Analysis of the DSTP parameters

corrado

2023-09-20

```r
library("here")
```

```
## here() starts at /Users/corrado/_repositories/surprise
```

```r
suppressPackageStartupMessages({
  library("tidyverse")
  library("brms")
  library("cmdstanr")
  library("mice")
  library("tidybayes")
  library("emmeans")
  library("broom.mixed")
  library("patchwork")
})

theme_set(bayesplot::theme_default(base_family = "sans", base_size = 14))
set.seed(123)

params_cntl <- rio::import(
  here::here(
    "data", "processed", "params_data", "dstp", "control_DSTP_params.csv"
  )
)
params_cntl$exp <- "control"

params_surprise <- rio::import(
  here::here(
    "data", "processed", "params_data", "dstp", "surprise_DSTP_params.csv"
  )
)
params_surprise$exp <- "surprise"
# In both experiments, the subjects' id start from 1.
params_surprise$subject <- params_surprise$subject + 500

df <- bind_rows(params_cntl, params_surprise)
df$blk <- factor(df$block)
```

Parameter A:

Height of the boundary for the response selection diffusion process

```r
m1 <- brm(
  A ~ exp * blk + (1 + blk | subject),
  family = shifted_lognormal(),
  backend = "cmdstanr",
  data = df
)
```

```
## In file included from /var/folders/cl/wwjrsxdd5tz7y9jr82nd5hrw0000gn/T/RtmpDVAVEa/model-d44073536660
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/src/stan/model/model_header.hpp:4:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math.hpp:19:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev.hpp:10
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev/fun.hp
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
```

```
## ed [-Wdeprecated-declarations]
##         struct hash_base : std::unary_function<T, std::size_t> {};
##                                 ^
```

```
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         : public boost::hash_detail::hash_base<T*>
##                  ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         boost::hash<T> hasher;
##                        ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         hash_combine(seed, &v.category());
##         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__functional/unary_function.h
## struct _LIBCPP_TEMPLATE_VIS _LIBCPP_DEPRECATED_IN_CXX11 unary_function
##                             ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:825:41: note: expande
## #    define _LIBCPP_DEPRECATED_IN_CXX11 _LIBCPP_DEPRECATED
##                                         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:810:49: note: expande
## #      define _LIBCPP_DEPRECATED __attribute__((deprecated))
##                                                 ^
```

```
## 1 warning generated.
```

```
## Start sampling
```

```
## Running MCMC with 4 sequential chains...
```

```
##
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 1 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 1 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 1 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 1 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 1 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 1 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 1 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 1 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 1 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 7.1 seconds.
## Chain 2 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 2 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 2 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 2 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 2 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 2 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2 Iteration: 1001 / 2000 [ 50%]  (Sampling)
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## Chain 2 Iteration: 1400 / 2000 [ 70%]  (Sampling)
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## Chain 2 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 7.0 seconds.
## Chain 3 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 3 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3 Iteration:  300 / 2000 [ 15%]  (Warmup)
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## Chain 3 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3 Iteration: 1001 / 2000 [ 50%]  (Sampling)
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## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 7.5 seconds.
## Chain 4 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 4 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 4 Iteration:  400 / 2000 [ 20%]  (Warmup)
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## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
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## Chain 4 Iteration: 1001 / 2000 [ 50%]  (Sampling)
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## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 finished in 7.1 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 7.2 seconds.
## Total execution time: 29.0 seconds.
```
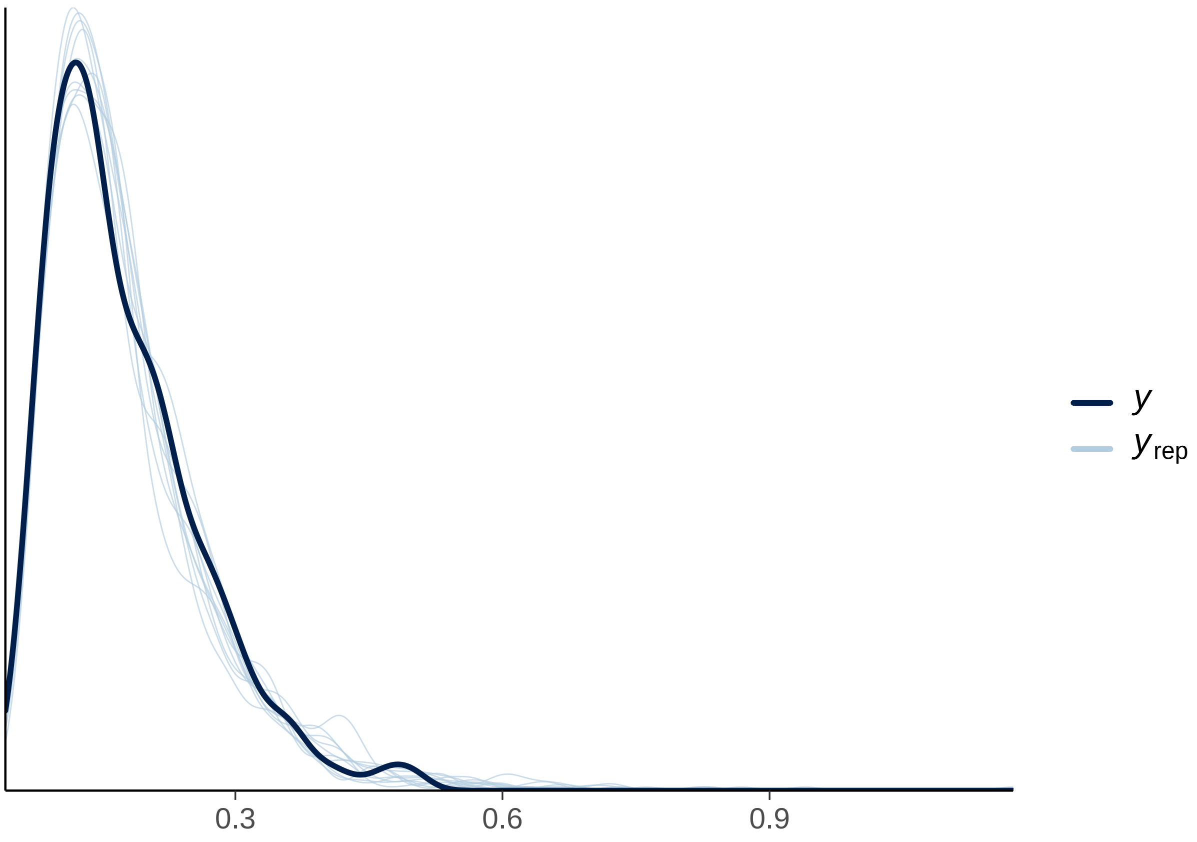

```
## Warning: 4 of 4 chains had an E-BFMI less than 0.2.
## See https://mc-stan.org/misc/warnings for details.
```

```r
pp_check(m1)
```

```
## Using 10 posterior draws for ppc type 'dens_overlay' by default.
```

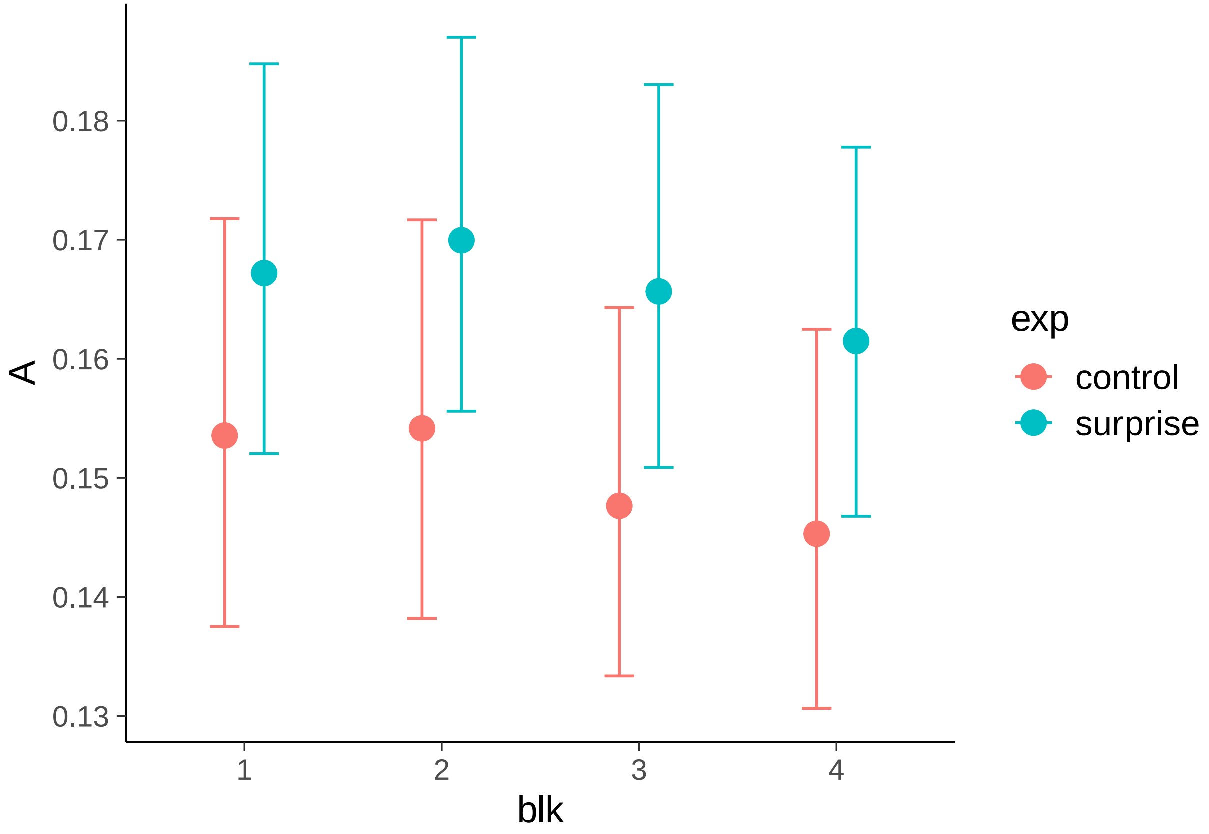


```
summary(m1)
```

```
## Warning: Parts of the model have not converged (some Rhats are > 1.05). Be
## careful when analysing the results! We recommend running more iterations and/or
## setting stronger priors.
```

