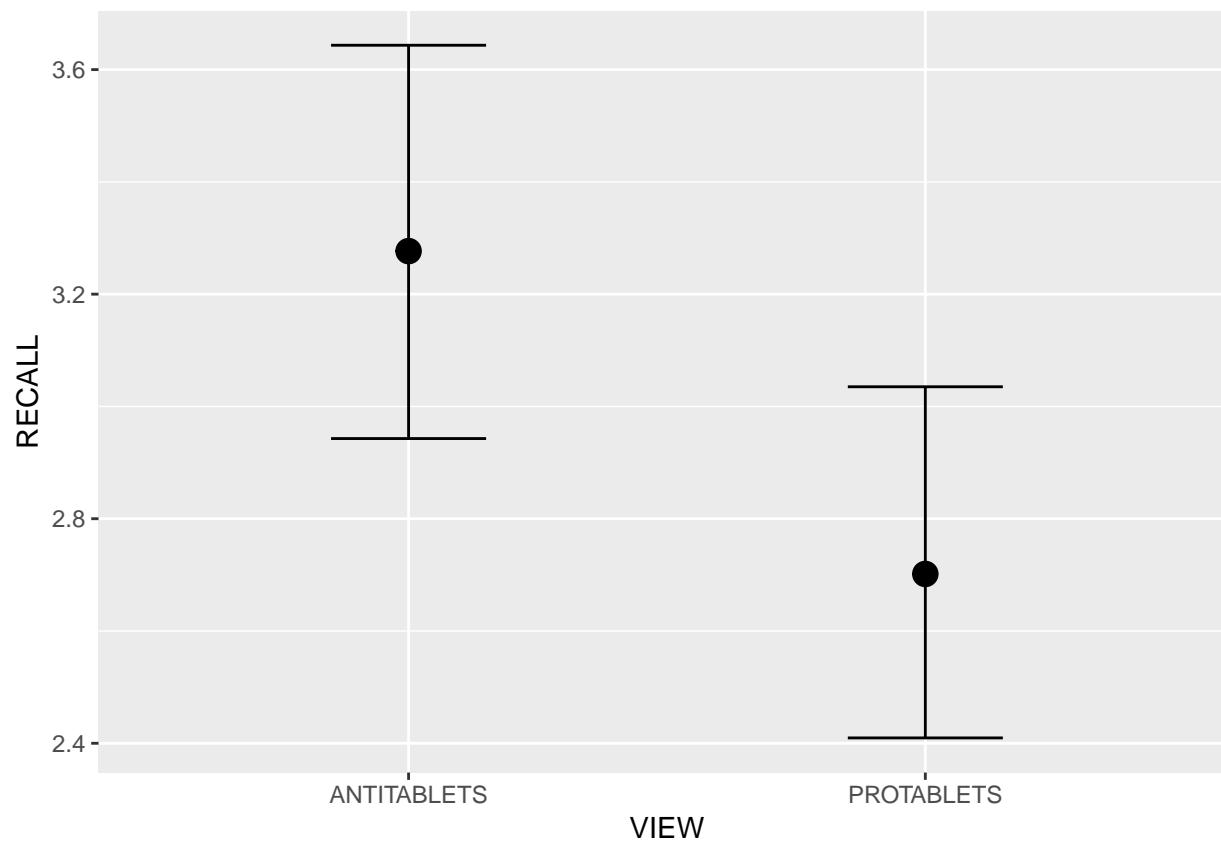


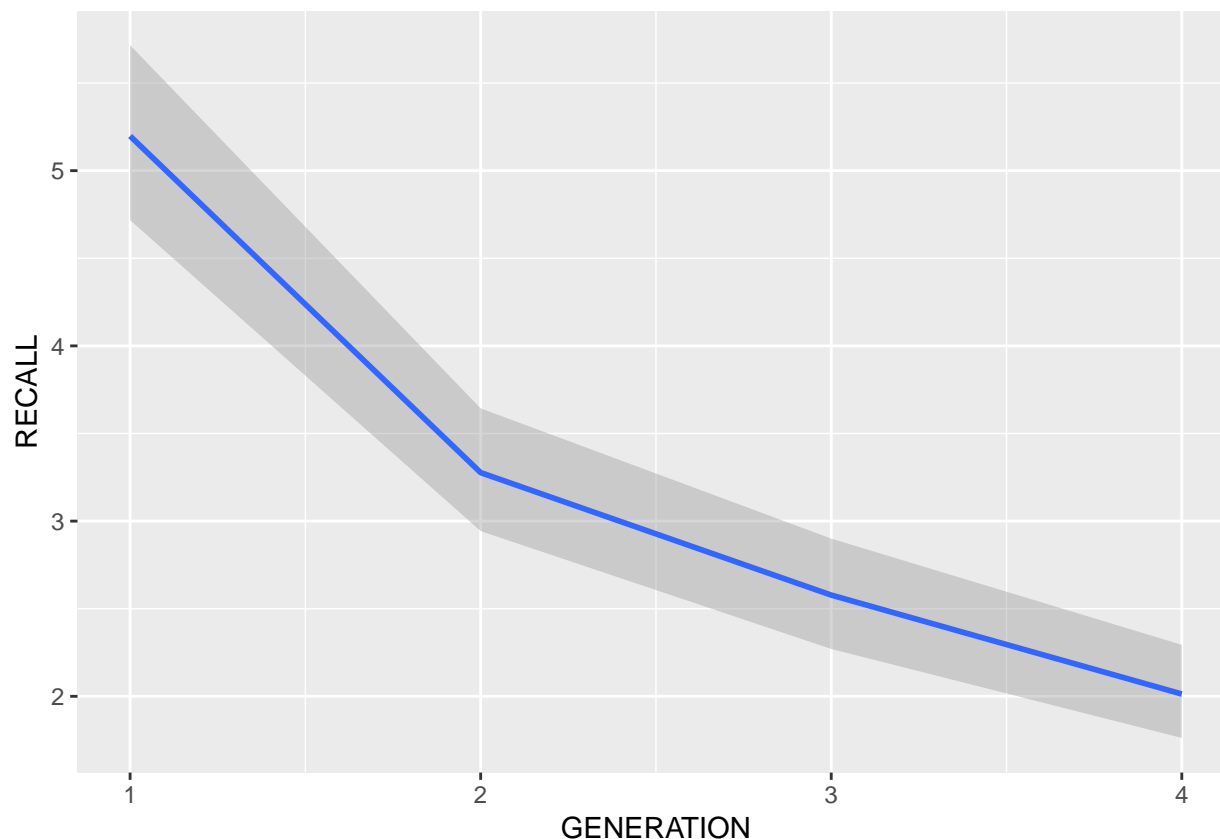
```
## moGENERATION      -0.95      0.09     -1.12     -0.78      6014 1.00
##
## Simplex Parameters:
##               Estimate Est.Error 1-95% CI u-95% CI Eff.Sample Rhat
## moGENERATION1[1]    0.49     0.07   0.35   0.64     6334 1.00
## moGENERATION1[2]    0.26     0.09   0.08   0.45     5113 1.00
## moGENERATION1[3]    0.26     0.09   0.06   0.42     4534 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(mo.2a, prob=0.89, probs = c(0.055, 0.945))
```



```
marginal_effects(mo.2a, probs = c(0.055, 0.945))
```





```
(loo.2a<-loo(mo.2a))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -650.6   7.2
## p_loo       12.2    0.8
## looic      1301.2  14.4
## -----
## 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.
```

```
# View model with interaction
```

```
mo.2b<-brm(RECALL ~ VIEW * mo(GENERATION) + (1|CHAIN), data = d, family = "poisson")
```

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

```
## Start sampling
```

```
##
```

```
## SAMPLING FOR MODEL '85a6da1fd01c80201be81888c81c8ba1' 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: 5.048 seconds (Warm-up)
## Chain 1:                2.936 seconds (Sampling)
## Chain 1:                7.984 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '85a6da1fd01c80201be81888c81c8ba1' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 5.319 seconds (Warm-up)
## Chain 2:                2.936 seconds (Sampling)
## Chain 2:                8.255 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '85a6da1fd01c80201be81888c81c8ba1' 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: 5.577 seconds (Warm-up)
## Chain 3: 2.869 seconds (Sampling)
## Chain 3: 8.446 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '85a6da1fd01c80201be81888c81c8ba1' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 5.107 seconds (Warm-up)
## Chain 4: 2.918 seconds (Sampling)
## Chain 4: 8.025 seconds (Total)
## Chain 4:

```

```

mo.2b<-add_criterion(mo.2b, c("loo", "waic"))
summary(mo.2b, prob=0.89)

```

```

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ VIEW * mo(GENERATION) + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
## Estimate Est.Error l-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept) 0.19 0.05 0.12 0.27 1338 1.00

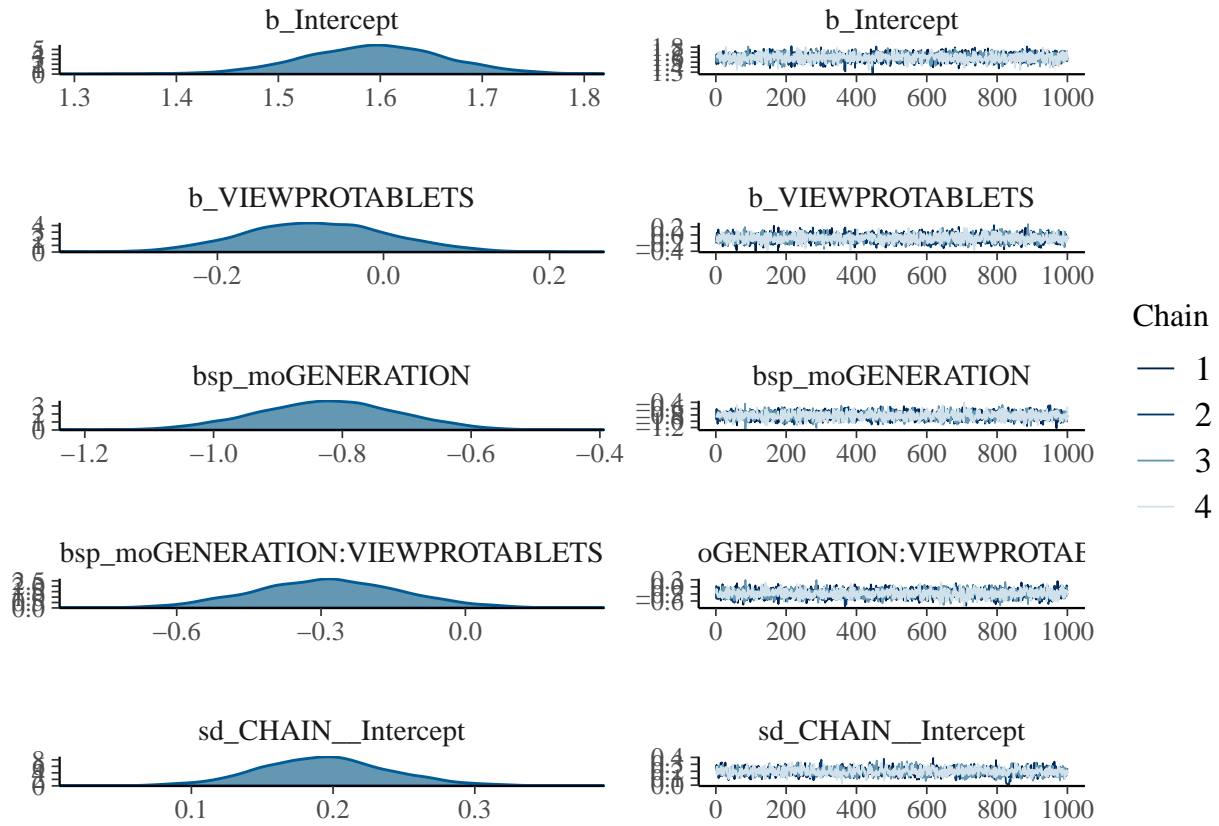
```

```

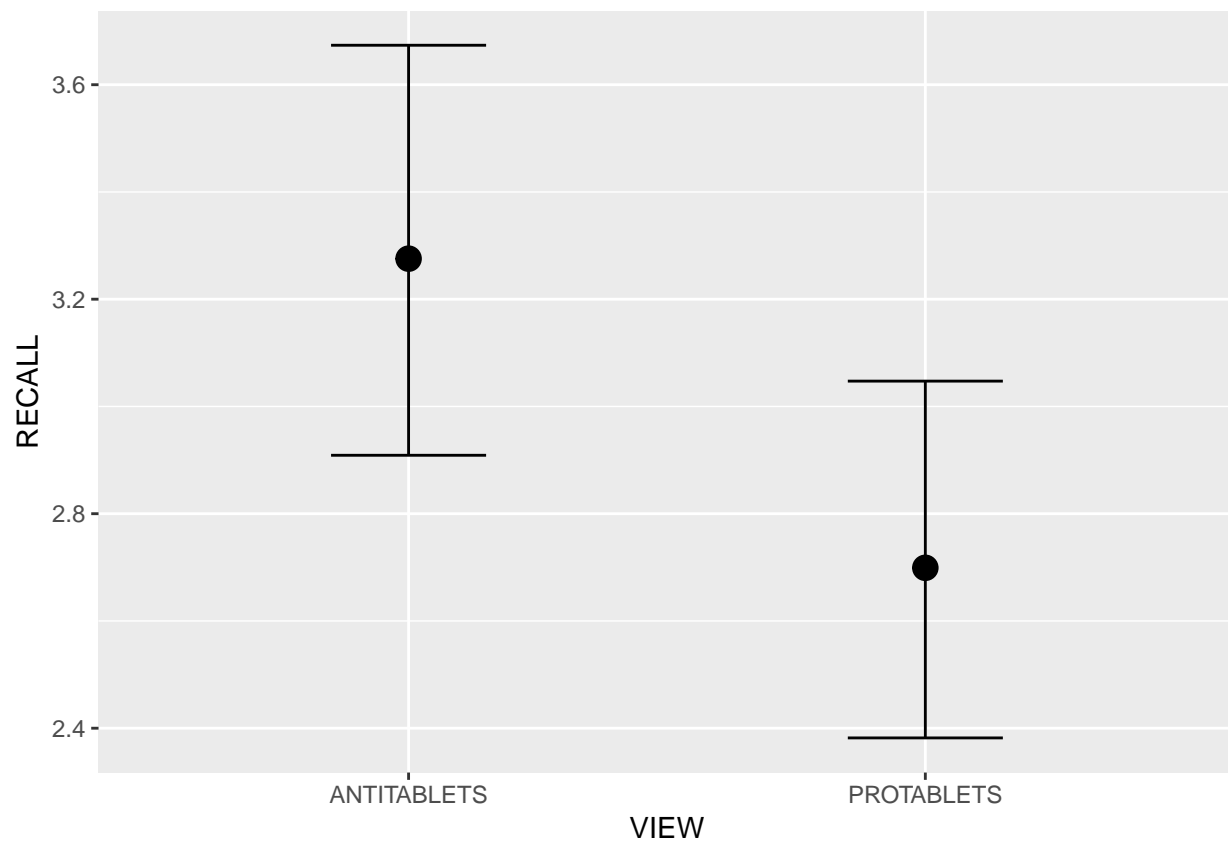
##
## Population-Level Effects:
##
##               Estimate Est.Error 1-89% CI u-89% CI
## Intercept           1.59      0.07    1.48    1.70
## VIEWPROTABLETS      -0.08      0.09   -0.22    0.06
## moGENERATION         -0.82      0.11   -1.00   -0.64
## moGENERATION:VIEWPROTABLETS -0.29      0.15   -0.53   -0.04
##
##               Eff.Sample Rhat
## Intercept           3297 1.00
## VIEWPROTABLETS      3811 1.00
## moGENERATION         3260 1.00
## moGENERATION:VIEWPROTABLETS 3119 1.00
##
## Simplex Parameters:
##
##               Estimate Est.Error 1-89% CI u-89% CI
## moGENERATION1[1]      0.50      0.10    0.35    0.66
## moGENERATION1[2]      0.24      0.11    0.06    0.43
## moGENERATION1[3]      0.26      0.11    0.08    0.42
## moGENERATION:VIEWPROTABLETS1[1] 0.39      0.23    0.05    0.78
## moGENERATION:VIEWPROTABLETS1[2] 0.33      0.22    0.04    0.74
## moGENERATION:VIEWPROTABLETS1[3] 0.28      0.20    0.03    0.65
##
##               Eff.Sample Rhat
## moGENERATION1[1]      4487 1.00
## moGENERATION1[2]      4121 1.00
## moGENERATION1[3]      5002 1.00
## moGENERATION:VIEWPROTABLETS1[1] 5476 1.00
## moGENERATION:VIEWPROTABLETS1[2] 4713 1.00
## moGENERATION:VIEWPROTABLETS1[3] 5507 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).

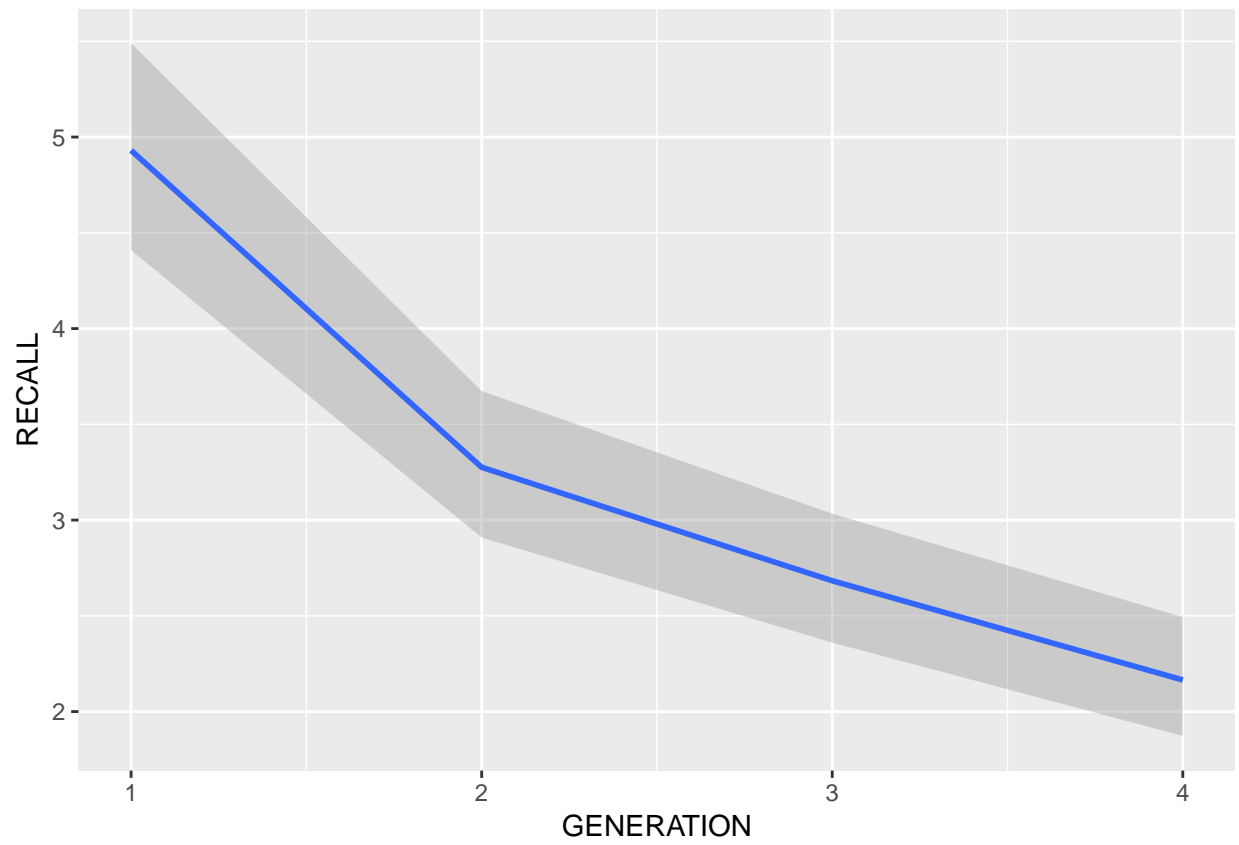
```

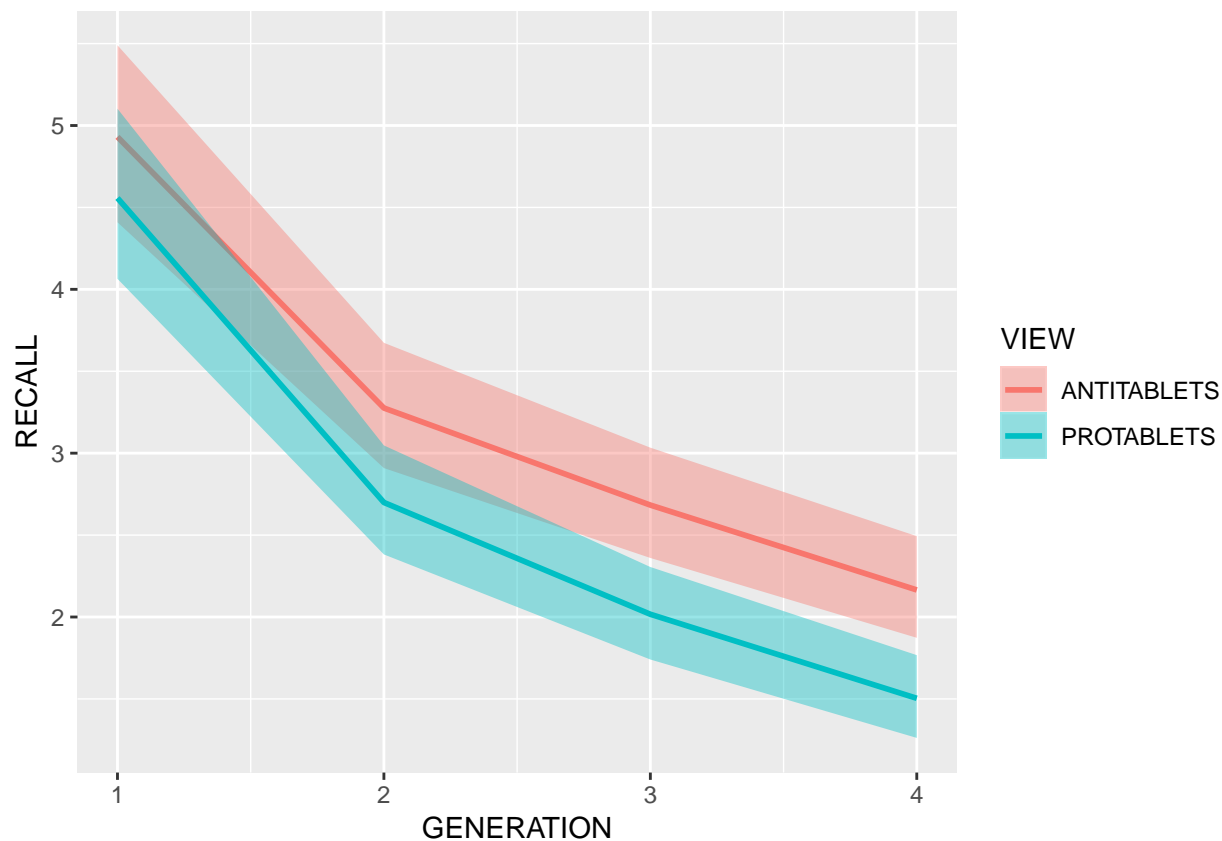
```
plot(mo.2b)
```



```
marginal_effects(mo.2b, probs = c(0.055, 0.945))
```







```
(loo.2b<-loo(mo.2b))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo    -649.2  7.2
## p_loo         12.5  0.8
## looic        1298.5 14.3
## -----
## 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.
```

