HW 8

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Research Question

Do effort preferences on rewarded trials in the training section differ between the effort and performance conditions? (model1)

Do effort preferences on rewarded trials in the training section differ between the effort and neutral conditions? (model2)

Do effort preferences on probe (unrewarded) trials in the training section differ between the effort and performance conditions? (model3)

Do effort preferences on probe (unrewarded) trials in the training section differ between the effort and neutral conditons? (model4)

Do effort preferences on the dot-motion task in the post-training section differ between the effort and performance conditions? (model5)

Do effort preferences on the dot-motion task in the post-training section differ between the effort and neutral conditions? (model6)

Do effort preferences on the math task in the post-training section differ between the effort and performance conditions? (model7)

Do effort preferences on the math task in the post-training section differ between the effort and neutral conditions? (model8)

#Summary of the study design:

The entire study is divided into three sections: the pre-training section, the training section, and the post-training section. The pre-training section includes two types of cognitive tasks: the dot motion task and the math task. This section is designed to establish a baseline for participants regarding their effort expenditure. The training section is further divided into reward trials and probe trials (unrewarded), with three conditions: reward, performance, and

neutral. It employs a between-subjects design to manipulate participants' effort preferences based on the different conditions, but it includes only one cognitive task, which is the dot motion task. In the post-training section, two cognitive tasks are included: the dot motion task and the math task. The dot motion task aims to demonstrate that the manipulation in the training section has a lasting effect over time. Meanwhile, the math task is designed to show that this training not only has a sustained effect on the same task but also exerts an influence across different tasks.

Variables in dtdotavgwide (dotmotion task dataset)

- `condition`: performance(The higher the accuracy of the task, the greater the reward), effort(Choosing the hard task yields a high reward, while choosing the easy task results in a low reward), neutral(The reward is a fixed value.).
- `reward`: The proportion of participants choosing the hard difficulty task in the reward trials during the training section (N_reward = 40 for each subject).
- `Y_reward`: The number of trials in which participants chose the hard difficulty task during the reward trials in the training section (Y_reward =reward * N_reward).
- `probe`: The proportion of participants choosing the hard difficulty task in the unreward trials during the training section (N_probe = 20 for each subject).
- `Y_probe`: The number of trials in which participants chose the hard difficulty task during the unreward trials in the training section (Y_reward = probe * N_probe).
- `pre_training`: The proportion of participants choosing the hard difficulty task in the trials of the pre-training section (N_pretraining = 40).
- `Y_pretraining`: The number of trials in which participants chose the hard difficulty task during the trials in the pre-training section (Y_pretraining = pre_training * N_pretraining).
- `post_training`: The proportion of participants choosing the hard difficulty task in the trials of the post_training section (N_posttraining = 20).
- `Y_posttraining`: The number of trials in which participants chose the hard difficulty task during the trials in the post-training section (Y_posttraining = post_training * N_posttraining).

Variables in dtmathavgwide (math task dataset)

The math task will not appear in the training section (reward trials + probe trials), so the math task dataset does not include any probe or reward trials. - `condition`: Same as above. - `pre_training`: Same as above. - `Y_pretraining`: Same as above. - `post_training`: Same as above. - `Y_posttraining`: Same as above.

Table 1: Descriptive statistics by condition for effort preferences for the dot motion task in the pre-training section

		performance	neutral	effort
Y_pretraining	N	255	252	254
	Mean	14.04	13.99	14.37
	SD	10.20	9.76	10.87
	Min	0.00	0.00	0.00
	Max	40.00	40.00	40.00
	Histogram			

Table 2: Descriptive statistics by condition for effort preferences on rewarded trials in the training section for the dot motion task

		performance	neutral	effort
Y_reward	N	255	252	254
	Mean	9.89	12.87	23.55
	SD	9.85	10.37	14.72
	Min	0.00	0.00	0.00
	Max	40.00	40.00	40.00
	Histogram			

Data Import

Variable Summary

Table Table 1 displays the summary statistics of effort preferences for the dot motion task in the pre-training(baseline) section by condition.

Table Table 2 displays the summary statistics of effort preferences for the dot motion task during the rewarded trials in the training section, categorized by condition.

Table Table 3 displays the summary statistics of effort preferences for the dot motion task during the unrewarded trials (probe trials) in the training section, categorized by condition.

Table Table 4 displays the summary statistics of effort preferences for the dot motion task in the post-training section by condition.

Table Table 5 displays the summary statistics of effort preferences for the math task in the pre-training section by condition.

Table 3: Descriptive statistics by condition for effort preferences on unrewarded trials (probe trials) in the training section for the dot motion task

		performance	neutral	effort
Y_probe	N	255	252	254
	Mean	7.60	7.53	8.57
	SD	5.55	4.93	6.35
	Min	0.00	0.00	0.00
	Max	20.00	20.00	20.00
	Histogram			

Table 4: Descriptive statistics by condition for effort preferences for the dot motion task in the post-training section

		performance	neutral	effort
Y_posttraining	N	255	252	254
	Mean	5.32	6.07	7.09
	SD	5.39	5.40	6.51
	Min	0.00	0.00	0.00
	Max	20.00	20.00	20.00
	Histogram			

Table 5: Descriptive statistics by condition for effort preferences for the math task in the pre-training section

		performance	neutral	effort
Y_pretraining	N	255	252	254
	Mean	15.32	16.75	15.60
	SD	10.12	9.88	10.78
	Min	0.00	0.00	0.00
	Max	40.00	40.00	36.00
	Histogram			

Table 6: Descriptive statistics by condition for effort preferences for the math task in the post-training section

		performance	neutral	effort
Y_posttraining	N	255	252	254
	Mean	6.05	6.81	7.13
	SD	5.40	5.38	6.07
	Min	0.00	0.00	0.00
	Max	20.00	20.00	20.00
	Histogram			

Table Table 6 displays the summary statistics of effort preferences for the math task in the post-training section by condition.

Model

1)
$$Y_i \sim \text{Bin}(Nreward_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:
$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

2)
$$Y_i \sim \text{Bin}(Nreward_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:
$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

3)
$$Y_i \sim \text{Bin}(Nprobe_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:
$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

4)
$$Y_i \sim \text{Bin}(Nprobe_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:
$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

5)
$$Y_i \sim \text{Bin}(Nposttraining_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:
$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

6)
$$Y_i \sim \text{Bin}(Nposttraining_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:
$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

7)
$$Y_i \sim \text{Bin}(Nposttraining_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:
$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

8)
$$Y_i \sim \text{Bin}(Nposttraining_i, \mu_i)$$
$$logit(\mu_i) = \eta_i$$
$$\eta_j = \beta_0 + \beta_1(\text{condition}_i) + \beta_2(\text{pretraining}_i)$$

Prior:

$$\beta_0 \sim t4(0, 2.5)$$
$$\beta_1, \beta_2 \sim t4(0, 1)$$

Do effort preferences on rewarded trials in the training section differ between the effort and performance conditions? (model1)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_reward | trials(N_reward) ~ condition + Y_pretraining + (1 | subj)
   Data: dtdotavgwide[condition %in% e_vs_p] (Number of observations: 509)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000


Multilevel Hyperparameters:
~subj (Number of levels: 509)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.99      0.08     1.84     2.16 1.00     2408     5280


Regression Coefficients:
                Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept          -3.25      0.19    -3.62    -2.89 1.00     1671     2906
conditioneffort     1.86      0.19     1.50     2.24 1.00     1065     1914
Y_pretraining       0.11      0.01     0.10     0.13 1.00     1662     3454