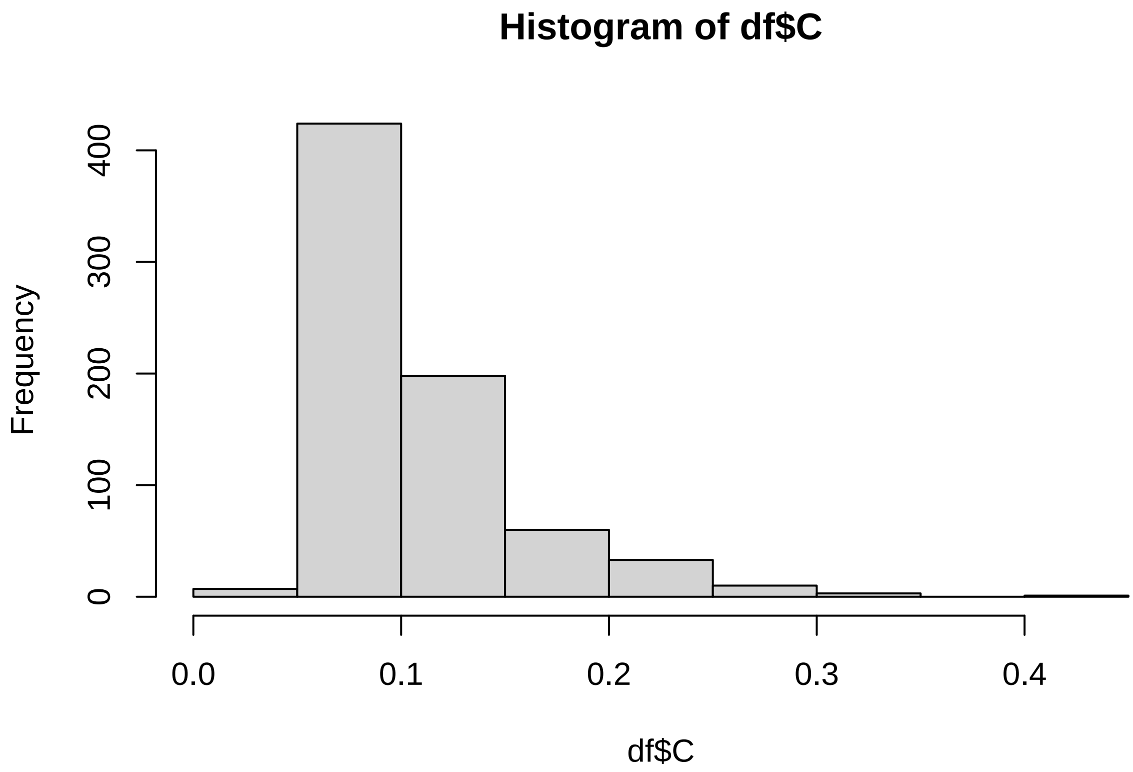
```
##  Family: shifted_lognormal
##   Links: mu = identity; sigma = identity; ndt = identity
## Formula: A ~ exp * blk + (1 + blk | subject)
##    Data: df (Number of observations: 736)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Group-Level Effects:
## ~subject (Number of levels: 184)
##                    Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)          0.52      0.05     0.42     0.63 1.09       34      112
## sd(blk2)               0.46      0.08     0.31     0.63 1.14       20       31
## sd(blk3)               0.49      0.08     0.35     0.66 1.13       22       33
## sd(blk4)               0.56      0.08     0.42     0.73 1.12       25       37
## cor(Intercept,blk2)   -0.47      0.10    -0.64    -0.24 1.03      156     1302
## cor(Intercept,blk3)   -0.50      0.09    -0.66    -0.30 1.03      158     1567
## cor(blk2,blk3)         0.83      0.08     0.68     0.97 1.08       39      761
## cor(Intercept,blk4)   -0.56      0.08    -0.69    -0.39 1.02      287     1787
## cor(blk2,blk4)         0.79      0.08     0.62     0.95 1.06       50      516
## cor(blk3,blk4)          0.89      0.06     0.76     0.99 1.12       24       66
##
## Population-Level Effects:
##                   Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept            -2.15      0.08    -2.31    -1.99 1.00     1124     1471
## expsurprise           0.11      0.09    -0.07     0.29 1.00     1064     1659
## blk2                  0.00      0.08    -0.14     0.15 1.00     1181     1779
## blk3                 -0.05      0.08    -0.20     0.11 1.00     1153     1629
## blk4                 -0.07      0.09    -0.23     0.10 1.00     1053     1468
## expsurprise:blk2      0.02      0.10    -0.17     0.21 1.00     1136     1737
## expsurprise:blk3      0.04      0.10    -0.16     0.23 1.00     1168     1963
## expsurprise:blk4      0.03      0.11    -0.19     0.24 1.00     1111     1662
##
## Family Specific Parameters:
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.32      0.05     0.19     0.39 1.19       15       19
## ndt       0.03      0.00     0.02     0.04 1.00     2017     2192
##
## Draws were sampled using sample(hmc). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
conditional_effects(m1, "blk:exp")
```



Parameter C: Height of the boundary for the stimulus selection diffusion process

```r
hist(df$C)
```



```r
m2 <- brm(
  C ~ exp * blk + (1 + blk | subject),
  family = shifted_lognormal(),
  backend = "cmdstanr",
  # algorithm = "meanfield",
  data = df
)
```

```
## In file included from /var/folders/cl/wwjrsxdd5tz7y9jr82nd5hrw0000gn/T/RtmpDVAVEa/model-d44059b7cd9e
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/src/stan/model/model_header.hpp:4:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math.hpp:19:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev.hpp:10
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev/fun.hp
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
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## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash

## ed [-Wdeprecated-declarations]
##         struct hash_base : std::unary_function<T, std::size_t> {};
##                                 ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         : public boost::hash_detail::hash_base<T*>
##                  ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         boost::hash<T> hasher;
##                        ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         hash_combine(seed, &v.category());
##         ^

## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__functional/unary_function.h
## struct _LIBCPP_TEMPLATE_VIS _LIBCPP_DEPRECATED_IN_CXX11 unary_function
##                             ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:825:41: note: expande
## #    define _LIBCPP_DEPRECATED_IN_CXX11 _LIBCPP_DEPRECATED
##                                         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:810:49: note: expande
## #      define _LIBCPP_DEPRECATED __attribute__((deprecated))
##                                                 ^

## 1 warning generated.

## Start sampling

## Running MCMC with 4 sequential chains...
##
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 1 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 1 Iteration:  400 / 2000 [ 20%]  (Warmup)
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## Chain 1 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 1 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 1 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 1 Iteration: 1200 / 2000 [ 60%]  (Sampling)
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## Chain 1 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 1 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 1 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 10.4 seconds.
## Chain 2 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 2 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2 Iteration:  300 / 2000 [ 15%]  (Warmup)
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## Chain 2 Iteration:  600 / 2000 [ 30%]  (Warmup)
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## Chain 2 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 2 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 2 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 2 Iteration: 1400 / 2000 [ 70%]  (Sampling)
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## Chain 2 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 2 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 7.2 seconds.
## Chain 3 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 3 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 3 Iteration:  400 / 2000 [ 20%]  (Warmup)
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## Chain 3 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3 Iteration:  900 / 2000 [ 45%]  (Warmup)
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## Chain 3 Iteration: 1001 / 2000 [ 50%]  (Sampling)
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## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
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## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 8.7 seconds.
## Chain 4 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 4 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 4 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4 Iteration:  500 / 2000 [ 25%]  (Warmup)
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## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 4 Iteration:  800 / 2000 [ 40%]  (Warmup)
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## Chain 4 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 4 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 finished in 9.9 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 9.0 seconds.
## Total execution time: 36.4 seconds.
```
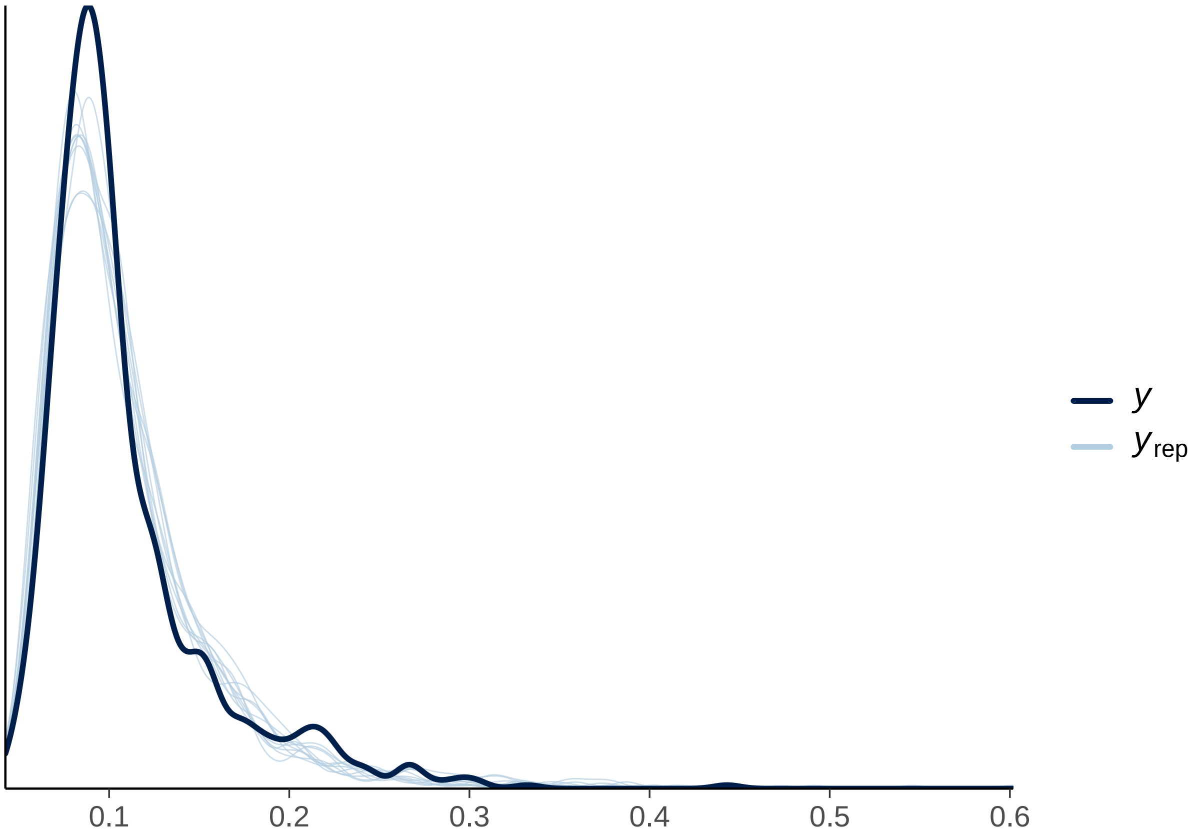

```
## Warning: 81 of 4000 (2.0%) transitions ended with a divergence.
## See https://mc-stan.org/misc/warnings for details.
```

```
## Warning: 3 of 4 chains had an E-BFMI less than 0.2.
## See https://mc-stan.org/misc/warnings for details.
```

```r
pp_check(m2)
```

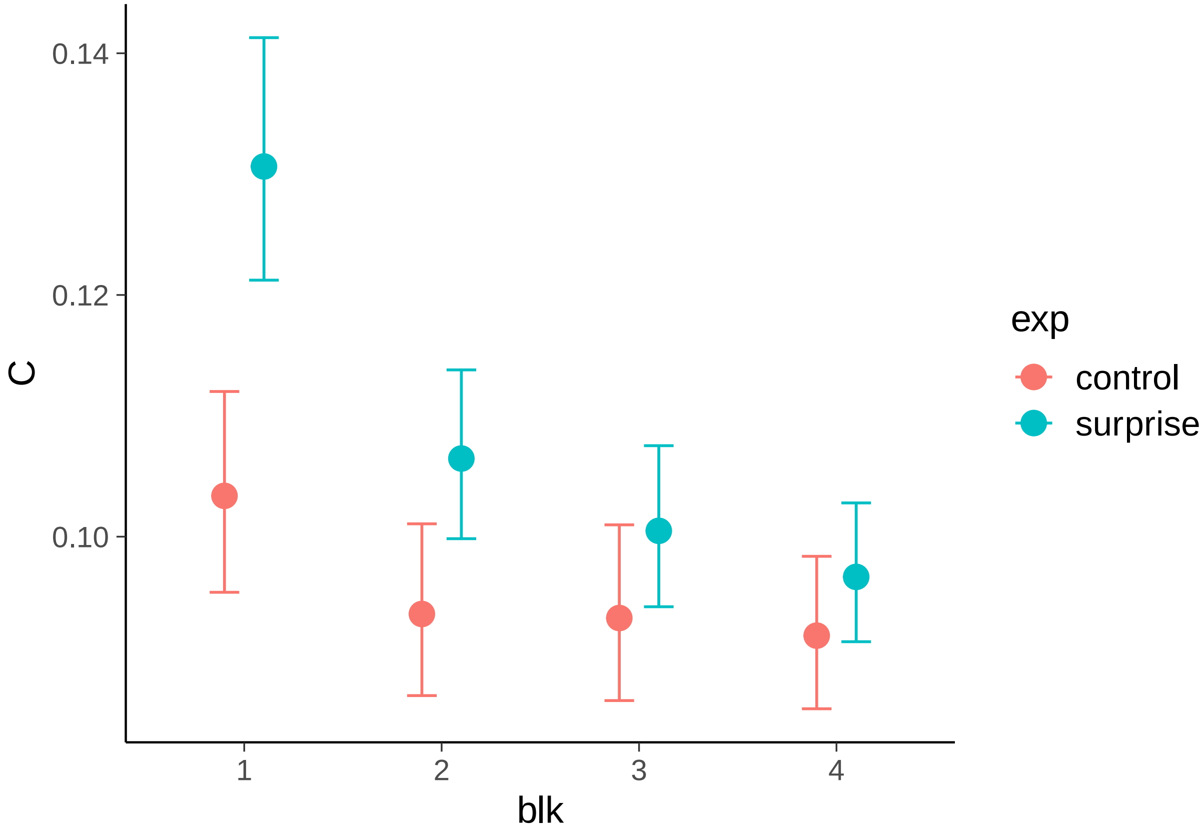
```
## Using 10 posterior draws for ppc type 'dens_overlay' by default.
```



```r
summary(m2)
```