View model + pretest

```
mo.2c<-brm(RECALL ~ mo(PRE_AGREE)+ VIEW + mo(GENERATION) + (1|CHAIN), data = d, family = "poisson")

## Compiling the C++ model
## Start sampling
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 5.902 seconds (Warm-up)
## Chain 1:                2.999 seconds (Sampling)
## Chain 1:                8.901 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 5.803 seconds (Warm-up)
## Chain 2:                3.018 seconds (Sampling)
## Chain 2:                8.821 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 5.764 seconds (Warm-up)
## Chain 3: 2.951 seconds (Sampling)
## Chain 3: 8.715 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 5.895 seconds (Warm-up)
## Chain 4: 2.981 seconds (Sampling)
## Chain 4: 8.876 seconds (Total)
## Chain 4:
mo.2c<-add_criterion(mo.2c, c("loo", "waic"))
summary(mo.2c, prob=0.89)

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(PRE_AGREE) + VIEW + mo(GENERATION) + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:

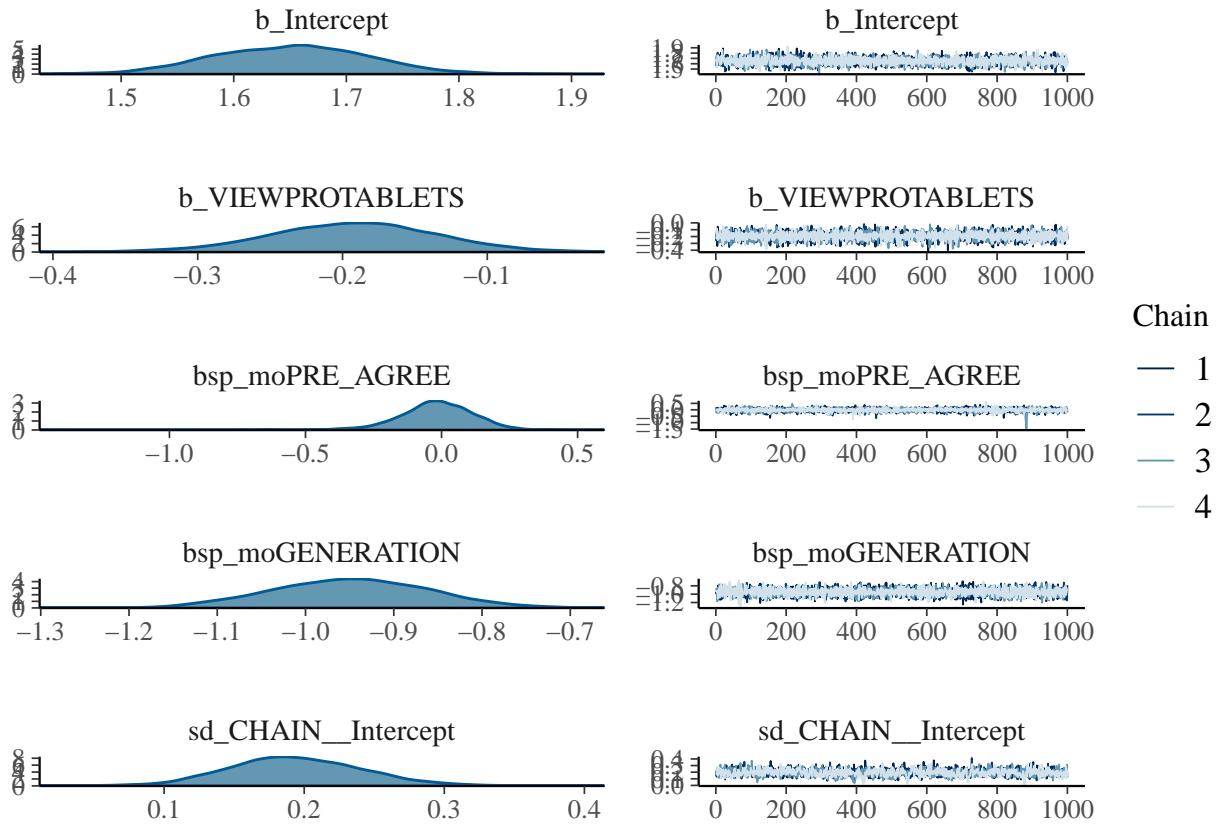
```

```

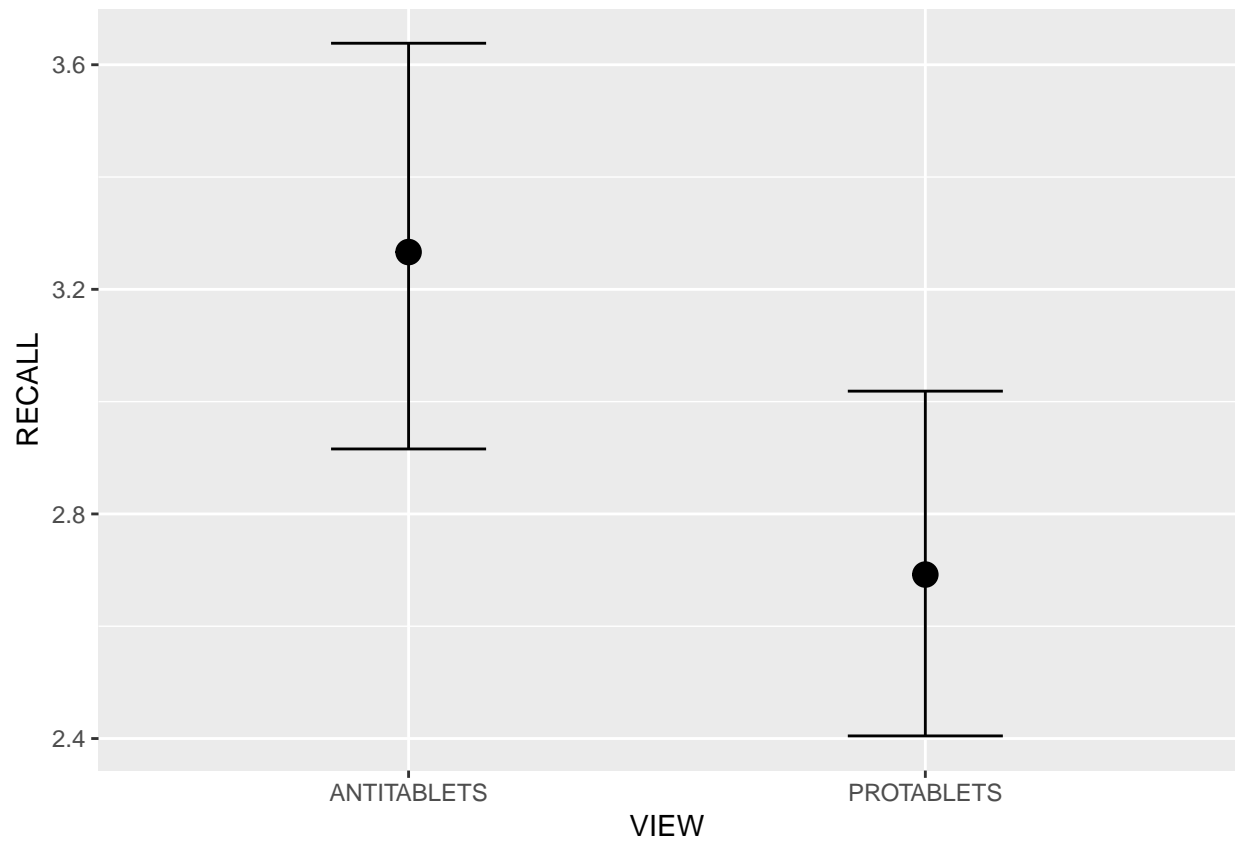
## ~CHAIN (Number of levels: 48)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)      0.19      0.05      0.12      0.27      1394 1.00
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept          1.65      0.07      1.54      1.76      4409 1.00
## VIEWPROTABLETS     -0.19      0.06     -0.29     -0.10      8620 1.00
## moPRE_AGREE        -0.02      0.14     -0.23      0.18      3469 1.00
## moGENERATION       -0.95      0.09     -1.09     -0.81      5972 1.00
##
## Simplex Parameters:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moPRE_AGREE1[1]      0.16      0.13      0.01      0.41      5948 1.00
## moPRE_AGREE1[2]      0.15      0.13      0.01      0.41      6337 1.00
## moPRE_AGREE1[3]      0.16      0.14      0.01      0.43      6040 1.00
## moPRE_AGREE1[4]      0.16      0.14      0.01      0.43      6303 1.00
## moPRE_AGREE1[5]      0.18      0.15      0.01      0.47      5829 1.00
## moPRE_AGREE1[6]      0.19      0.15      0.01      0.49      4822 1.00
## moGENERATION1[1]     0.49      0.08      0.37      0.61      5680 1.00
## moGENERATION1[2]     0.25      0.09      0.11      0.41      6699 1.00
## moGENERATION1[3]     0.26      0.09      0.11      0.40      5666 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).

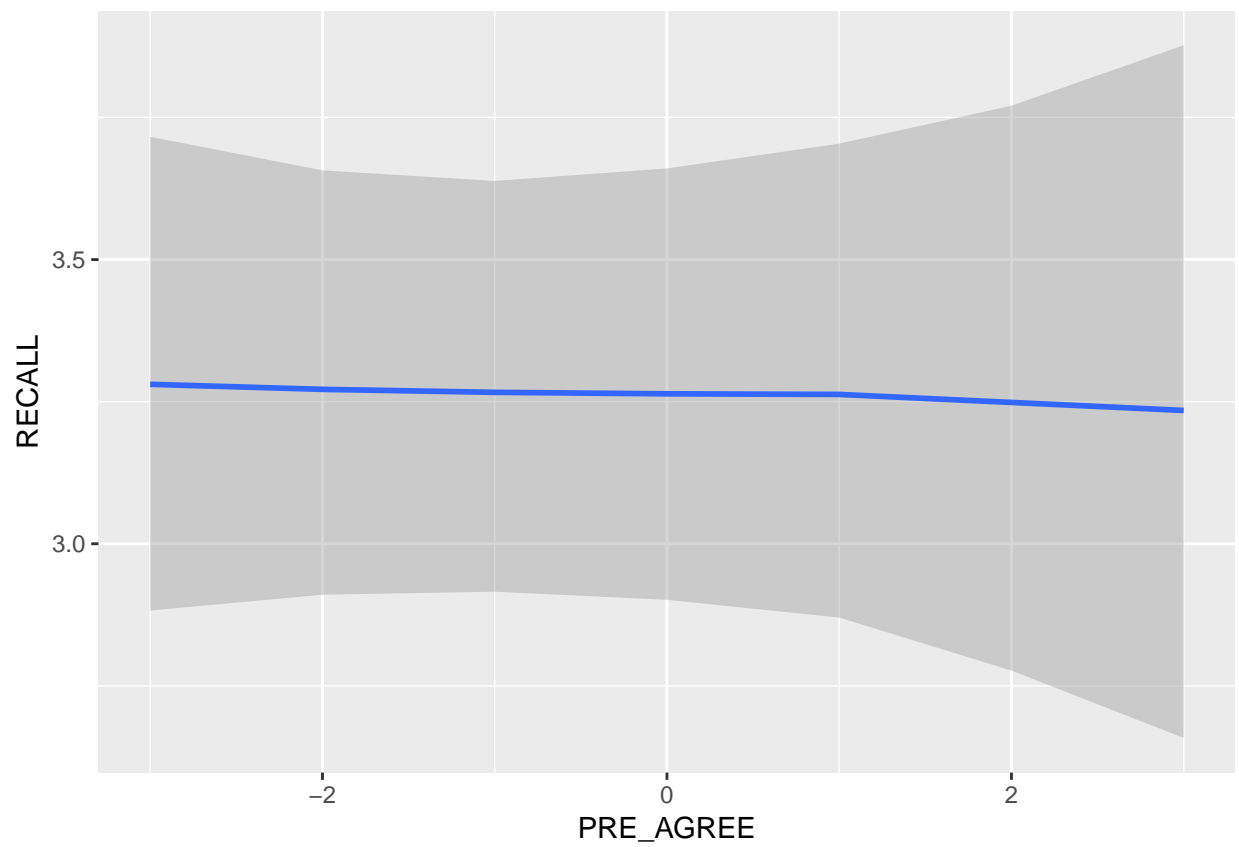
```

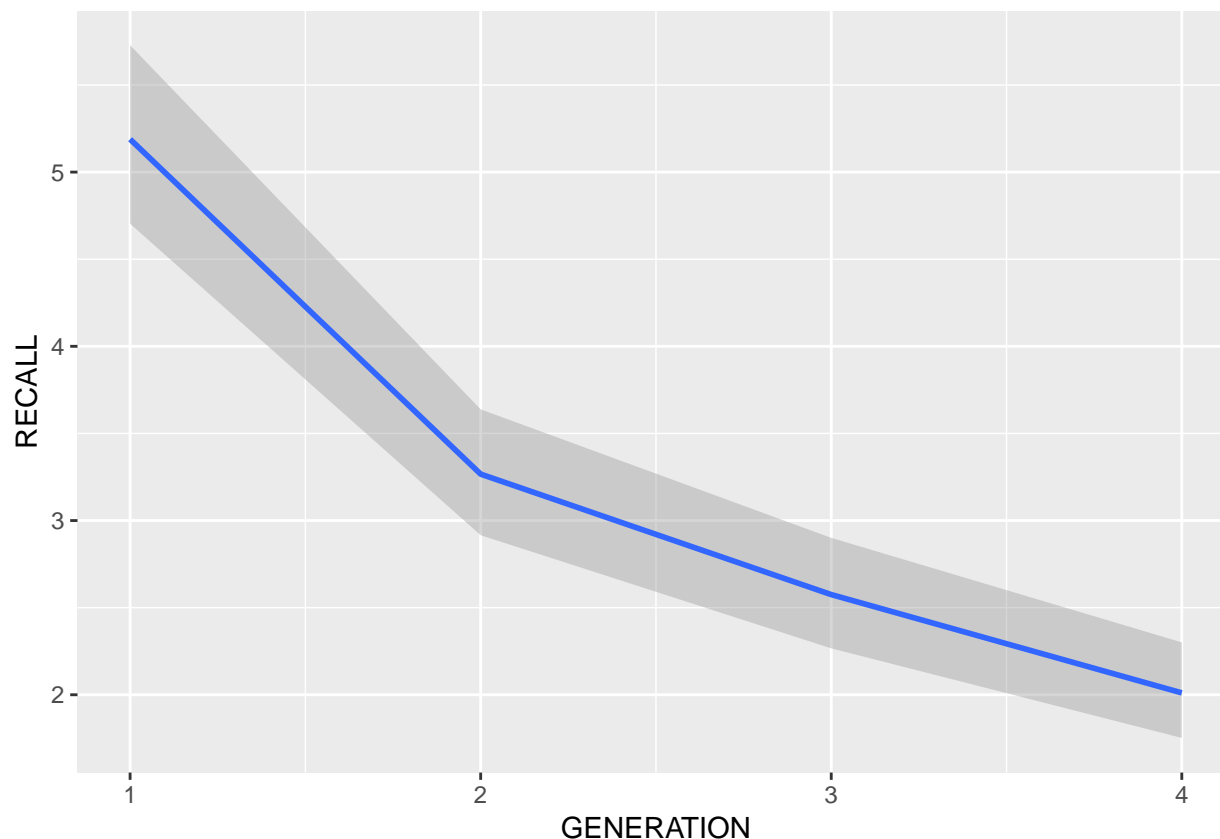
```
plot(mo.2c)
```



```
marginal_effects(mo.2c, probs = c(0.055, 0.945))
```







```
(loo.2c<-loo(mo.2c))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -650.8  7.2
## p_loo       12.5  0.8
## looic      1301.6 14.4
## -----
## 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.
```

```
# View model * pretest
```

```
mo.2d<-brm(RECALL ~ mo(PRE_AGREE)*VIEW + mo(GENERATION) + (1|CHAIN), data = d, family = "poisson")
```

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

```
## Start sampling
```

```
##
```

```
## SAMPLING FOR MODEL 'a2b9543a0c10e2baf050a892baee25f4' 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: 9.757 seconds (Warm-up)
## Chain 1:                5.096 seconds (Sampling)
## Chain 1:                14.853 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'a2b9543a0c10e2baf050a892baee25f4' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 10.785 seconds (Warm-up)
## Chain 2:                4.63 seconds (Sampling)
## Chain 2:                15.415 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'a2b9543a0c10e2baf050a892baee25f4' 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: 12.428 seconds (Warm-up)
## Chain 3: 5.21 seconds (Sampling)
## Chain 3: 17.638 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'a2b9543a0c10e2baf050a892baee25f4' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 11.894 seconds (Warm-up)
## Chain 4: 4.224 seconds (Sampling)
## Chain 4: 16.118 seconds (Total)
## Chain 4:

```

```

mo.2d<-add_criterion(mo.2d, c("loo", "waic"))
summary(mo.2d, prob=0.89)

```

```

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(PRE_AGREE) * VIEW + mo(GENERATION) + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
## Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat

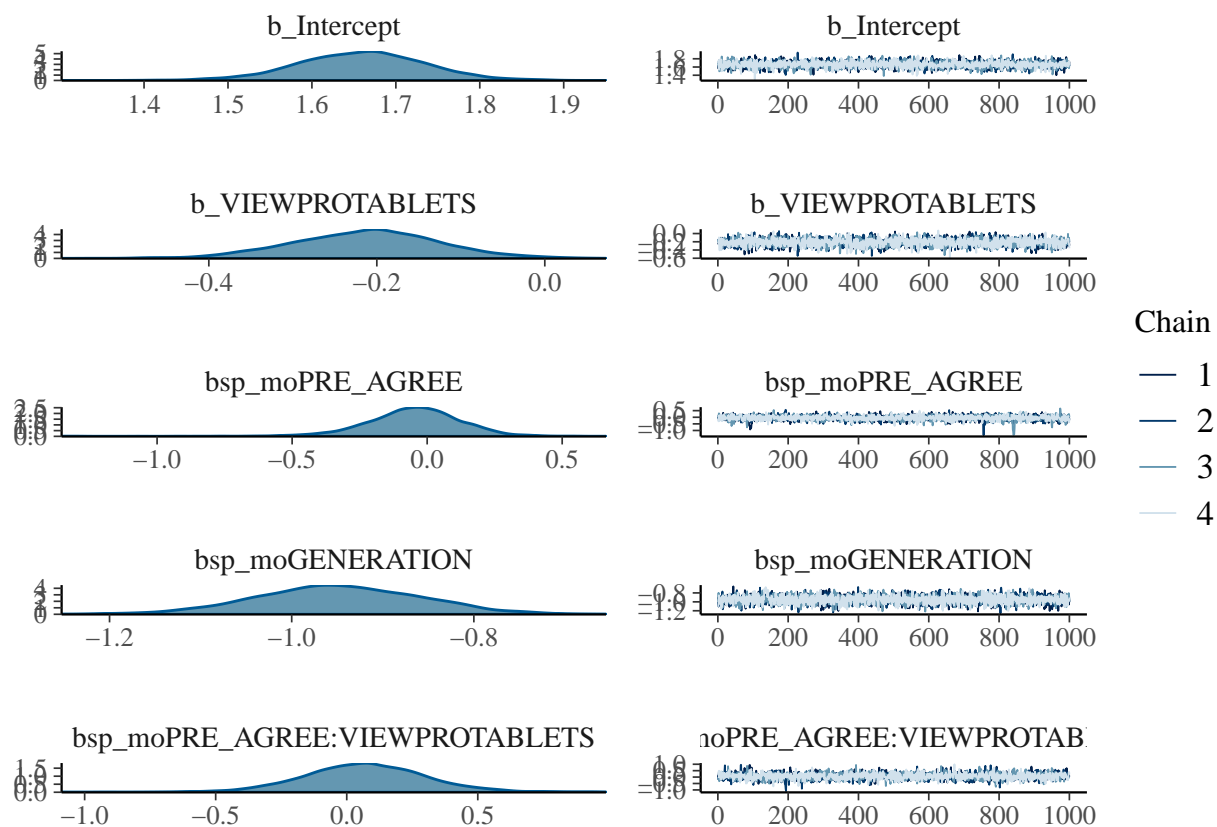
```

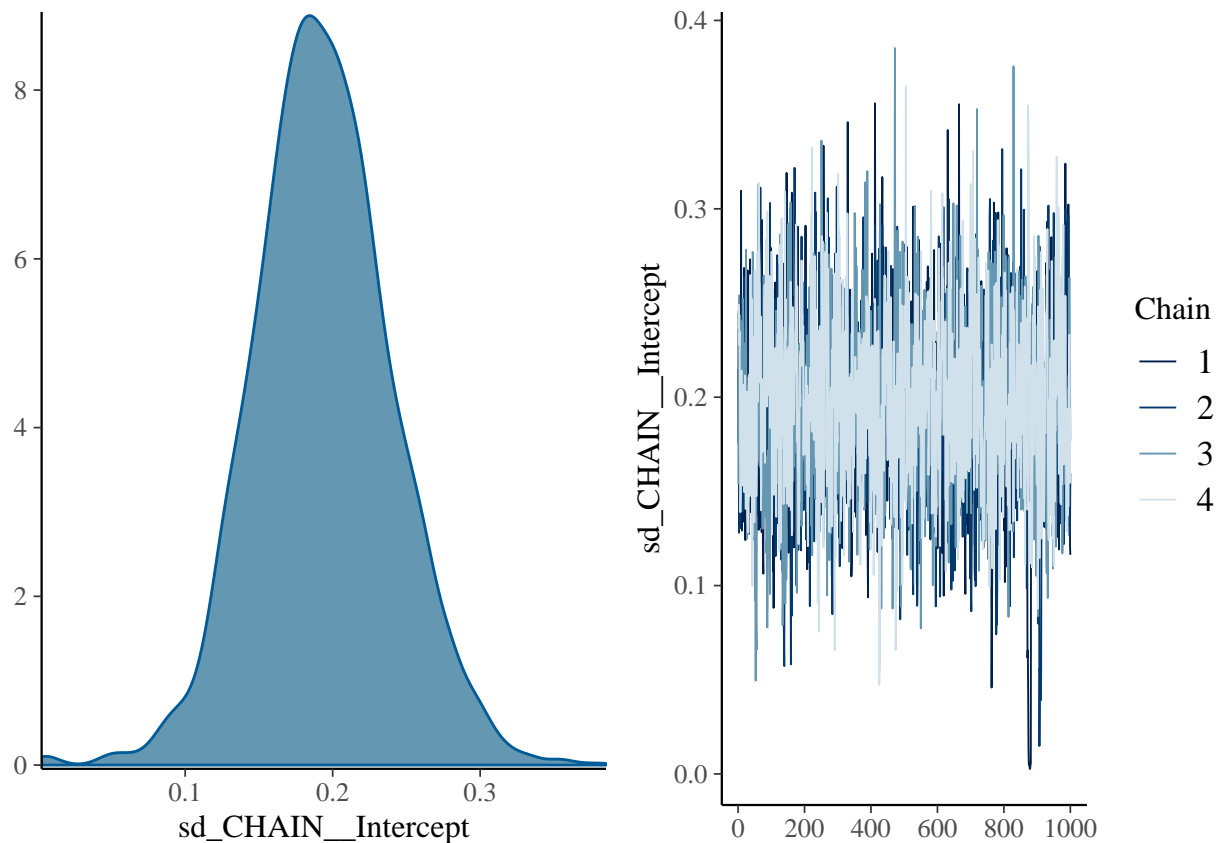
```

## sd(Intercept)      0.19      0.05      0.12      0.27      1555 1.00
##
## Population-Level Effects:
##
##               Estimate Est.Error 1-89% CI u-89% CI Eff.Sample
## Intercept           1.66      0.08    1.54    1.78      2882
## VIEWPROTABLETS      -0.21      0.09   -0.36   -0.08      3114
## moPRE_AGREE          -0.05      0.18   -0.33    0.21      2138
## moGENERATION         -0.95      0.09   -1.09   -0.81      3481
## moPRE_AGREE:VIEWPROTABLETS  0.07      0.23   -0.30    0.44      2359
##
##               Rhat
## Intercept           1.00
## VIEWPROTABLETS      1.00
## moPRE_AGREE          1.00
## moGENERATION         1.00
## moPRE_AGREE:VIEWPROTABLETS 1.00
##
## Simplex Parameters:
##
##               Estimate Est.Error 1-89% CI u-89% CI
## moPRE_AGREE1[1]       0.16      0.13    0.01    0.42
## moPRE_AGREE1[2]       0.15      0.13    0.01    0.39
## moPRE_AGREE1[3]       0.15      0.13    0.01    0.42
## moPRE_AGREE1[4]       0.16      0.13    0.01    0.42
## moPRE_AGREE1[5]       0.18      0.15    0.01    0.47
## moPRE_AGREE1[6]       0.20      0.16    0.02    0.51
## moGENERATION1[1]      0.49      0.08    0.37    0.62
## moGENERATION1[2]      0.26      0.10    0.11    0.41
## moGENERATION1[3]      0.26      0.09    0.10    0.40
## moPRE_AGREE:VIEWPROTABLETS1[1] 0.16      0.14    0.01    0.43
## moPRE_AGREE:VIEWPROTABLETS1[2] 0.16      0.13    0.01    0.42
## moPRE_AGREE:VIEWPROTABLETS1[3] 0.16      0.13    0.01    0.42
## moPRE_AGREE:VIEWPROTABLETS1[4] 0.16      0.13    0.01    0.41
## moPRE_AGREE:VIEWPROTABLETS1[5] 0.18      0.14    0.01    0.45
## moPRE_AGREE:VIEWPROTABLETS1[6] 0.19      0.15    0.01    0.48
##
##               Eff.Sample Rhat
## moPRE_AGREE1[1]       5927 1.00
## moPRE_AGREE1[2]       5435 1.00
## moPRE_AGREE1[3]       5906 1.00
## moPRE_AGREE1[4]       4259 1.00
## moPRE_AGREE1[5]       4819 1.00
## moPRE_AGREE1[6]       3920 1.00
## moGENERATION1[1]      3555 1.00
## moGENERATION1[2]      4783 1.00
## moGENERATION1[3]      3736 1.00
## moPRE_AGREE:VIEWPROTABLETS1[1] 5402 1.00
## moPRE_AGREE:VIEWPROTABLETS1[2] 5740 1.00
## moPRE_AGREE:VIEWPROTABLETS1[3] 4916 1.00
## moPRE_AGREE:VIEWPROTABLETS1[4] 5633 1.00
## moPRE_AGREE:VIEWPROTABLETS1[5] 4946 1.00
## moPRE_AGREE:VIEWPROTABLETS1[6] 4434 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(mo.2d)
```