Draws were sampled using sampling(NUTS). 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).
```
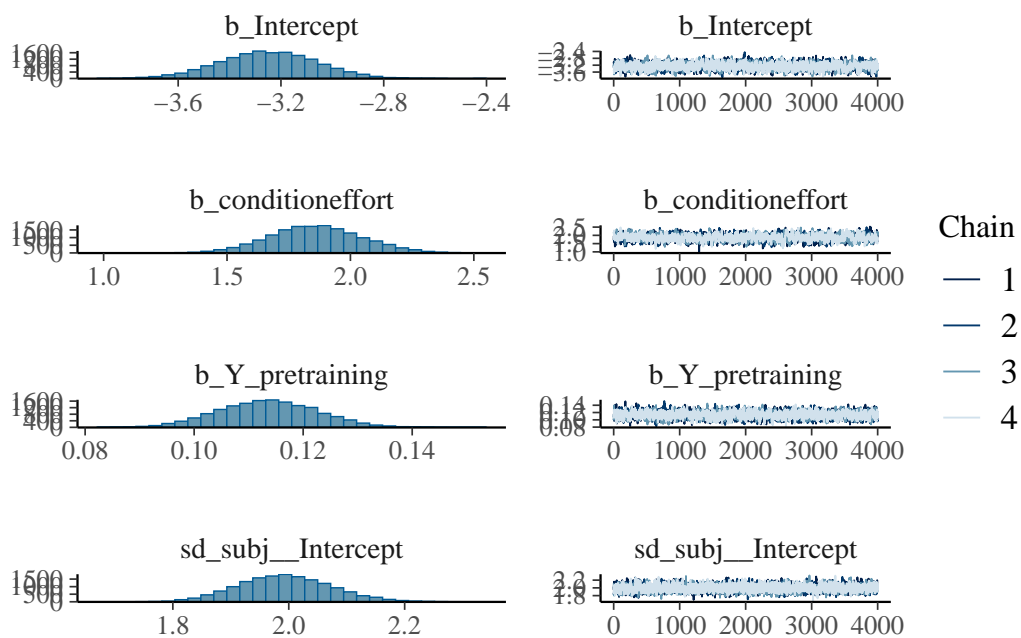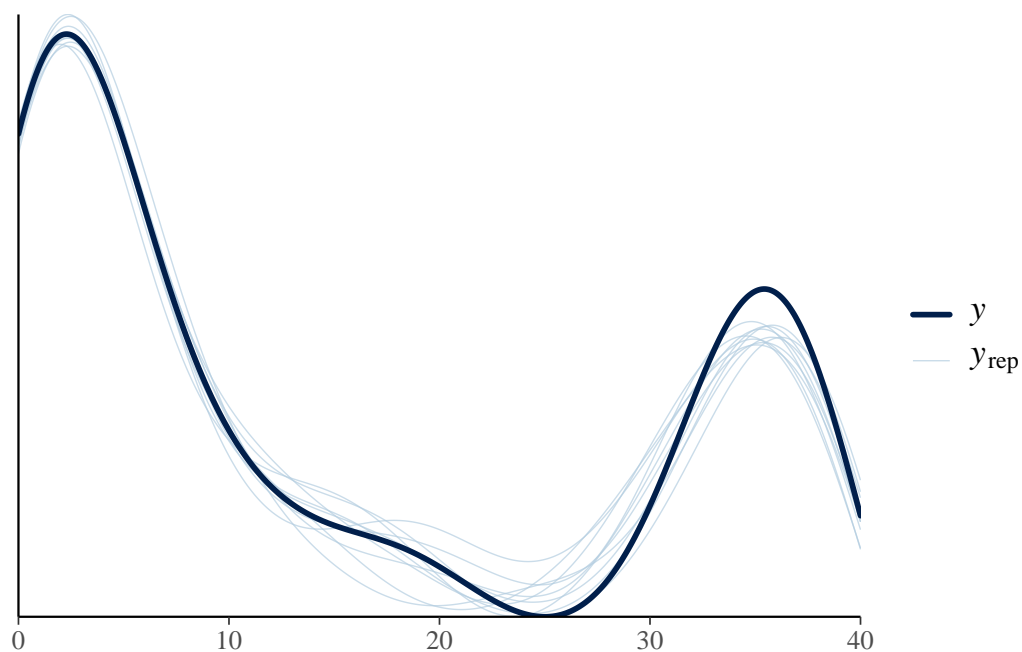
Using 10 posterior draws for ppc type 'dens_overlay' by default.

As shown in the rank histogram in Figure 1 below, the chains mixed well.

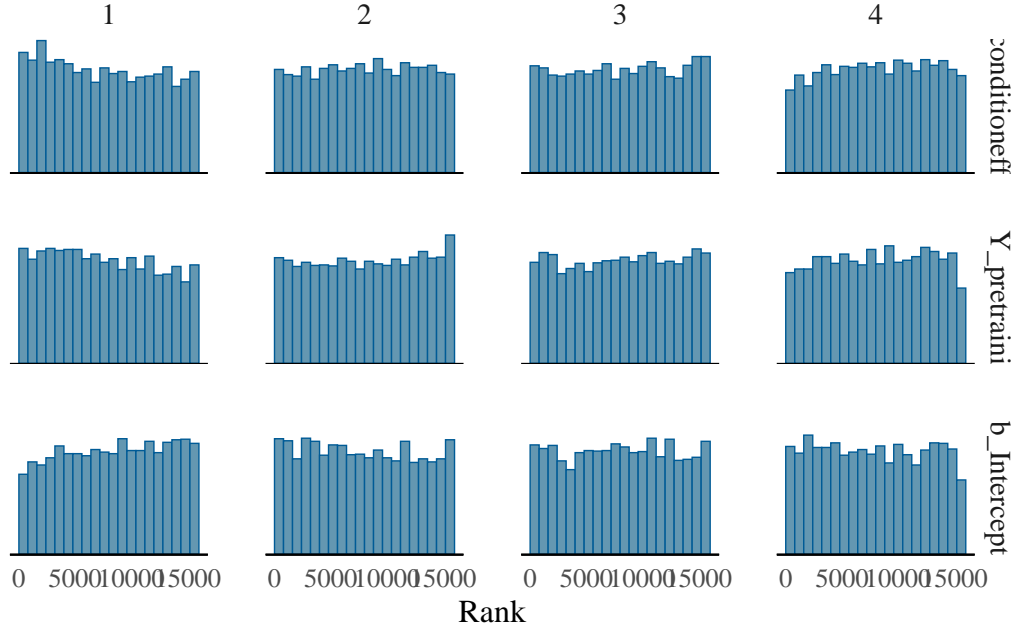Table 7 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Figure 1: Rank histogram of the posterior distributions of model parameters.

Table 7: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	1.86	1.86	0.19	0.19	1.56	2.17	1	1064.71	1914.25
b_Y_pretraining	0.11	0.11	0.01	0.01	0.10	0.13	1	1661.56	3453.93
b_Intercept	-3.25	-3.25	0.19	0.19	-3.56	-2.94	1	1671.11	2906.44

The analysis showed that effort preferences in rewarded trials under effort conditions were significantly higher than those in the performance condition., with a posterior mean of 1.86 and a 90% CI of [1.56, 2.17].

> Do effort preferences on rewarded trials in the training section differ between the effort and neutral conditions? (model2)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_reward | trials(N_reward) ~ condition + Y_pretraining + (1 | subj)
   Data: dtdotavgwide[condition %in% e_vs_n] (Number of observations: 506)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000


Multilevel Hyperparameters:
~subj (Number of levels: 506)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.97      0.08     1.82     2.13 1.00     2500     4747


Regression Coefficients:
                Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept          -2.90      0.19    -3.27    -2.53 1.00     1300     2469
conditioneffort     1.43      0.18     1.06     1.79 1.00     1108     2058
Y_pretraining       0.12      0.01     0.10     0.14 1.00     1331     2891


Draws were sampled using sampling(NUTS). 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).
```
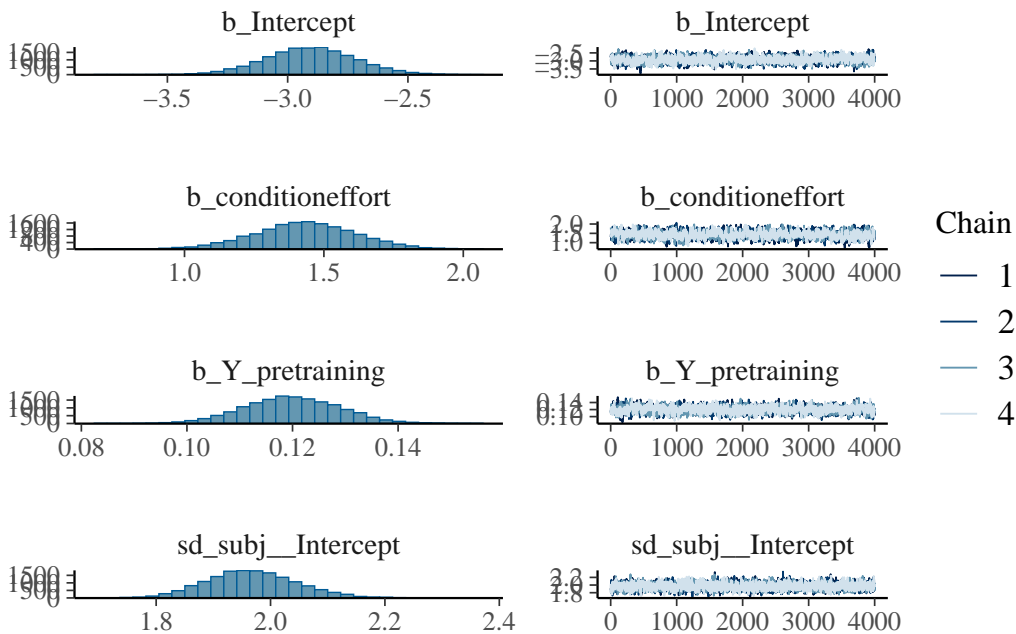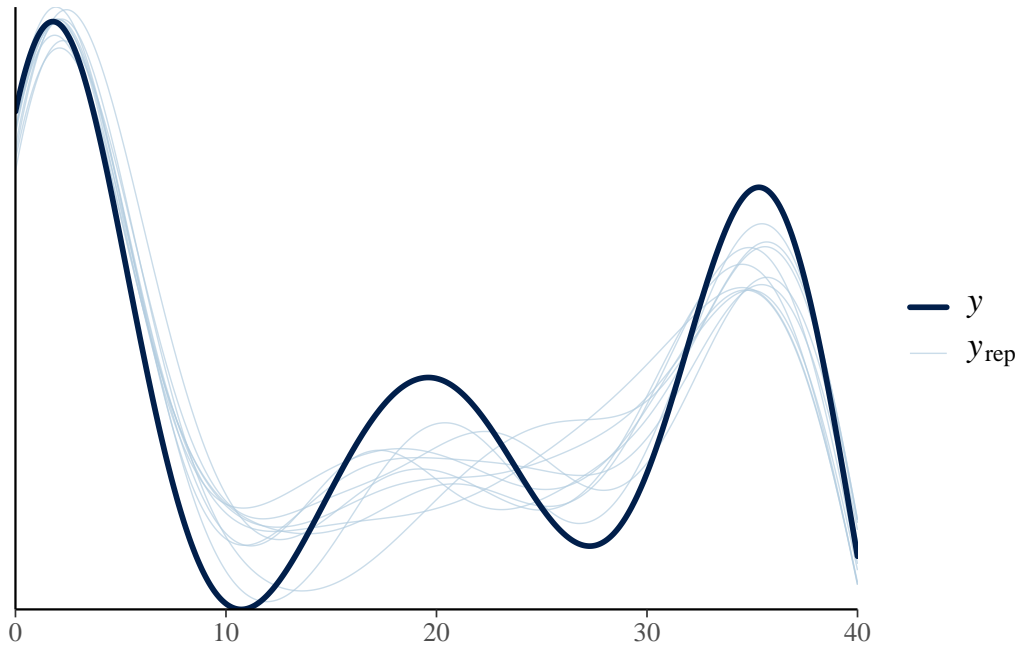
```
Using 10 posterior draws for ppc type 'dens_overlay' by default.
```


