

# Effort spent in different studies

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## Introduction

Here we report the effort spent on activities in three different studies, two of which did not and one of which did have the possibility of receiving human feedback.

Required files:

- Data/effort\_for\_study\_comparison\_onlyneverfeedback\_study2.csv

## Setup

First, we load the rethinking package, which we need to fit and sample from models. We also load formatR for formatting.

```
library(formatR) # For formatting
library(rethinking) # For Bayesian models
```

Also, we set the number of chains used for fitting models.

```
NUM_CHAINS = 4 # our value: 4
```

## Data file

We load the pre-processed data.

```
df_neverfeedback = read.csv(file = "Data/effort_for_study_comparison_onlyneverfeedback_study2.csv")

df_study01 = df_neverfeedback[df_neverfeedback$study_idx %in%
  c(0, 1), ]
df_study2neverfeedback = df_neverfeedback[df_neverfeedback$study_idx ==
  2, ]
```

## Fit models for each sample

### Studies without chance of getting human feedback

Here we only use the effort scores from the first two studies which did not include the chance of receiving human feedback.

```
# Create a data list to be used for the model
dat_list_study01 <- list(effort = df_study01$effort, activity_idx = df_study01$activity_combined_index +
  1)

set.seed(18)

ml.study01 <- ulam(alist(effort ~ dstudent(v, mu, sigma), mu <- a_bar +
  z_activity[activity_idx] * sigma_a_act, v ~ gamma(2, 0.1),
  z_activity[activity_idx] ~ dnorm(0, 1), sigma_a_act ~ dexp(1),
  a_bar ~ dnorm(5, 10), sigma ~ dexp(1)), data = dat_list_study01,
  chains = NUM_CHAINS, log_lik = TRUE, cores = NUM_CHAINS,
  iter = 4000)

## Running MCMC with 4 parallel chains, with 1 thread(s) per chain...
##
## Chain 1 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 1 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 1 Exception: student_t_lpdf: Scale parameter is inf, but must be positive finite! (in '/tmp/Rtmp2E...
## Chain 1 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 1 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 1
## Chain 1 Informational Message: The current Metropolis proposal is about to be rejected because of the
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## Chain 1 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 1 Exception: gamma_lpdf: Random variable is inf, but must be positive finite! (in '/tmp/Rtmp2E...
## Chain 1 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 1 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 1
## Chain 2 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 2 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 2 Exception: gamma_lpdf: Random variable is inf, but must be positive finite! (in '/tmp/Rtmp2E...
## Chain 2 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 2 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 2
```

```
## Chain 3 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 3 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 3 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIz')
## Chain 3 If this warning occurs sporadically, such as for highly constrained variable types like covariance
## Chain 3 but if this warning occurs often then your model may be either severely ill-conditioned or misspecified
## Chain 3
## Chain 3 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 3 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIz')
## Chain 3 If this warning occurs sporadically, such as for highly constrained variable types like covariance
## Chain 3 but if this warning occurs often then your model may be either severely ill-conditioned or misspecified
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## Chain 3 Informational Message: The current Metropolis proposal is about to be rejected because of the
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## Chain 3 If this warning occurs sporadically, such as for highly constrained variable types like covariance
## Chain 3 but if this warning occurs often then your model may be either severely ill-conditioned or misspecified
## Chain 3
## Chain 4 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 4 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 4 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIz')
## Chain 4 If this warning occurs sporadically, such as for highly constrained variable types like covariance
## Chain 4 but if this warning occurs often then your model may be either severely ill-conditioned or misspecified
## Chain 4
## Chain 4 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 4 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIz')
## Chain 4 If this warning occurs sporadically, such as for highly constrained variable types like covariance
## Chain 4 but if this warning occurs often then your model may be either severely ill-conditioned or misspecified
```

```

## Chain 4
## Chain 4 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 4 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIz
## Chain 4 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 4 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 4
## Chain 4 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 4 Exception: student_t_lpdf: Scale parameter is inf, but must be positive finite! (in '/tmp/Rt
## Chain 4 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 4 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 4
## Chain 3 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 1 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 2 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 4 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 2 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 3 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 1 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 4 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 2 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 3 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 1 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 4 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 1 Iteration: 400 / 4000 [ 10%] (Warmup)
## Chain 2 Iteration: 400 / 4000 [ 10%] (Warmup)
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## Chain 4 Iteration: 400 / 4000 [ 10%] (Warmup)
## Chain 1 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 2 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 3 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 1 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 4 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 2 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 3 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 4 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 1 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 2 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 3 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 4 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 1 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 2 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 3 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 4 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 1 Iteration: 900 / 4000 [ 22%] (Warmup)
## Chain 2 Iteration: 900 / 4000 [ 22%] (Warmup)
## Chain 3 Iteration: 900 / 4000 [ 22%] (Warmup)
## Chain 1 Iteration: 1000 / 4000 [ 25%] (Warmup)
## Chain 4 Iteration: 900 / 4000 [ 22%] (Warmup)