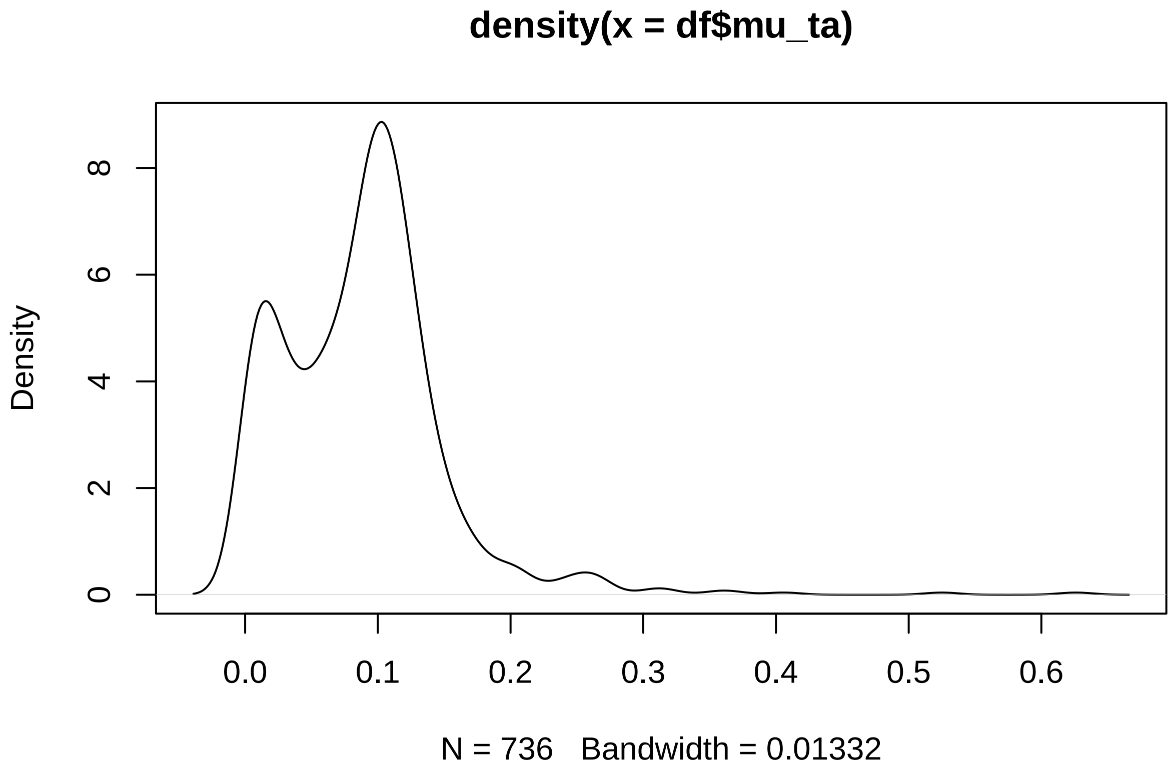
```
## Warning: Parts of the model have not converged (some Rhats are > 1.05). Be
## careful when analysing the results! We recommend running more iterations and/or
## setting stronger priors.

## Warning: There were 81 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: shifted_lognormal
##   Links: mu = identity; sigma = identity; ndt = identity
## Formula: C ~ exp * blk + (1 + blk | subject)
##    Data: df (Number of observations: 736)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Group-Level Effects:
## ~subject (Number of levels: 184)
##                        Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)              0.41      0.05     0.32     0.51 1.08       37      288
## sd(blk2)                   0.15      0.10     0.01     0.35 1.10       31      124
## sd(blk3)                   0.20      0.12     0.01     0.40 1.12       26      273
## sd(blk4)                   0.22      0.11     0.02     0.42 1.11       26       84
## cor(Intercept,blk2)       -0.35      0.32    -0.79     0.50 1.03      210     1024
## cor(Intercept,blk3)    -0.34      0.29    -0.73     0.44 1.03      203      735
## cor(blk2,blk3)          0.39      0.41    -0.64     0.90 1.05      100      734
## cor(Intercept,blk4)    -0.62      0.20    -0.88    -0.08 1.03     1201      482
## cor(blk2,blk4)          0.54      0.40    -0.51     0.95 1.07       50      859
## cor(blk3,blk4)          0.59      0.38    -0.48     0.95 1.04       92      566
##
## Population-Level Effects:
##                    Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept           -2.67      0.07    -2.81    -2.53 1.00     1072     1672
## expsurprise          0.32      0.08     0.17     0.47 1.00      897     1554
## blk2                -0.14      0.06    -0.25    -0.03 1.00      596     2114
## blk3                -0.15      0.06    -0.27    -0.03 1.00      810     1250
## blk4                -0.17      0.06    -0.29    -0.06 1.00      852     1488
## expsurprise:blk2    -0.13      0.07    -0.28     0.01 1.00     1015     1778
## expsurprise:blk3    -0.21      0.08    -0.36    -0.06 1.00      885     1033
## expsurprise:blk4    -0.24      0.08    -0.39    -0.09 1.00     1027     1454
##
## Family Specific Parameters:
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.32      0.03     0.25     0.37 1.09       36      209
## ndt       0.03      0.00     0.02     0.03 1.00     1013     1886
##
## Draws were sampled using sample(hmc). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```r
conditional_effects(m2, "blk:exp")
```



Parameter mu_ta: Drift rate for central target during response selection phase 1

```
plot(density(df$mu_ta))
```



```
m3 <- brm(
  mu_ta ~ exp * blk + (1 + blk | subject),
  family = student(),
  backend = "cmdstanr",
  # algorithm = "meanfield",
  data = df
)
```

```
## In file included from /var/folders/cl/wwjrsxdd5tz7y9jr82nd5hrw0000gn/T/RtmpDVAVEa/model-d440365afac4
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/src/stan/model/model_header.hpp:4:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math.hpp:19:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev.hpp:10
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev/fun.hp
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash

## ed [-Wdeprecated-declarations]
##         struct hash_base : std::unary_function<T, std::size_t> {};
##                                 ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         : public boost::hash_detail::hash_base<T*>
##                  ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         boost::hash<T> hasher;
##                        ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         hash_combine(seed, &v.category());
##         ^
```

```
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__functional/unary_function.h
## struct _LIBCPP_TEMPLATE_VIS _LIBCPP_DEPRECATED_IN_CXX11 unary_function
##                             ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:825:41: note: expand
## #    define _LIBCPP_DEPRECATED_IN_CXX11 _LIBCPP_DEPRECATED
##                                         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:810:49: note: expand
## #      define _LIBCPP_DEPRECATED __attribute__((deprecated))
##                                                 ^
```

```
## 1 warning generated.
```

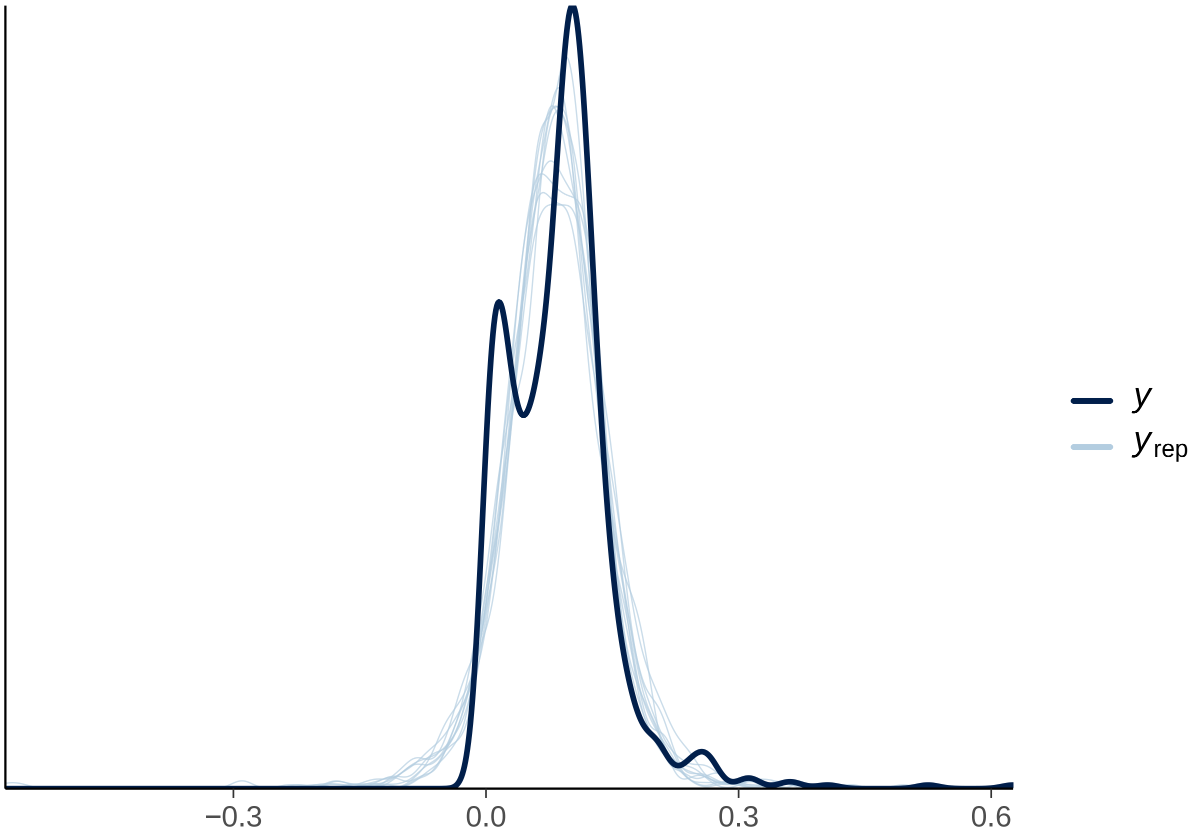
```
## Start sampling
```

```
## Running MCMC with 4 sequential chains...
##
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 1 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 1 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 1 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 1 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 1 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 1 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 1 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 1 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 1 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 11.4 seconds.
## Chain 2 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 2 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 2 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 2 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 2 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 2 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 2 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 2 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 2 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 2 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 13.0 seconds.
## Chain 3 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 3 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 3 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 3 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 3 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 3 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 3 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 3 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 11.0 seconds.
## Chain 4 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 4 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 4 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 4 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 4 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 4 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 4 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 4 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 finished in 12.4 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 11.9 seconds.
## Total execution time: 48.1 seconds.
```

```
## Warning: 1 of 4000 (0.0%) transitions ended with a divergence.
## See https://mc-stan.org/misc/warnings for details.
```

```
pp_check(m3)
```