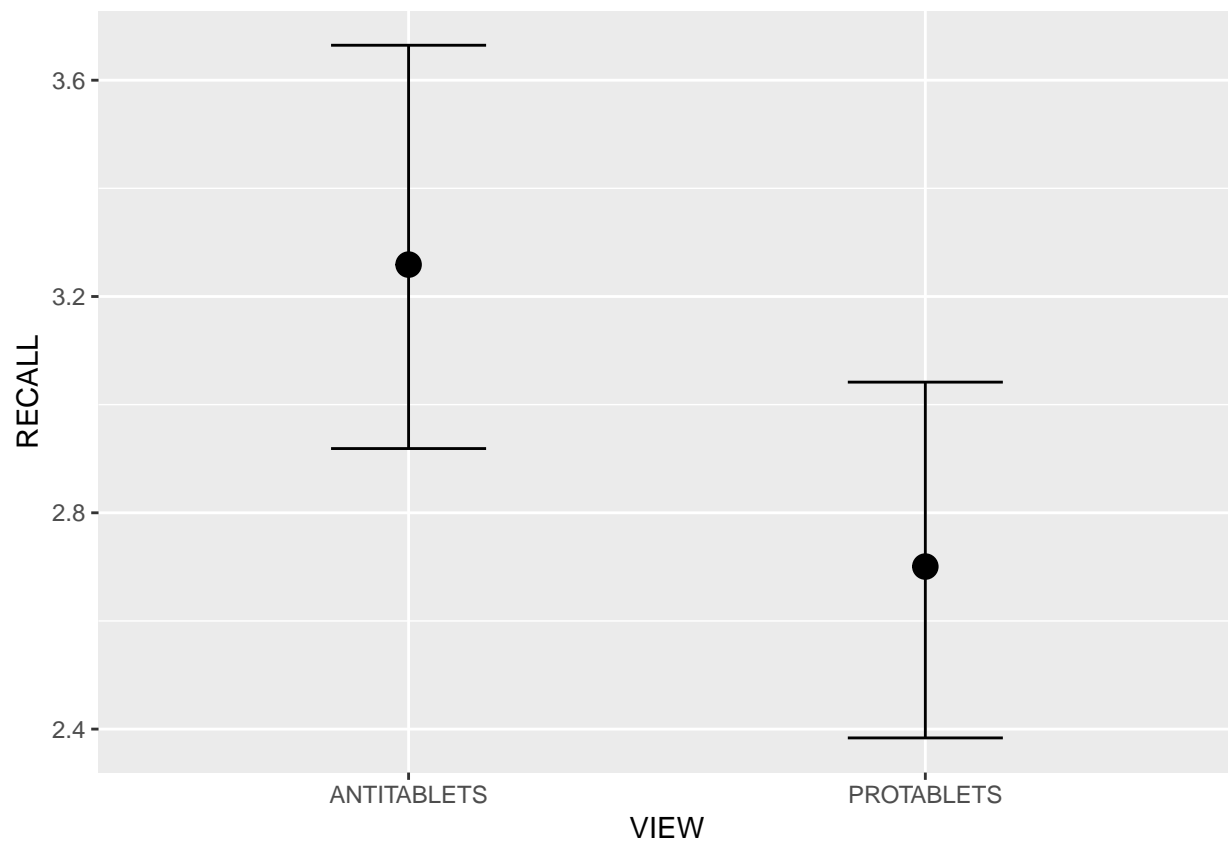


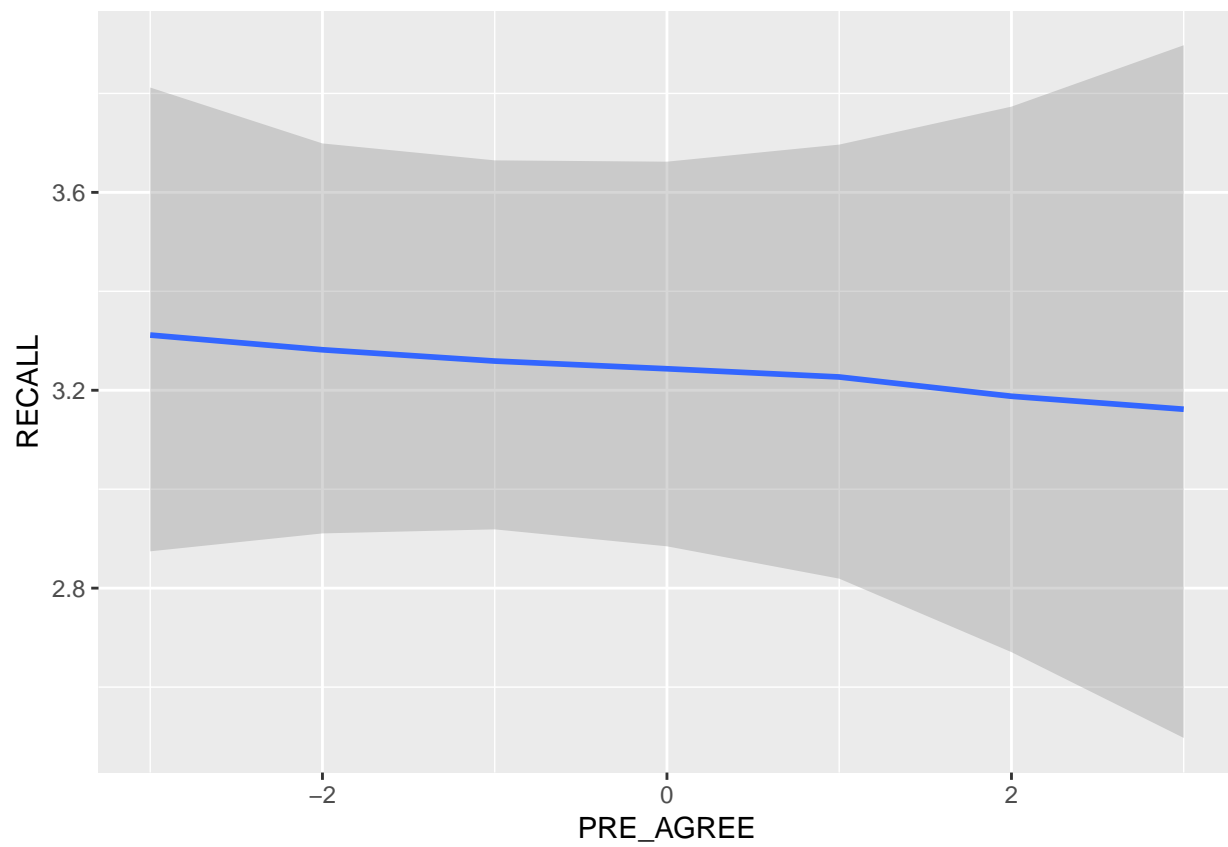


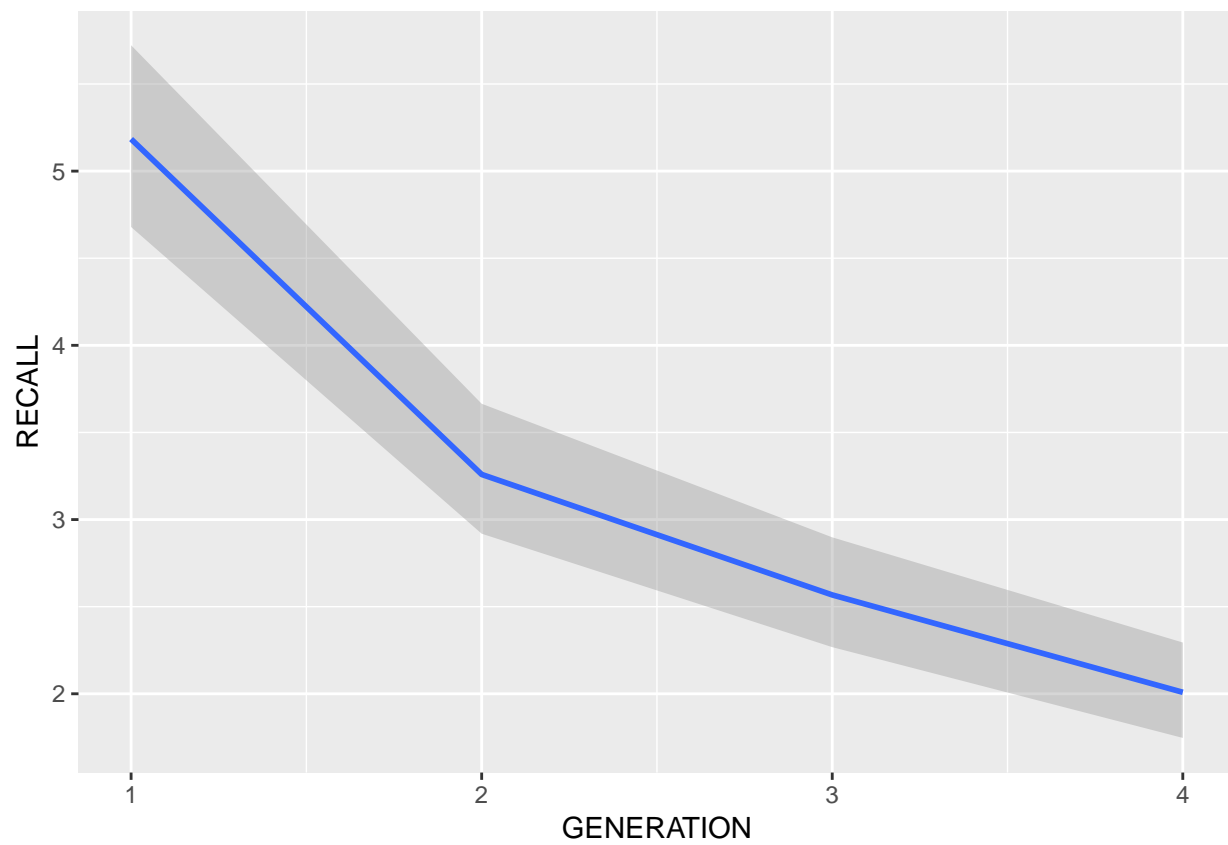
```
(loo.2d<-loo(mo.2d))
```

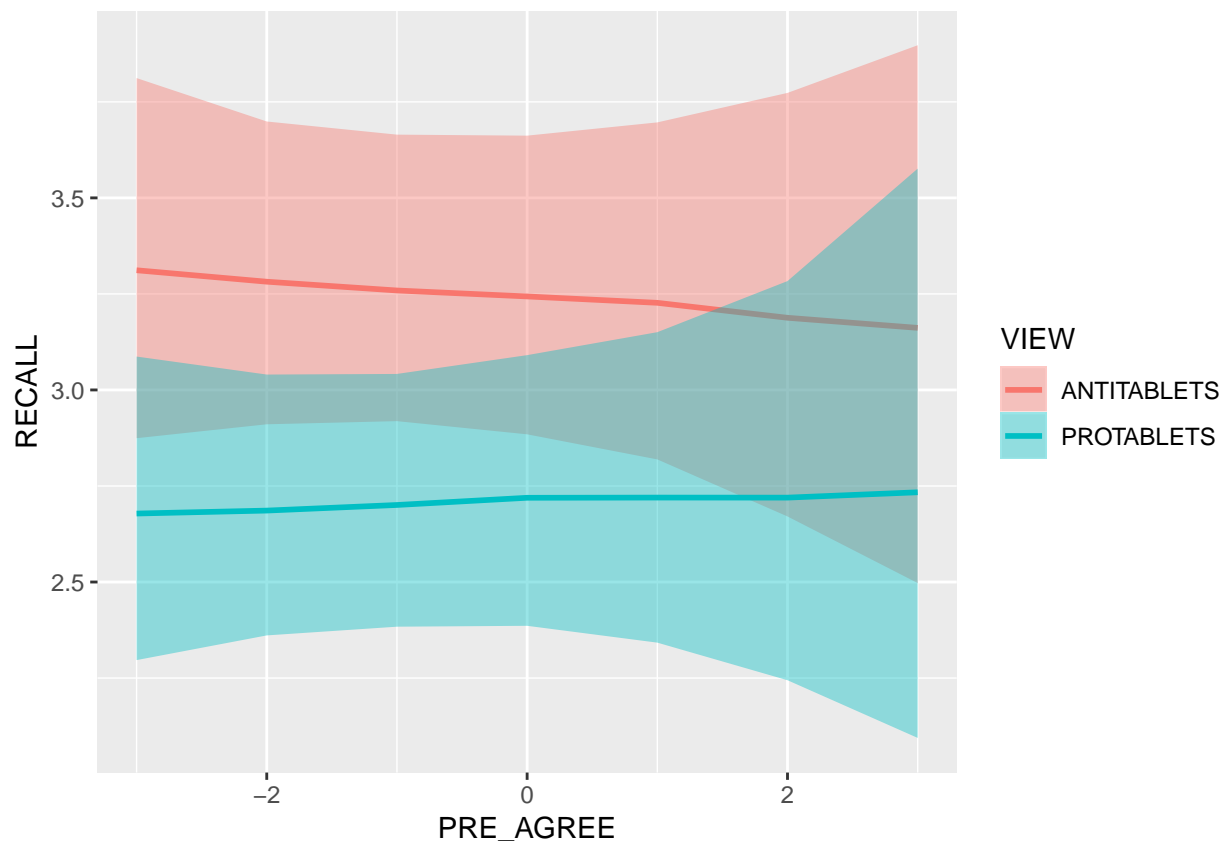
```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo    -651.7  7.3
## p_loo         13.2  0.9
## looic        1303.3 14.5
## -----
## Monte Carlo SE of elpd_loo is 0.1.
##
## All Pareto k estimates are good (k < 0.5).
## See help('pareto-k-diagnostic') for details.
```

```
marginal_effects(mo.2d, probs = c(0.055, 0.945))
```









```
# View model * pretest * Generation
```

```
mo.2e<-brm(RECALL ~ mo(PRE_AGREE)* VIEW * mo(GENERATION) + (1|CHAIN), data = d, family = "poisson")
```

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

```
## Start sampling
```

```
##
```

```
## SAMPLING FOR MODEL 'ec556a9e4c170d3c41ba9222f08eac28' 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: 116.526 seconds (Warm-up)
## Chain 1: 134.055 seconds (Sampling)
## Chain 1: 250.581 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'ec556a9e4c170d3c41ba9222f08eac28' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 96.403 seconds (Warm-up)
## Chain 2: 120.939 seconds (Sampling)
## Chain 2: 217.342 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'ec556a9e4c170d3c41ba9222f08eac28' 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: 65.561 seconds (Warm-up)
## Chain 3: 130 seconds (Sampling)

```

```

## Chain 3:          195.561 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'ec556a9e4c170d3c41ba9222f08eac28' 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: 78.476 seconds (Warm-up)
## Chain 4:          143.219 seconds (Sampling)
## Chain 4:          221.695 seconds (Total)
## Chain 4:

## Warning: There were 50 divergent transitions after warmup. Increasing adapt_delta above 0.8 may help
## http://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup

## Warning: There were 1 transitions after warmup that exceeded the maximum treedepth. Increase max_tre
## http://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded

## Warning: Examine the pairs() plot to diagnose sampling problems
mo.2e<-add_criterion(mo.2e, c("loo", "waic"))
summary(mo.2e, prob=0.89)

## Warning: There were 50 divergent transitions after warmup. Increasing adapt_delta above 0.8 may help
## See http://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(PRE_AGREE) * VIEW * mo(GENERATION) + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.19     0.05    0.12    0.27     1234 1.01
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI
## Intercept          1.64     0.08    1.52

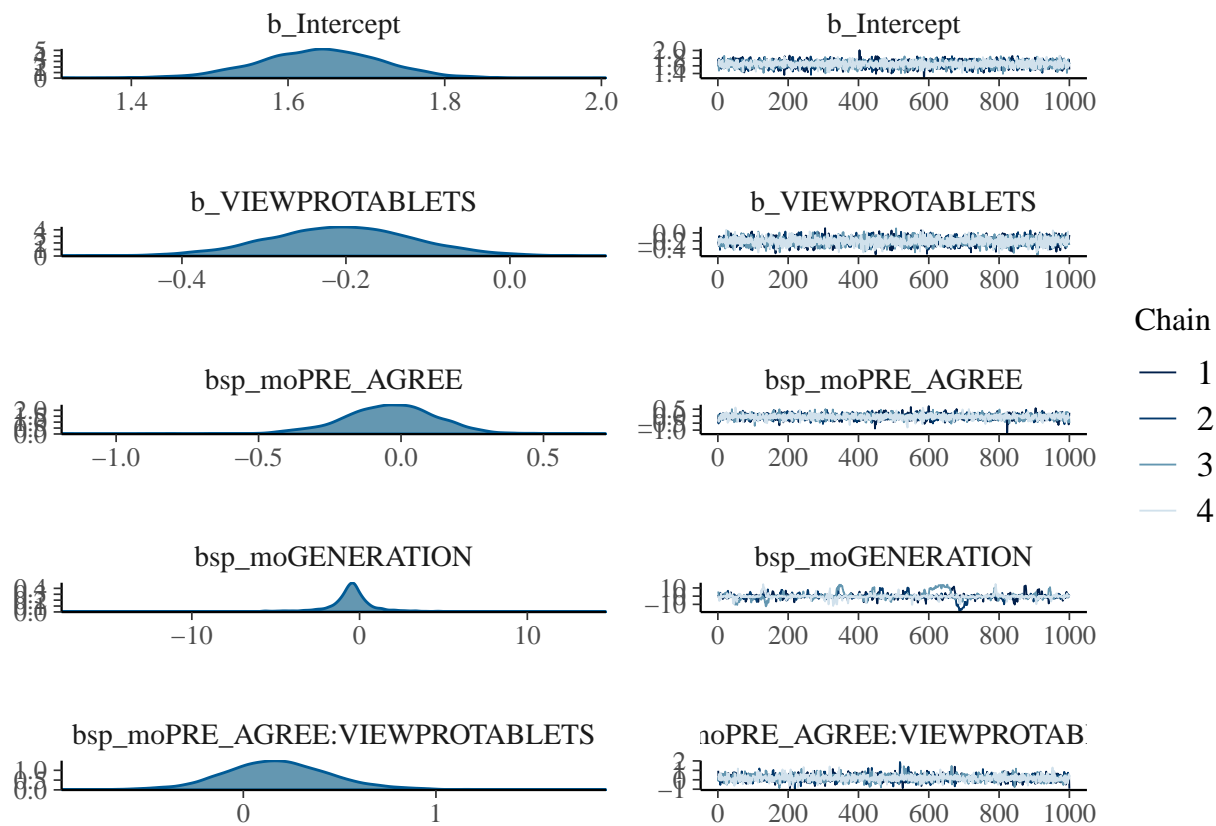
```

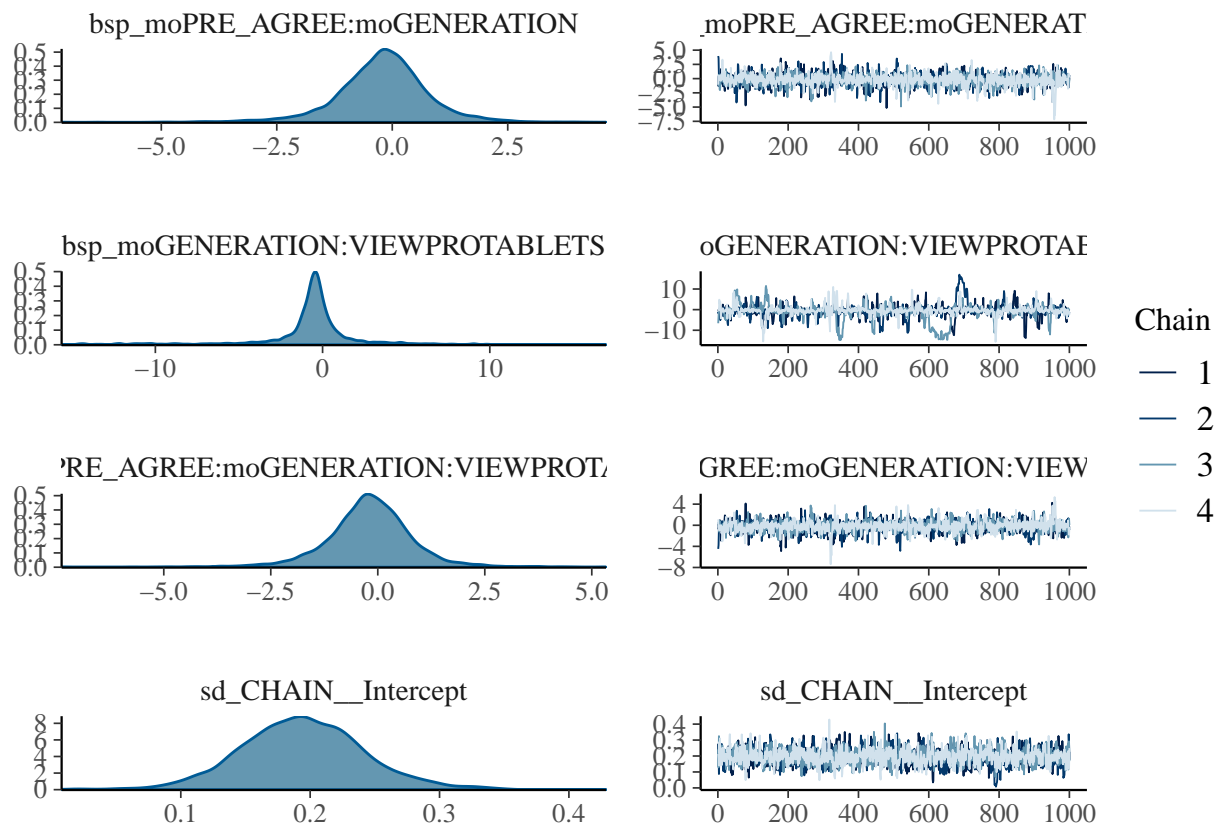
## VIEWPROTABLETS	-0.21	0.09	-0.35
## moPRE_AGREE	-0.04	0.17	-0.32
## moGENERATION	-0.28	3.10	-4.31
## moPRE_AGREE:VIEWPROTABLETS	0.18	0.29	-0.26
## moPRE_AGREE:moGENERATION	-0.20	1.00	-1.75
## moGENERATION:VIEWPROTABLETS	-0.63	3.10	-5.45
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS	-0.19	1.00	-1.75
##	u-89% CI	Eff.Sample	Rhat
## Intercept	1.76	4733	1.00
## VIEWPROTABLETS	-0.06	4531	1.00
## moPRE_AGREE	0.22	3683	1.00
## moGENERATION	4.54	173	1.02
## moPRE_AGREE:VIEWPROTABLETS	0.66	3426	1.00
## moPRE_AGREE:moGENERATION	1.28	2043	1.00
## moGENERATION:VIEWPROTABLETS	3.39	173	1.02
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS	1.28	1931	1.00
##			
## Simplex Parameters:			
##	Estimate	Est.Error	1-89% CI
## moPRE_AGREE1 [1]	0.16	0.13	0.01
## moPRE_AGREE1 [2]	0.15	0.13	0.01
## moPRE_AGREE1 [3]	0.15	0.14	0.01
## moPRE_AGREE1 [4]	0.16	0.14	0.01
## moPRE_AGREE1 [5]	0.18	0.15	0.01
## moPRE_AGREE1 [6]	0.19	0.15	0.01
## moGENERATION1 [1]	0.41	0.21	0.06
## moGENERATION1 [2]	0.29	0.19	0.04
## moGENERATION1 [3]	0.30	0.19	0.04
## moPRE_AGREE:VIEWPROTABLETS1 [1]	0.17	0.13	0.01
## moPRE_AGREE:VIEWPROTABLETS1 [2]	0.15	0.13	0.01
## moPRE_AGREE:VIEWPROTABLETS1 [3]	0.16	0.13	0.01
## moPRE_AGREE:VIEWPROTABLETS1 [4]	0.15	0.13	0.01
## moPRE_AGREE:VIEWPROTABLETS1 [5]	0.18	0.15	0.01
## moPRE_AGREE:VIEWPROTABLETS1 [6]	0.20	0.16	0.01
## moPRE_AGREE:moGENERATION1 [1]	0.16	0.13	0.01
## moPRE_AGREE:moGENERATION1 [2]	0.15	0.13	0.01
## moPRE_AGREE:moGENERATION1 [3]	0.16	0.13	0.01
## moPRE_AGREE:moGENERATION1 [4]	0.17	0.14	0.01
## moPRE_AGREE:moGENERATION1 [5]	0.18	0.14	0.01
## moPRE_AGREE:moGENERATION1 [6]	0.19	0.15	0.01
## moPRE_AGREE:moGENERATION2 [1]	0.31	0.21	0.03
## moPRE_AGREE:moGENERATION2 [2]	0.35	0.23	0.03
## moPRE_AGREE:moGENERATION2 [3]	0.35	0.23	0.03
## moGENERATION:VIEWPROTABLETS1 [1]	0.40	0.21	0.06
## moGENERATION:VIEWPROTABLETS1 [2]	0.29	0.19	0.04
## moGENERATION:VIEWPROTABLETS1 [3]	0.30	0.19	0.04
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1 [1]	0.16	0.13	0.01
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1 [2]	0.15	0.12	0.01
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1 [3]	0.16	0.13	0.01
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1 [4]	0.17	0.14	0.01
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1 [5]	0.18	0.14	0.01
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1 [6]	0.19	0.16	0.01
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS2 [1]	0.31	0.22	0.03
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS2 [2]	0.34	0.23	0.04

```

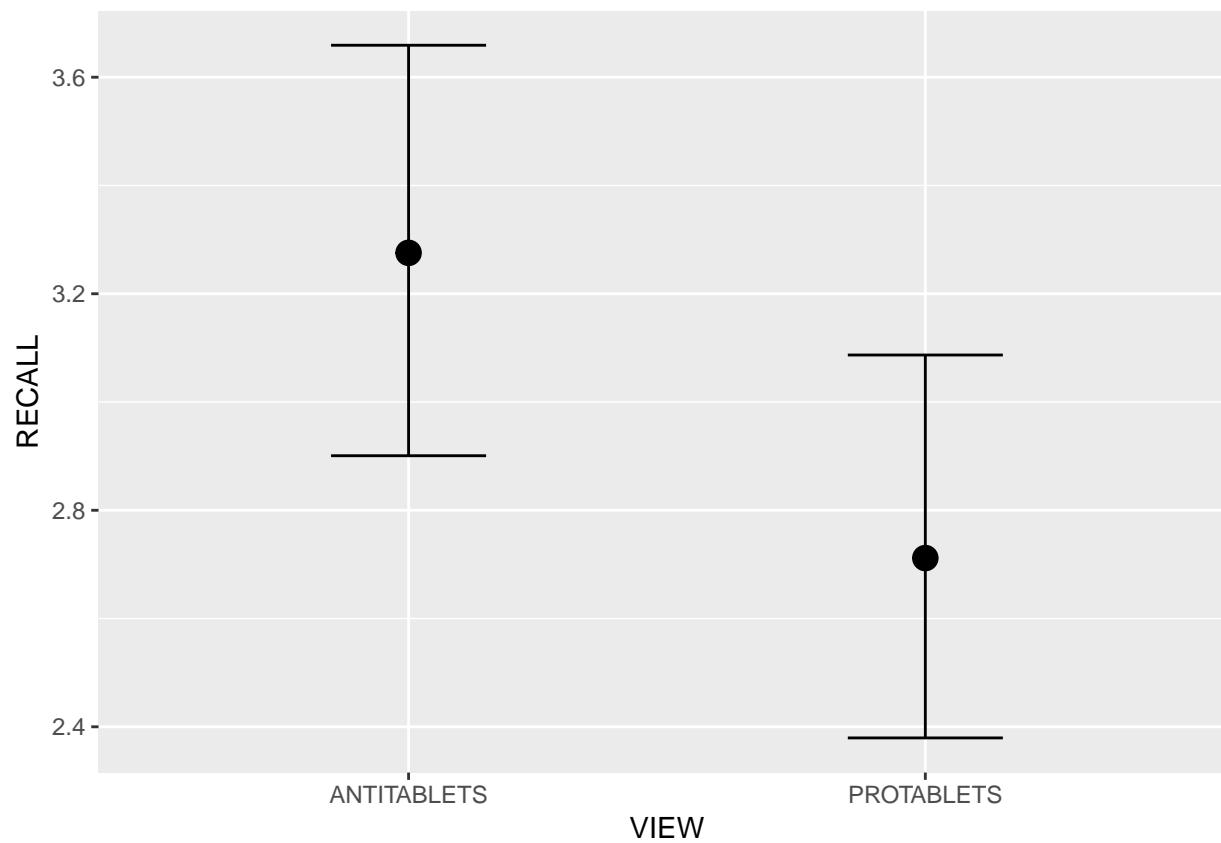
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS2[3]      0.35      0.23      0.03
##                                     u-89% CI Eff.Sample Rhat
## moPRE_AGREE1[1]                                0.41      6543 1.00
## moPRE_AGREE1[2]                                0.41      6190 1.00
## moPRE_AGREE1[3]                                0.42      5701 1.00
## moPRE_AGREE1[4]                                0.43      5696 1.00
## moPRE_AGREE1[5]                                0.47      4354 1.00
## moPRE_AGREE1[6]                                0.48      4883 1.00
## moGENERATION1[1]                               0.76      1600 1.00
## moGENERATION1[2]                               0.68      3556 1.00
## moGENERATION1[3]                               0.66      2368 1.00
## moPRE_AGREE:VIEWPROTABLETS1[1]                 0.42      5608 1.00
## moPRE_AGREE:VIEWPROTABLETS1[2]                 0.40      6033 1.00
## moPRE_AGREE:VIEWPROTABLETS1[3]                 0.41      7741 1.00
## moPRE_AGREE:VIEWPROTABLETS1[4]                 0.39      4715 1.00
## moPRE_AGREE:VIEWPROTABLETS1[5]                 0.46      5721 1.00
## moPRE_AGREE:VIEWPROTABLETS1[6]                 0.51      5363 1.00
## moPRE_AGREE:moGENERATION1[1]                   0.40      5484 1.00
## moPRE_AGREE:moGENERATION1[2]                   0.40      6303 1.00
## moPRE_AGREE:moGENERATION1[3]                   0.42      5676 1.00
## moPRE_AGREE:moGENERATION1[4]                   0.43      4889 1.00
## moPRE_AGREE:moGENERATION1[5]                   0.43      4503 1.00
## moPRE_AGREE:moGENERATION1[6]                   0.49      4659 1.00
## moPRE_AGREE:moGENERATION2[1]                   0.70      6786 1.00
## moPRE_AGREE:moGENERATION2[2]                   0.75      6578 1.00
## moPRE_AGREE:moGENERATION2[3]                   0.75      6714 1.00
## moGENERATION:VIEWPROTABLETS1[1]                 0.73      2184 1.00
## moGENERATION:VIEWPROTABLETS1[2]                 0.67      3449 1.00
## moGENERATION:VIEWPROTABLETS1[3]                 0.66      3031 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1[1]    0.41      6376 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1[2]    0.38      5609 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1[3]    0.41      6336 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1[4]    0.43      5108 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1[5]    0.45      4510 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS1[6]    0.50      5076 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS2[1]    0.72      5400 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS2[2]    0.75      6073 1.00
## moPRE_AGREE:moGENERATION:VIEWPROTABLETS2[3]    0.77      5700 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(mo.2e)

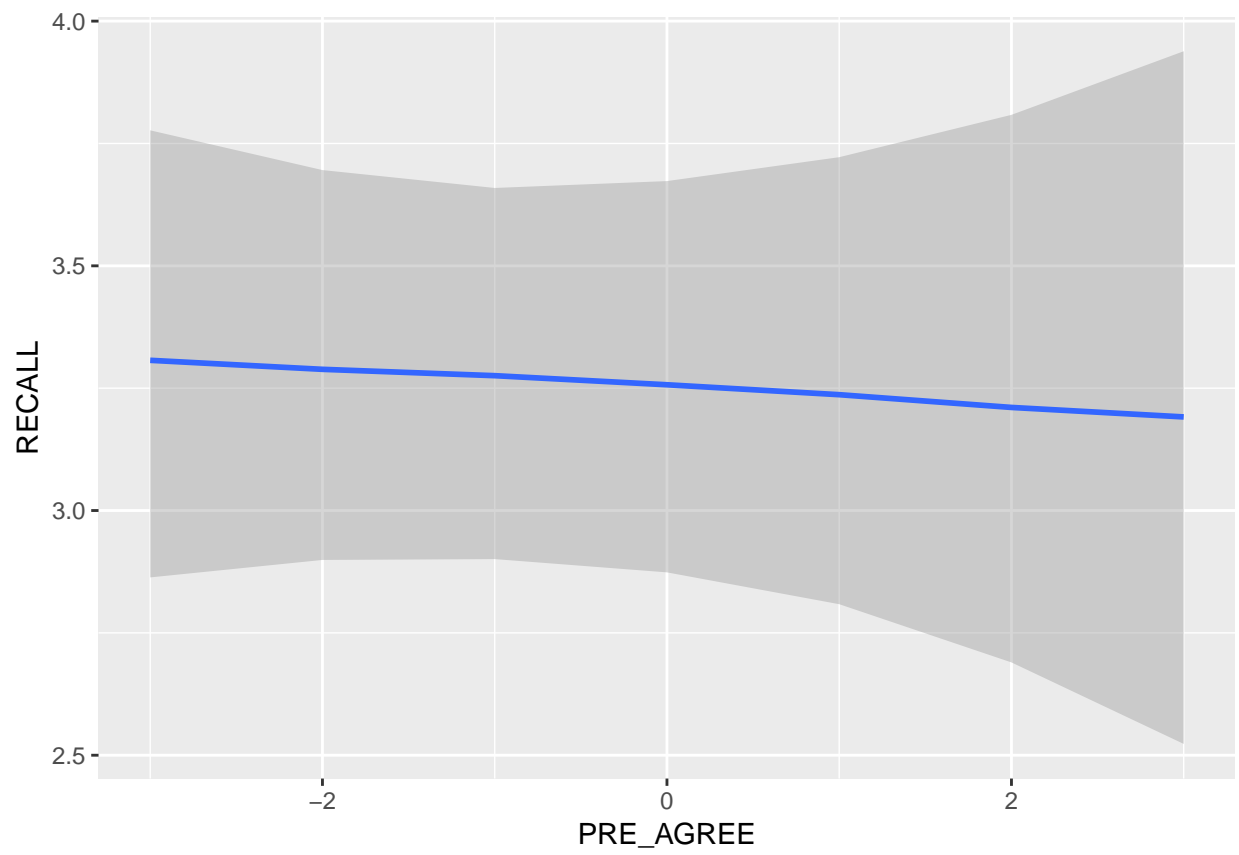
```