```



## Chain 1 Iteration: 2200 / 4000 [ 55%] (Sampling)  
## Chain 2 Iteration: 2300 / 4000 [ 57%] (Sampling)  
## Chain 3 Iteration: 2300 / 4000 [ 57%] (Sampling)  
## Chain 4 Iteration: 2300 / 4000 [ 57%] (Sampling)  
## Chain 2 Iteration: 2400 / 4000 [ 60%] (Sampling)  
## Chain 1 Iteration: 2300 / 4000 [ 57%] (Sampling)  
## Chain 3 Iteration: 2400 / 4000 [ 60%] (Sampling)  
## Chain 4 Iteration: 2400 / 4000 [ 60%] (Sampling)  
## Chain 2 Iteration: 2500 / 4000 [ 62%] (Sampling)  
## Chain 1 Iteration: 2400 / 4000 [ 60%] (Sampling)  
## Chain 3 Iteration: 2500 / 4000 [ 62%] (Sampling)  
## Chain 4 Iteration: 2500 / 4000 [ 62%] (Sampling)  
## Chain 2 Iteration: 2600 / 4000 [ 65%] (Sampling)  
## Chain 3 Iteration: 2600 / 4000 [ 65%] (Sampling)  
## Chain 4 Iteration: 2600 / 4000 [ 65%] (Sampling)  
## Chain 1 Iteration: 2500 / 4000 [ 62%] (Sampling)  
## Chain 2 Iteration: 2700 / 4000 [ 67%] (Sampling)  
## Chain 3 Iteration: 2700 / 4000 [ 67%] (Sampling)  
## Chain 4 Iteration: 2700 / 4000 [ 67%] (Sampling)  
## Chain 2 Iteration: 2800 / 4000 [ 70%] (Sampling)  
## Chain 1 Iteration: 2600 / 4000 [ 65%] (Sampling)  
## Chain 3 Iteration: 2800 / 4000 [ 70%] (Sampling)  
## Chain 4 Iteration: 2800 / 4000 [ 70%] (Sampling)  
## Chain 2 Iteration: 2900 / 4000 [ 72%] (Sampling)  
## Chain 1 Iteration: 2700 / 4000 [ 67%] (Sampling)  
## Chain 3 Iteration: 2900 / 4000 [ 72%] (Sampling)  
## Chain 4 Iteration: 2900 / 4000 [ 72%] (Sampling)  
## Chain 2 Iteration: 3000 / 4000 [ 75%] (Sampling)  
## Chain 4 Iteration: 3000 / 4000 [ 75%] (Sampling)  
## Chain 1 Iteration: 2800 / 4000 [ 70%] (Sampling)  
## Chain 2 Iteration: 3100 / 4000 [ 77%] (Sampling)  
## Chain 3 Iteration: 3000 / 4000 [ 75%] (Sampling)  
## Chain 2 Iteration: 3200 / 4000 [ 80%] (Sampling)  
## Chain 3 Iteration: 3100 / 4000 [ 77%] (Sampling)  
## Chain 4 Iteration: 3100 / 4000 [ 77%] (Sampling)  
## Chain 1 Iteration: 2900 / 4000 [ 72%] (Sampling)  
## Chain 2 Iteration: 3300 / 4000 [ 82%] (Sampling)  
## Chain 4 Iteration: 3200 / 4000 [ 80%] (Sampling)  
## Chain 3 Iteration: 3200 / 4000 [ 80%] (Sampling)  
## Chain 1 Iteration: 3000 / 4000 [ 75%] (Sampling)  
## Chain 2 Iteration: 3400 / 4000 [ 85%] (Sampling)  
## Chain 3 Iteration: 3300 / 4000 [ 82%] (Sampling)  
## Chain 4 Iteration: 3300 / 4000 [ 82%] (Sampling)  
## Chain 2 Iteration: 3500 / 4000 [ 87%] (Sampling)  
## Chain 1 Iteration: 3100 / 4000 [ 77%] (Sampling)  
## Chain 3 Iteration: 3400 / 4000 [ 85%] (Sampling)  
## Chain 4 Iteration: 3400 / 4000 [ 85%] (Sampling)  
## Chain 2 Iteration: 3600 / 4000 [ 90%] (Sampling)  
## Chain 1 Iteration: 3200 / 4000 [ 80%] (Sampling)  
## Chain 3 Iteration: 3500 / 4000 [ 87%] (Sampling)  
## Chain 2 Iteration: 3700 / 4000 [ 92%] (Sampling)  
## Chain 4 Iteration: 3500 / 4000 [ 87%] (Sampling)  
## Chain 3 Iteration: 3600 / 4000 [ 90%] (Sampling)  
## Chain 1 Iteration: 3300 / 4000 [ 82%] (Sampling)

```

## Chain 2 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 4 Iteration: 3600 / 4000 [ 90%] (Sampling)
## Chain 3 Iteration: 3700 / 4000 [ 92%] (Sampling)
## Chain 1 Iteration: 3400 / 4000 [ 85%] (Sampling)
## Chain 2 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 4 Iteration: 3700 / 4000 [ 92%] (Sampling)
## Chain 3 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 2 Iteration: 4000 / 4000 [100%] (Sampling)
## Chain 4 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 2 finished in 16.2 seconds.
## Chain 1 Iteration: 3500 / 4000 [ 87%] (Sampling)
## Chain 3 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 4 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 1 Iteration: 3600 / 4000 [ 90%] (Sampling)
## Chain 3 Iteration: 4000 / 4000 [100%] (Sampling)
## Chain 4 Iteration: 4000 / 4000 [100%] (Sampling)
## Chain 3 finished in 16.9 seconds.
## Chain 4 finished in 16.9 seconds.
## Chain 1 Iteration: 3700 / 4000 [ 92%] (Sampling)
## Chain 1 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 1 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 1 Iteration: 4000 / 4000 [100%] (Sampling)
## Chain 1 finished in 18.2 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 17.0 seconds.
## Total execution time: 18.4 seconds.