As shown in the rank histogram in Figure 2 below, the chains mixed well.
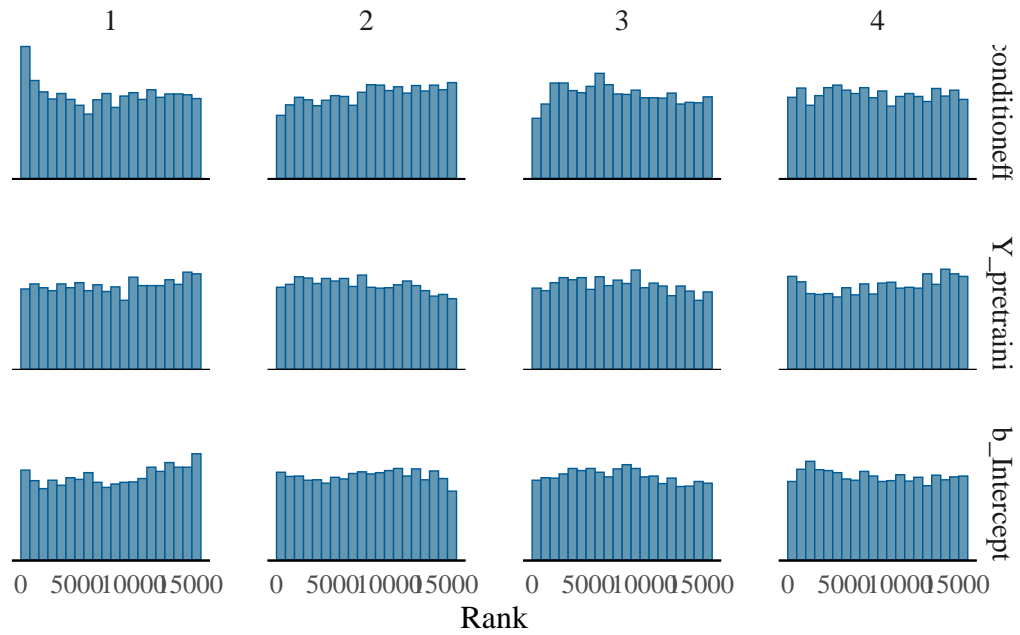

Figure 2: Rank histogram of the posterior distributions of model parameters.

Table 8 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Table 8: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	1.43	1.43	0.18	0.18	1.13	1.73	1	1108.45	2058.50
b_Y_pretraining	0.12	0.12	0.01	0.01	0.11	0.13	1	1330.96	2891.40
b_Intercept	-2.90	-2.90	0.19	0.19	-3.21	-2.59	1	1300.18	2469.07

The analysis showed that effort preferences in rewarded trials under effort conditions were significantly higher than those in the neutral condition., with a posterior mean of 1.43 and a 90% CI of [1.13, 1.73].

> Do effort preferences on probe (unrewarded) trials in the training section differ between the effort and performance conditions? (model3)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_probe | trials(N_probe) ~ condition + Y_pretraining + (1 | subj)
   Data: dtdotavgwide[condition %in% e_vs_p] (Number of observations: 509)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000

Multilevel Hyperparameters:
~subj (Number of levels: 509)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.64      0.07     1.50     1.78 1.00     5170     8843