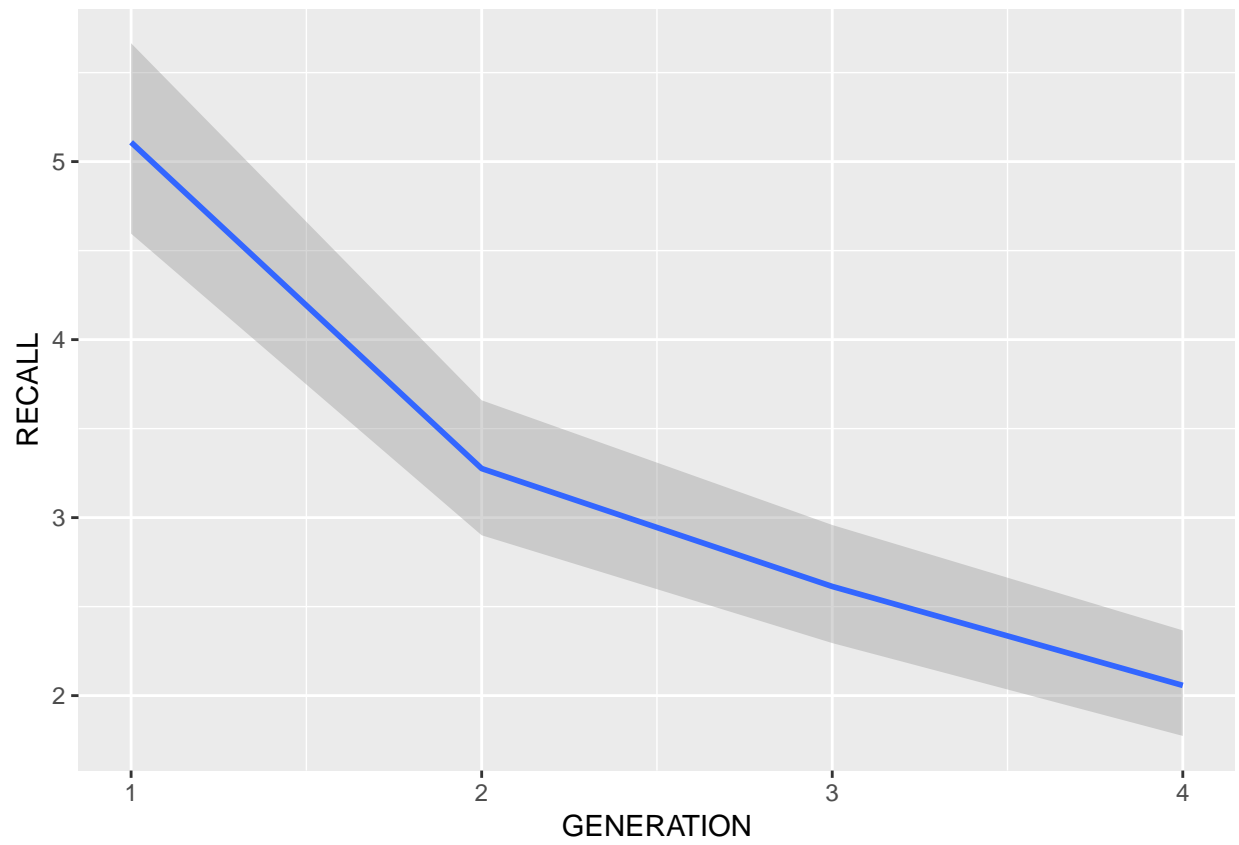


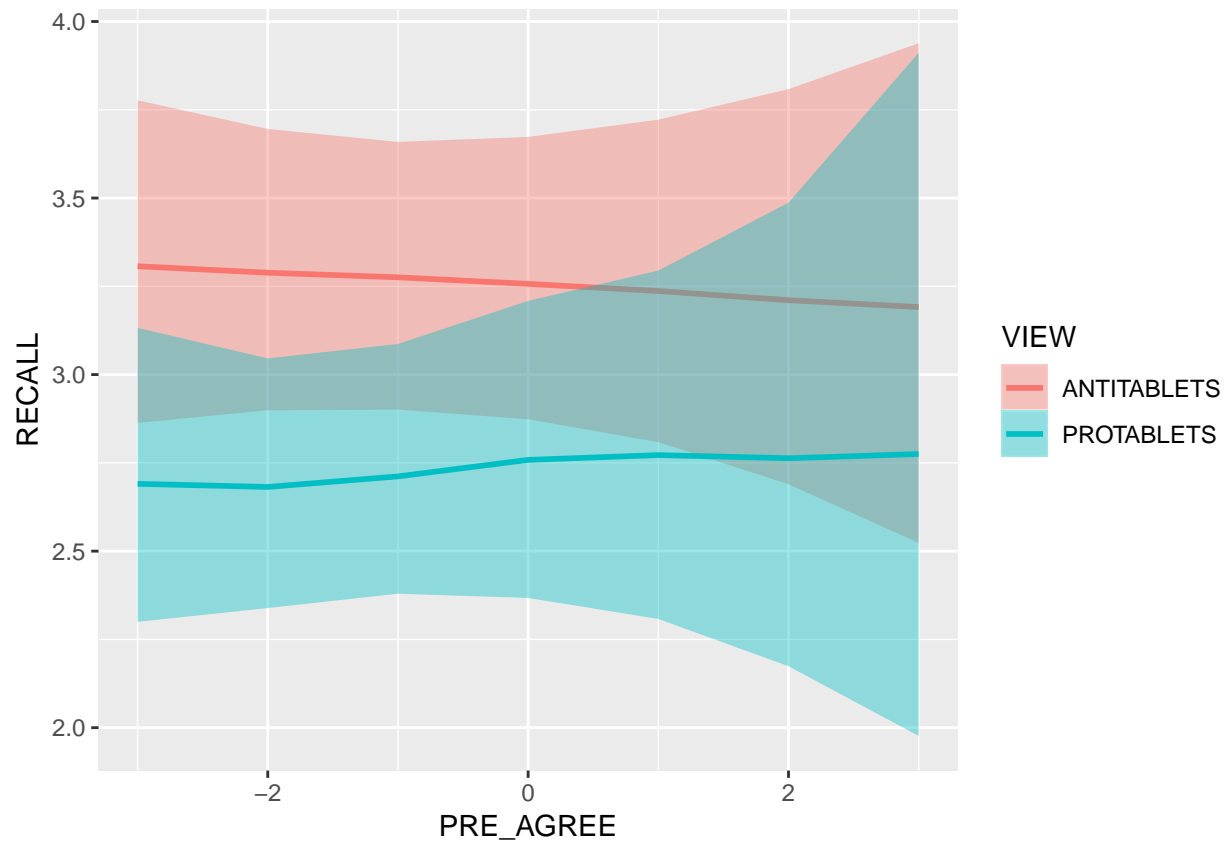


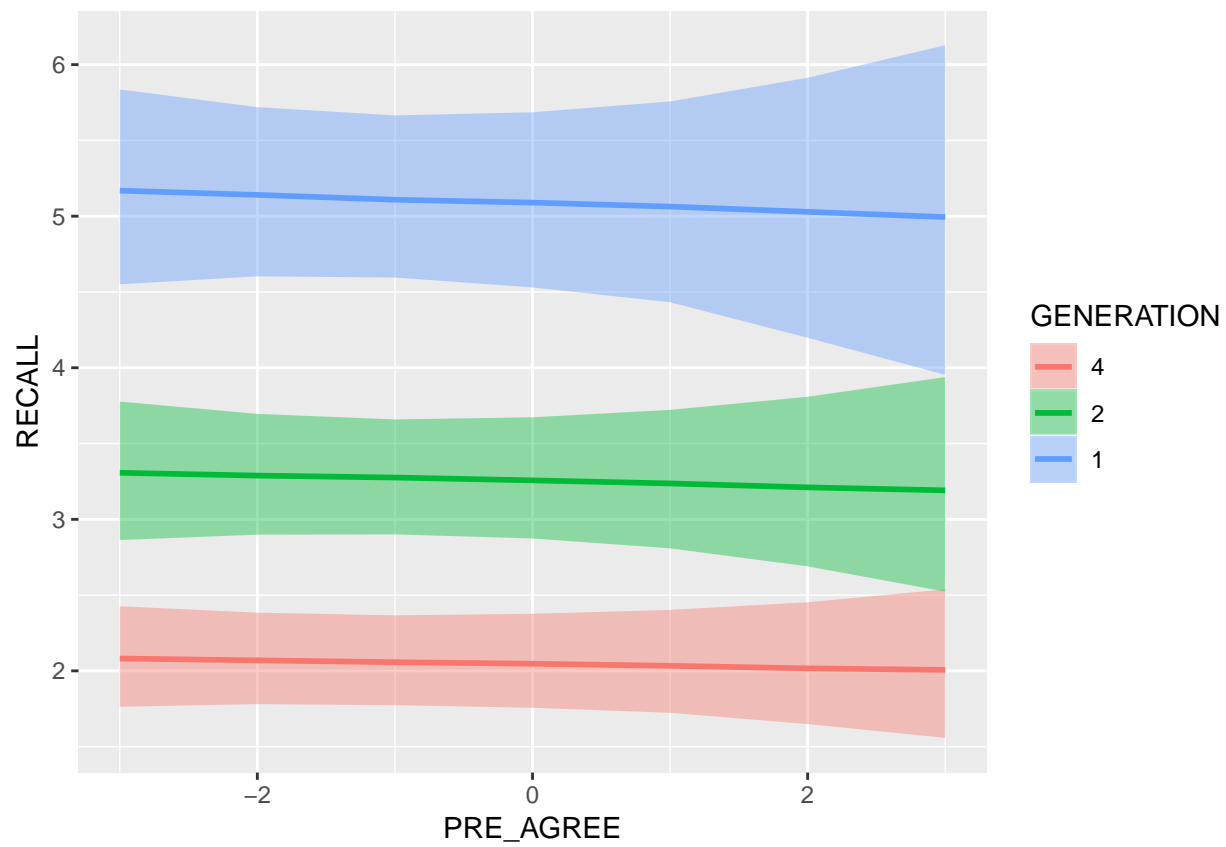
```
marginal_effects(mo.2e, probs = c(0.055, 0.945))
```

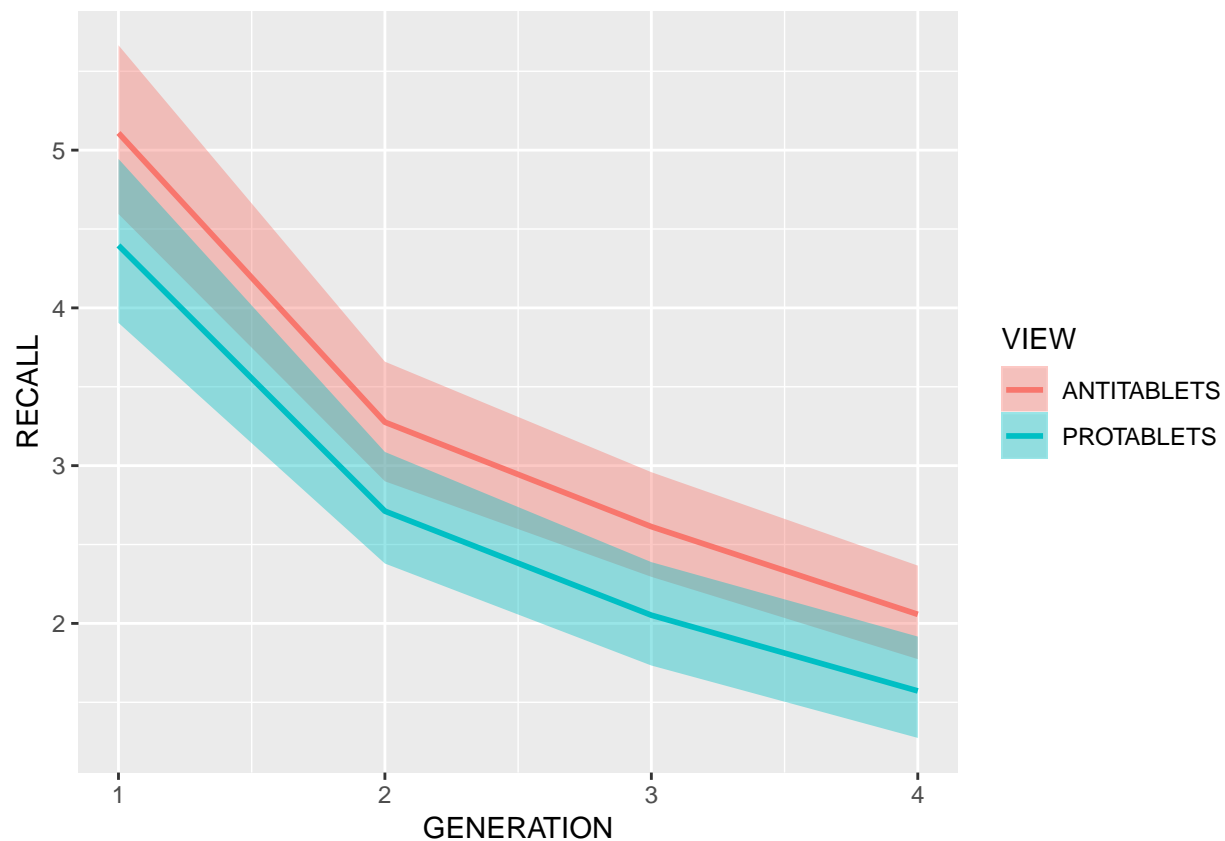













```
(loo.2e<-loo(mo.2e))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##      Estimate   SE
## elpd_loo -652.5  7.2
## p_loo    14.2   0.9
## looic    1305.0 14.4
## -----
## Monte Carlo SE of elpd_loo is 0.1.
##
## Pareto k diagnostic values:
##               Count Pct.    Min. n_eff
## (-Inf, 0.5] (good)   383  99.7%    2549
## (0.5, 0.7]  (ok)     1    0.3%    2908
## (0.7, 1]    (bad)     0    0.0%    <NA>
## (1, Inf)    (very bad) 0    0.0%    <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
```

TEST FOR H1

```
# Summaries
library(tidyverse)

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

## v ggplot2 3.1.0      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()

d %>%
  group_by(SOURCE) %>%
  summarise(meanrecall=mean(RECALL), sdrecall=sd(RECALL))

## # A tibble: 3 x 3
##   SOURCE meanrecall sdrecall
##   <fct>      <dbl>      <dbl>
## 1 CLEANER      2.93      1.75
## 2 EDUCATOR      3.09      1.70
## 3 PILOT        3.09      1.77

# Source model
d <- within(d, SOURCE <- relevel(SOURCE, ref = 'CLEANER'))
mo.3a<-brm(RECALL ~ SOURCE+VIEW + mo(GENERATION) + (1|CHAIN), data = d, family = "poisson")

## Compiling the C++ model

## recompiling to avoid crashing R session

## Start sampling

##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' 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: 4.775 seconds (Warm-up)
## Chain 1:           2.621 seconds (Sampling)
## Chain 1:           7.396 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 4.585 seconds (Warm-up)
## Chain 2:           2.828 seconds (Sampling)
## Chain 2:           7.413 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' 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: 4.857 seconds (Warm-up)
## Chain 3:           3.003 seconds (Sampling)
## Chain 3:           7.86 seconds (Total)

```



```

## Chain 3:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 4.917 seconds (Warm-up)
## Chain 4:                3 seconds (Sampling)
## Chain 4:                7.917 seconds (Total)
## Chain 4:

```

```

mo.3a<-add_criterion(mo.3a, c("loo", "waic"))
summary(mo.3a, prob=0.89)

```

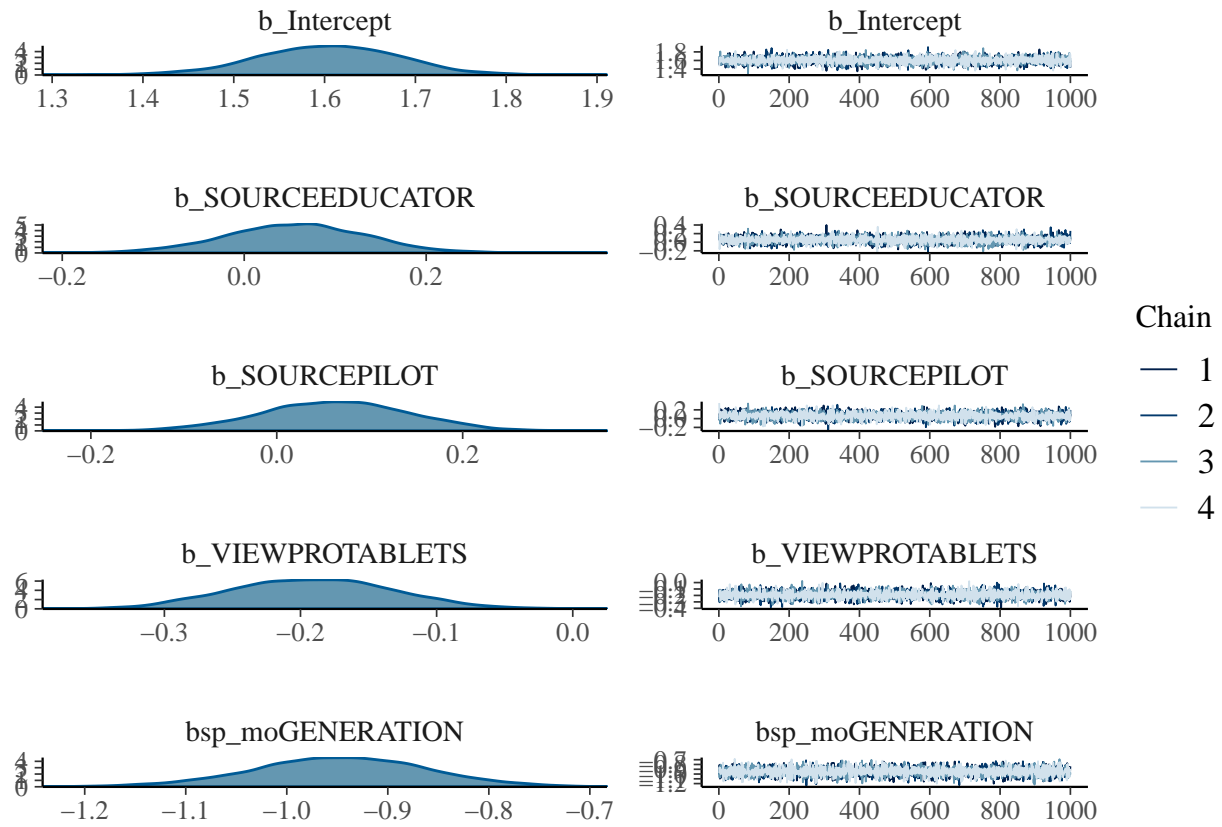
```

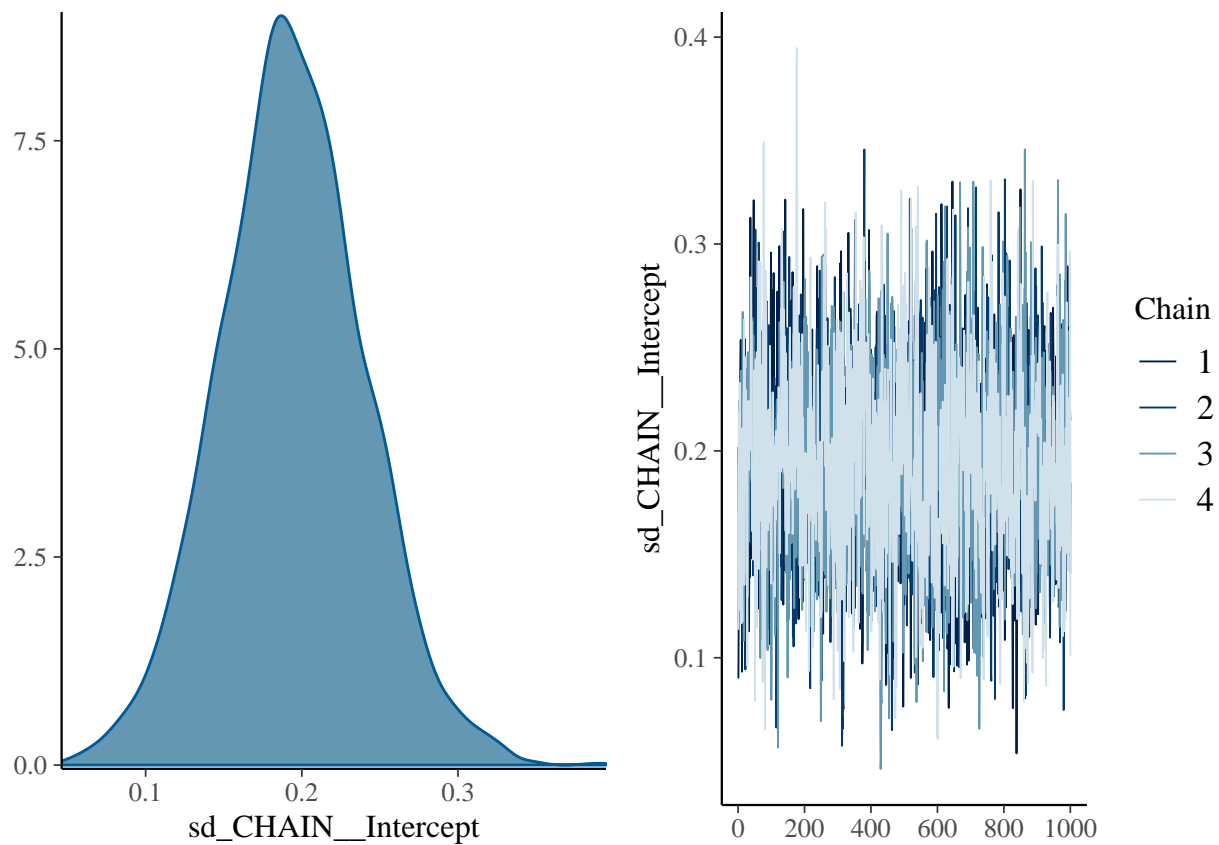
## Family: poisson
## Links: mu = log
## Formula: RECALL ~ SOURCE + VIEW + mo(GENERATION) + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept)    0.19      0.05    0.12    0.27     1551 1.00
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept          1.60      0.08    1.48    1.73     5229 1.00
## SOURCEEDUCATOR      0.06      0.08   -0.07    0.18     4978 1.00
## SOURCEPILOT         0.06      0.08   -0.06    0.19     5571 1.00
## VIEWPROTABLETS     -0.19      0.06   -0.29   -0.10    10027 1.00
## moGENERATION       -0.95      0.08   -1.09   -0.81     6601 1.00
##
## Simplex Parameters:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moGENERATION1[1]    0.49      0.08    0.37    0.62     5400 1.00
## moGENERATION1[2]    0.25      0.09    0.11    0.41     6756 1.00
## moGENERATION1[3]    0.26      0.09    0.11    0.39     6078 1.00