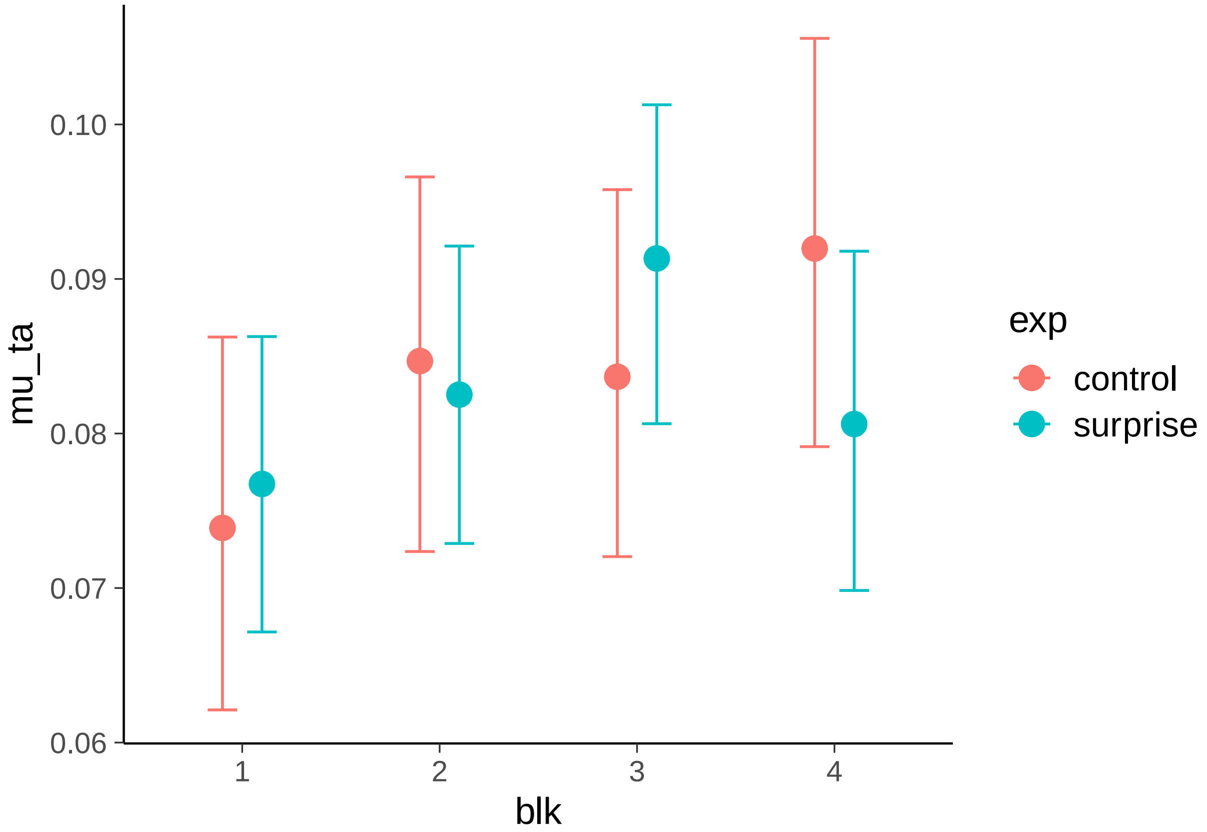
```
## Using 10 posterior draws for ppc type 'dens_overlay' by default.
```



```r
summary(m3)
```

```
## Warning: Parts of the model have not converged (some Rhats are > 1.05). Be
## careful when analysing the results! We recommend running more iterations and/or
## setting stronger priors.

## Warning: There were 1 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: student 
##   Links: mu = identity; sigma = identity; nu = identity 
## Formula: mu_ta ~ exp * blk + (1 + blk | subject) 
##    Data: df (Number of observations: 736) 
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
## 
## Group-Level Effects: 
## ~subject (Number of levels: 184) 
##                      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)            0.03      0.00     0.02     0.03 1.02      370      559
## sd(blk2)                 0.01      0.01     0.00     0.03 1.01      383      387
## sd(blk3)                 0.03      0.01     0.00     0.04 1.07       51      283
## sd(blk4)                 0.04      0.01     0.02     0.05 1.06       66      237
## cor(Intercept,blk2)      0.03      0.40    -0.70     0.78 1.00     2524     2911
## cor(Intercept,blk3)     -0.18      0.29    -0.61     0.56 1.03      209      810
## cor(blk2,blk3)           0.21      0.42    -0.70     0.87 1.03      286      818
## cor(Intercept,blk4)     -0.33      0.21    -0.64     0.19 1.03      151      578
## cor(blk2,blk4)           0.11      0.40    -0.72     0.79 1.02      238      469
## cor(blk3,blk4)           0.56      0.27    -0.18     0.92 1.02      460      431
## 
## Population-Level Effects: 
##                   Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept             0.07      0.01     0.06     0.09 1.00     1775     1699
## expsurprise           0.00      0.01    -0.01     0.02 1.00     1501     1228
## blk2                  0.01      0.01    -0.00     0.03 1.00     2569     3133
## blk3                  0.01      0.01    -0.01     0.03 1.00     1525     1683
## blk4                  0.02      0.01     0.00     0.03 1.00     1913     2841
## expsurprise:blk2     -0.01      0.01    -0.02     0.01 1.00     2339     2846
## expsurprise:blk3      0.00      0.01    -0.01     0.02 1.00     1427     1466
## expsurprise:blk4     -0.01      0.01    -0.04     0.01 1.00     1661     2601
## 
## Family Specific Parameters: 
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.03      0.00     0.03     0.04 1.05      101      275
## nu        3.23      0.58     2.28     4.50 1.02      267      615
## 
## Draws were sampled using sample(hmc). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```r
conditional_effects(m3, "blk:exp")
```



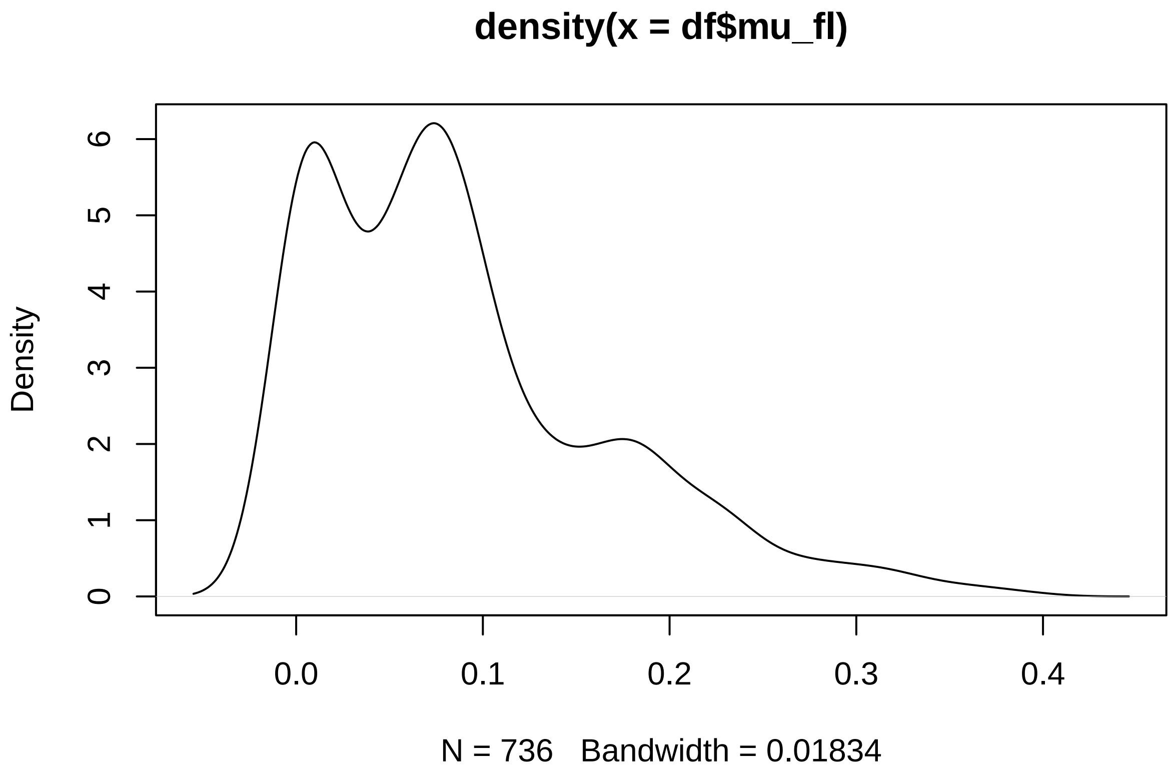
Parameter mu_fl: Drift rate for the flankers during response selection phase 1

```r
df |>
  group_by(exp, blk) |>
  summarize(
    mu_fl = mean(mu_fl, trim = 0.1),
    n = n(),
    stderr = sqrt(var(mu_fl) / n)
  )
```

```
## ‘summarise()‘ has grouped output by ’exp’. You can override using the ‘.groups‘
## argument.
```

```
## # A tibble: 8 x 5
## # Groups:   exp [2]
##   exp      blk    mu_fl     n stderr
##   <chr>    <fct>  <dbl> <int>  <dbl>
## 1 control  1     0.0775    75     NA
## 2 control  2     0.0892    75     NA
## 3 control  3     0.103     75     NA
## 4 control  4     0.119     75     NA
## 5 surprise 1     0.0423   109     NA
## 6 surprise 2     0.0661   109     NA
## 7 surprise 3      0.0707   109      NA
## 8 surprise 4      0.0887   109      NA
```

```
# df$mu_fl <- 0.001 + df$mu_fl * 10
plot(density(df$mu_fl))
```



```
m4 <- brm(
  mu_fl ~ exp * blk + (1 + blk | subject),
  family = zero_inflated_beta(),
  backend = "cmdstanr",
  # control = list(max_treedepth = 15, adapt_delta = 0.95),
  # algorithm = "meanfield",
  # iter = 10000,
  data = df
)
```

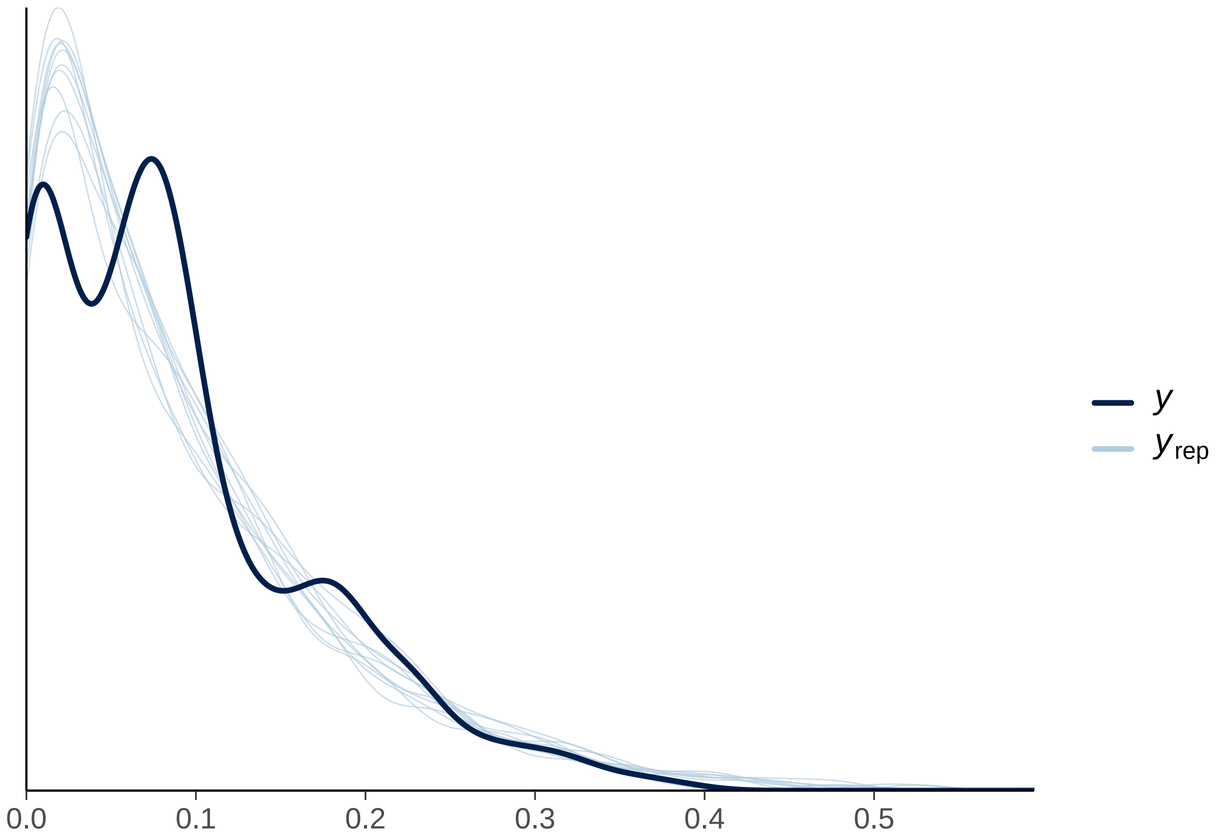
```
## In file included from /var/folders/cl/wwjrsxdd5tz7y9jr82nd5hrw0000gn/T/RtmpDVAVEa/model-d44052c839e9
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/src/stan/model/model_header.hpp:4:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math.hpp:19:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev.hpp:10
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev/fun.hp
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
## ed [-Wdeprecated-declarations]
##         struct hash_base : std::unary_function<T, std::size_t> {};
##                                 ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         : public boost::hash_detail::hash_base<T*>
##                  ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         boost::hash<T> hasher;
##                        ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         hash_combine(seed, &v.category());
##         ^
##
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__functional/unary_function.h
## struct _LIBCPP_TEMPLATE_VIS _LIBCPP_DEPRECATED_IN_CXX11 unary_function
##                             ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:825:41: note: expande
## #    define _LIBCPP_DEPRECATED_IN_CXX11 _LIBCPP_DEPRECATED
##                                         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:810:49: note: expande
## #      define _LIBCPP_DEPRECATED __attribute__((deprecated))
##                                                 ^
##
## 1 warning generated.
##
## Start sampling
```

```
## Running MCMC with 4 sequential chains...
##
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 1 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 1 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 1 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 1 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 1 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 1 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 1 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 1 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 1 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 20.0 seconds.
## Chain 2 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 2 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 2 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 2 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 2 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 2 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 2 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 2 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 2 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 2 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 20.0 seconds.
## Chain 3 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 3 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 3 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 3 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 3 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 3 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 3 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 3 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 18.9 seconds.
## Chain 4 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 4 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 4 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 4 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 4 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 4 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 4 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 4 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 finished in 19.8 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 19.7 seconds.
## Total execution time: 79.0 seconds.
```

```
## Warning: 2 of 4000 (0.0%) transitions ended with a divergence.
## See https://mc-stan.org/misc/warnings for details.
```

```
pp_check(m4)
```

```
## Using 10 posterior draws for ppc type 'dens_overlay' by default.
```