```

```
output_study01 = precis(ml.study01, prob = 0.95)
```

```
## 22 vector or matrix parameters hidden. Use depth=2 to show them.
```

```
output_study01
```

```

##              mean          sd      2.5%    97.5%    rhat    ess_bulk
## v              7.8135695 0.66486301 6.58556575 9.1872768 0.9999867 10463.316
## sigma_a_act    0.2680339 0.10028345 0.07079564 0.4781072 1.0011109  2288.900
## a_bar          5.6049955 0.08931315 5.42690000 5.7801815 1.0009742  4273.934
## sigma         2.5550989 0.04489101 2.46767850 2.6439507 1.0001524  9552.531

```

## Current study without feedback

Here we only use the effort scores from our current study of people who never got human feedback.

```

# Create a data list to be used for the model
dat_list_study2neverfeedback <- list(effort = df_study2neverfeedback$effort,
  activity_idx = df_study2neverfeedback$activity_combined_index +
  1)

set.seed(18)

ml.study2neverfeedback <- ulam(alist(effort ~ dstudent(v, mu,
  sigma), mu <- a_bar + z_activity[activity_idx] * sigma_a_act,
  v ~ gamma(2, 0.1), z_activity[activity_idx] ~ dnorm(0, 1),
  sigma_a_act ~ dexp(1), a_bar ~ dnorm(5, 10), sigma ~ dexp(1)),
  data = dat_list_study2neverfeedback, chains = NUM_CHAINS,