```

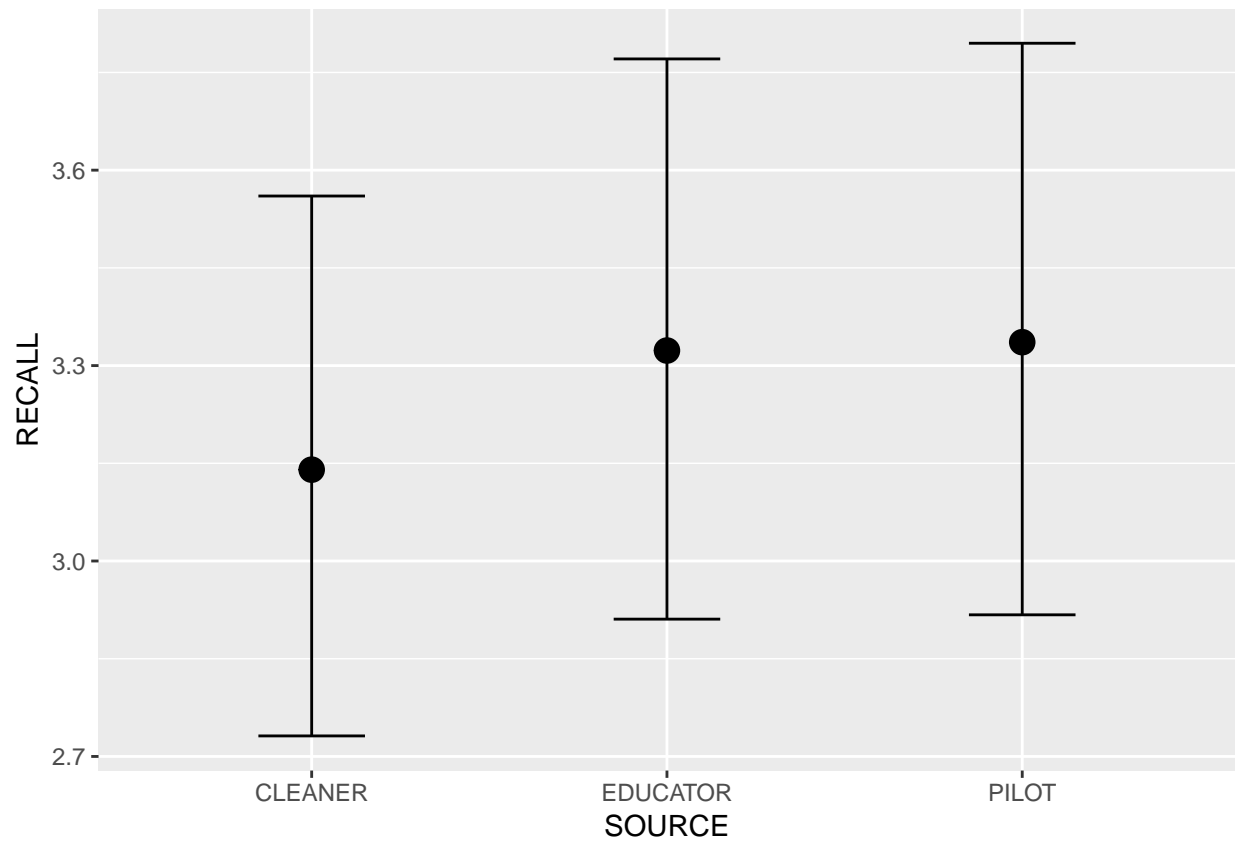
```
##
## Samples were drawn using sampling(NUTS). For each parameter, Eff.Sample
## is a crude measure of effective sample size, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

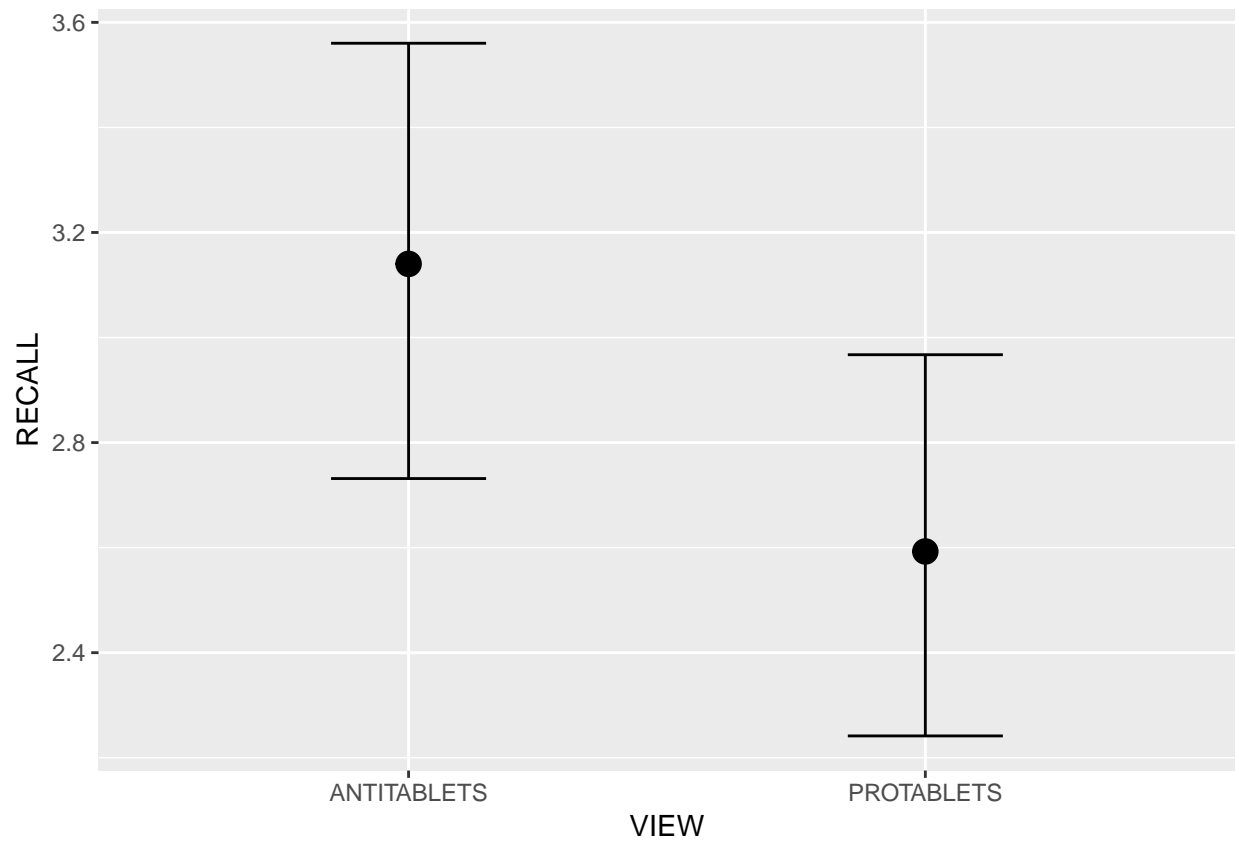
```
plot(mo.3a)
```

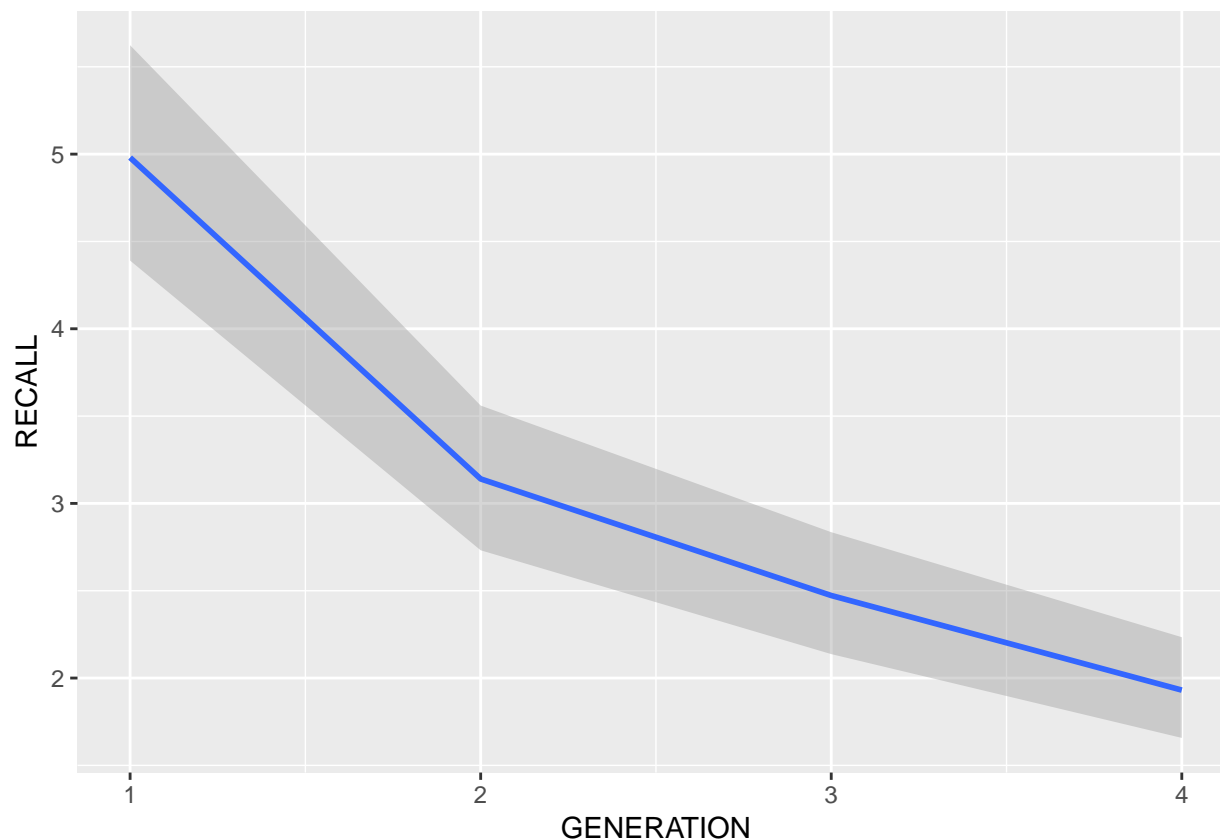




```
marginal_effects(mo.3a, probs = c(0.055, 0.945))
```







```
(loo.3a<-loo(mo.3a))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -651.2  7.2
## p_loo       13.1  0.9
## looic      1302.5 14.5
## -----
## 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.
```

```
# Source model with interaction
```

```
mo.3b<-brm(RECALL ~ SOURCE*mo(GENERATION)+VIEW + (1|CHAIN), data = d, family = "poisson")
```

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

```
## Start sampling
```

```
##
```

```
## SAMPLING FOR MODEL '358a2f1bfca68a5d9c2b522d9e422c17' 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: 9.494 seconds (Warm-up)
## Chain 1:           5.915 seconds (Sampling)
## Chain 1:           15.409 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '358a2f1bfca68a5d9c2b522d9e422c17' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 7.989 seconds (Warm-up)
## Chain 2:           3.467 seconds (Sampling)
## Chain 2:           11.456 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '358a2f1bfca68a5d9c2b522d9e422c17' 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: 6.471 seconds (Warm-up)
## Chain 3: 3.474 seconds (Sampling)
## Chain 3: 9.945 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '358a2f1bfca68a5d9c2b522d9e422c17' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 6.371 seconds (Warm-up)
## Chain 4: 3.379 seconds (Sampling)
## Chain 4: 9.75 seconds (Total)
## Chain 4:

```

```

mo.3b<-add_criterion(mo.3b, c("loo", "waic"))
summary(mo.3b, prob=0.89)

```

```

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ SOURCE * mo(GENERATION) + VIEW + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
## Estimate Est.Error l-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept) 0.19 0.05 0.12 0.27 1488 1.00

```

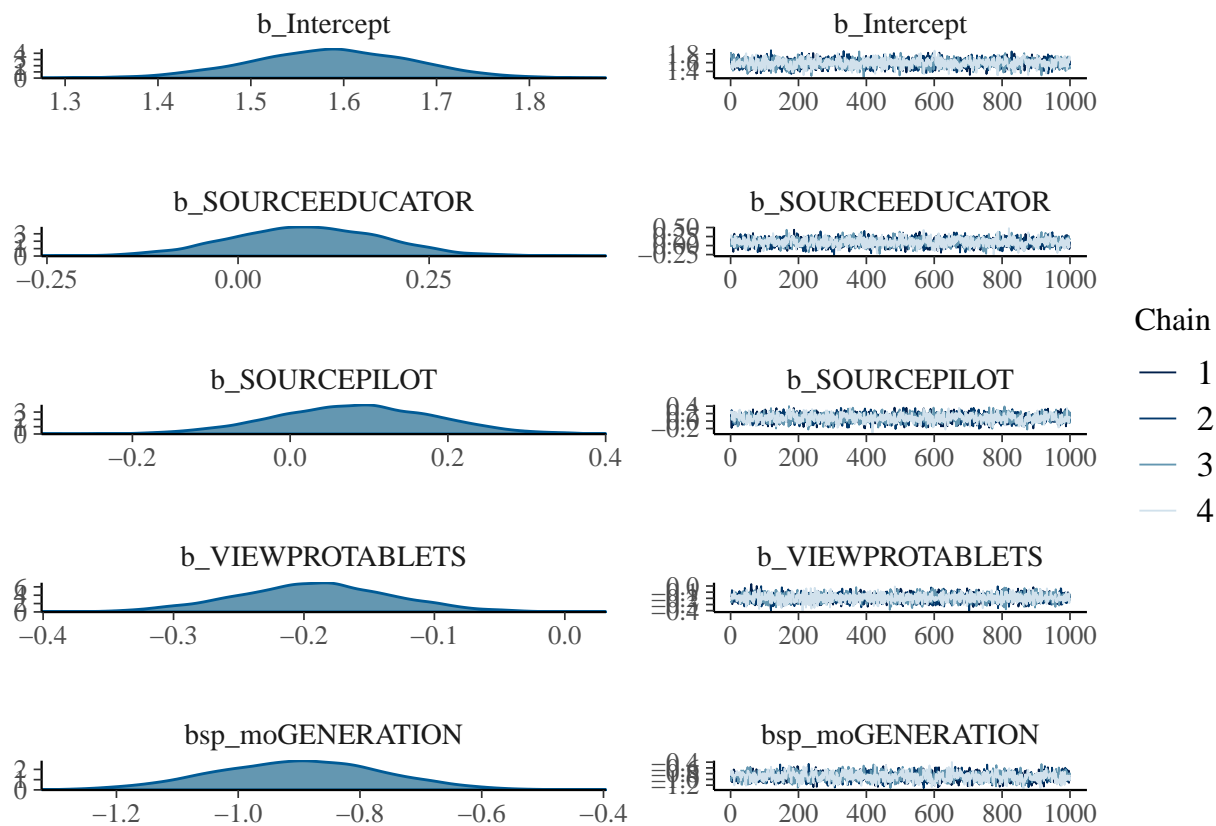


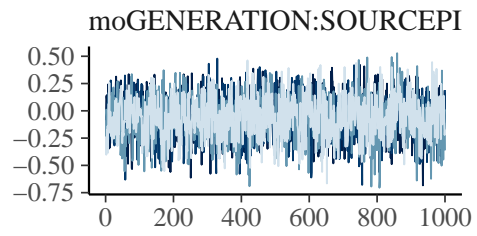
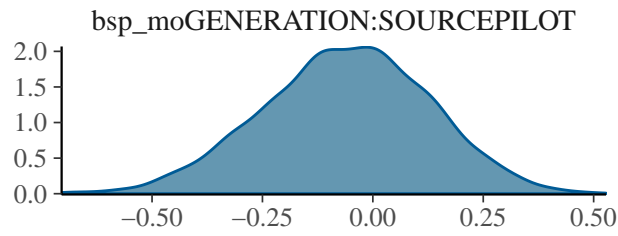
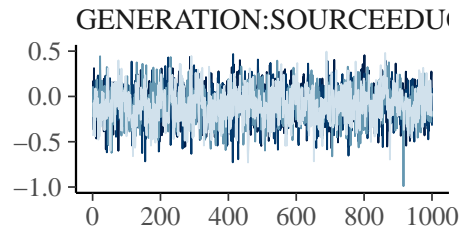
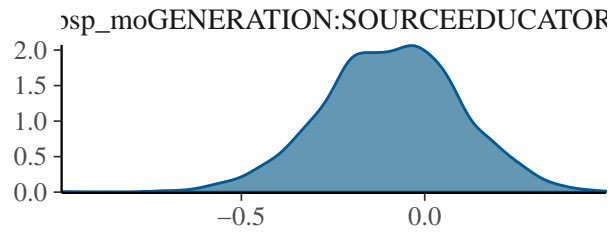
```

##
## Population-Level Effects:
##
##               Estimate Est.Error 1-89% CI u-89% CI
## Intercept           1.59      0.09    1.45    1.72
## SOURCEEDUCATOR       0.09      0.10   -0.07    0.25
## SOURCEPILOT          0.08      0.10   -0.08    0.24
## VIEWPROTABLETS      -0.19      0.06   -0.29   -0.10
## moGENERATION        -0.90      0.14   -1.12   -0.68
## moGENERATION:SOURCEEDUCATOR -0.09      0.19   -0.40    0.21
## moGENERATION:SOURCEPILOT  -0.06      0.19   -0.37    0.24
##
##               Eff.Sample Rhat
## Intercept           2112 1.00
## SOURCEEDUCATOR       2185 1.00
## SOURCEPILOT          2046 1.00
## VIEWPROTABLETS      5151 1.00
## moGENERATION        1420 1.00
## moGENERATION:SOURCEEDUCATOR 1846 1.00
## moGENERATION:SOURCEPILOT 1709 1.00
##
## Simplex Parameters:
##
##               Estimate Est.Error 1-89% CI u-89% CI
## moGENERATION1[1]      0.50      0.09    0.37    0.65
## moGENERATION1[2]      0.25      0.10    0.09    0.41
## moGENERATION1[3]      0.25      0.10    0.08    0.40
## moGENERATION:SOURCEEDUCATOR1[1] 0.32      0.22    0.03    0.73
## moGENERATION:SOURCEEDUCATOR1[2] 0.32      0.22    0.03    0.72
## moGENERATION:SOURCEEDUCATOR1[3] 0.36      0.23    0.04    0.77
## moGENERATION:SOURCEPILOT1[1] 0.32      0.23    0.03    0.75
## moGENERATION:SOURCEPILOT1[2] 0.33      0.23    0.03    0.75
## moGENERATION:SOURCEPILOT1[3] 0.36      0.24    0.03    0.80
##
##               Eff.Sample Rhat
## moGENERATION1[1]      3348 1.00
## moGENERATION1[2]      4457 1.00
## moGENERATION1[3]      4218 1.00
## moGENERATION:SOURCEEDUCATOR1[1] 5311 1.00
## moGENERATION:SOURCEEDUCATOR1[2] 5473 1.00
## moGENERATION:SOURCEEDUCATOR1[3] 4590 1.00
## moGENERATION:SOURCEPILOT1[1] 4224 1.00
## moGENERATION:SOURCEPILOT1[2] 3959 1.00
## moGENERATION:SOURCEPILOT1[3] 3770 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).

```

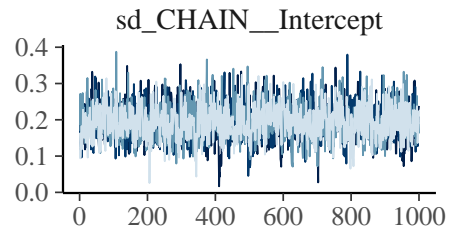
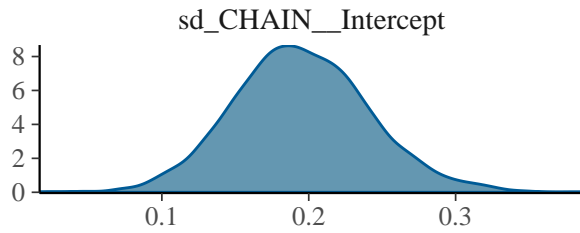
```
plot(mo.3b)
```



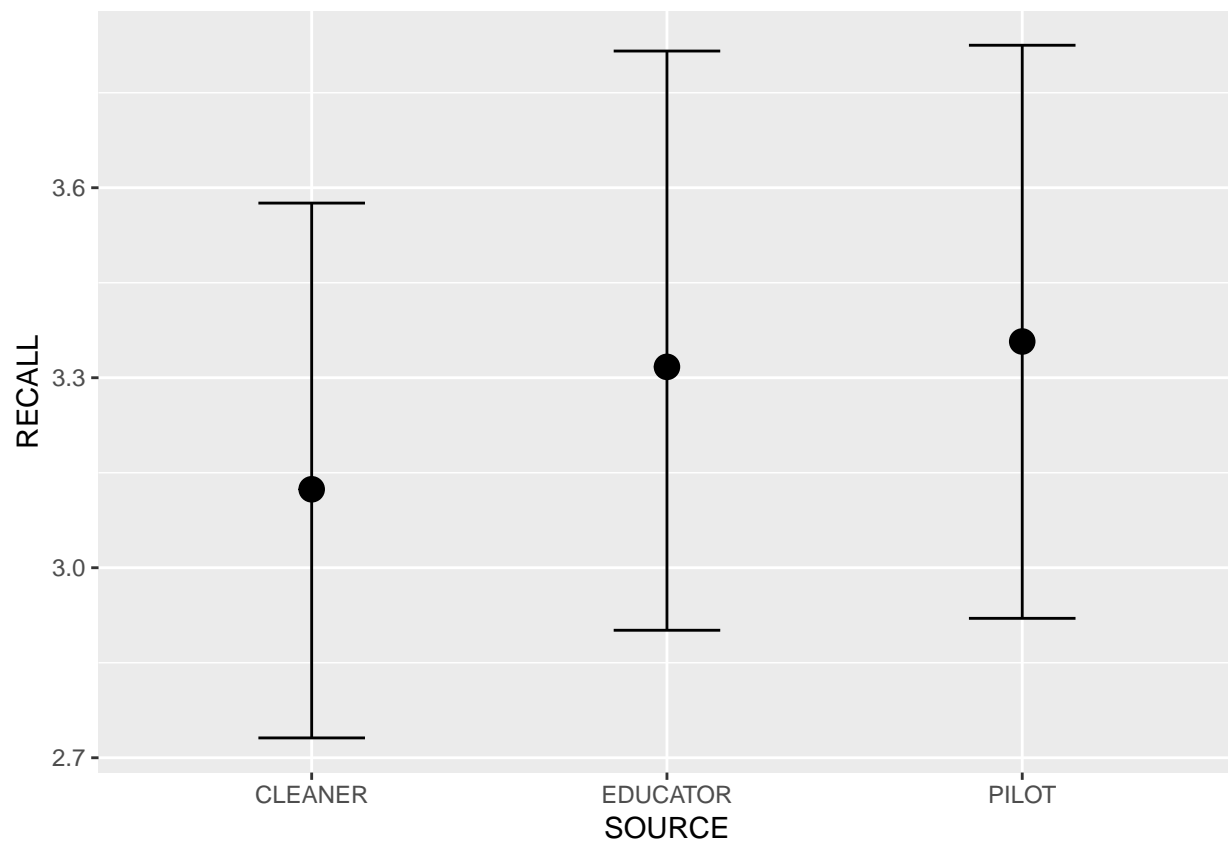


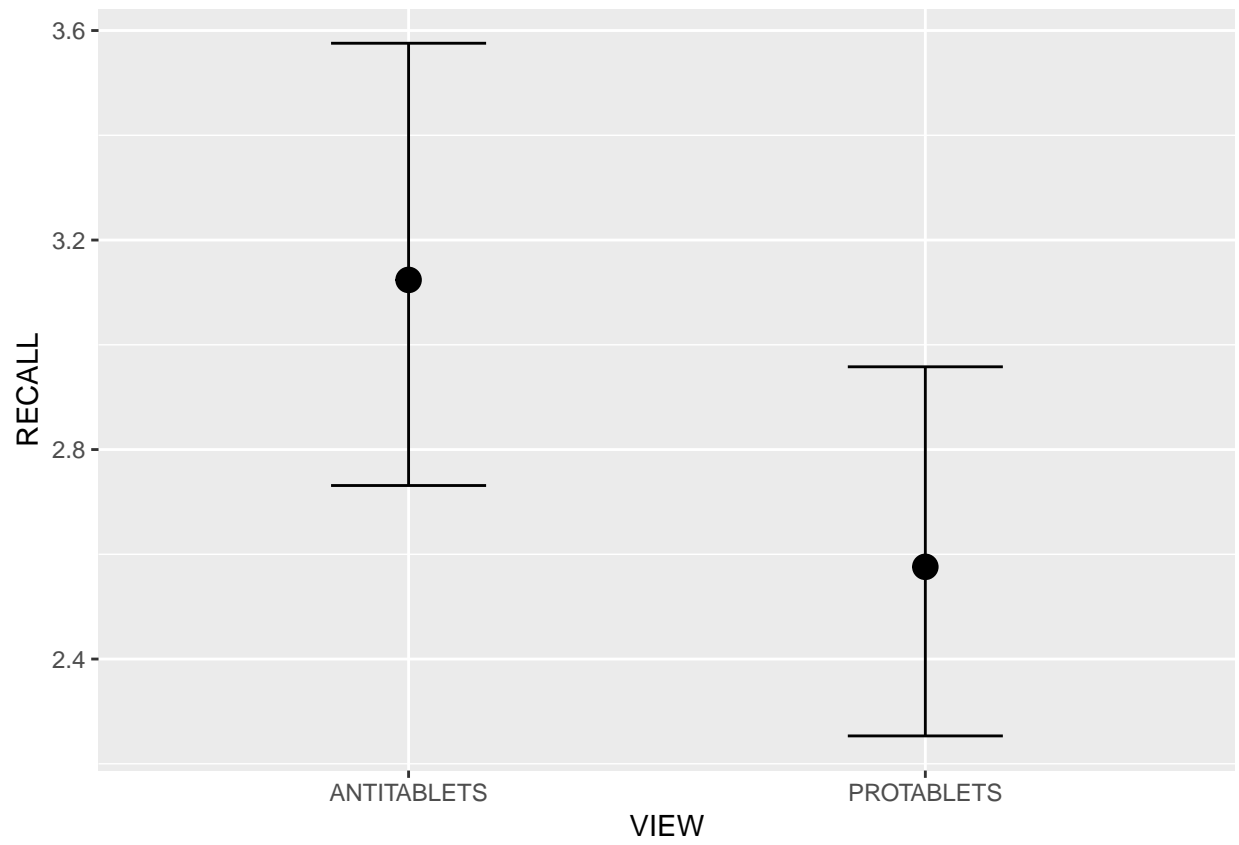
Chain

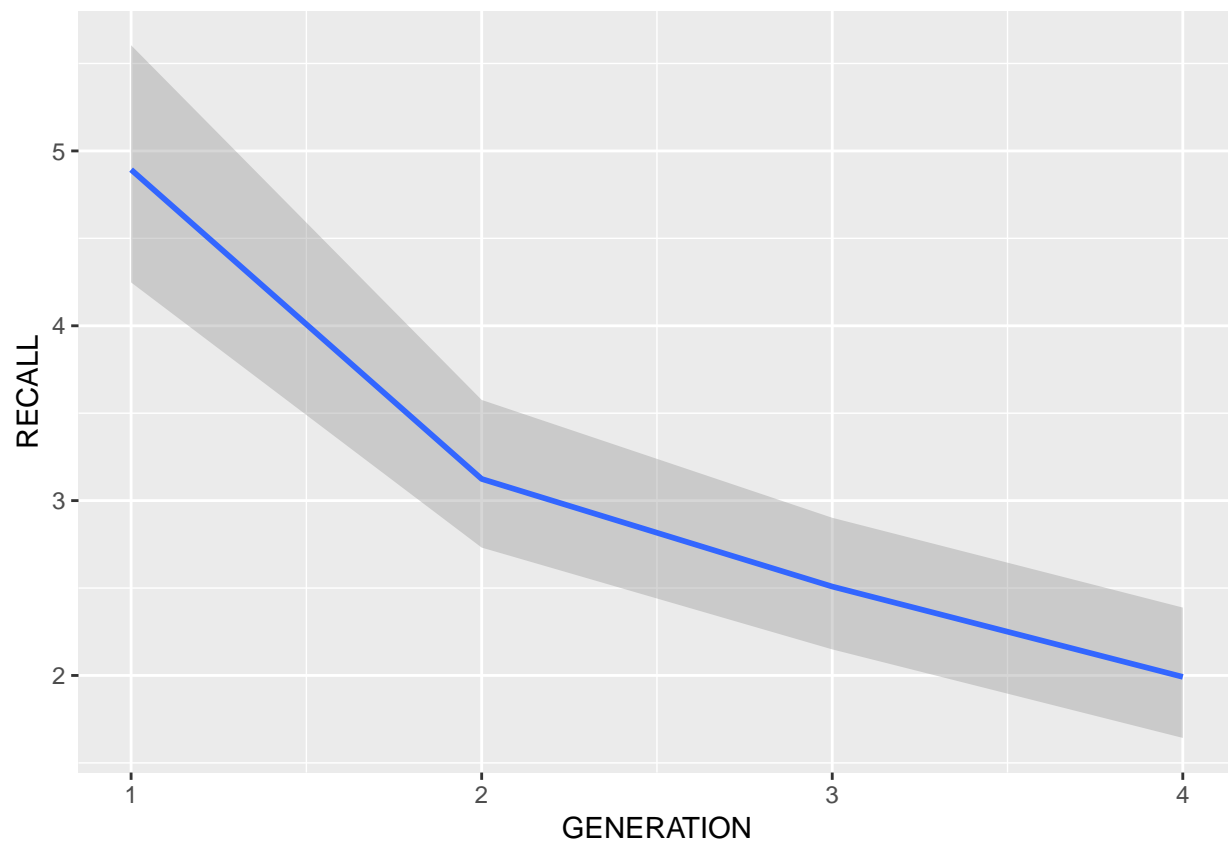
- 1
- 2
- 3
- 4

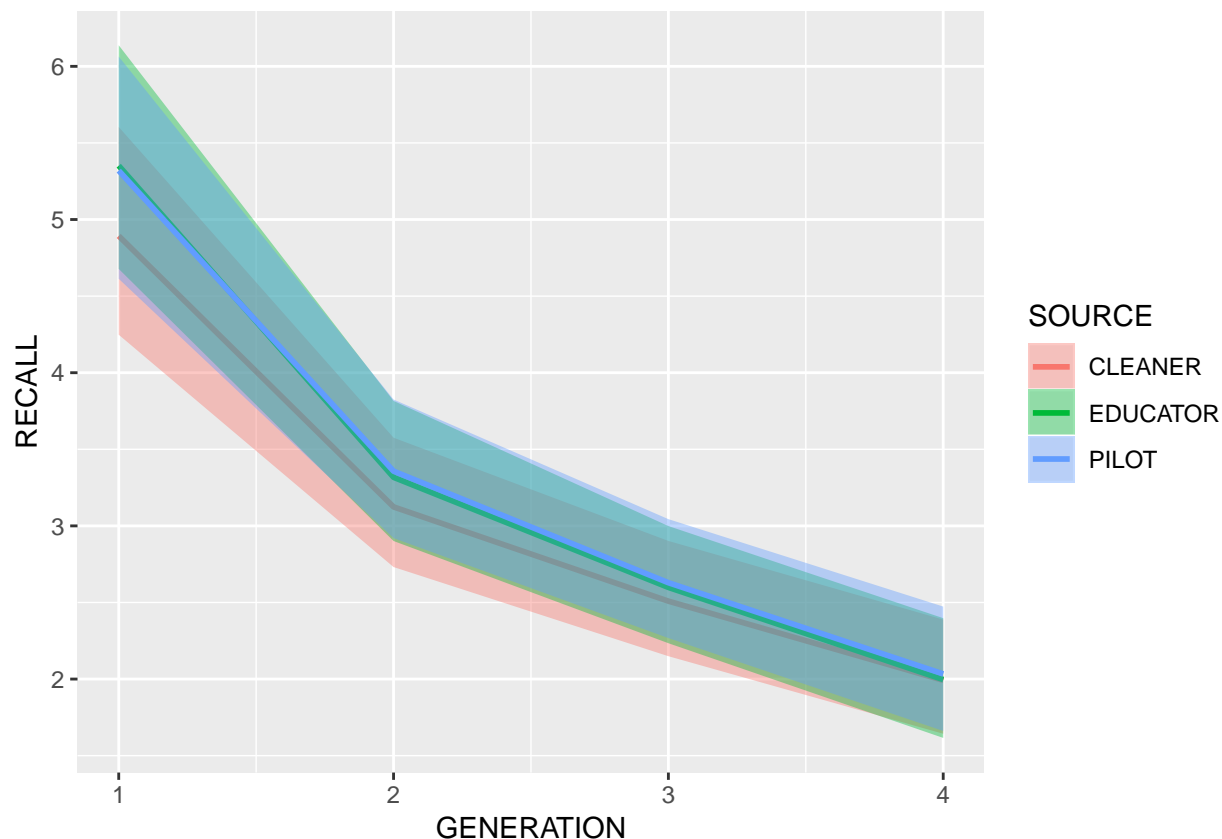