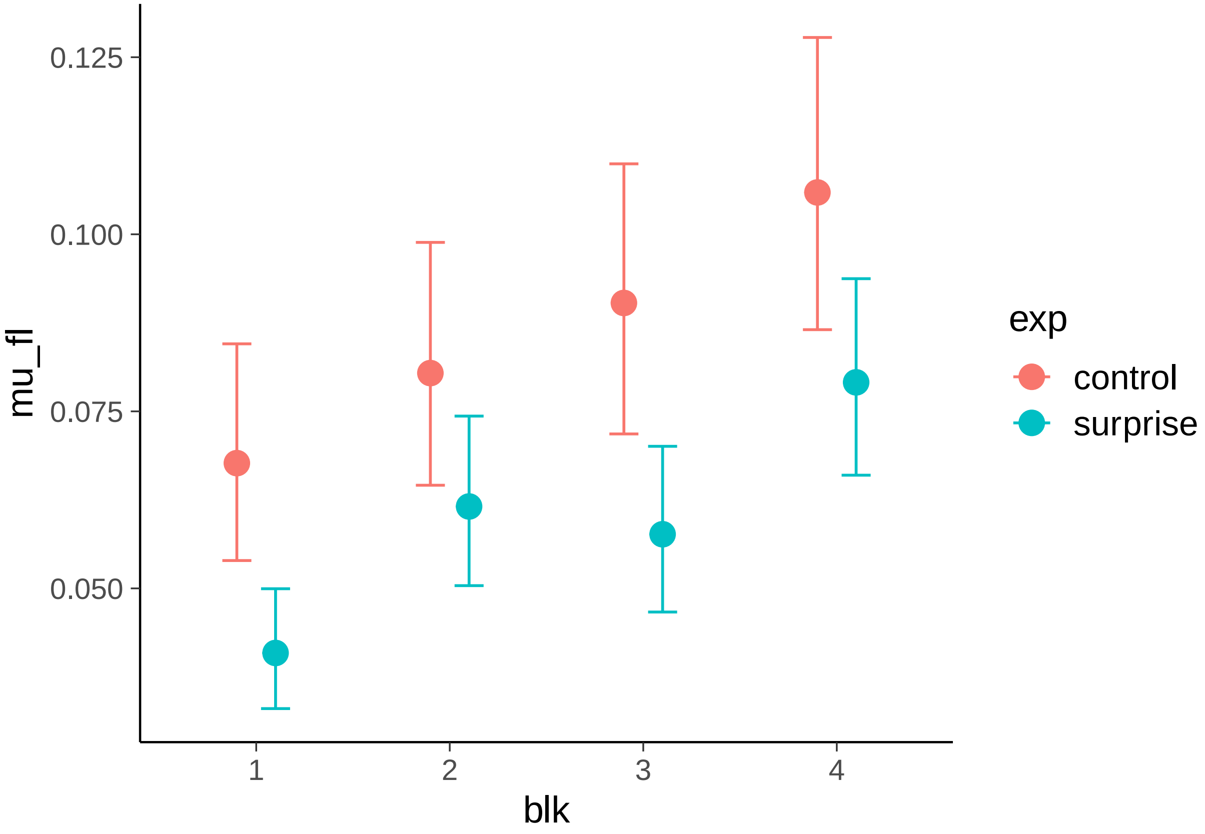


```
summary(m4)
```

```
## 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
```

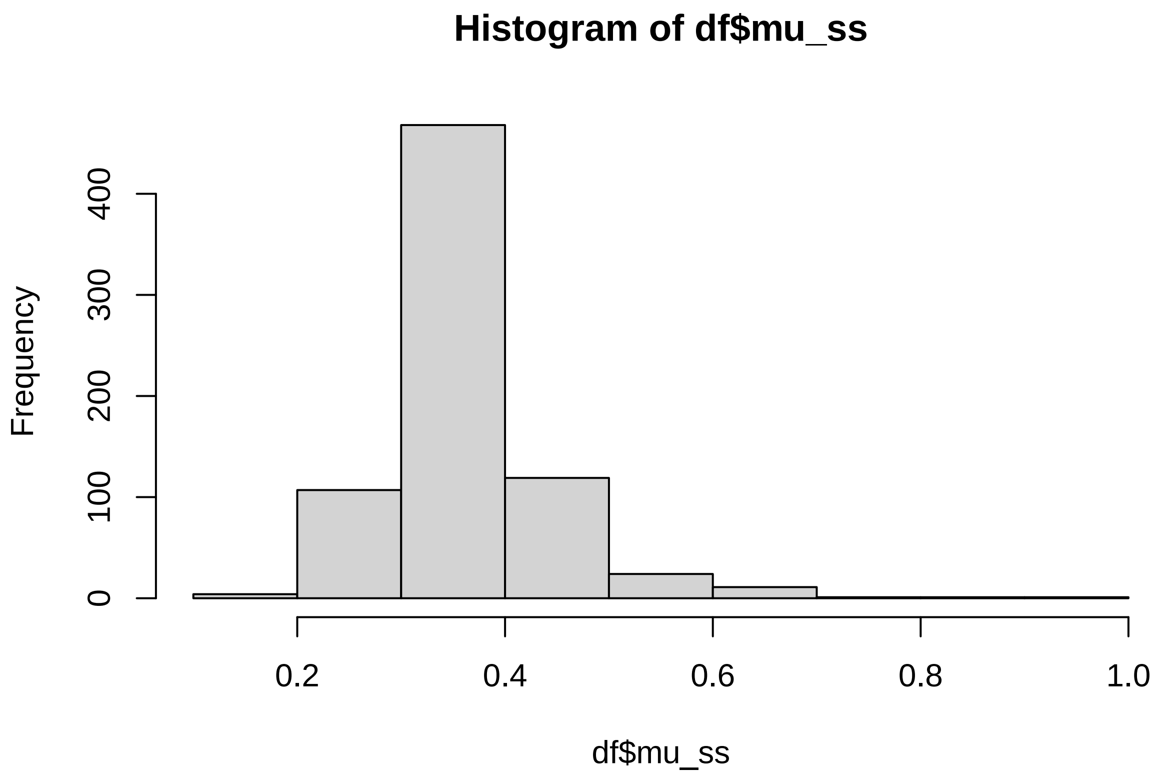
```
##  Family: zero_inflated_beta 
##   Links: mu = logit; phi = identity; zi = identity 
## Formula: mu_fl ~ exp * blk + (1 + blk | subject) 
##    Data: df (Number of observations: 736) 
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
## 
## Group-Level Effects: 
## ~subject (Number of levels: 184) 
##                      Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)            0.76      0.06     0.65     0.88 1.00     1258     1905
## sd(blk2)                 0.13      0.10     0.00     0.35 1.01      657      737
## sd(blk3)                 0.17      0.11     0.01     0.41 1.00      505      767
## sd(blk4)                 0.12      0.09     0.00     0.34 1.01      546      505
## cor(Intercept,blk2)      0.11      0.38    -0.65     0.80 1.00     4322     2361
## cor(Intercept,blk3)      0.19      0.35    -0.58     0.81 1.00     3351     2491
## cor(blk2,blk3)           0.12      0.43    -0.75     0.85 1.00     1269     2099
## cor(Intercept,blk4)     -0.13      0.39    -0.80     0.68 1.00     3958     2208
## cor(blk2,blk4)           0.14      0.46    -0.76     0.88 1.01     1291     2129
## cor(blk3,blk4)           0.03      0.45     -0.79     0.81 1.00     2019     2861
##
## Population-Level Effects:
##                  Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept           -2.59      0.12    -2.83    -2.35 1.00     1260     2052
## expsurprise         -0.53      0.16    -0.84    -0.22 1.00      987     1634
## blk2                 0.18      0.11    -0.04     0.41 1.00     2326     2487
## blk3                 0.31      0.12     0.09     0.54 1.00     2217     2424
## blk4                 0.49      0.11     0.28     0.71 1.00     2185     2282
## expsurprise:blk2     0.25      0.15    -0.05     0.54 1.00     2309     2467
## expsurprise:blk3     0.05      0.15    -0.25     0.35 1.00     2247     2538
## expsurprise:blk4     0.21      0.15    -0.09     0.49 1.00     2139     2327
##
## Family Specific Parameters:
##     Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## phi    24.49      1.75    21.28    28.02 1.00     1187     1594
## zi      0.03      0.01     0.02     0.05 1.00     6723     2662
##
## Draws were sampled using sample(hmc). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
conditional_effects(m4, "blk:exp")
```