Regression Coefficients:
               Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept         -1.84      0.15    -2.15    -1.55 1.00     5272     8523
conditioneffort    0.24      0.15    -0.07     0.54 1.00     4222     7411
Y_pretraining      0.08      0.01     0.06     0.09 1.00     5251     8514
```
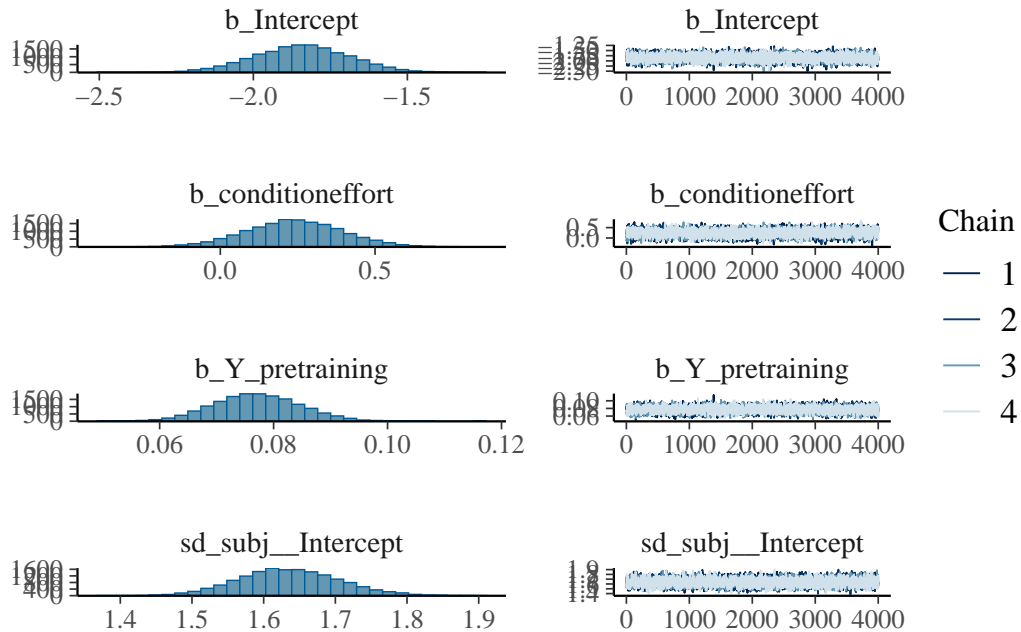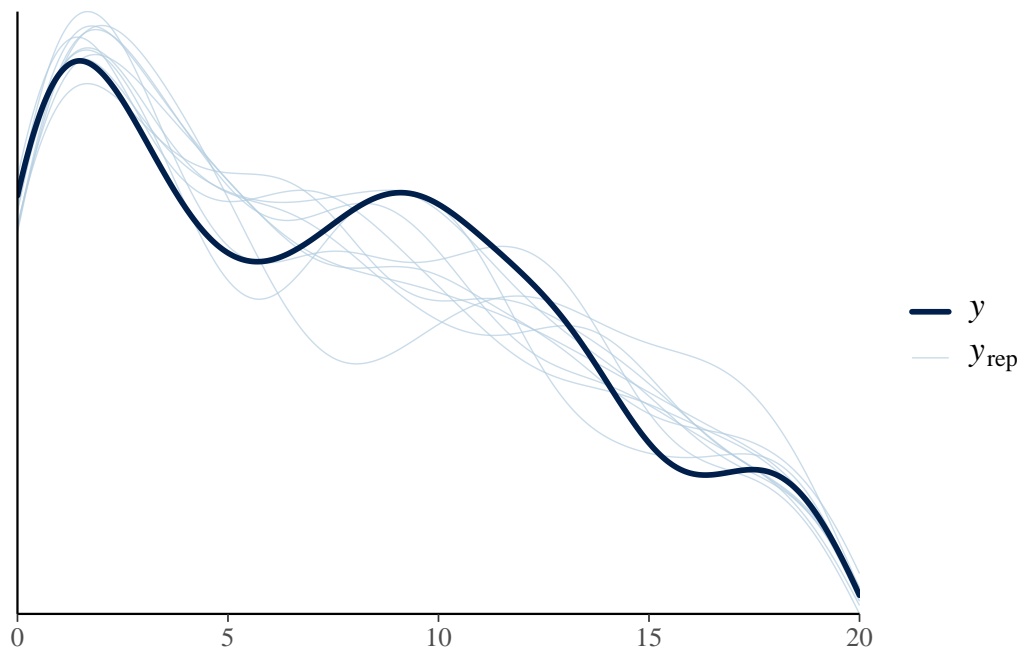
Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
and Tail_ESS are effective sample size measures, and Rhat is the potential
scale reduction factor on split chains (at convergence, Rhat = 1).

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

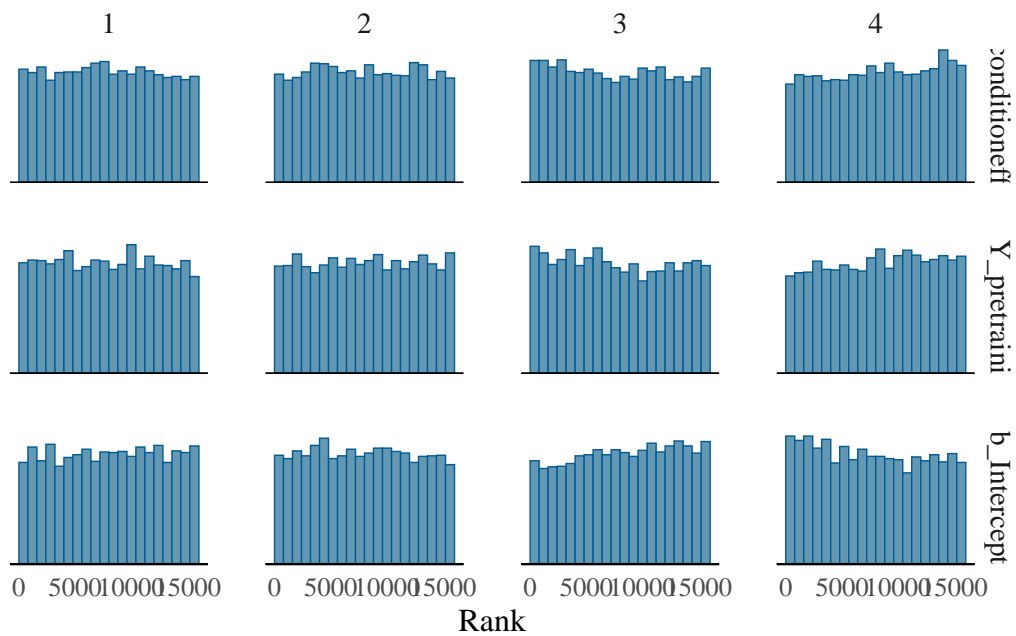As shown in the rank histogram in Figure 3 below, the chains mixed well.

Figure 3: Rank histogram of the posterior distributions of model parameters.

Table 9 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Table 9: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	0.24	0.24	0.15	0.15	-0.01	0.50	1	4222.38	7411.14
b_Y_pretraining	0.08	0.08	0.01	0.01	0.06	0.09	1	5251.37	8514.10
b_Intercept	-1.84	-1.84	0.15	0.15	-2.10	-1.59	1	5271.64	8523.24

The analysis showed that effort preferences in probe trials under effort conditions were not significantly higher than those in the performance condition., with a posterior mean of 0.24 and a 90% CI of [-0.01, 0.5].

> Do effort preferences on probe (unrewarded) trials in the training section differ between the effort and neutral conditons? (model4)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_probe | trials(N_probe) ~ condition + Y_pretraining + (1 | subj)
   Data: dtdotavgwide[condition %in% e_vs_n] (Number of observations: 506)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000

Multilevel Hyperparameters:
~subj (Number of levels: 506)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.44      0.06     1.33     1.57 1.00     4438     8380

Regression Coefficients:
               Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept         -1.89      0.14    -2.17    -1.61 1.00     3066     5840
conditioneffort    0.23      0.14    -0.04     0.50 1.00     2397     4423
Y_pretraining      0.08      0.01     0.07     0.10 1.00     2967     5056

Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
and Tail_ESS are effective sample size measures, and Rhat is the potential
```
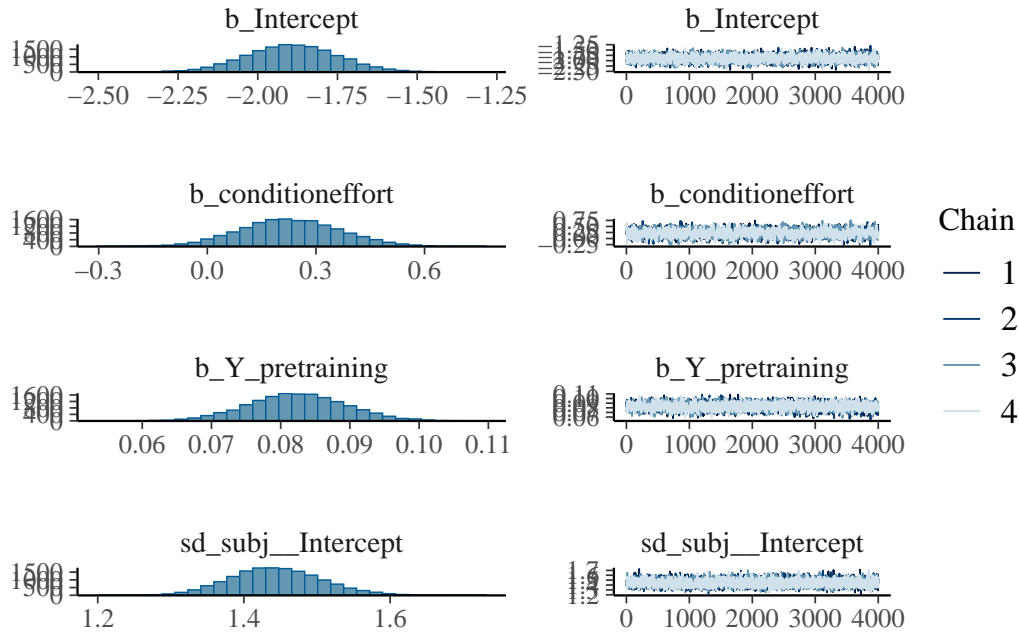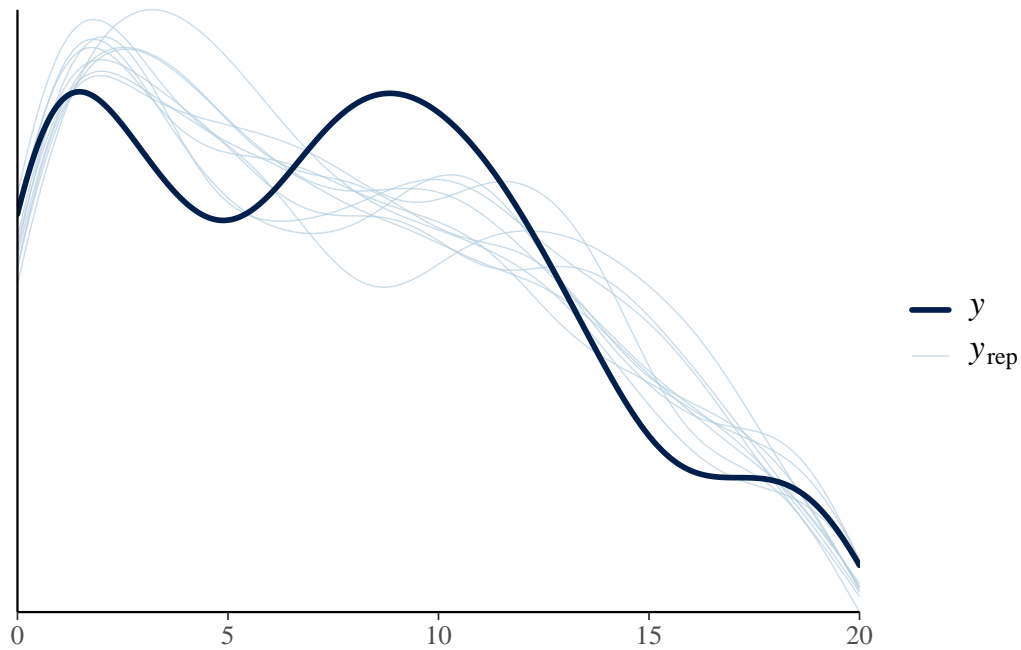
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scale reduction factor on split chains (at convergence, Rhat = 1).