```
marginal_effects(mo.3b, probs = c(0.055, 0.945))
```









```
(loo.3b<-loo(mo.3b))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##      Estimate   SE
## elpd_loo -652.7  7.3
## p_loo    14.1  0.9
## looic    1305.5 14.5
## -----
## Monte Carlo SE of elpd_loo is 0.1.
```

```
## Pareto k diagnostic values:
##
##      Count Pct.   Min. n_eff
## (-Inf, 0.5] (good)   383 99.7% 2551
## (0.5, 0.7]  (ok)     1  0.3% 3900
## (0.7, 1]    (bad)     0  0.0% <NA>
## (1, Inf)    (very bad) 0  0.0% <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
```

```
# TEST FOR H2
d <- within(d, SOURCE <- relevel(SOURCE, ref = 'EDUCATOR'))
mo.3a<-brm(RECALL ~ SOURCE+mo(GENERATION)+VIEW + (1|CHAIN), data = d, family = "poisson")
```

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

```

## recompiling to avoid crashing R session

## Start sampling

##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' 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: 4.19 seconds (Warm-up)
## Chain 1:                2.627 seconds (Sampling)
## Chain 1:                6.817 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 4.054 seconds (Warm-up)
## Chain 2:                2.472 seconds (Sampling)
## Chain 2:                6.526 seconds (Total)
## Chain 2:
##

```



```

## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' 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: 4.088 seconds (Warm-up)
## Chain 3:                2.529 seconds (Sampling)
## Chain 3:                6.617 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'd5a1f2ac14f32b0315689f1865c7407d' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 3.471 seconds (Warm-up)
## Chain 4:                2.111 seconds (Sampling)
## Chain 4:                5.582 seconds (Total)
## Chain 4:
mo.3a<-add_criterion(mo.3a, c("loo", "waic"))
summary(mo.3a, prob=0.89)

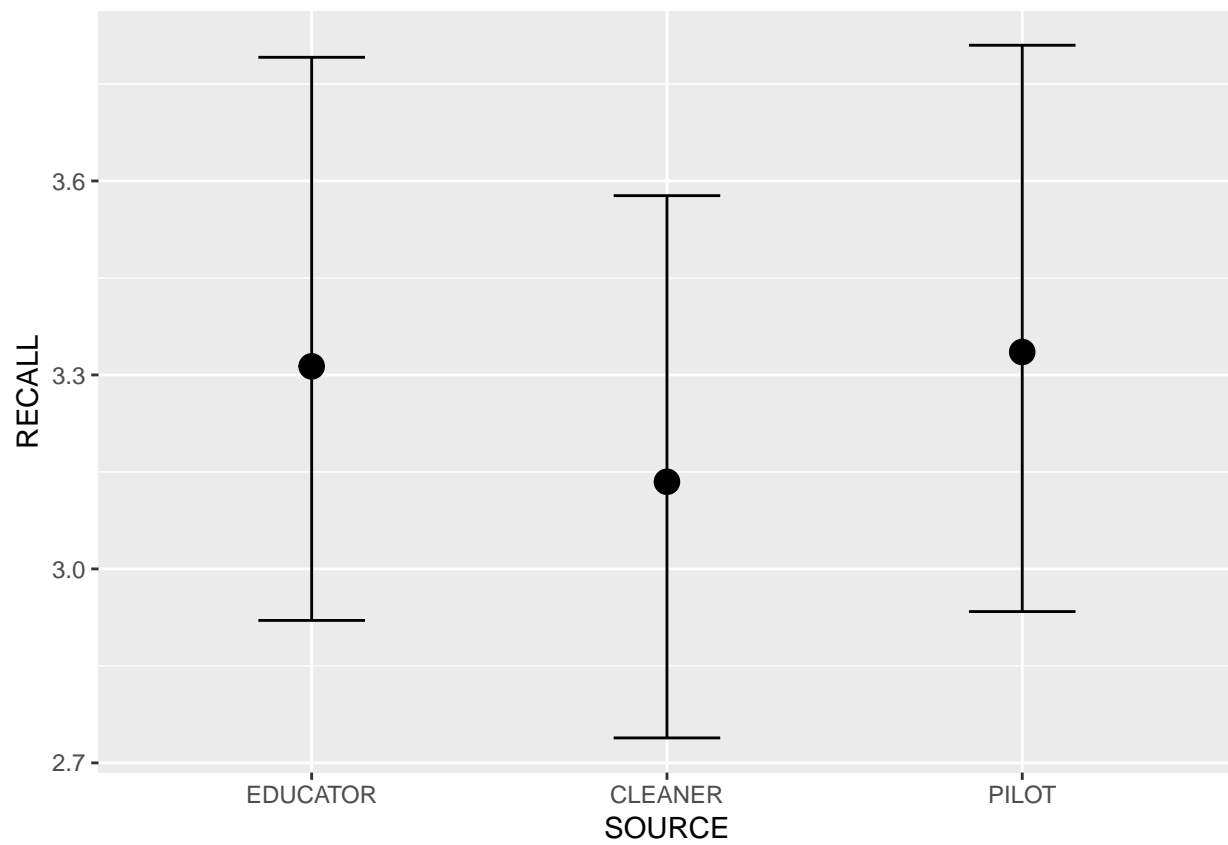
## Family: poisson
## Links: mu = log

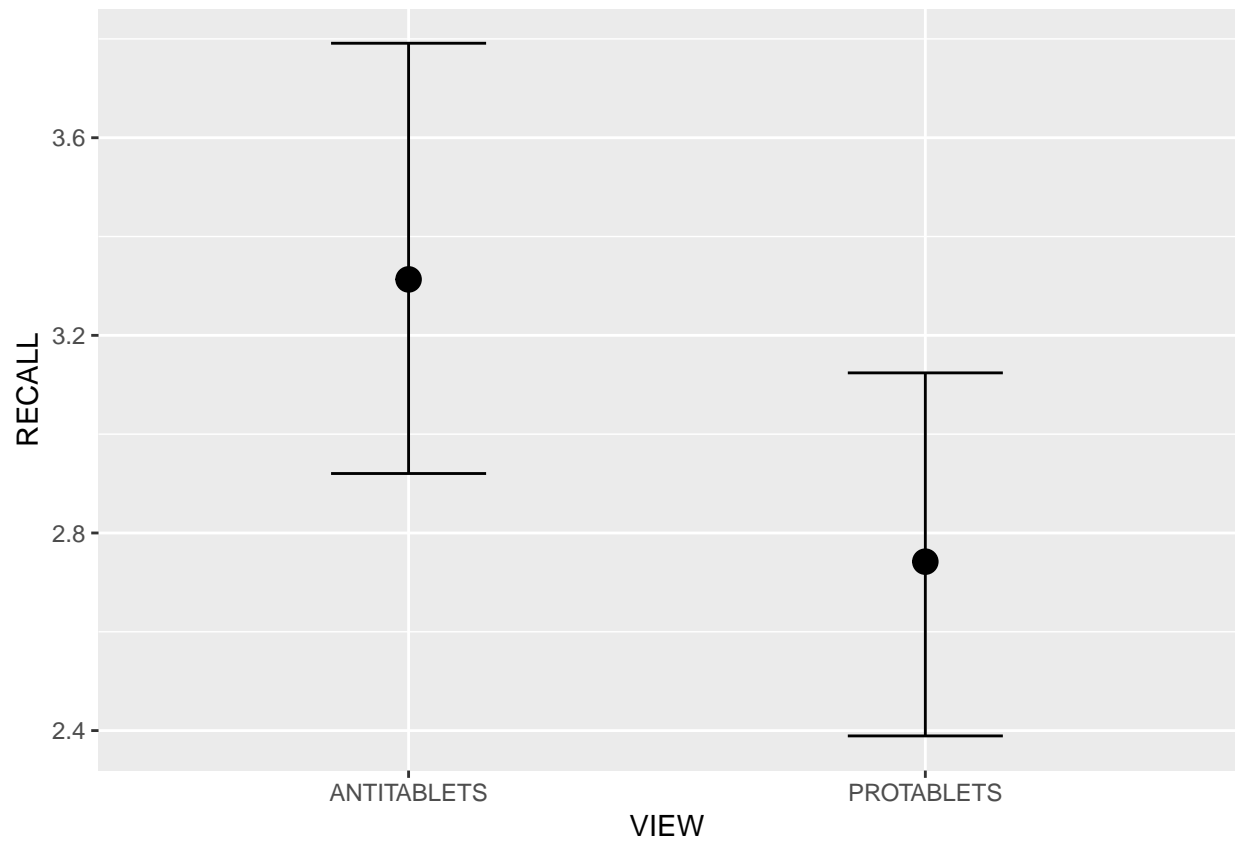
```

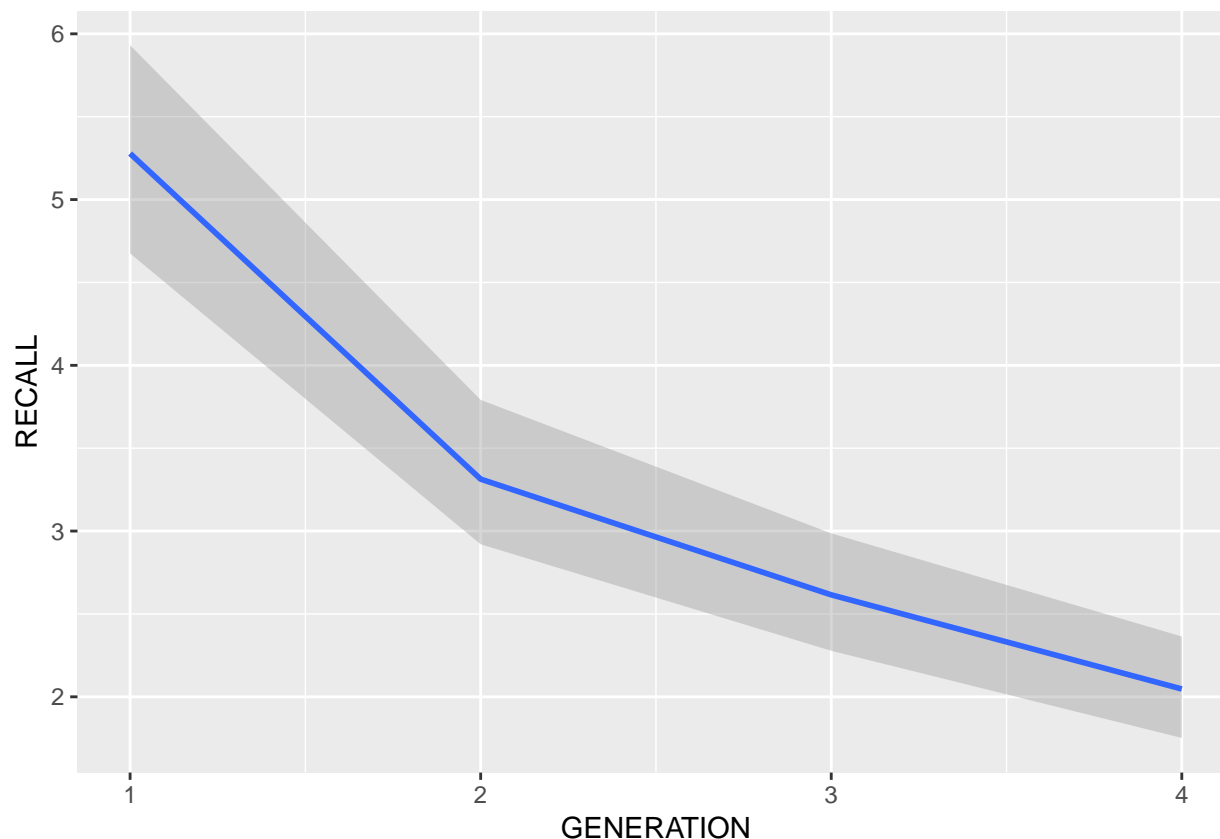
```

## Formula: RECALL ~ SOURCE + mo(GENERATION) + VIEW + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
## Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept) 0.20 0.05 0.12 0.27 1645 1.00
##
## Population-Level Effects:
## Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept 1.66 0.07 1.54 1.78 4667 1.00
## SOURCECLEANER -0.06 0.08 -0.18 0.07 5176 1.00
## SOURCEPILOT 0.01 0.07 -0.11 0.12 5100 1.00
## VIEWPROTABLETS -0.19 0.06 -0.29 -0.10 9138 1.00
## moGENERATION -0.95 0.09 -1.09 -0.82 6355 1.00
##
## Simplex Parameters:
## Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moGENERATION1[1] 0.49 0.08 0.37 0.62 6375 1.00
## moGENERATION1[2] 0.25 0.10 0.10 0.41 5960 1.00
## moGENERATION1[3] 0.25 0.09 0.10 0.39 5294 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).
marginal_effects(mo.3a, probs = c(0.055, 0.945))

```







```
(loo.3a<-loo(mo.3a))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -651.1   7.2
## p_loo       13.1    0.9
## looic      1302.1  14.5
## -----
## 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.
```

```
# Prestige model
```

```
mo.4a<-brm(RECALL ~ mo(GENERATION) + mo(PRESTIGE) + VIEW + (1|CHAIN), data = d, family = "poisson")
```

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

```
## recompiling to avoid crashing R session
```

```
## Start sampling
```

```
##
```

```
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 6.825 seconds (Warm-up)
## Chain 1:                5.127 seconds (Sampling)
## Chain 1:                11.952 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 8.439 seconds (Warm-up)
## Chain 2:                2.87 seconds (Sampling)
## Chain 2:                11.309 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 7.814 seconds (Warm-up)
## Chain 3: 3.551 seconds (Sampling)
## Chain 3: 11.365 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 6.051 seconds (Warm-up)
## Chain 4: 4.094 seconds (Sampling)
## Chain 4: 10.145 seconds (Total)
## Chain 4:
summary(mo.4a, prob=0.89)

```

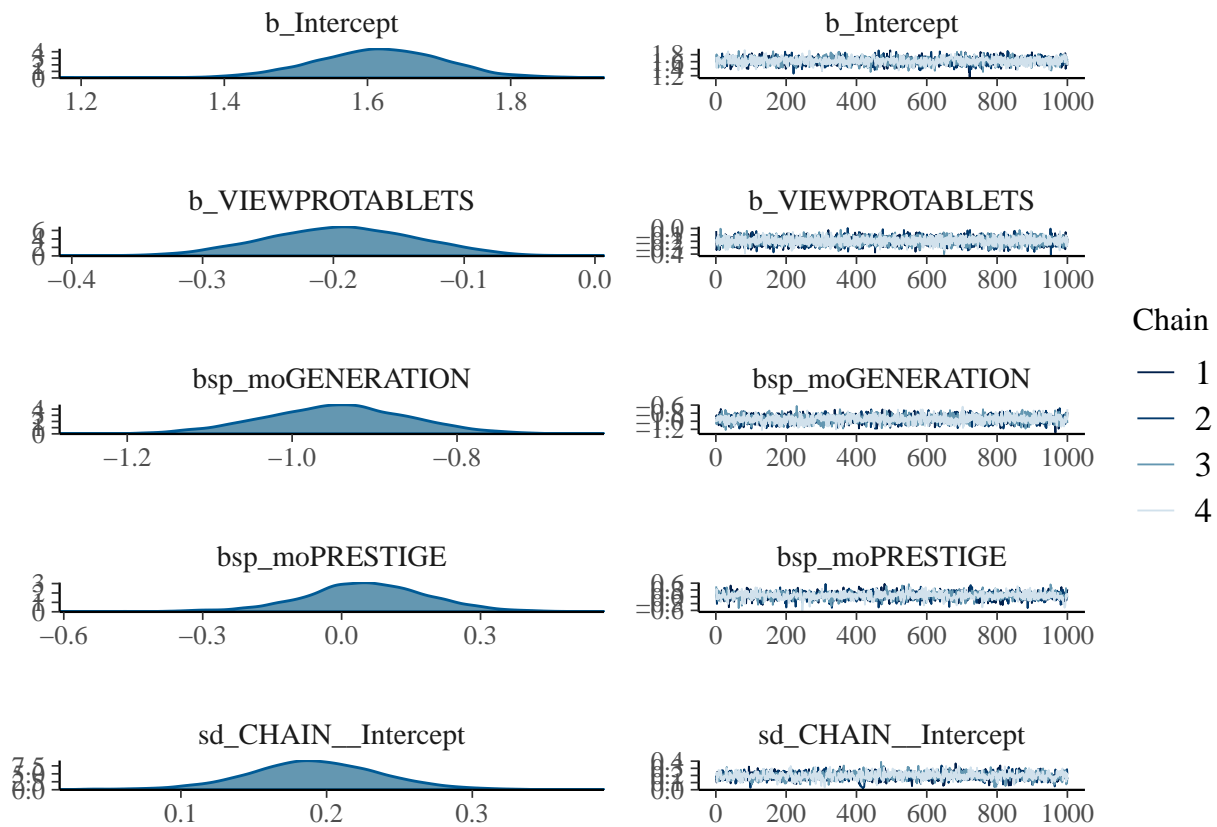
```

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(GENERATION) + mo(PRESTIGE) + VIEW + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
## Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept) 0.19 0.05 0.12 0.27 1384 1.00

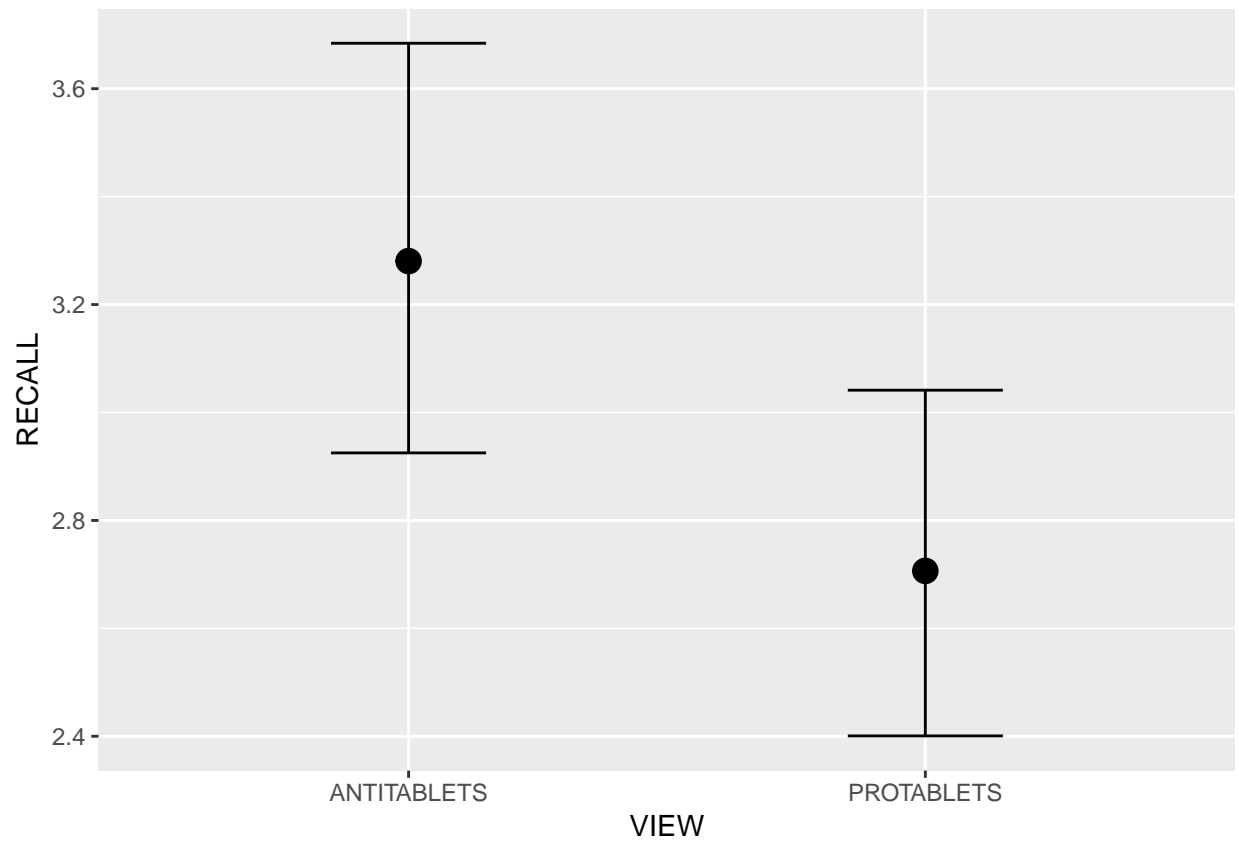
```

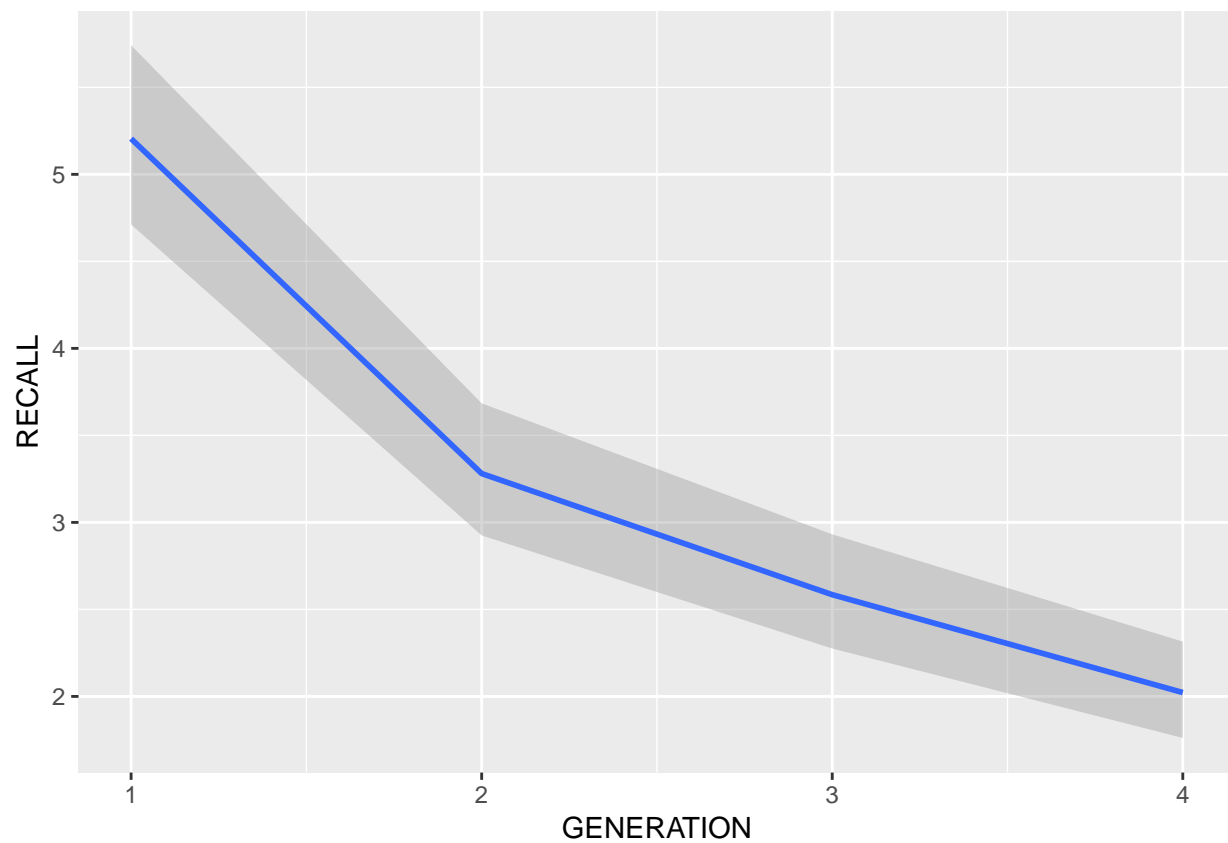
```
##
## Population-Level Effects:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept           1.62     0.09   1.47   1.76     2240 1.00
## VIEWPROTABLETS      -0.19     0.06  -0.29  -0.10     5016 1.00
## moGENERATION        -0.95     0.09  -1.09  -0.81     3265 1.00
## moPRESTIGE           0.05     0.14  -0.17   0.27     2390 1.00
##
## Simplex Parameters:
##           Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moGENERATION1[1]      0.49     0.08   0.37   0.62     3520 1.00
## moGENERATION1[2]      0.25     0.10   0.11   0.41     4413 1.00
## moGENERATION1[3]      0.26     0.09   0.10   0.40     4125 1.00
## moPRESTIGE1[1]        0.26     0.19   0.02   0.62     4833 1.00
## moPRESTIGE1[2]        0.24     0.19   0.02   0.61     4345 1.00
## moPRESTIGE1[3]        0.22     0.18   0.01   0.56     4344 1.00
## moPRESTIGE1[4]        0.28     0.20   0.02   0.65     3925 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).
```

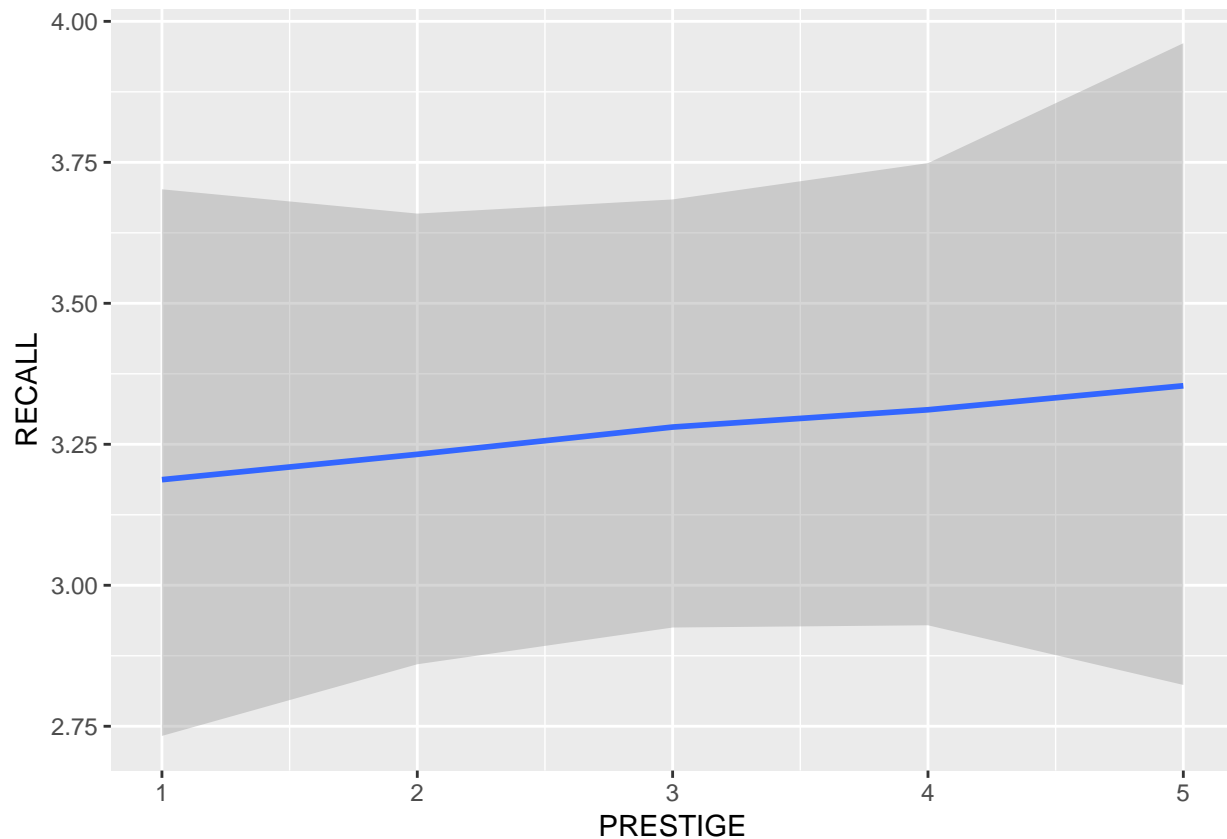
```
plot(mo.4a)
```