Parameter mu_ss: Drift rate for stimulus selection

```
hist(df$mu_ss)
```



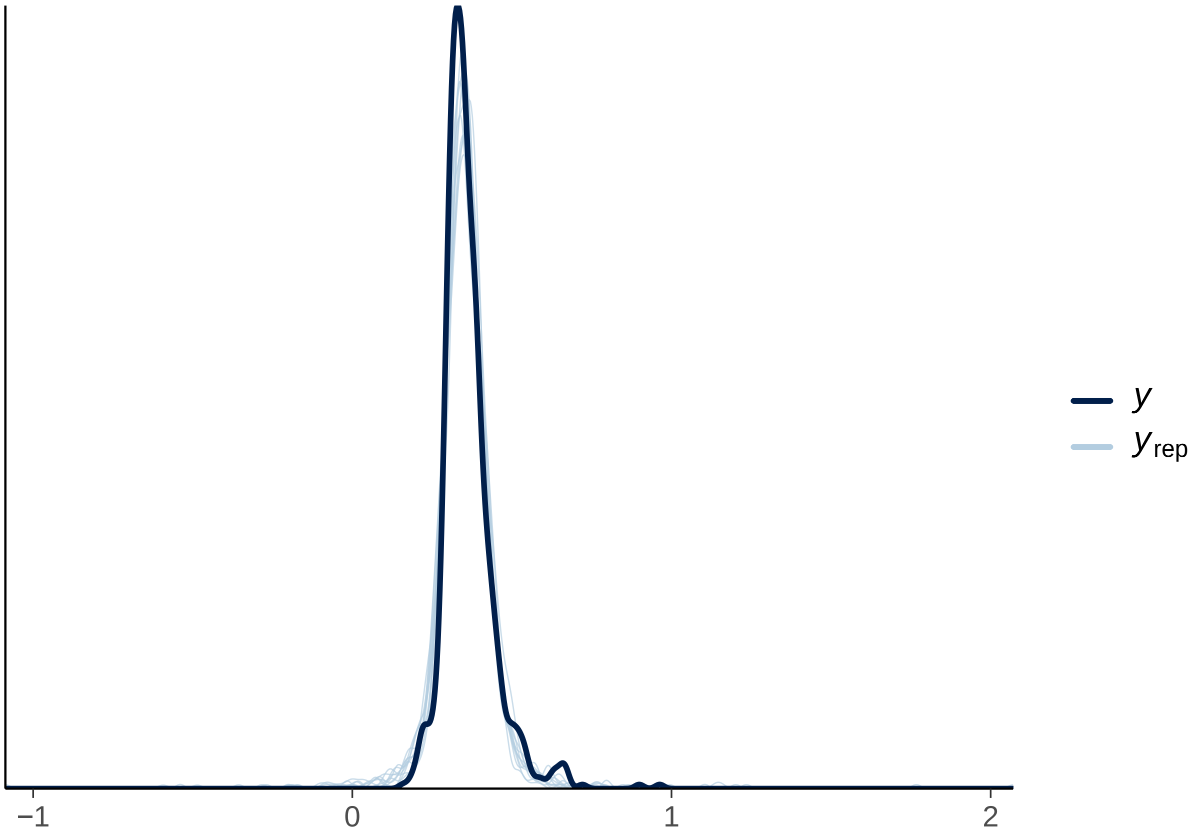
```
m5 <- brm(
  mu_ss ~ exp * blk + (1 + blk | subject),
  family = student(),
  backend = "cmdstanr",
  # algorithm = "meanfield",
  data = df
)
```

```
## In file included from /var/folders/cl/wwjrsxdd5tz7y9jr82nd5hrw0000gn/T/RtmpDVAVEa/model-d4405613fe24
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/src/stan/model/model_header.hpp:4:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math.hpp:19:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev.hpp:10
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev/fun.hpp
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/functo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/functo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/functo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boos
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash

## ed [-Wdeprecated-declarations]
##         struct hash_base : std::unary_function<T, std::size_t> {};
##                                 ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         : public boost::hash_detail::hash_base<T*>
##                  ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         boost::hash<T> hasher;
##                        ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         hash_combine(seed, &v.category());
##         ^

## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__functional/unary_function.h
## struct _LIBCPP_TEMPLATE_VIS _LIBCPP_DEPRECATED_IN_CXX11 unary_function
##                             ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:825:41: note: expande
## #    define _LIBCPP_DEPRECATED_IN_CXX11 _LIBCPP_DEPRECATED
##                                         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:810:49: note: expande
## #      define _LIBCPP_DEPRECATED __attribute__((deprecated))
##                                                 ^

## 1 warning generated.

## Start sampling

## Running MCMC with 4 sequential chains...
##
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 1 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 1 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 1 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 1 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 1 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 1 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 1 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 1 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 1 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 11.2 seconds.
## Chain 2 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 2 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 2 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 2 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 2 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 2 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 2 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 2 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 2 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 2 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 11.1 seconds.
## Chain 3 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 3 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 3 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 3 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 3 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 3 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 3 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 3 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 10.9 seconds.
## Chain 4 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 4 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 4 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 4 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 4 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 4 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 4 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 4 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 finished in 10.5 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 10.9 seconds.
## Total execution time: 43.9 seconds.
```

```
## Warning: 5 of 4000 (0.0%) transitions ended with a divergence.
## See https://mc-stan.org/misc/warnings for details.
```

```r
pp_check(m5)
```

```
## Using 10 posterior draws for ppc type 'dens_overlay' by default.
```

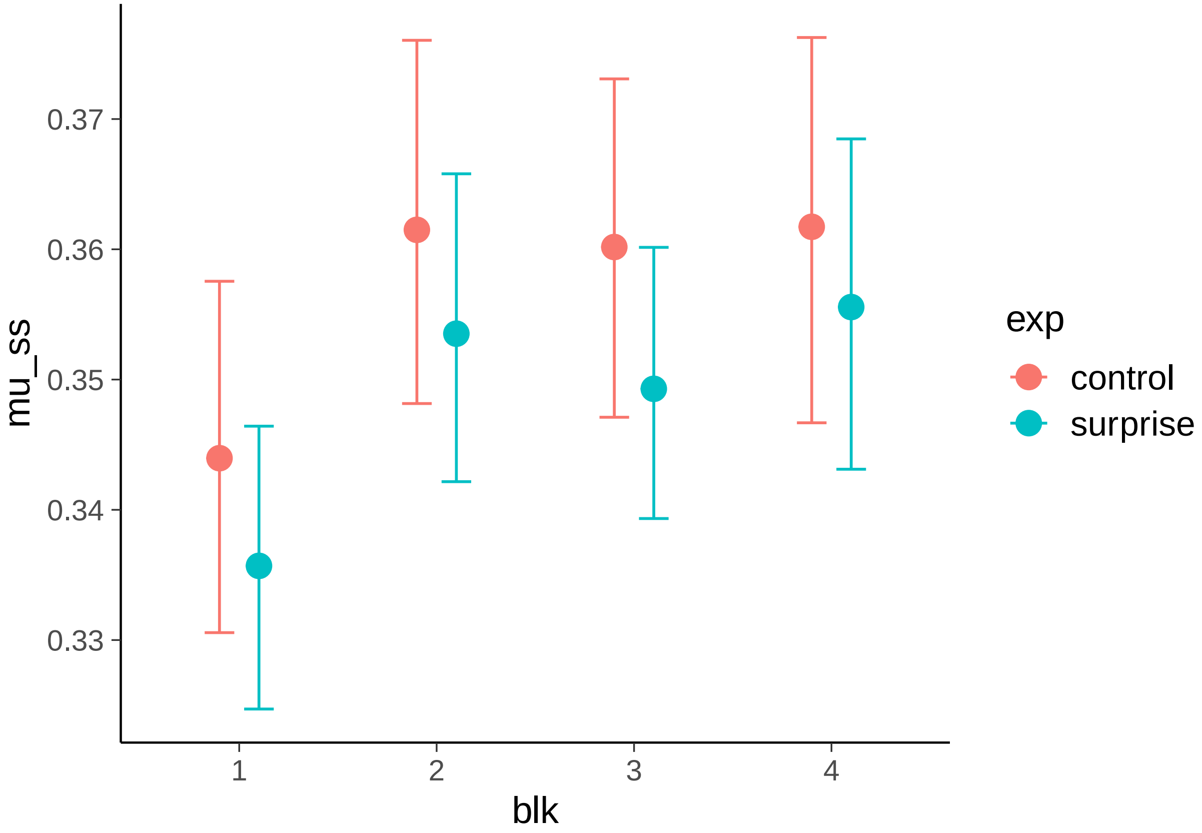


```r
summary(m5)
```

```
## Warning: There were 5 divergent transitions after warmup. Increasing
## adapt_delta above 0.8 may help. See
## http://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup
```

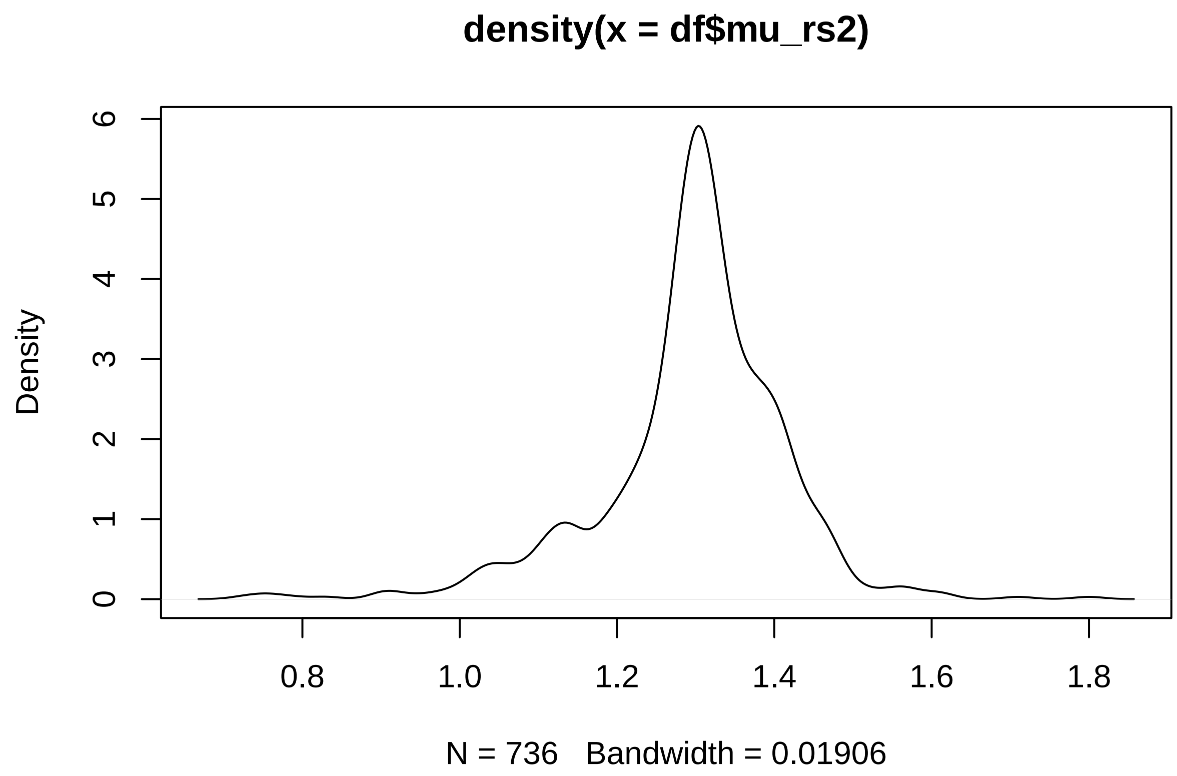
```
##  Family: student
##   Links: mu = identity; sigma = identity; nu = identity
## Formula: mu_ss ~ exp * blk + (1 + blk | subject)
##    Data: df (Number of observations: 736)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Group-Level Effects:
## ~subject (Number of levels: 184)
##                     Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)           0.03      0.00     0.03     0.04 1.01      955     1819
## sd(blk2)                0.01      0.01     0.00     0.03 1.01      465      870
## sd(blk3)                0.01      0.01     0.00     0.03 1.02      170      539
## sd(blk4)                0.02      0.01     0.00     0.04 1.01      278      447
## cor(Intercept,blk2)     0.34      0.35    -0.47     0.89 1.00     2039     2323
## cor(Intercept,blk3)    -0.16      0.38    -0.80     0.66 1.00     2011     2379
## cor(blk2,blk3)          0.09      0.44    -0.76     0.82 1.01      647     1778
## cor(Intercept,blk4)     0.32      0.29    -0.26     0.84 1.01      539     1783
## cor(blk2,blk4)          0.16      0.39    -0.64     0.82 1.01      481      912
## cor(blk3,blk4)          0.24      0.42    -0.66     0.87 1.02      297     1206
##
## Population-Level Effects:
##                  Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept            0.34      0.01     0.33     0.36 1.01     1234     1736
## expsurprise         -0.01      0.01    -0.03     0.01 1.00     1351     1994
## blk2                 0.02      0.01     0.00     0.03 1.00     1596     1814
## blk3                 0.02      0.01     0.00     0.03 1.00     1766     1736
## blk4                 0.02      0.01     0.00     0.03 1.00     1484     1914
## expsurprise:blk2     0.00      0.01    -0.02     0.02 1.00     1855     2382
## expsurprise:blk3    -0.00      0.01    -0.02     0.02 1.00     1681     1772
## expsurprise:blk4     0.00      0.01    -0.02     0.02 1.00     1758     2166
##
## Family Specific Parameters:
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.03      0.00     0.03     0.04 1.01      400      576
## nu        2.22      0.29     1.72     2.86 1.00      808      724
##
## Draws were sampled using sample(hmc). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```r
conditional_effects(m5, "blk:exp")
```



Parameter mu_rs2: Drift rate for phase 2 of response selection

```r
plot(density(df$mu_rs2))
```