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

As shown in the rank histogram in Figure 4 below, the chains mixed well.
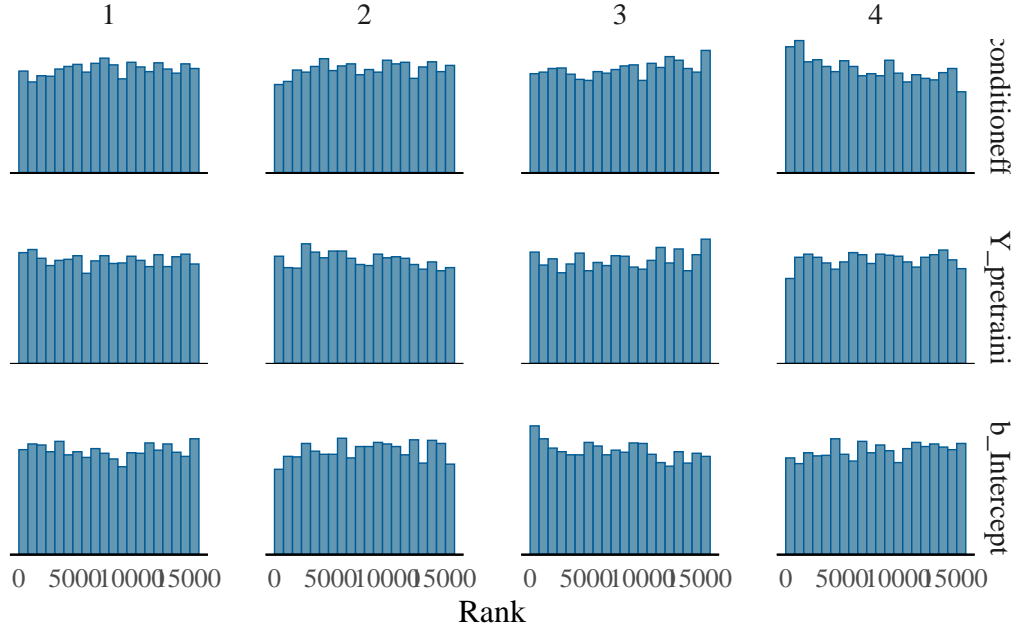
Figure 4: Rank histogram of the posterior distributions of model parameters.

Table 10 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Table 10: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	0.229	0.227	0.139	0.138	0.004	0.460	1.002	2396.683	4423.097
b_Y_pretraining	0.082	0.082	0.007	0.007	0.071	0.094	1.002	2967.361	5055.577
b_Intercept	-1.892	-1.892	0.143	0.142	-2.125	-1.656	1.001	3066.032	5839.875

The analysis showed that effort preferences in probe trials under effort conditions were not significantly higher than those in the neutral condition., with a posterior mean of 0.229 and a 90% CI of [0.004, 0.46].

> Do effort preferences on the dot-motion task in the post-training section differ between the effort and performance conditions? (model5)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

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Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_posttraining | trials(N_posttraining) ~ condition + Y_pretraining + (1 | subj)
   Data: dtdotavgwide[condition %in% e_vs_p] (Number of observations: 509)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000


Multilevel Hyperparameters:
~subj (Number of levels: 509)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.81      0.09     1.64     1.99 1.00     3646     7687


Regression Coefficients:
                Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept          -4.00      0.20    -4.41    -3.61 1.00     3701     6790
conditioneffort     0.50      0.18     0.15     0.85 1.00     1733     3778
Y_pretraining       0.15      0.01     0.14     0.17 1.00     2974     5666