```

```
log_lik = TRUE, cores = NUM_CHAINS, iter = 4000)
```

```
## Running MCMC with 4 parallel chains, with 1 thread(s) per chain...
##
## Chain 1 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 1 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 1 Exception: gamma_lpdf: Random variable is inf, but must be positive finite! (in '/tmp/Rtmp2E...
## Chain 1 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 1 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 1
## Chain 2 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 2 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 2 Exception: gamma_lpdf: Random variable is inf, but must be positive finite! (in '/tmp/Rtmp2E...
## Chain 2 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 2 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 2
## Chain 3 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 3 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 3 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIZ...
## Chain 3 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 3 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 3
## Chain 3 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 3 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIZ...
## Chain 3 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 3 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 3
## Chain 3 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 3 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIZ...
## Chain 3 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 3 but if this warning occurs often then your model may be either severely ill-conditioned or m
## Chain 3
## Chain 4 Iteration:    1 / 4000 [ 0%] (Warmup)
## Chain 4 Informational Message: The current Metropolis proposal is about to be rejected because of the
## Chain 4 Exception: gamma_lpdf: Random variable is 0, but must be positive finite! (in '/tmp/Rtmp2EIZ...
## Chain 4 If this warning occurs sporadically, such as for highly constrained variable types like covar
## Chain 4 but if this warning occurs often then your model may be either severely ill-conditioned or m
```

```
## Chain 4
## Chain 1 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 2 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 1 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 1 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 2 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 3 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 4 Iteration: 100 / 4000 [ 2%] (Warmup)
## Chain 1 Iteration: 400 / 4000 [ 10%] (Warmup)
## Chain 2 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 3 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 4 Iteration: 200 / 4000 [ 5%] (Warmup)
## Chain 2 Iteration: 400 / 4000 [ 10%] (Warmup)
## Chain 3 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 4 Iteration: 300 / 4000 [ 7%] (Warmup)
## Chain 1 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 2 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 3 Iteration: 400 / 4000 [ 10%] (Warmup)
## Chain 4 Iteration: 400 / 4000 [ 10%] (Warmup)
## Chain 1 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 1 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 2 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 3 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 1 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 2 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 2 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 3 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 4 Iteration: 500 / 4000 [ 12%] (Warmup)
## Chain 1 Iteration: 900 / 4000 [ 22%] (Warmup)
## Chain 3 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 4 Iteration: 600 / 4000 [ 15%] (Warmup)
## Chain 1 Iteration: 1000 / 4000 [ 25%] (Warmup)
## Chain 2 Iteration: 900 / 4000 [ 22%] (Warmup)
## Chain 3 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 4 Iteration: 700 / 4000 [ 17%] (Warmup)
## Chain 2 Iteration: 1000 / 4000 [ 25%] (Warmup)
## Chain 3 Iteration: 900 / 4000 [ 22%] (Warmup)
## Chain 4 Iteration: 800 / 4000 [ 20%] (Warmup)
## Chain 1 Iteration: 1100 / 4000 [ 27%] (Warmup)
## Chain 2 Iteration: 1100 / 4000 [ 27%] (Warmup)
## Chain 3 Iteration: 1000 / 4000 [ 25%] (Warmup)
## Chain 4 Iteration: 900 / 4000 [ 22%] (Warmup)
## Chain 1 Iteration: 1200 / 4000 [ 30%] (Warmup)
## Chain 2 Iteration: 1200 / 4000 [ 30%] (Warmup)
## Chain 3 Iteration: 1100 / 4000 [ 27%] (Warmup)
## Chain 4 Iteration: 1000 / 4000 [ 25%] (Warmup)
## Chain 1 Iteration: 1300 / 4000 [ 32%] (Warmup)
## Chain 2 Iteration: 1300 / 4000 [ 32%] (Warmup)
## Chain 3 Iteration: 1200 / 4000 [ 30%] (Warmup)
## Chain 4 Iteration: 1100 / 4000 [ 27%] (Warmup)
## Chain 1 Iteration: 1400 / 4000 [ 35%] (Warmup)
## Chain 2 Iteration: 1400 / 4000 [ 35%] (Warmup)
## Chain 3 Iteration: 1300 / 4000 [ 32%] (Warmup)
```