```
marginal_effects(mo.4a, probs = c(0.055, 0.945))
```





```
mo.4a<-add_criterion(mo.4a, c("loo", "waic"))
(loo.4a<-loo(mo.4a))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -651.1   7.2
## p_loo       12.7   0.9
## looic      1302.2  14.5
## -----
## 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.
```

```
# Relevance model
```

```
mo.5a<-brm(RECALL ~ mo(GENERATION) + mo(RELEVANCE) + VIEW + (1|CHAIN), data = d, family = "poisson")
```

```
## Compiling the C++ model
## recompiling to avoid crashing R session
## Start sampling
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 9.082 seconds (Warm-up)
## Chain 1:                5.391 seconds (Sampling)
## Chain 1:                14.473 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 5.949 seconds (Warm-up)
## Chain 2:                5.397 seconds (Sampling)
## Chain 2:                11.346 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' 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: 6.442 seconds (Warm-up)
## Chain 3:                4.785 seconds (Sampling)
## Chain 3:                11.227 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'fb87163d7682f49372b3ab16ffdb1fa7' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 6.301 seconds (Warm-up)
## Chain 4:                5.411 seconds (Sampling)
## Chain 4:                11.712 seconds (Total)
## Chain 4:

```

```
summary(mo.5a, prob=0.89)
```

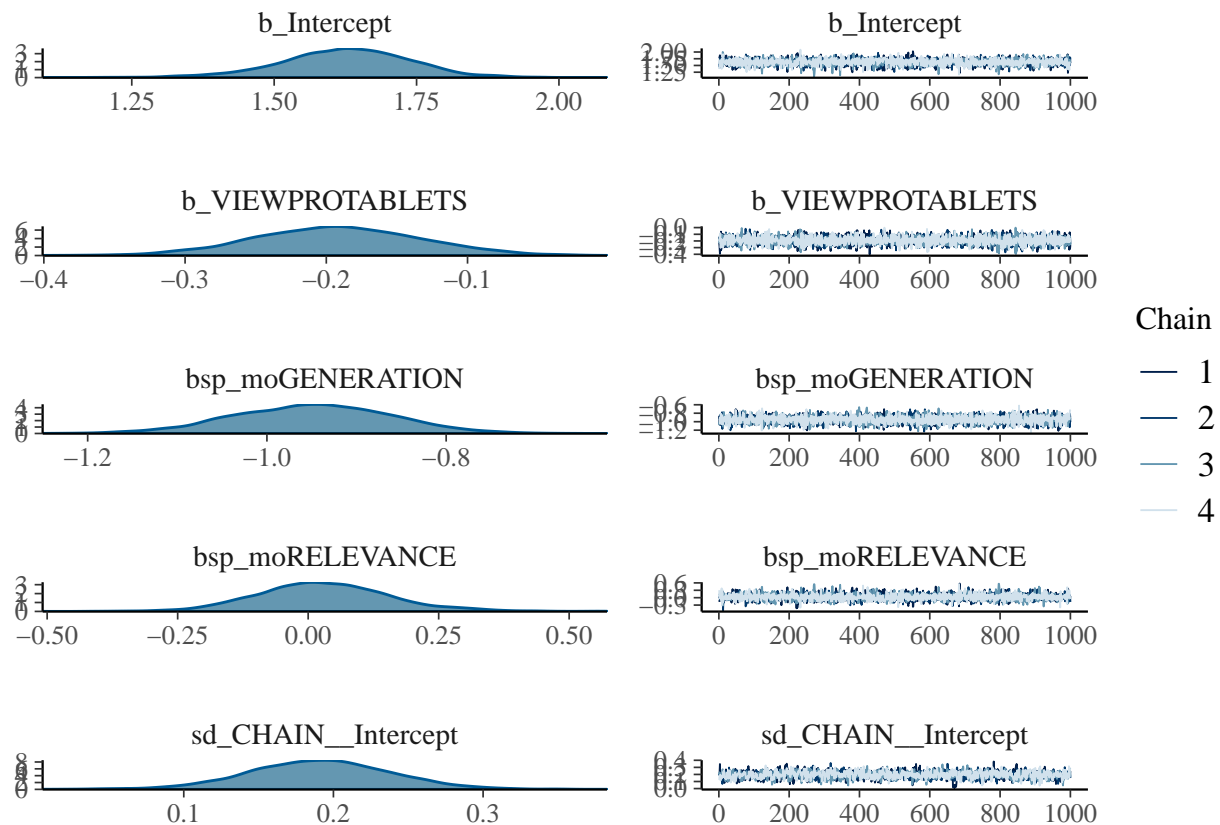
```

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(GENERATION) + mo(RELEVANCE) + VIEW + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
##          Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat

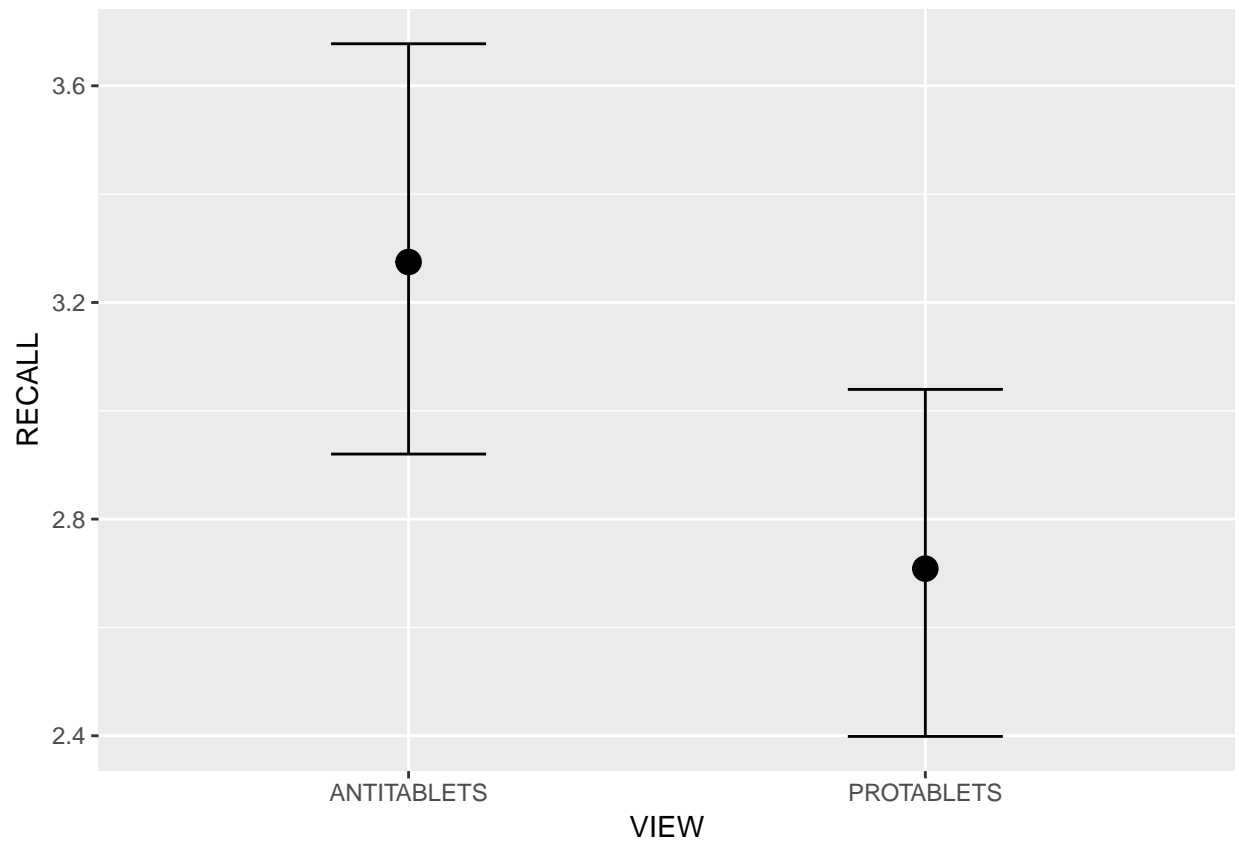
```

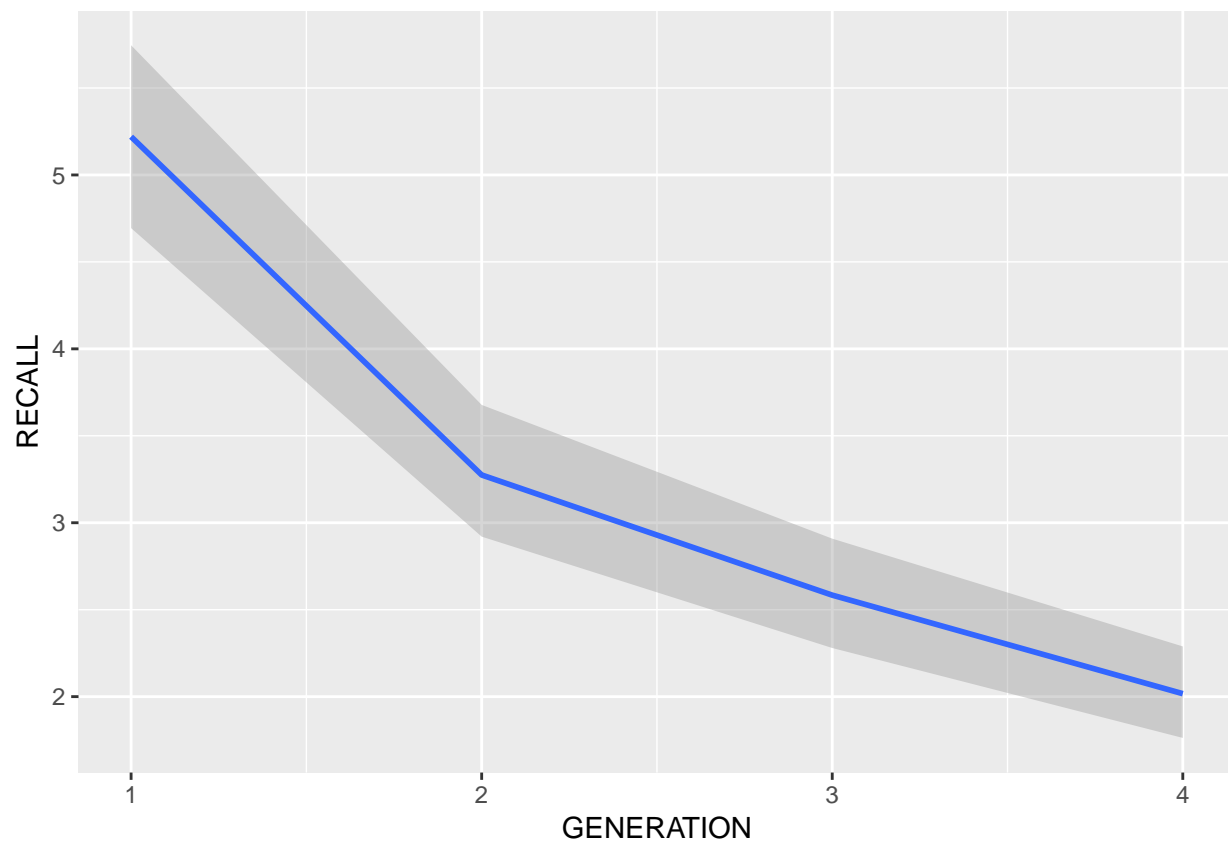
```
## sd(Intercept)      0.19      0.05      0.12      0.27      1494 1.00
##
## Population-Level Effects:
##               Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept           1.63      0.12    1.44    1.80     3639 1.00
## VIEWPROTABLETS      -0.19      0.06   -0.29   -0.10     7039 1.00
## moGENERATION         -0.95      0.09   -1.09   -0.81     5322 1.00
## moRELEVANCE          0.03      0.13   -0.17    0.24     3335 1.00
##
## Simplex Parameters:
##               Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moGENERATION1[1]      0.49      0.08    0.36    0.62     6133 1.00
## moGENERATION1[2]      0.25      0.09    0.11    0.41     5611 1.00
## moGENERATION1[3]      0.26      0.09    0.11    0.39     4484 1.00
## moRELEVANCE1[1]       0.19      0.16    0.01    0.51     5520 1.00
## moRELEVANCE1[2]       0.18      0.15    0.01    0.46     5885 1.00
## moRELEVANCE1[3]       0.17      0.13    0.01    0.43     5765 1.00
## moRELEVANCE1[4]       0.15      0.13    0.01    0.41     5778 1.00
## moRELEVANCE1[5]       0.15      0.13    0.01    0.40     5221 1.00
## moRELEVANCE1[6]       0.16      0.13    0.01    0.41     4283 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).
```

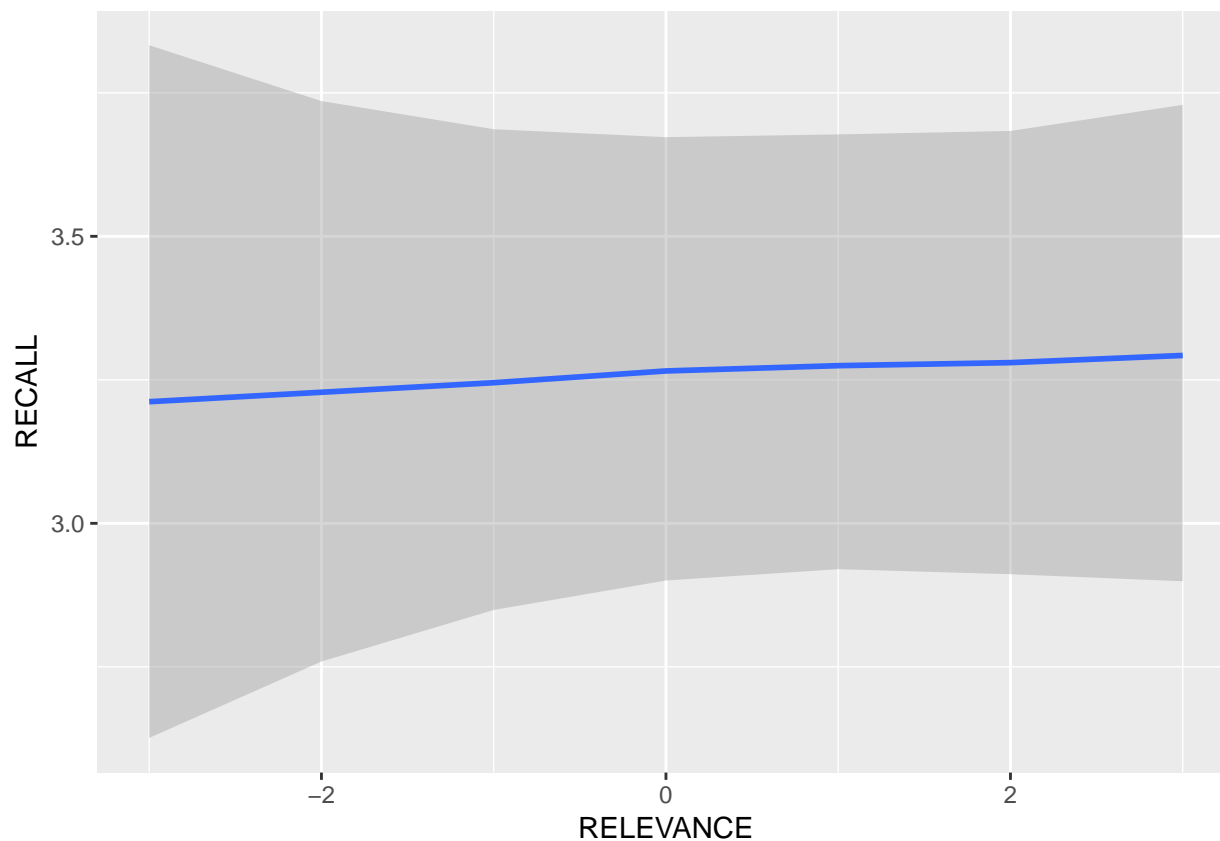
```
plot(mo.5a)
```



```
marginal_effects(mo.5a, probs = c(0.055, 0.945))
```







```
mo.5a<-add_criterion(mo.5a, c("loo", "waic"))
(loo.5a<-loo(mo.5a))
```

```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo   -651.3   7.3
## p_loo       12.8   0.8
## looic      1302.6  14.5
## -----
## 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.
```

```
# Prestige + relevance model
```

```
mo.6a<-brm(RECALL ~ mo(GENERATION) + mo(PRESTIGE) + mo(RELEVANCE) +VIEW + (1|CHAIN), data = d, family =
```

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

```
## Start sampling
```

```
##
```

```
## SAMPLING FOR MODEL '0e1d5ba188bd5d6f1c195bb598f65420' 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: 9.275 seconds (Warm-up)
## Chain 1:                6.988 seconds (Sampling)
## Chain 1:                16.263 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL '0e1d5ba188bd5d6f1c195bb598f65420' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 10.187 seconds (Warm-up)
## Chain 2:                7.148 seconds (Sampling)
## Chain 2:                17.335 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL '0e1d5ba188bd5d6f1c195bb598f65420' 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: 8.789 seconds (Warm-up)
## Chain 3: 6.789 seconds (Sampling)
## Chain 3: 15.578 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL '0e1d5ba188bd5d6f1c195bb598f65420' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 0 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0 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: 8.765 seconds (Warm-up)
## Chain 4: 6.551 seconds (Sampling)
## Chain 4: 15.316 seconds (Total)
## Chain 4:

```

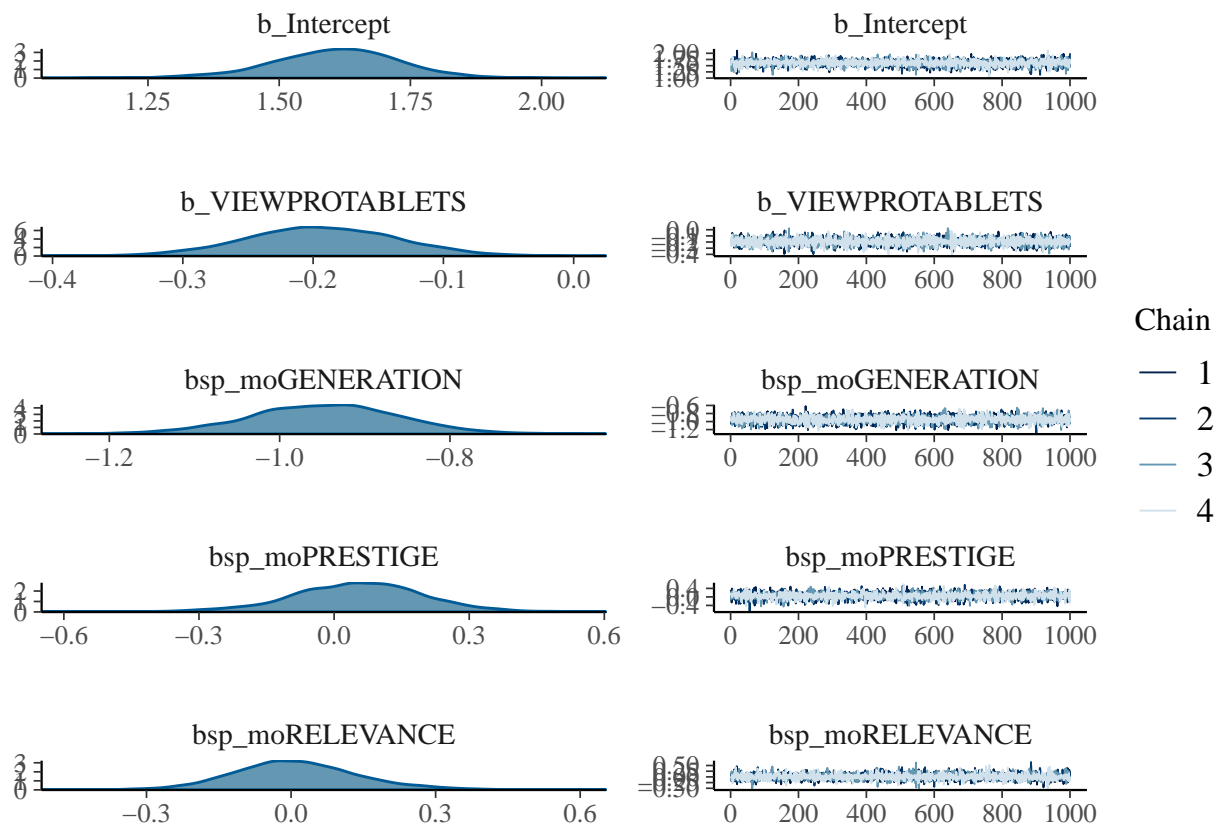
```
summary(mo.6a, prob=0.89)
```

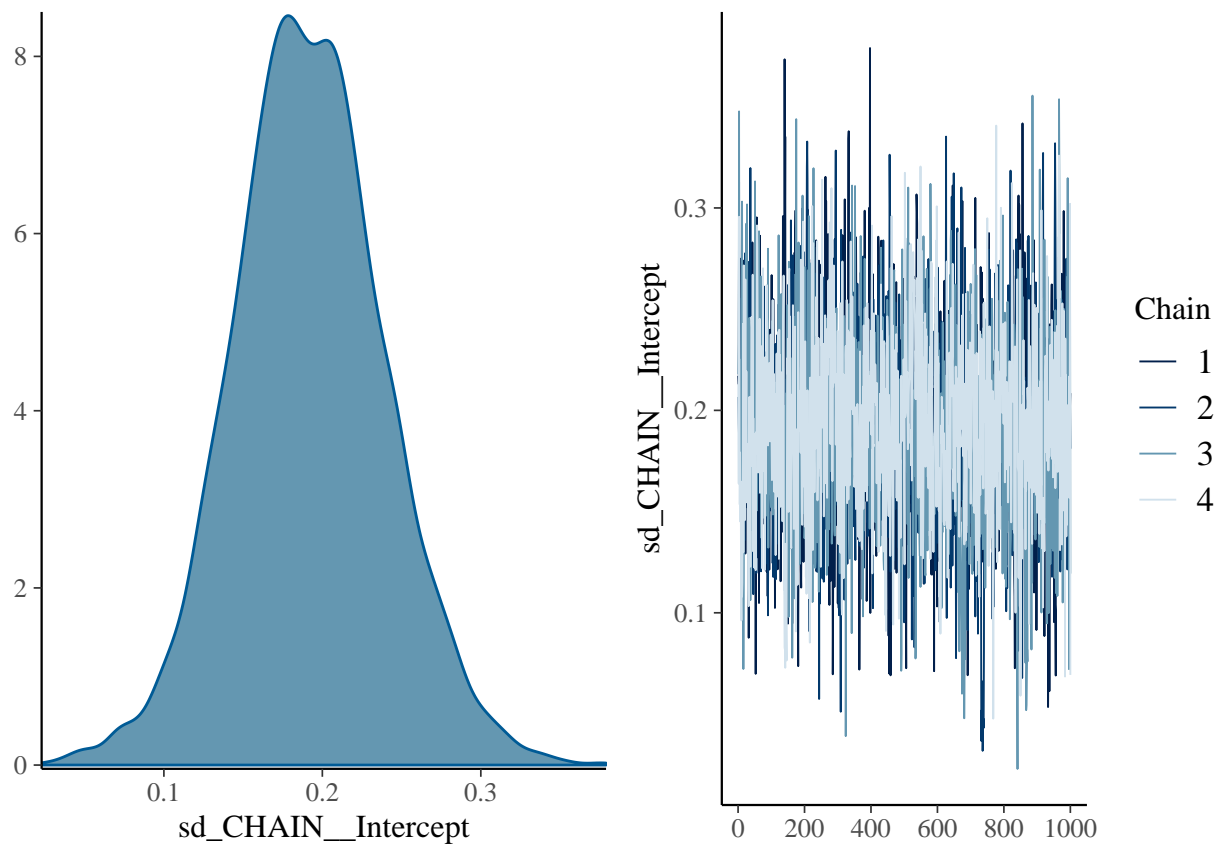
```

## Family: poisson
## Links: mu = log
## Formula: RECALL ~ mo(GENERATION) + mo(PRESTIGE) + mo(RELEVANCE) + VIEW + (1 | CHAIN)
## Data: d (Number of observations: 384)
## Samples: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
## total post-warmup samples = 4000
##
## Group-Level Effects:
## ~CHAIN (Number of levels: 48)
## Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## sd(Intercept) 0.19 0.05 0.12 0.27 1397 1.00