Draws were sampled using sampling(NUTS). 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).
```
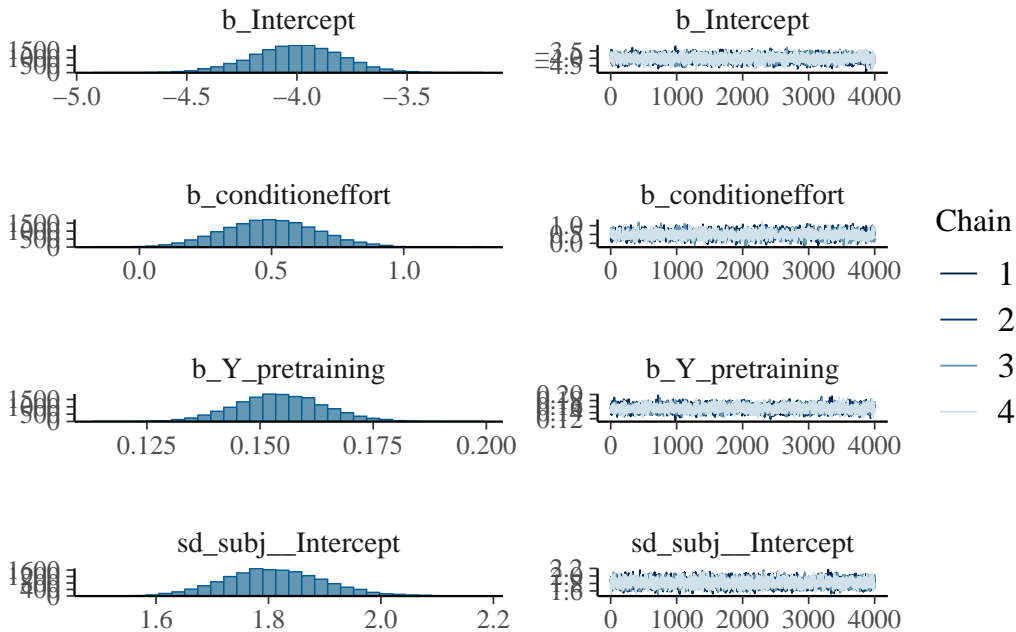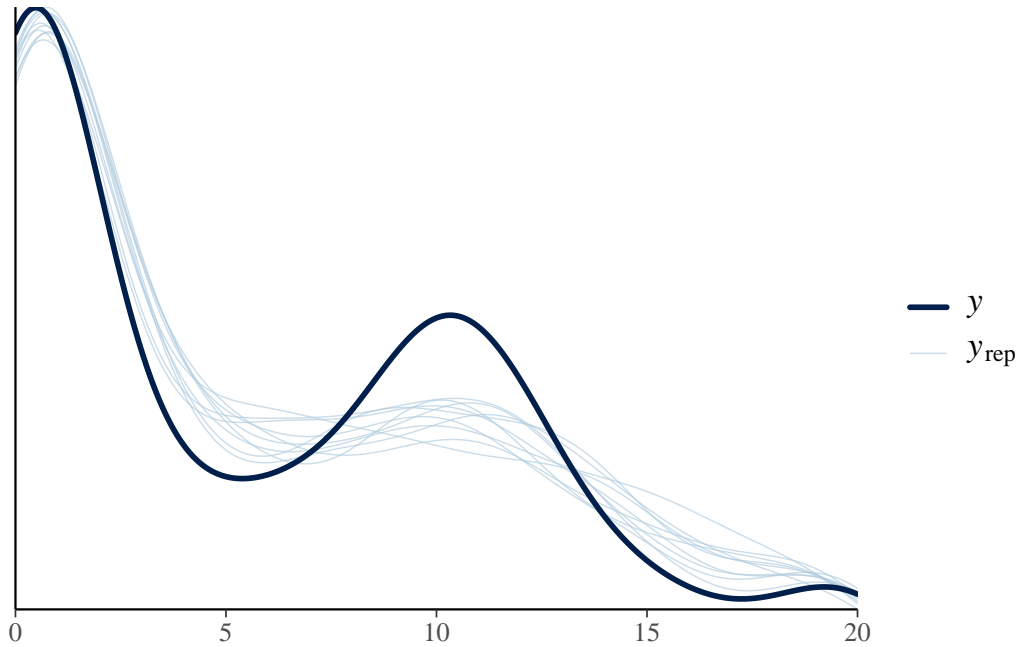
```
Using 10 posterior draws for ppc type 'dens_overlay' by default.
```


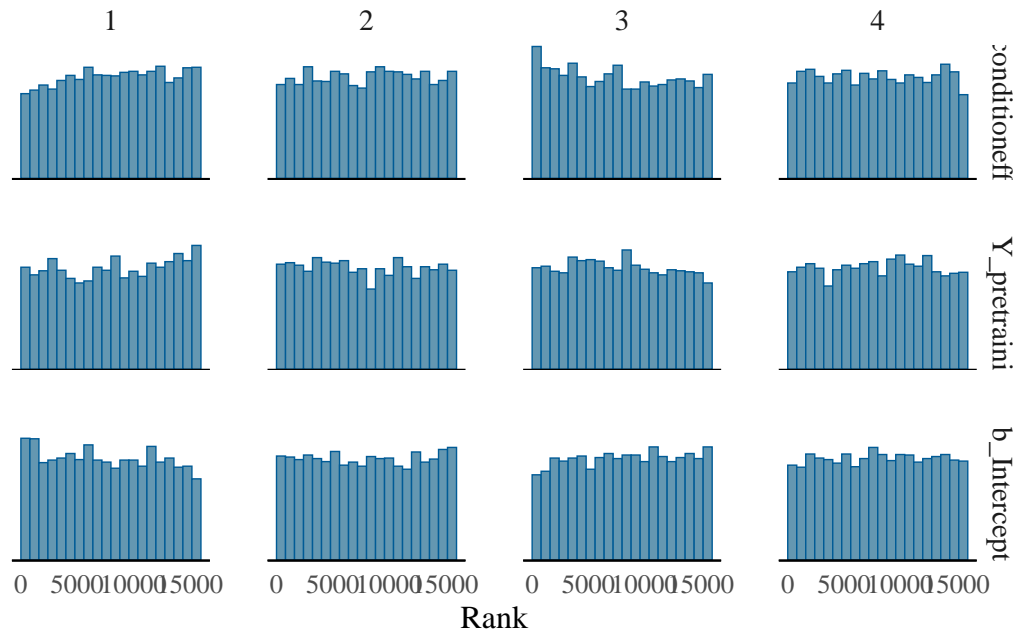As shown in the rank histogram in Figure 5 below, the chains mixed well.

Figure 5: Rank histogram of the posterior distributions of model parameters.

Table 11 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Table 11: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	0.50	0.50	0.18	0.18	0.20	0.80	1	1733.50	3778.50
b_Y_pretraining	0.15	0.15	0.01	0.01	0.14	0.17	1	2974.31	5666.04
b_Intercept	-4.00	-4.00	0.20	0.20	-4.34	-3.68	1	3700.80	6789.94

The analysis showed that effort preferences in post-training section under effort conditions were significantly higher than those in the performance condition in dot motion task, with a posterior mean of 0.5 and a 90% CI of [0.2, 0.8].

> Do effort preferences on the dot-motion task in the post-training section differ between the effort and neutral conditions? (model6)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_posttraining | trials(N_posttraining) ~ condition + Y_pretraining + (1 | subj)
   Data: dtdotavgwide[condition %in% e_vs_n] (Number of observations: 506)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000

Multilevel Hyperparameters:
~subj (Number of levels: 506)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.74      0.09     1.58     1.91 1.00     4738     8299

Regression Coefficients:
               Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept         -3.91      0.20    -4.31    -3.52 1.00     4615     7712
conditioneffort    0.25      0.17    -0.09     0.58 1.00     2390     4750
Y_pretraining      0.17      0.01     0.15     0.19 1.00     3891     7120
```
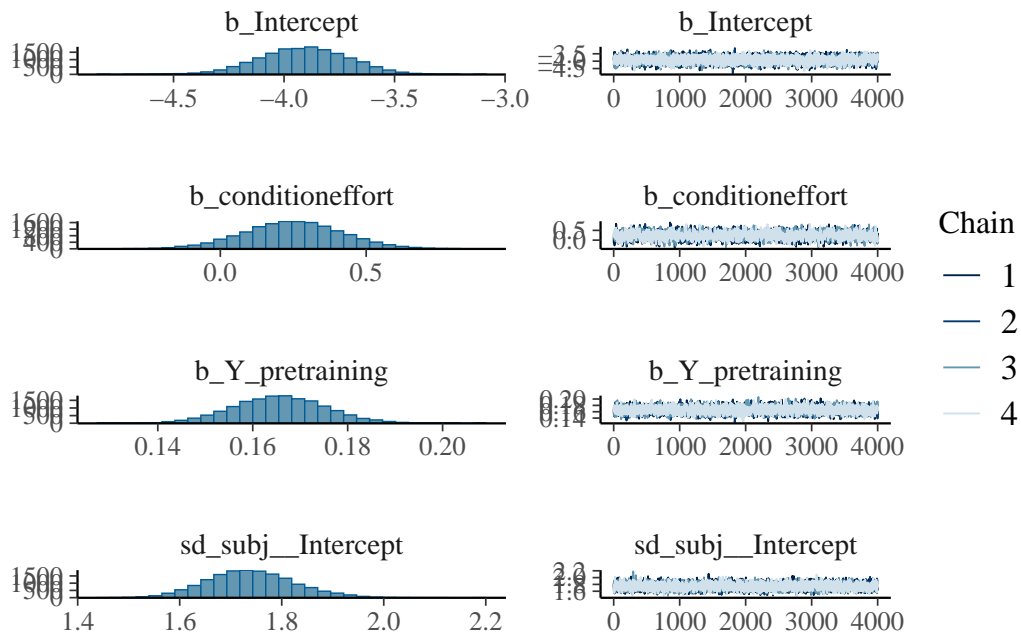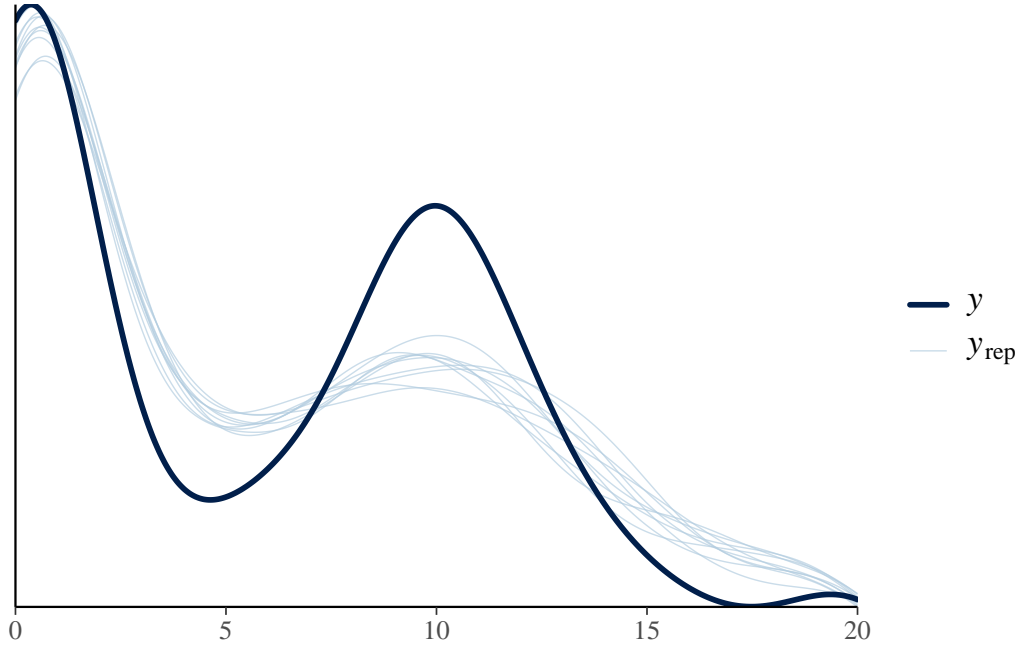
Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
and Tail_ESS are effective sample size measures, and Rhat is the potential
scale reduction factor on split chains (at convergence, Rhat = 1).

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

As shown in the rank histogram in Figure 6 below, the chains mixed well.
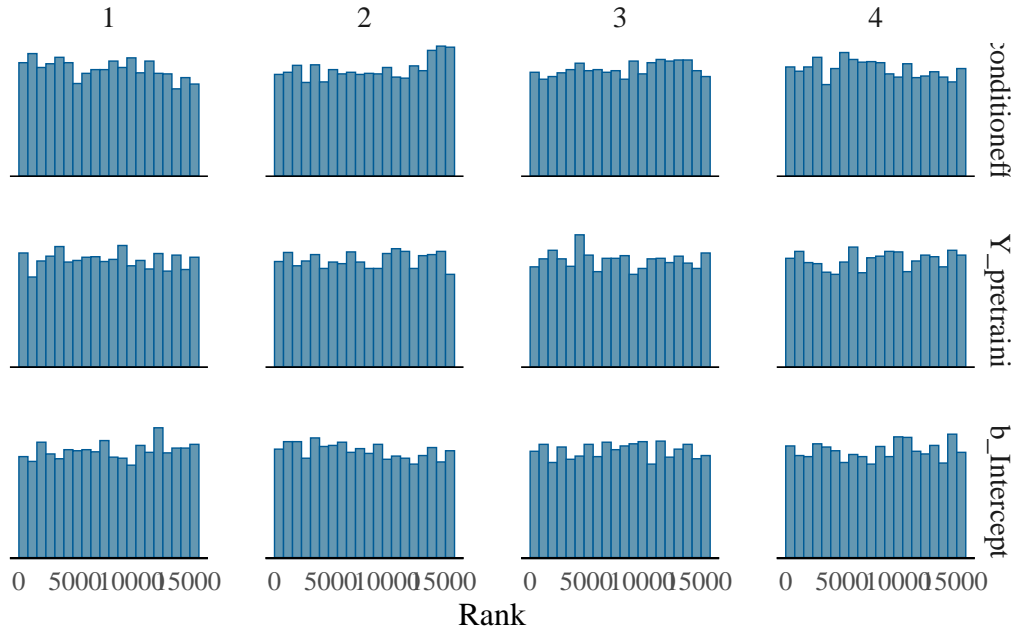

Figure 6: Rank histogram of the posterior distributions of model parameters.