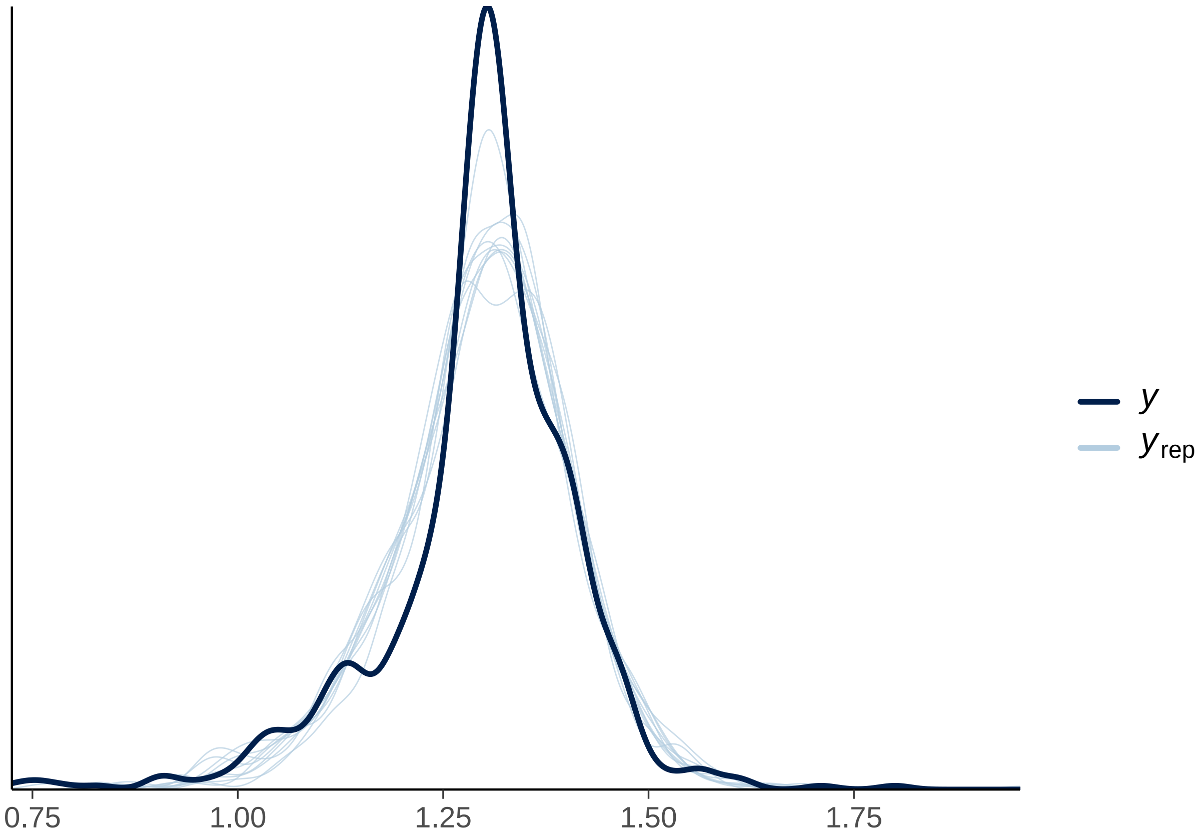


```r
m6 <- brm(
  mu_rs2 ~ exp * blk + (1 + blk | subject),
  family = asym_laplace(),
  backend = "cmdstanr",
  # algorithm = "meanfield",
  data = df
)
```

```
## In file included from /var/folders/cl/wwjrsxdd5tz7y9jr82nd5hrw0000gn/T/RtmpDVAVEa/model-d4401893cee9
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/src/stan/model/model_header.hpp:4:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math.hpp:19:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev.hpp:10
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev/fun.hp
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash

## ed [-Wdeprecated-declarations]
##         struct hash_base : std::unary_function<T, std::size_t> {};
##                                 ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         : public boost::hash_detail::hash_base<T*>
##                  ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         boost::hash<T> hasher;
##                        ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         hash_combine(seed, &v.category());
##         ^

## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__functional/unary_function.h
## struct _LIBCPP_TEMPLATE_VIS _LIBCPP_DEPRECATED_IN_CXX11 unary_function
##                             ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:825:41: note: expande
## #    define _LIBCPP_DEPRECATED_IN_CXX11 _LIBCPP_DEPRECATED
##                                         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:810:49: note: expande
## #      define _LIBCPP_DEPRECATED __attribute__((deprecated))
##                                                 ^

## 1 warning generated.

## Start sampling

## Running MCMC with 4 sequential chains...
##
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 1 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 1 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 1 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 1 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 1 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 1 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 1 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 1 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 1 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 37.0 seconds.
## Chain 2 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 2 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 2 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 2 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 2 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 2 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 2 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 2 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 2 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 2 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 30.2 seconds.
## Chain 3 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 3 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 3 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 3 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 3 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 3 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 3 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 3 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 28.8 seconds.
## Chain 4 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 4 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 4 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 4 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 4 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 4 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 4 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 4 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 finished in 37.4 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 33.3 seconds.
## Total execution time: 133.6 seconds.
```

```
pp_check(m6)
```

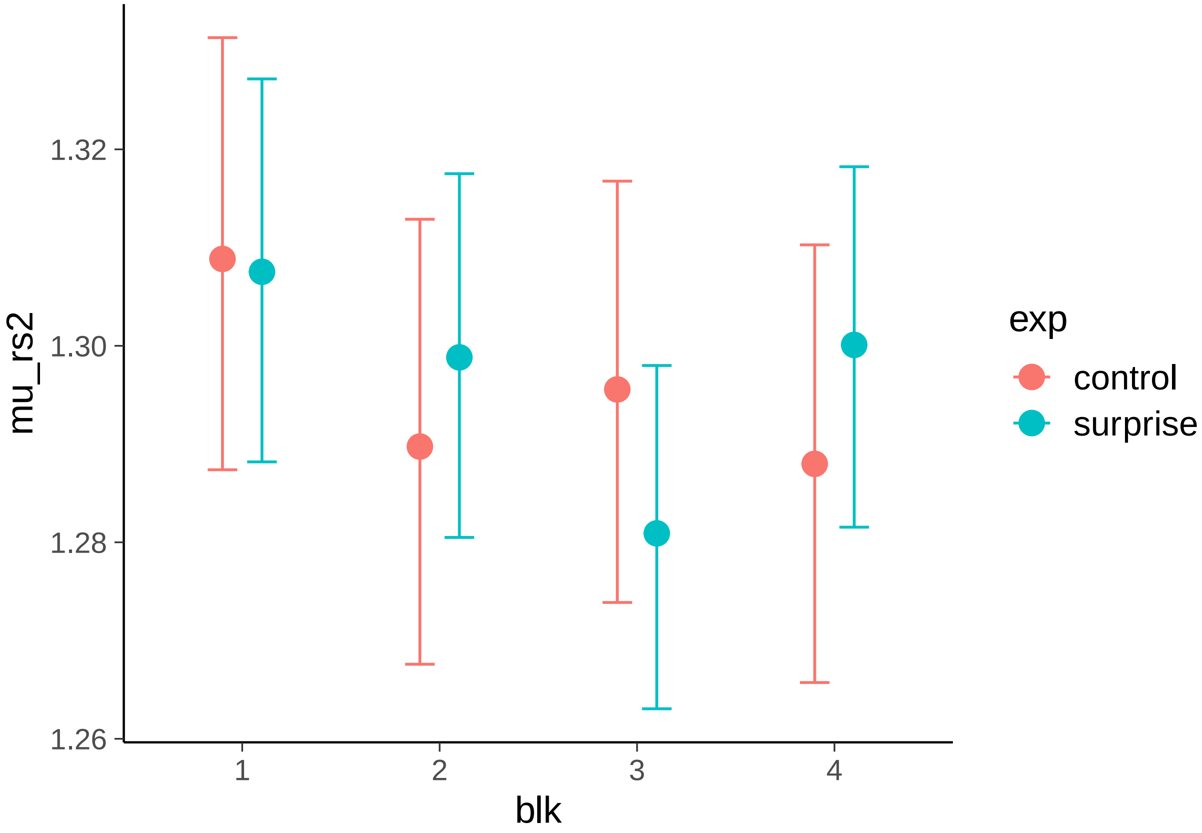
```
## Using 10 posterior draws for ppc type 'dens_overlay' by default.
```



```r
summary(m6)
```

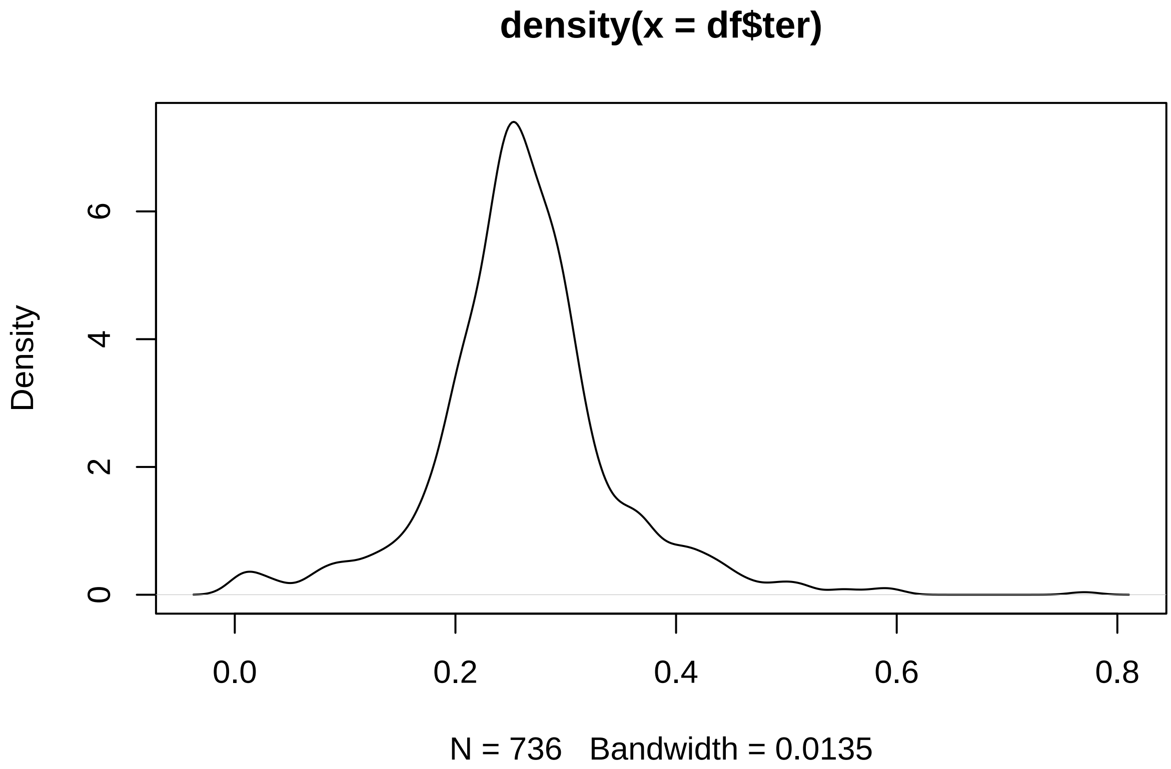
```
##  Family: asym_laplace 
##   Links: mu = identity; sigma = identity; quantile = identity 
## Formula: mu_rs2 ~ exp * blk + (1 + blk | subject) 
##    Data: df (Number of observations: 736) 
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
## 
## Group-Level Effects: 
## ~subject (Number of levels: 184) 
##                         Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)               0.06      0.01     0.05     0.07 1.00      912     1423
## sd(blk2)                    0.01      0.01     0.00     0.03 1.00      881     1339
## sd(blk3)                    0.01      0.01     0.00     0.03 1.00      996      954
## sd(blk4)                    0.01      0.01     0.00     0.04 1.01      538     1025
## cor(Intercept,blk2)         0.09      0.42    -0.75     0.82 1.00     3006     2342
## cor(Intercept,blk3)        -0.01      0.44    -0.81     0.78 1.00     3165     2255
## cor(blk2,blk3)              0.09      0.45    -0.77     0.84 1.00     1837     2743
## cor(Intercept,blk4)        -0.15      0.39    -0.80     0.68 1.00     2379     2232
## cor(blk2,blk4)              0.06      0.45    -0.77     0.85 1.00     1216     1572
## cor(blk3,blk4)              0.10      0.45    -0.77     0.87 1.00     1215     1638
## 
## Population-Level Effects: 
##                  Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept            1.33      0.01     1.31     1.36 1.01      862     1865
## expsurprise         -0.00      0.01    -0.03     0.03 1.00      998     1515
## blk2                -0.02      0.01    -0.04     0.00 1.00     1446     2594
## blk3                -0.01      0.01    -0.04     0.01 1.00     1236     2388
## blk4                -0.02      0.01    -0.04     0.00 1.00     1546     2468
## expsurprise:blk2     0.01      0.02    -0.02     0.04 1.00     1485     2641
## expsurprise:blk3    -0.01      0.02    -0.04     0.02 1.00     1274     2090
## expsurprise:blk4     0.01      0.02    -0.02     0.04 1.00     1389     2325
## 
## Family Specific Parameters: 
##          Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma        0.03      0.00     0.03     0.03 1.00     1727     2350
## quantile     0.59      0.03     0.54     0.64 1.00     1431     2264
## 
## Draws were sampled using sample(hmc). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```r
conditional_effects(m6, "blk:exp")
```