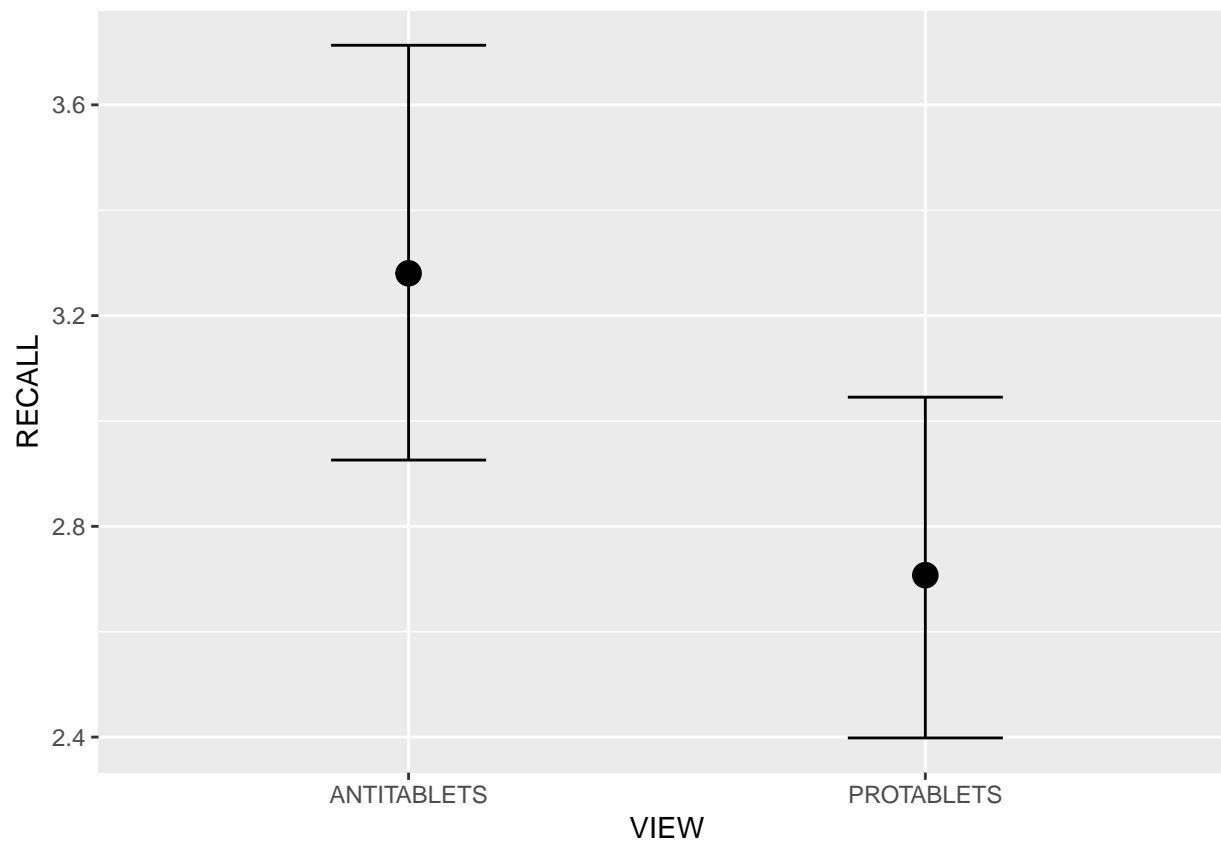
```

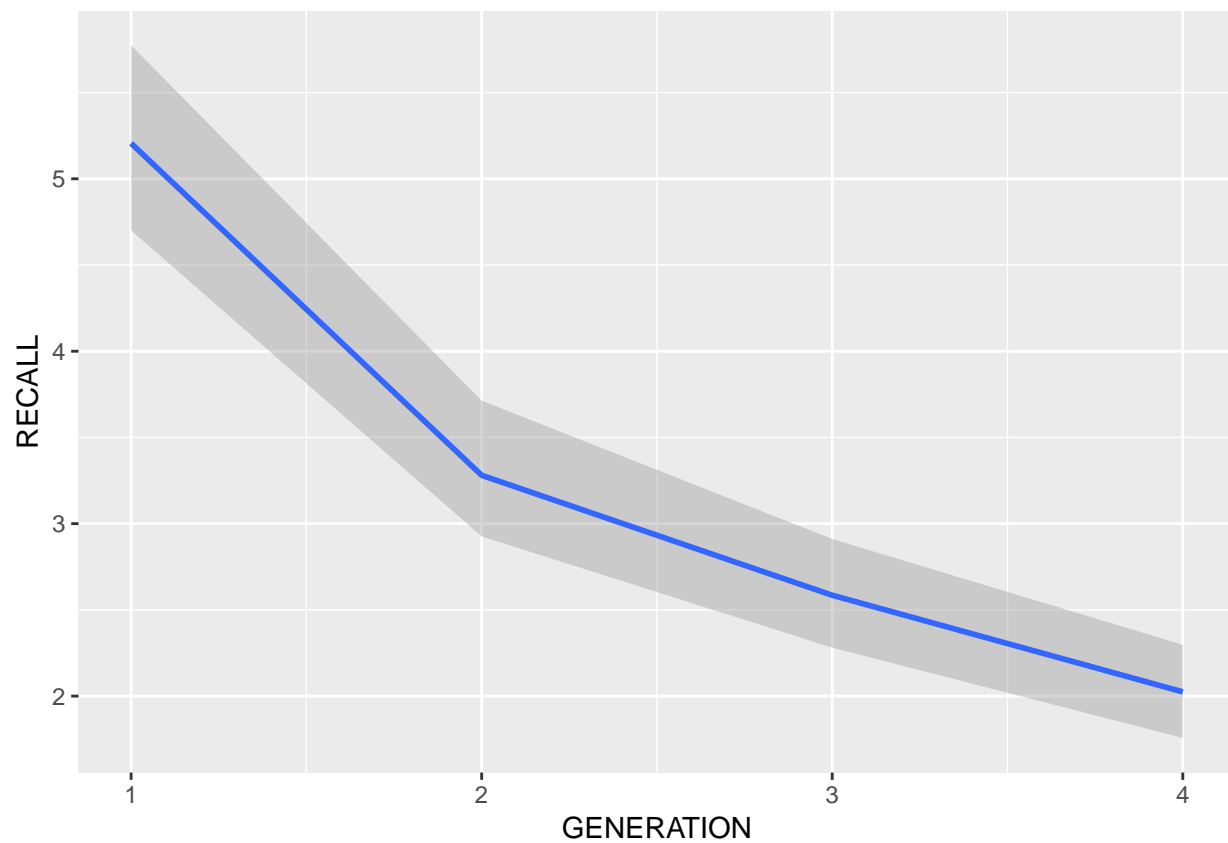
```
##
## Population-Level Effects:
##      Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## Intercept      1.61      0.12    1.40    1.79    3661 1.00
## VIEWPROTABLETS  -0.19      0.06   -0.29   -0.10    7643 1.00
## moGENERATION    -0.95      0.09   -1.09   -0.81    5536 1.00
## moPRESTIGE       0.05      0.15   -0.19    0.28    4818 1.00
## moRELEVANCE      0.01      0.13   -0.19    0.23    4125 1.00
##
## Simplex Parameters:
##      Estimate Est.Error 1-89% CI u-89% CI Eff.Sample Rhat
## moGENERATION1[1]  0.49      0.08    0.37    0.61    6746 1.00
## moGENERATION1[2]  0.26      0.09    0.11    0.41    6681 1.00
## moGENERATION1[3]  0.26      0.09    0.11    0.40    6200 1.00
## moPRESTIGE1[1]    0.26      0.19    0.02    0.61    7825 1.00
## moPRESTIGE1[2]    0.24      0.19    0.02    0.60    5708 1.00
## moPRESTIGE1[3]    0.23      0.18    0.02    0.58    5141 1.00
## moPRESTIGE1[4]    0.27      0.20    0.02    0.64    5220 1.00
## moRELEVANCE1[1]   0.19      0.15    0.01    0.49    5714 1.00
## moRELEVANCE1[2]   0.18      0.14    0.01    0.46    7110 1.00
## moRELEVANCE1[3]   0.16      0.14    0.01    0.43    6356 1.00
## moRELEVANCE1[4]   0.15      0.13    0.01    0.42    6181 1.00
## moRELEVANCE1[5]   0.16      0.14    0.01    0.43    5045 1.00
## moRELEVANCE1[6]   0.16      0.13    0.01    0.42    5497 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(mo.6a)
```

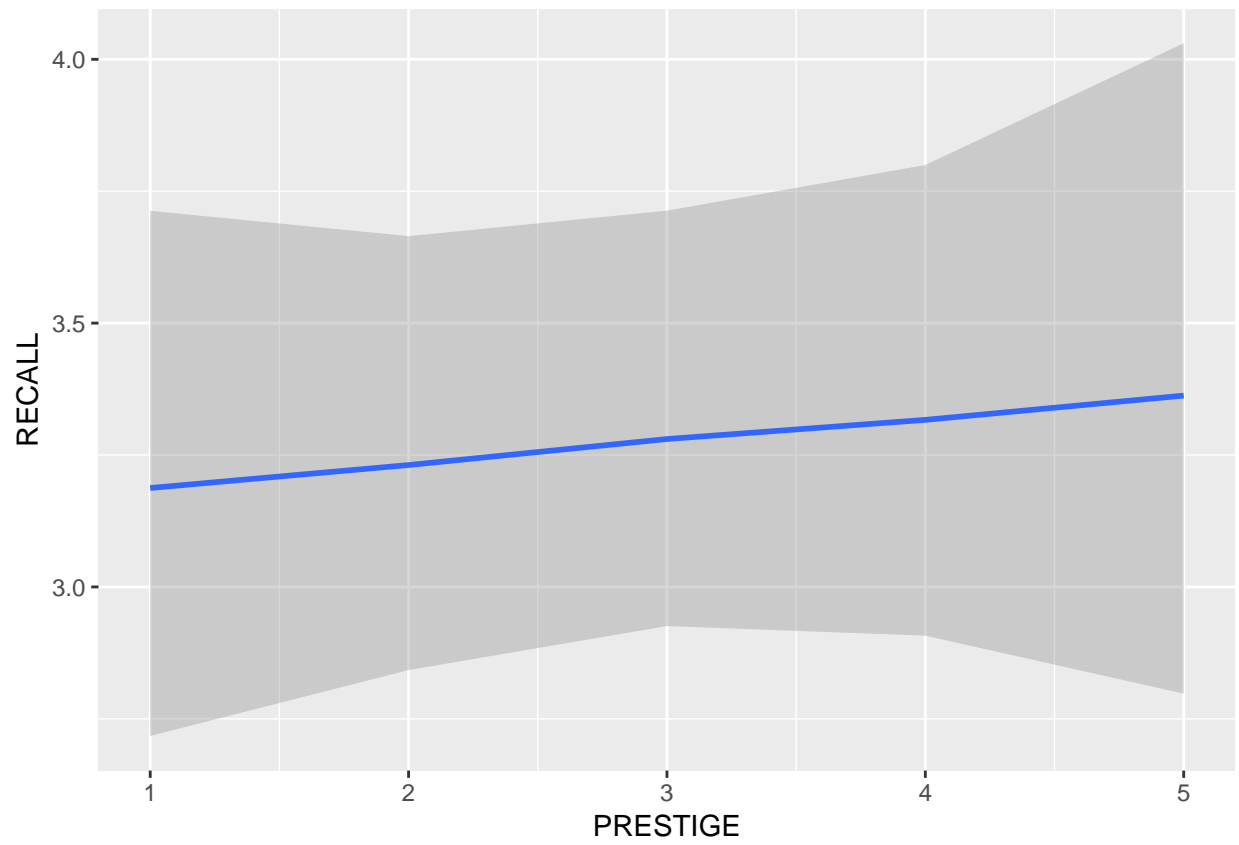


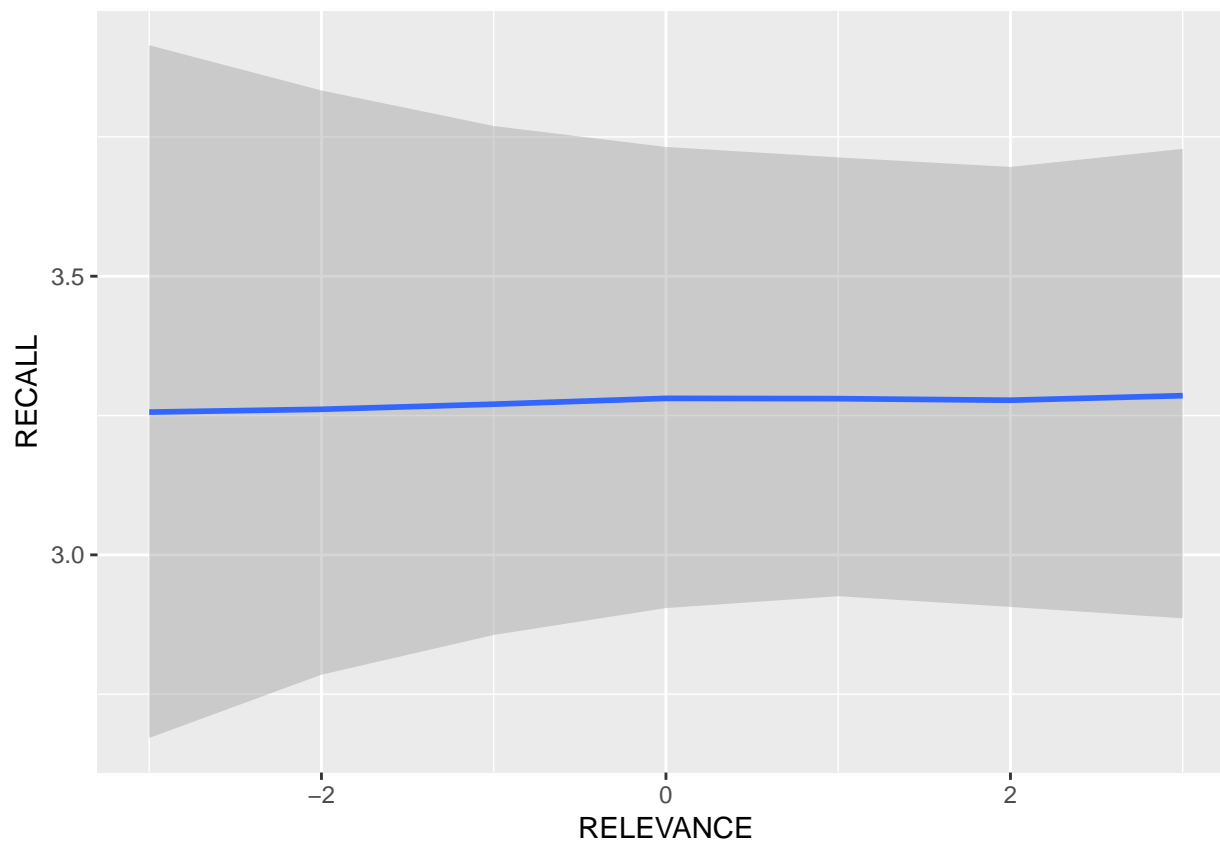


```
marginal_effects(mo.6a, probs = c(0.055, 0.945))
```







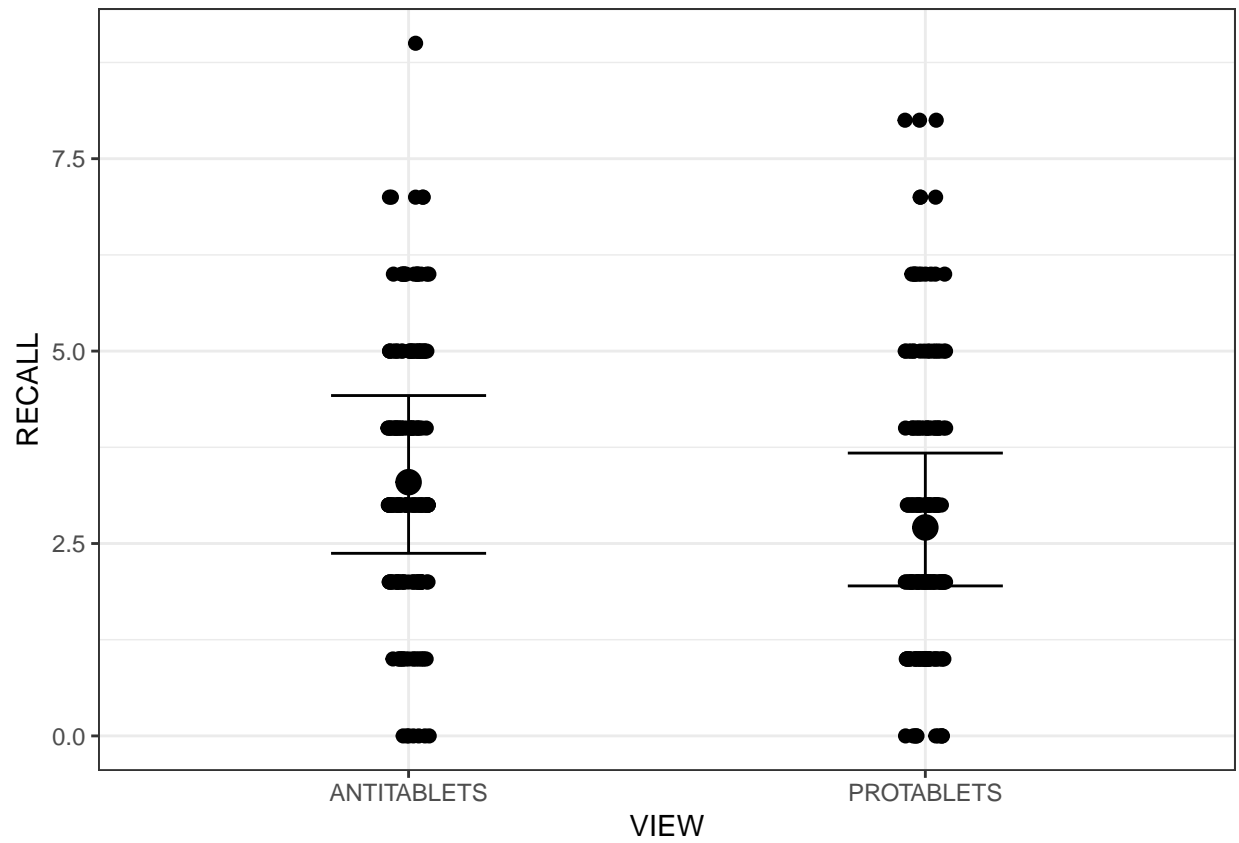


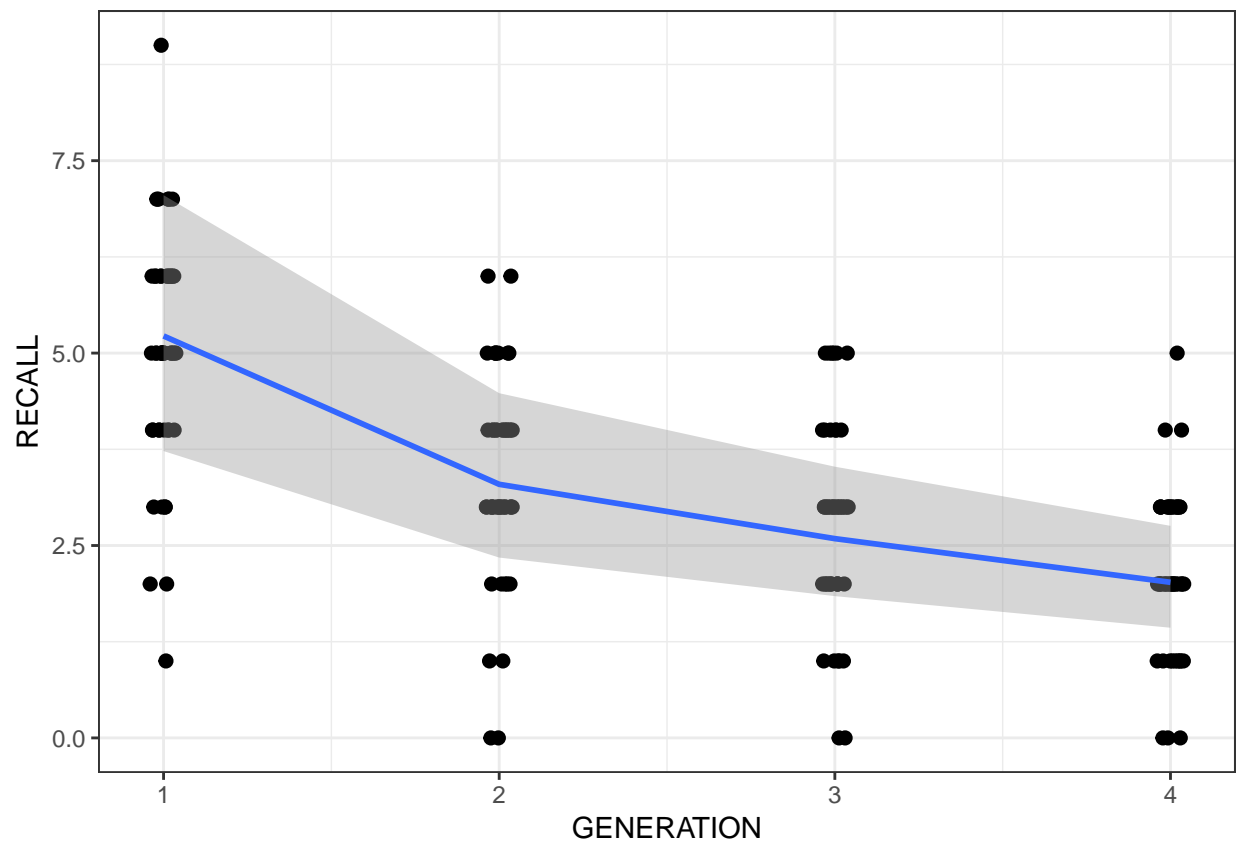
```
mo.6a<-add_criterion(mo.6a, c("loo", "waic"))
(loo.6a<-loo(mo.6a))
```

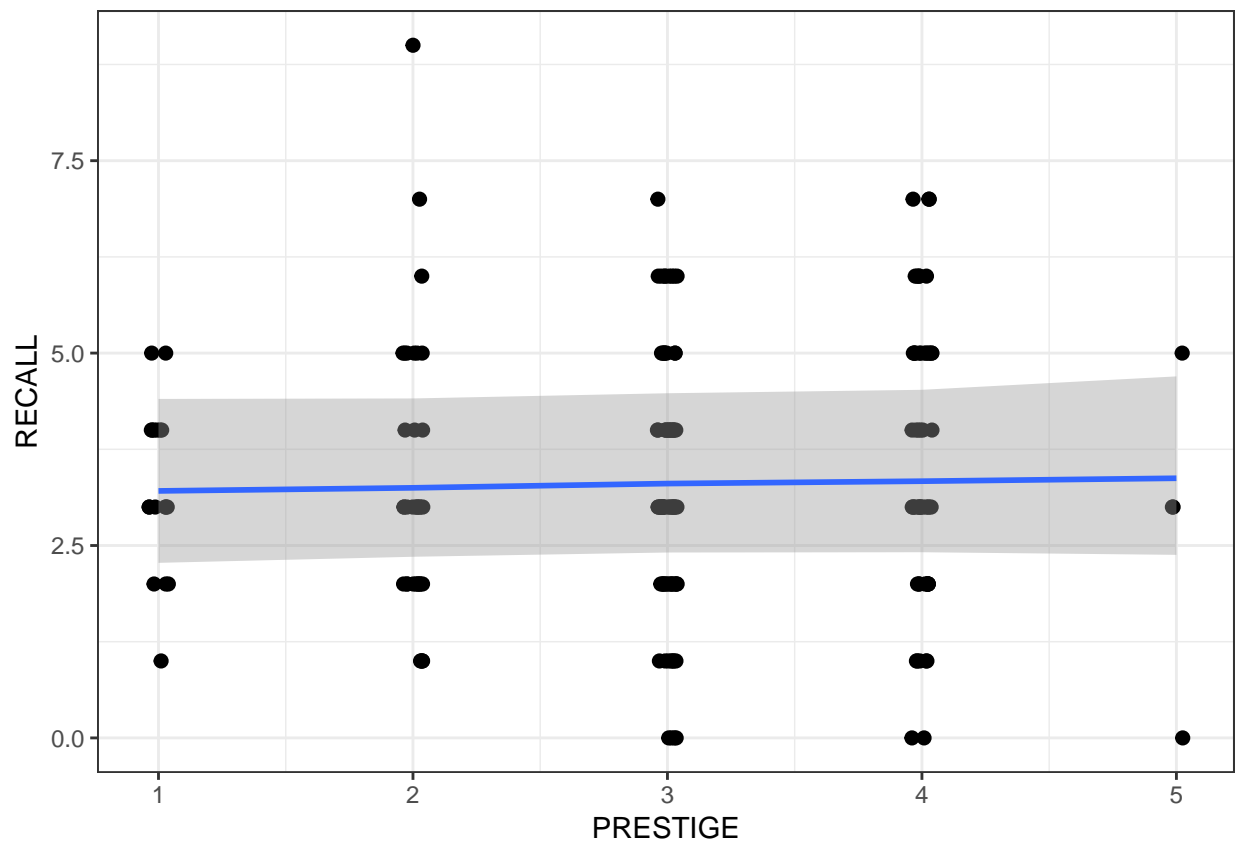
```
##
## Computed from 4000 by 384 log-likelihood matrix
##
##           Estimate   SE
## elpd_loo  -651.9  7.3
## p_loo      13.2  0.9
## looic      1303.8 14.5
## -----
## Monte Carlo SE of elpd_loo is 0.1.
##
## Pareto k diagnostic values:
##               Count Pct.    Min. n_eff
## (-Inf, 0.5] (good)   383  99.7%   2733
## (0.5, 0.7]  (ok)     1   0.3%   3506
## (0.7, 1]    (bad)     0   0.0%   <NA>
## (1, Inf)    (very bad) 0   0.0%   <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
```

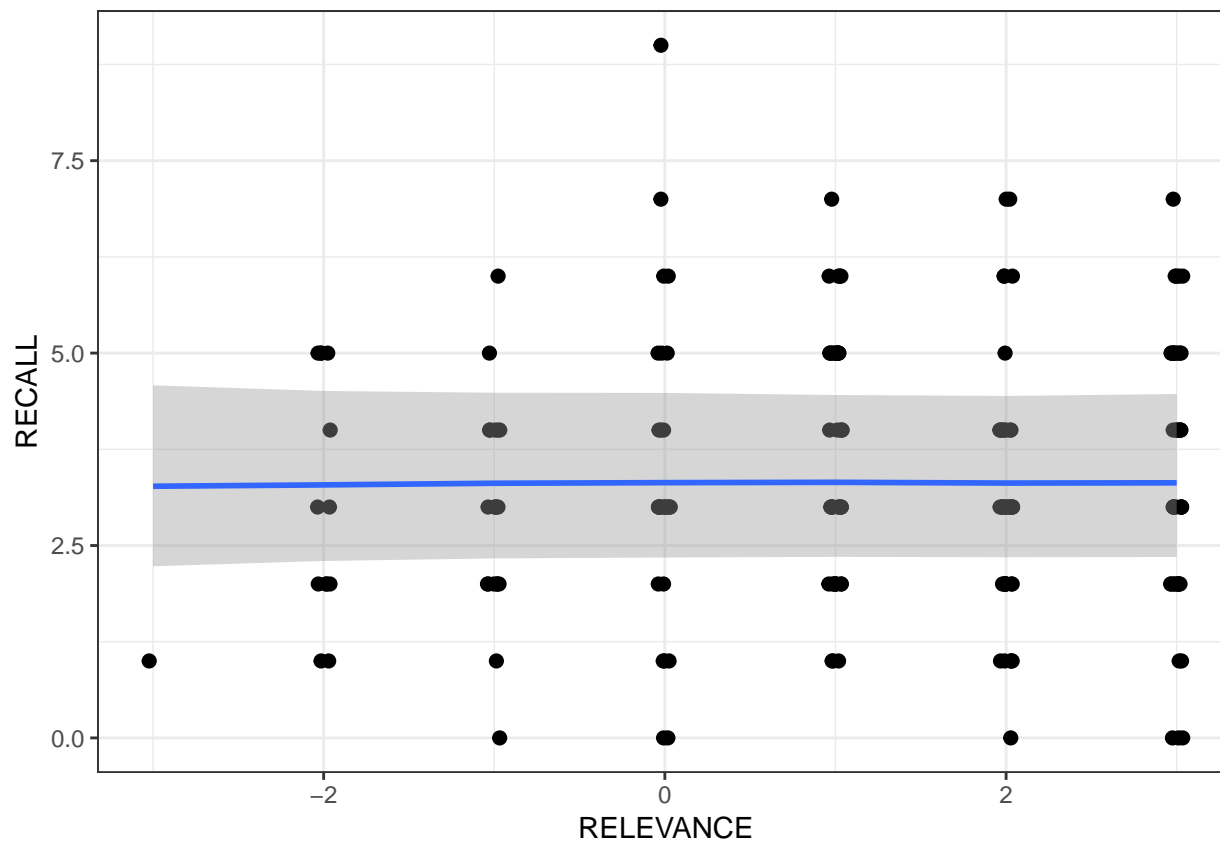
```
library(ggplot2)
```

```
plot(marginal_effects(mo.6a, probs = c(0.055, 0.945), re_formula=NULL), points = TRUE,
     point_args = list(width = 0.04), theme=theme_bw())
```









```
# Pseudo-BMA weights
```

```
lpd_point <- cbind(
  loo.1b$pointwise[, "elpd_loo"],
  loo.2a$pointwise[, "elpd_loo"],
  loo.3a$pointwise[, "elpd_loo"],
  loo.4a$pointwise[, "elpd_loo"],
  loo.5a$pointwise[, "elpd_loo"],
  loo.6a$pointwise[, "elpd_loo"])
```

```
# weights
```

```
library(loo)
```

```
## This is loo version 2.1.0.
```

```
## **NOTE: As of version 2.0.0 loo defaults to 1 core but we recommend using as many as possible. Use the
```

```
## **NOTE for Windows 10 users: loo may be very slow if 'mc.cores' is set in your .Rprofile file (see https://
```

```
(pbma_wts<-pseudobma_weights(lpd_point, BB=FALSE))
```

```
## Method: pseudo-BMA
```

```
## -----
```

```
##      weight
```

```
## model1 0.002
```

```
## model2 0.329
```

```
## model3 0.208
```

```
## model4 0.205
```

```
## model5 0.167
```

```
## model6 0.089
```