Table 12 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Table 12: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	0.25	0.25	0.17	0.17	-0.03	0.53	1	2390.30	4750.09
b_Y_pretraining	0.17	0.17	0.01	0.01	0.15	0.18	1	3891.13	7120.06
b_Intercept	-3.91	-3.91	0.20	0.20	-4.24	-3.58	1	4615.11	7711.87

The analysis showed that effort preferences in post-training section under effort conditions were not significantly higher than those in the neutral condition in dot motion task, with a posterior mean of 0.25 and a 90% CI of [-0.03, 0.53].

> Do effort preferences on the math task in the post-training section differ between the effort and performance conditions? (model7)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_posttraining | trials(N_posttraining) ~ condition + Y_pretraining + (1 | subj)
   Data: dtmathavgwide[condition %in% e_vs_p] (Number of observations: 509)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000

Multilevel Hyperparameters:
~subj (Number of levels: 509)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.20      0.06     1.08     1.32 1.00     4859     9533

Regression Coefficients:
                Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept          -4.09      0.16    -4.41    -3.77 1.00     6483     9893
conditioneffort     0.28      0.13     0.03     0.53 1.00     4250     7111
Y_pretraining       0.17      0.01     0.15     0.18 1.00     5423     9849

Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
and Tail_ESS are effective sample size measures, and Rhat is the potential
```
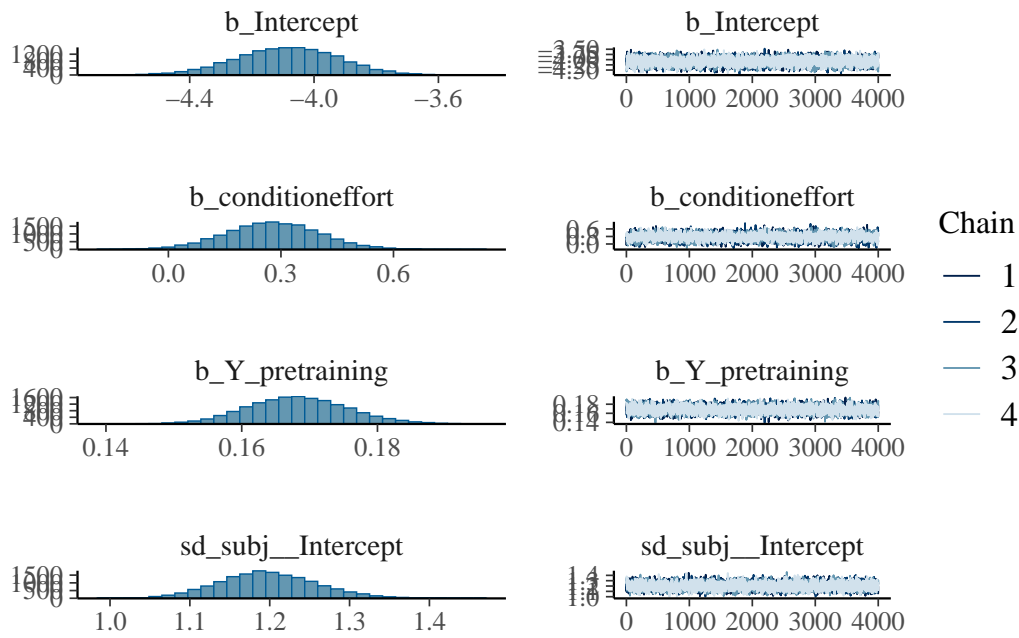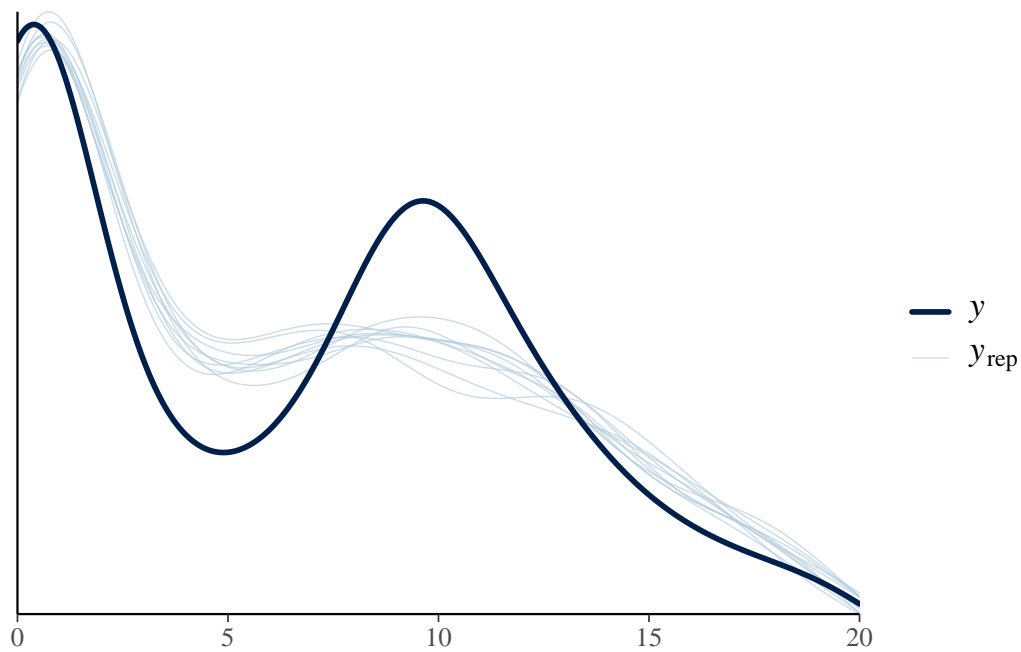
scale reduction factor on split chains (at convergence, Rhat = 1).

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

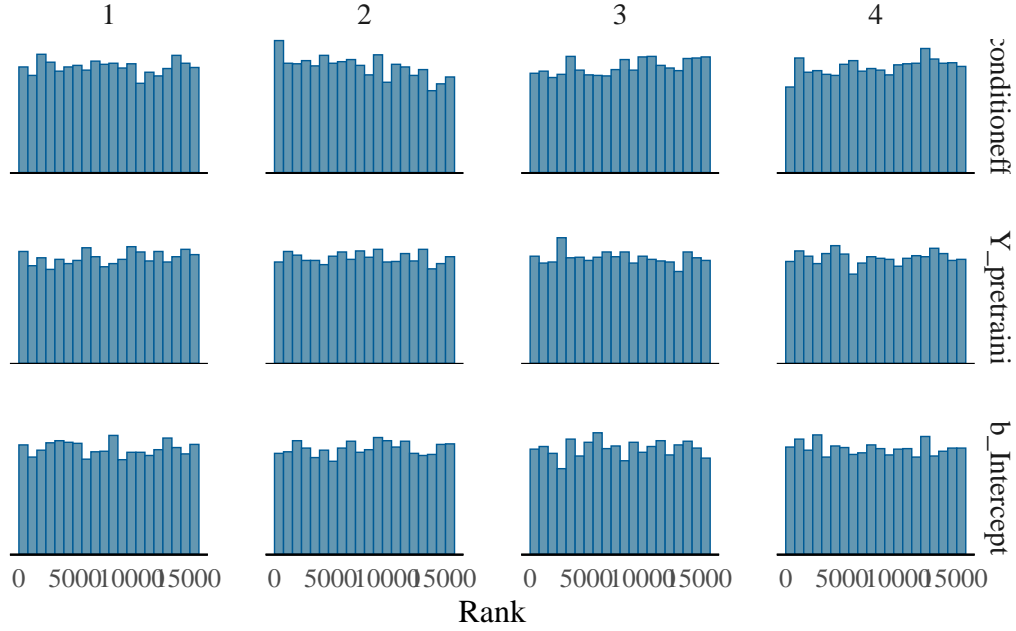As shown in the rank histogram in Figure 7 below, the chains mixed well.

Figure 7: Rank histogram of the posterior distributions of model parameters.

Table 13 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Table 13: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	0.28	0.28	0.13	0.12	0.07	0.48	1	4250.16	7111.04
b_Y_pretraining	0.17	0.17	0.01	0.01	0.16	0.18	1	5422.90	9848.77
b_Intercept	-4.09	-4.08	0.16	0.17	-4.36	-3.82	1	6482.95	9892.63

The analysis showed that effort preferences in post-training section under effort conditions were significantly higher than those in the performance condition in math task, with a posterior mean of 0.28 and a 90% CI of [0.07, 0.48].

> Do effort preferences on the math task in the post-training section differ between the effort and neutral conditions? (model8)

Analysis

We used 4 chains, each with 8,000 iterations (first 4,000 as warm-ups).

25

Results