Parameter ter: Drift rate for phase 2 of response selection

```r
plot(density(df$ter))
```



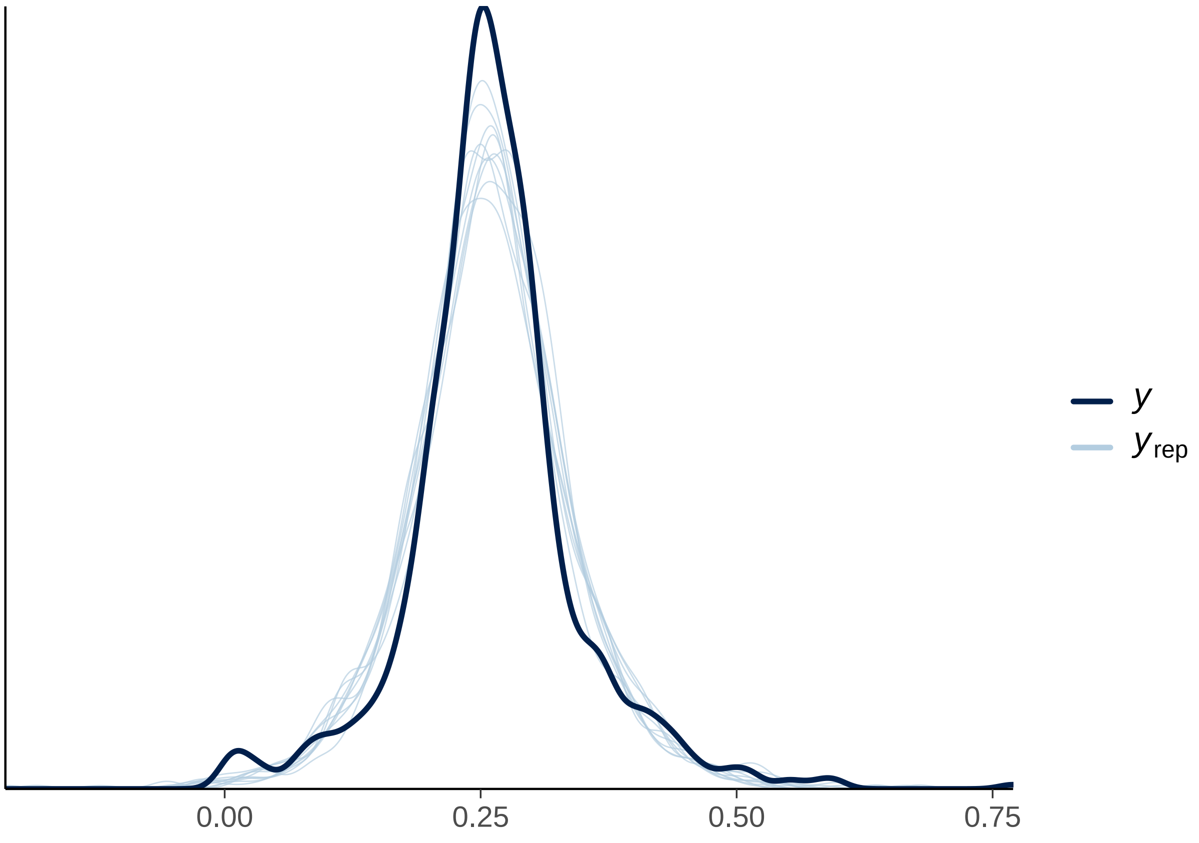
```
m7 <- brm(
  ter ~ exp * blk + (1 + blk | subject),
  family = asym_laplace(),
  backend = "cmdstanr",
  # algorithm = "meanfield",
  data = df
)
```

```
## In file included from /var/folders/cl/wwjrsxdd5tz7y9jr82nd5hrw0000gn/T/RtmpDVAVEa/model-d4405e73239b
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/src/stan/model/model_header.hpp:4:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math.hpp:19:
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev.hpp:10
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/rev/fun.hp
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/stan/math/prim/funct
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## In file included from /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boo
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
```

```
## ed [-Wdeprecated-declarations]
##         struct hash_base : std::unary_function<T, std::size_t> {};
##                                 ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         : public boost::hash_detail::hash_base<T*>
##                  ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         boost::hash<T> hasher;
##                        ^
## /Users/corrado/.cmdstan/cmdstan-2.33.1/stan/lib/stan_math/lib/boost_1.78.0/boost/container_hash/hash
##         hash_combine(seed, &v.category());
##         ^

## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__functional/unary_function.h
## struct _LIBCPP_TEMPLATE_VIS _LIBCPP_DEPRECATED_IN_CXX11 unary_function
##                             ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:825:41: note: expande
## #    define _LIBCPP_DEPRECATED_IN_CXX11 _LIBCPP_DEPRECATED
##                                         ^
## /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include/c++/v1/__config:810:49: note: expande
## #      define _LIBCPP_DEPRECATED __attribute__((deprecated))
##                                                 ^

## 1 warning generated.

## Start sampling

## Running MCMC with 4 sequential chains...
##
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 1 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 1 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 1 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 1 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 1 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 1 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 1 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 1 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 1 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 44.5 seconds.
## Chain 2 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 2 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 2 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 2 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 2 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 2 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 2 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 2 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 2 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 2 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 41.1 seconds.
## Chain 3 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 3 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 3 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 3 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 3 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 3 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 3 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 3 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 46.4 seconds.
## Chain 4 Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4 Iteration:  100 / 2000 [  5%]  (Warmup)
## Chain 4 Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4 Iteration:  300 / 2000 [ 15%]  (Warmup)
## Chain 4 Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4 Iteration:  500 / 2000 [ 25%]  (Warmup)
## Chain 4 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 4 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 4 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 4 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 4 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 finished in 40.0 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 43.0 seconds.
## Total execution time: 172.3 seconds.
```

```
pp_check(m7)
```

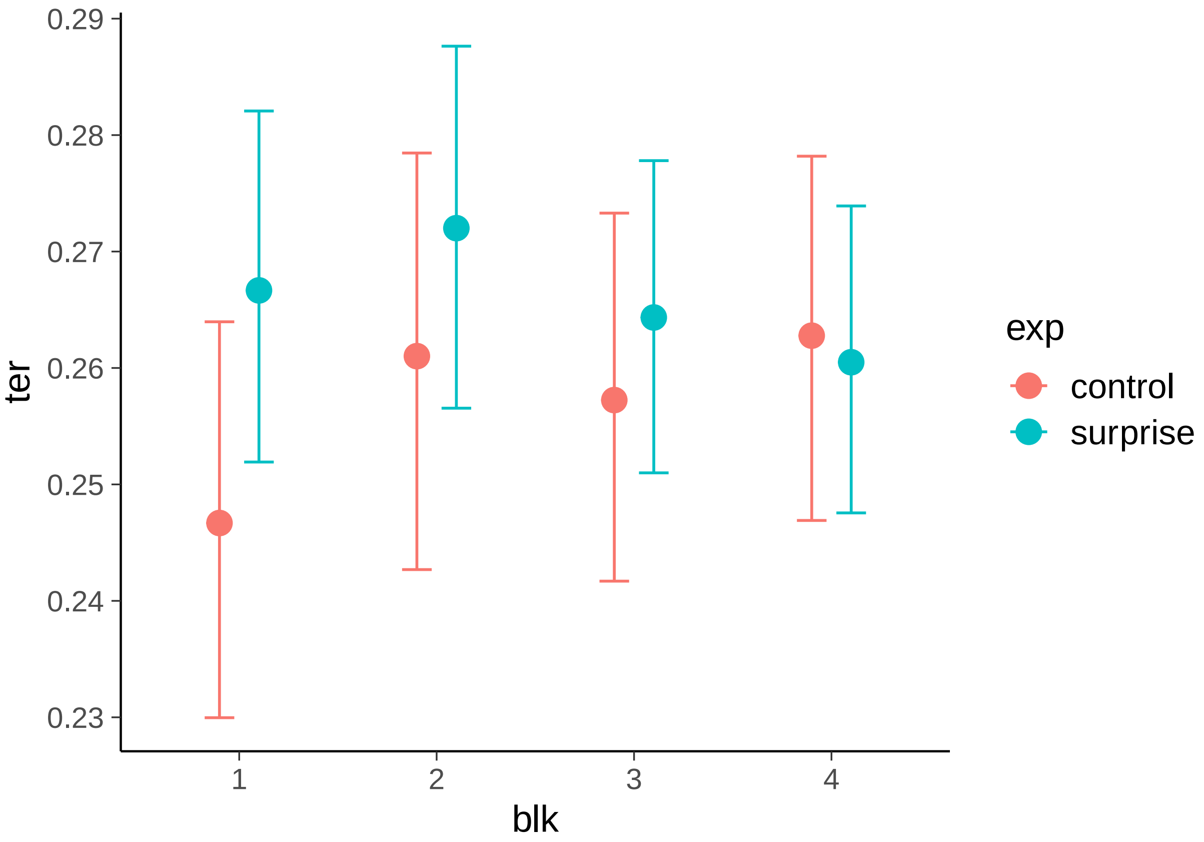
```
## Using 10 posterior draws for ppc type 'dens_overlay' by default.
```



```
summary(m7)
```

```
##  Family: asym_laplace
##   Links: mu = identity; sigma = identity; quantile = identity
## Formula: ter ~ exp * blk + (1 + blk | subject)
##    Data: df (Number of observations: 736)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Group-Level Effects:
## ~subject (Number of levels: 184)
##                     Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)           0.05      0.01     0.04     0.06 1.01      586      766
## sd(blk2)                0.01      0.01     0.00     0.03 1.01      776     1650
## sd(blk3)                0.01      0.01     0.00     0.03 1.01      439      491
## sd(blk4)                0.02      0.01     0.00     0.04 1.01      394      473
## cor(Intercept,blk2)     0.41      0.34    -0.38     0.91 1.00     1487     2562
## cor(Intercept,blk3)    -0.30      0.40    -0.88     0.64 1.00     1860     2405
## cor(blk2,blk3)          0.02      0.44    -0.80     0.80 1.00     1153     2280
## cor(Intercept,blk4)    -0.53      0.31    -0.91     0.34 1.00     2374     1795
## cor(blk2,blk4)         -0.09      0.41    -0.82     0.71 1.00      826     1549
## cor(blk3,blk4)          0.34      0.45    -0.66     0.95 1.01      678     1413
##
## Population-Level Effects:
##                  Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## Intercept            0.25      0.01     0.23     0.27 1.00     1336     2332
## expsurprise          0.02      0.01    -0.00     0.04 1.00     1155     2114
## blk2                 0.01      0.01    -0.00     0.03 1.00     2706     3087
## blk3                 0.01      0.01    -0.01     0.03 1.00     2053     2721
## blk4                 0.02      0.01    -0.00     0.03 1.00     2154     3000
## expsurprise:blk2    -0.01      0.01    -0.03     0.01 1.00     2566     2799
## expsurprise:blk3    -0.01      0.01    -0.03     0.01 1.00     1842     2281
## expsurprise:blk4    -0.02      0.01    -0.05     0.00 1.00     1729     2655
##
## Family Specific Parameters:
##          Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma        0.02      0.00     0.02     0.02 1.01     1019     1710
## quantile     0.52      0.03     0.47     0.58 1.00     1470     2001
##
## Draws were sampled using sample(hmc). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

```
conditional_effects(m7, "blk:exp")
```


ter
0.29
0.28
0.27
0.26
0.25
0.24
0.23
1
2
3
4
blk
exp
control
surprise