## Chain 4 Iteration: 1200 / 4000 [ 30%] (Warmup)  
## Chain 1 Iteration: 1500 / 4000 [ 37%] (Warmup)  
## Chain 2 Iteration: 1500 / 4000 [ 37%] (Warmup)  
## Chain 3 Iteration: 1400 / 4000 [ 35%] (Warmup)  
## Chain 4 Iteration: 1300 / 4000 [ 32%] (Warmup)  
## Chain 1 Iteration: 1600 / 4000 [ 40%] (Warmup)  
## Chain 2 Iteration: 1600 / 4000 [ 40%] (Warmup)  
## Chain 4 Iteration: 1400 / 4000 [ 35%] (Warmup)  
## Chain 1 Iteration: 1700 / 4000 [ 42%] (Warmup)  
## Chain 2 Iteration: 1700 / 4000 [ 42%] (Warmup)  
## Chain 2 Iteration: 1800 / 4000 [ 45%] (Warmup)  
## Chain 3 Iteration: 1500 / 4000 [ 37%] (Warmup)  
## Chain 4 Iteration: 1500 / 4000 [ 37%] (Warmup)  
## Chain 1 Iteration: 1800 / 4000 [ 45%] (Warmup)  
## Chain 3 Iteration: 1600 / 4000 [ 40%] (Warmup)  
## Chain 4 Iteration: 1600 / 4000 [ 40%] (Warmup)  
## Chain 1 Iteration: 1900 / 4000 [ 47%] (Warmup)  
## Chain 2 Iteration: 1900 / 4000 [ 47%] (Warmup)  
## Chain 2 Iteration: 2000 / 4000 [ 50%] (Warmup)  
## Chain 2 Iteration: 2001 / 4000 [ 50%] (Sampling)  
## Chain 3 Iteration: 1700 / 4000 [ 42%] (Warmup)  
## Chain 4 Iteration: 1700 / 4000 [ 42%] (Warmup)  
## Chain 1 Iteration: 2000 / 4000 [ 50%] (Warmup)  
## Chain 1 Iteration: 2001 / 4000 [ 50%] (Sampling)  
## Chain 1 Iteration: 2100 / 4000 [ 52%] (Sampling)  
## Chain 2 Iteration: 2100 / 4000 [ 52%] (Sampling)  
## Chain 3 Iteration: 1800 / 4000 [ 45%] (Warmup)  
## Chain 4 Iteration: 1800 / 4000 [ 45%] (Warmup)  
## Chain 1 Iteration: 2200 / 4000 [ 55%] (Sampling)  
## Chain 2 Iteration: 2200 / 4000 [ 55%] (Sampling)  
## Chain 3 Iteration: 1900 / 4000 [ 47%] (Warmup)  
## Chain 4 Iteration: 1900 / 4000 [ 47%] (Warmup)  
## Chain 1 Iteration: 2300 / 4000 [ 57%] (Sampling)  
## Chain 2 Iteration: 2300 / 4000 [ 57%] (Sampling)  
## Chain 3 Iteration: 2000 / 4000 [ 50%] (Warmup)  
## Chain 3 Iteration: 2001 / 4000 [ 50%] (Sampling)  
## Chain 4 Iteration: 2000 / 4000 [ 50%] (Warmup)  
## Chain 4 Iteration: 2001 / 4000 [ 50%] (Sampling)  
## Chain 1 Iteration: 2400 / 4000 [ 60%] (Sampling)  
## Chain 2 Iteration: 2400 / 4000 [ 60%] (Sampling)  
## Chain 2 Iteration: 2500 / 4000 [ 62%] (Sampling)  
## Chain 3 Iteration: 2100 / 4000 [ 52%] (Sampling)  
## Chain 4 Iteration: 2100 / 4000 [ 52%] (Sampling)  
## Chain 4 Iteration: 2200 / 4000 [ 55%] (Sampling)  
## Chain 1 Iteration: 2500 / 4000 [ 62%] (Sampling)  
## Chain 2 Iteration: 2600 / 4000 [ 65%] (Sampling)  
## Chain 3 Iteration: 2200 / 4000 [ 55%] (Sampling)  
## Chain 4 Iteration: 2300 / 4000 [ 57%] (Sampling)  
## Chain 1 Iteration: 2600 / 4000 [ 65%] (Sampling)  
## Chain 2 Iteration: 2700 / 4000 [ 67%] (Sampling)  
## Chain 3 Iteration: 2300 / 4000 [ 57%] (Sampling)  
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## Chain 1 Iteration: 2700 / 4000 [ 67%] (Sampling)  
## Chain 2 Iteration: 2800 / 4000 [ 70%] (Sampling)

```