```
 Family: binomial
  Links: mu = logit
Formula: Y_posttraining | trials(N_posttraining) ~ condition + Y_pretraining + (1 | subj)
   Data: dtmathavgwide[condition %in% e_vs_n] (Number of observations: 506)
  Draws: 4 chains, each with iter = 8000; warmup = 4000; thin = 1;
         total post-warmup draws = 16000


Multilevel Hyperparameters:
~subj (Number of levels: 506)
              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
sd(Intercept)     1.24      0.06     1.13     1.37 1.00     5045     8320


Regression Coefficients:
                Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
Intercept          -3.80      0.17    -4.15    -3.48 1.00     4288     7650
conditioneffort     0.19      0.13    -0.06     0.44 1.00     3281     6322
Y_pretraining       0.16      0.01     0.14     0.17 1.00     4076     6928


Draws were sampled using sampling(NUTS). 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).
```
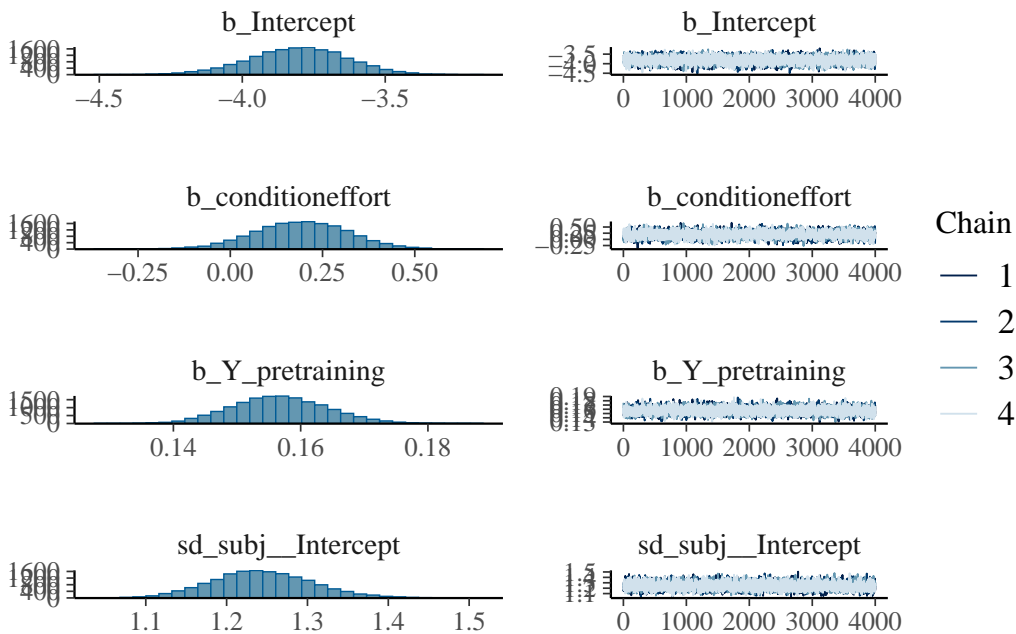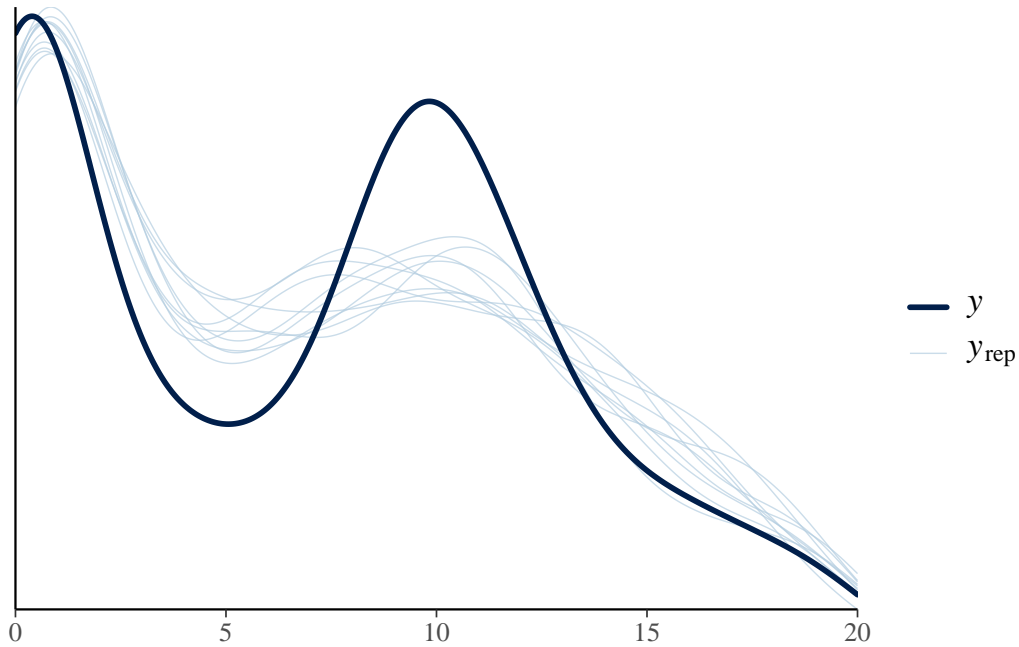
```
Using 10 posterior draws for ppc type 'dens_overlay' by default.
```


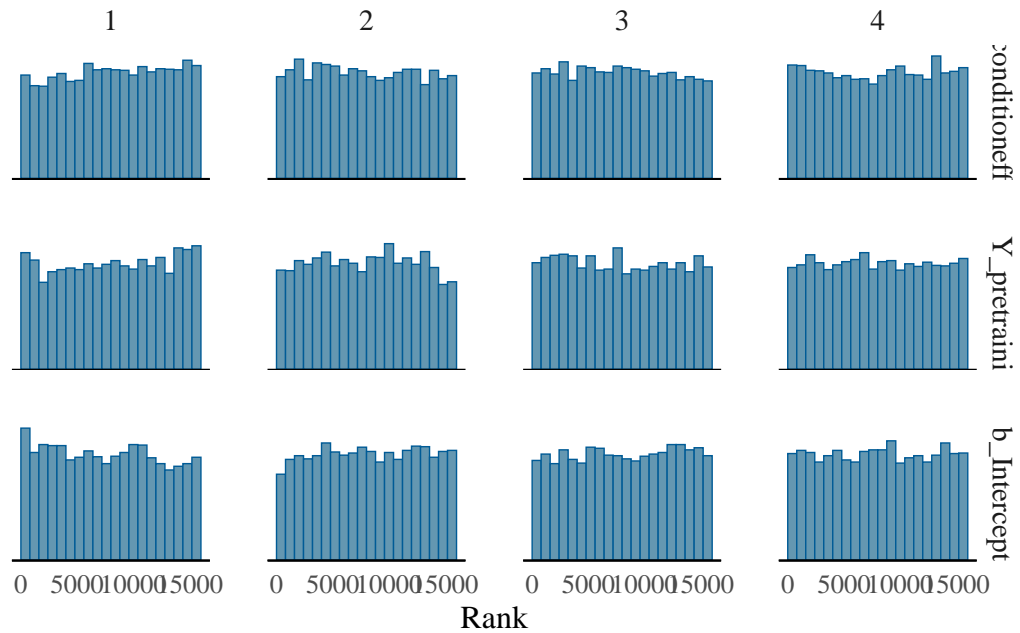As shown in the rank histogram in Figure 8 below, the chains mixed well.

Figure 8: Rank histogram of the posterior distributions of model parameters.

Table 14 shows the posterior distributions of b_conditioneffort, b_Y_pretraining, b_Intercept.

Table 14: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_conditioneffort	0.19	0.19	0.13	0.13	-0.02	0.40	1	3281.06	6322.11
b_Y_pretraining	0.16	0.16	0.01	0.01	0.14	0.17	1	4076.37	6928.48
b_Intercept	-3.80	-3.80	0.17	0.17	-4.09	-3.53	1	4287.53	7649.93

The analysis showed that effort preferences in post-training section under effort conditions were not significantly higher than those in the neutral condition in math task, with a posterior mean of 0.19 and a 90% CI of [-0.02, 0.4].