## Chain 3 Iteration: 2400 / 4000 [ 60%] (Sampling)
## Chain 4 Iteration: 2500 / 4000 [ 62%] (Sampling)
## Chain 2 Iteration: 2900 / 4000 [ 72%] (Sampling)
## Chain 3 Iteration: 2500 / 4000 [ 62%] (Sampling)
## Chain 4 Iteration: 2600 / 4000 [ 65%] (Sampling)
## Chain 1 Iteration: 2800 / 4000 [ 70%] (Sampling)
## Chain 2 Iteration: 3000 / 4000 [ 75%] (Sampling)
## Chain 3 Iteration: 2600 / 4000 [ 65%] (Sampling)
## Chain 4 Iteration: 2700 / 4000 [ 67%] (Sampling)
## Chain 4 Iteration: 2800 / 4000 [ 70%] (Sampling)
## Chain 1 Iteration: 2900 / 4000 [ 72%] (Sampling)
## Chain 2 Iteration: 3100 / 4000 [ 77%] (Sampling)
## Chain 3 Iteration: 2700 / 4000 [ 67%] (Sampling)
## Chain 4 Iteration: 2900 / 4000 [ 72%] (Sampling)
## Chain 1 Iteration: 3000 / 4000 [ 75%] (Sampling)
## Chain 2 Iteration: 3200 / 4000 [ 80%] (Sampling)
## Chain 3 Iteration: 2800 / 4000 [ 70%] (Sampling)
## Chain 4 Iteration: 3000 / 4000 [ 75%] (Sampling)
## Chain 1 Iteration: 3100 / 4000 [ 77%] (Sampling)
## Chain 2 Iteration: 3300 / 4000 [ 82%] (Sampling)
## Chain 2 Iteration: 3400 / 4000 [ 85%] (Sampling)
## Chain 3 Iteration: 2900 / 4000 [ 72%] (Sampling)
## Chain 4 Iteration: 3100 / 4000 [ 77%] (Sampling)
## Chain 1 Iteration: 3200 / 4000 [ 80%] (Sampling)
## Chain 2 Iteration: 3500 / 4000 [ 87%] (Sampling)
## Chain 3 Iteration: 3000 / 4000 [ 75%] (Sampling)
## Chain 4 Iteration: 3200 / 4000 [ 80%] (Sampling)
## Chain 1 Iteration: 3300 / 4000 [ 82%] (Sampling)
## Chain 2 Iteration: 3600 / 4000 [ 90%] (Sampling)
## Chain 3 Iteration: 3100 / 4000 [ 77%] (Sampling)
## Chain 4 Iteration: 3300 / 4000 [ 82%] (Sampling)
## Chain 1 Iteration: 3400 / 4000 [ 85%] (Sampling)
## Chain 2 Iteration: 3700 / 4000 [ 92%] (Sampling)
## Chain 4 Iteration: 3400 / 4000 [ 85%] (Sampling)
## Chain 1 Iteration: 3500 / 4000 [ 87%] (Sampling)
## Chain 2 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 3 Iteration: 3200 / 4000 [ 80%] (Sampling)
## Chain 4 Iteration: 3500 / 4000 [ 87%] (Sampling)
## Chain 1 Iteration: 3600 / 4000 [ 90%] (Sampling)
## Chain 2 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 3 Iteration: 3300 / 4000 [ 82%] (Sampling)
## Chain 4 Iteration: 3600 / 4000 [ 90%] (Sampling)
## Chain 1 Iteration: 3700 / 4000 [ 92%] (Sampling)
## Chain 1 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 2 Iteration: 4000 / 4000 [100%] (Sampling)
## Chain 3 Iteration: 3400 / 4000 [ 85%] (Sampling)
## Chain 3 Iteration: 3500 / 4000 [ 87%] (Sampling)
## Chain 4 Iteration: 3700 / 4000 [ 92%] (Sampling)
## Chain 4 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 2 finished in 4.0 seconds.
## Chain 3 Iteration: 3600 / 4000 [ 90%] (Sampling)
## Chain 4 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 1 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 1 Iteration: 4000 / 4000 [100%] (Sampling)
```

```
## Chain 3 Iteration: 3700 / 4000 [ 92%] (Sampling)
## Chain 4 Iteration: 4000 / 4000 [100%] (Sampling)
## Chain 1 finished in 4.3 seconds.
## Chain 4 finished in 4.1 seconds.
## Chain 3 Iteration: 3800 / 4000 [ 95%] (Sampling)
## Chain 3 Iteration: 3900 / 4000 [ 97%] (Sampling)
## Chain 3 Iteration: 4000 / 4000 [100%] (Sampling)
## Chain 3 finished in 4.4 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 4.2 seconds.
## Total execution time: 4.5 seconds.
```

```
output_study2neverfeedback = precis(ml.study2neverfeedback, prob = 0.95)
```

```
## 22 vector or matrix parameters hidden. Use depth=2 to show them.
```

```
output_study2neverfeedback
```

```
##           mean      sd    2.5%    97.5%    rhat  ess_bulk
## v          4.650840 0.54223489 3.6596445 5.7764372 1.000473 9371.922
## sigma_a_act 0.512591 0.19861381 0.1090481 0.9189789 1.001991 2541.404
## a_bar       5.825034 0.17049077 5.4907415 6.1693542 1.000467 5105.591
## sigma       2.425730 0.09472844 2.2451283 2.6141355 1.000869 8737.808
```