hw8_AvishaAvisha

```
library(bayesplot)
library(tidyverse)
library(brms)
library(modelsummary)
library(dplyr)
library(posterior)
```

Research Question

> Does the reaction time differ between participants with high versus low depression scores?

Variables

- `ID' Participant id.
- `agentType': Participants reaction time in trust games was measured when they played against two different kinds of agents, represented by agent type variable.
- 'trustRTVec': Reaction time for each trial.
- 'DASS_Depr': Self-reported depression scores.

Data Import

```
data <- read.csv("merged_dat_trustgame_indvdfs.csv", row.names = NULL)

data$agentType <- as.factor(data$agentType)

data <- data[!is.na(data$trustRTVec) & !is.nan(data$trustRTVec) & !is.infinite(data$trustRTVec
```

Variable Summary

Table Table 1 shows the summary statistics of RTs by agent types.

```
datasummary(trustRTVec*
                (N + Mean + SD + Min + Max + Histogram) ~
                factor(agentType),
            data = data)
```

Table 1: Descriptive statistics by groups

		BR, GO	GR, GO
trustRTVec	N	3513	7078

	BR, GO	GR, GO
Mean	703.40	671.53
SD	357.44	340.78
Min	5.00	2.00
Max	2011.00	2026.00
Histogram		

Tibble Table 2 shows statistics for trustRTVec across ranges of depressionScores (0-21)

Table 2

```
data %>%
  group_by(DASS_Depr) %>%
  summarise(
    N = n(),
    Mean = mean(trustRTVec, na.rm = TRUE),
    SD = sd(trustRTVec, na.rm = TRUE),
    Min = min(trustRTVec, na.rm = TRUE),
    Max = max(trustRTVec, na.rm = TRUE)
  ) %>%
  print()
```

```
# A tibble: 22 × 6
   DASS_Depr     N  Mean    SD   Min   Max
       <int> <int> <dbl> <dbl> <int> <int>
 1         0  2277  678.  366.     2  2026
 2         1  1632  670.  308.    11  1971
 3         2   740  693.  359.    13  1974
 4         3   666  793.  373.     9  1995
 5         4   381  669.  308.    53  1958
 6         5   527  702.  333.    18  1989
 7         6   686  635.  306.    26  1935
 8         7   418  690.  347.     8  1977
 9         8   491  643.  357.     2  1972
10         9   266  704.  390.   107  1993
# ℹ 12 more rows
```

```
data %>%
  summarise(N = n(),
            Mean = mean(trustRTVec, na.rm = TRUE),
            SD = sd(trustRTVec, na.rm = TRUE),
            Min = min(trustRTVec, na.rm = TRUE),
            Max = max(trustRTVec, na.rm = TRUE))
```

```
      N     Mean       SD Min  Max
1 10591 682.1052 346.6997   2 2026
```

Model 1 using lognormal family

Let Y_i = trustRTVec, X_1 = DASS_Depr, X_2 = agentType, Z_i = ID

Model:

$$Y_i \sim \text{LogNormal}(\mu_i, \sigma)$$
$$\mu_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 (X_1 \cdot X_2) + b_{0i} + b_{1i} X_2$$

Prior:

$$\beta_0 \sim N(7, 2)$$
$$\beta_k \sim N(0, 1), \quad k \in \{1, 2, 3\}$$
$$\sigma \sim N^{+}(0, 3)$$

Analysis

Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1; total post-warmup draws = 4000

```
m1 <- brm(trustRTVec ~ DASS_Depr * agentType + (1 + agentType | ID),
          family = lognormal(),
          data = data,
          prior <- c(
            prior(normal(7, 2), class = "Intercept"),      # Prior for intercept
            prior(normal(0, 1), class = "b"),              # Prior for fixed effects
            prior(normal(0, 3), class = "sigma")           # Prior for residual SD
          ),
          seed = 12345,
          file = "model_lognormal"
          )
```

Results

Convergence checks

According to the rank histogram in Figure 1 below, the chains mixed well.

```
as_draws(m1) |>
  mcmc_rank_hist(pars = c(
    "b_Intercept",                      # Intercept
    "b_DASS_Depr",                      # Fixed effect for DASS_Depr
    "b_agentTypeGRGO",                  # Fixed effect for agentTypeGRGO
    "b_DASS_Depr:agentTypeGRGO",        # Interaction effect
    "sigma"                             # Residual SD
  ))
```

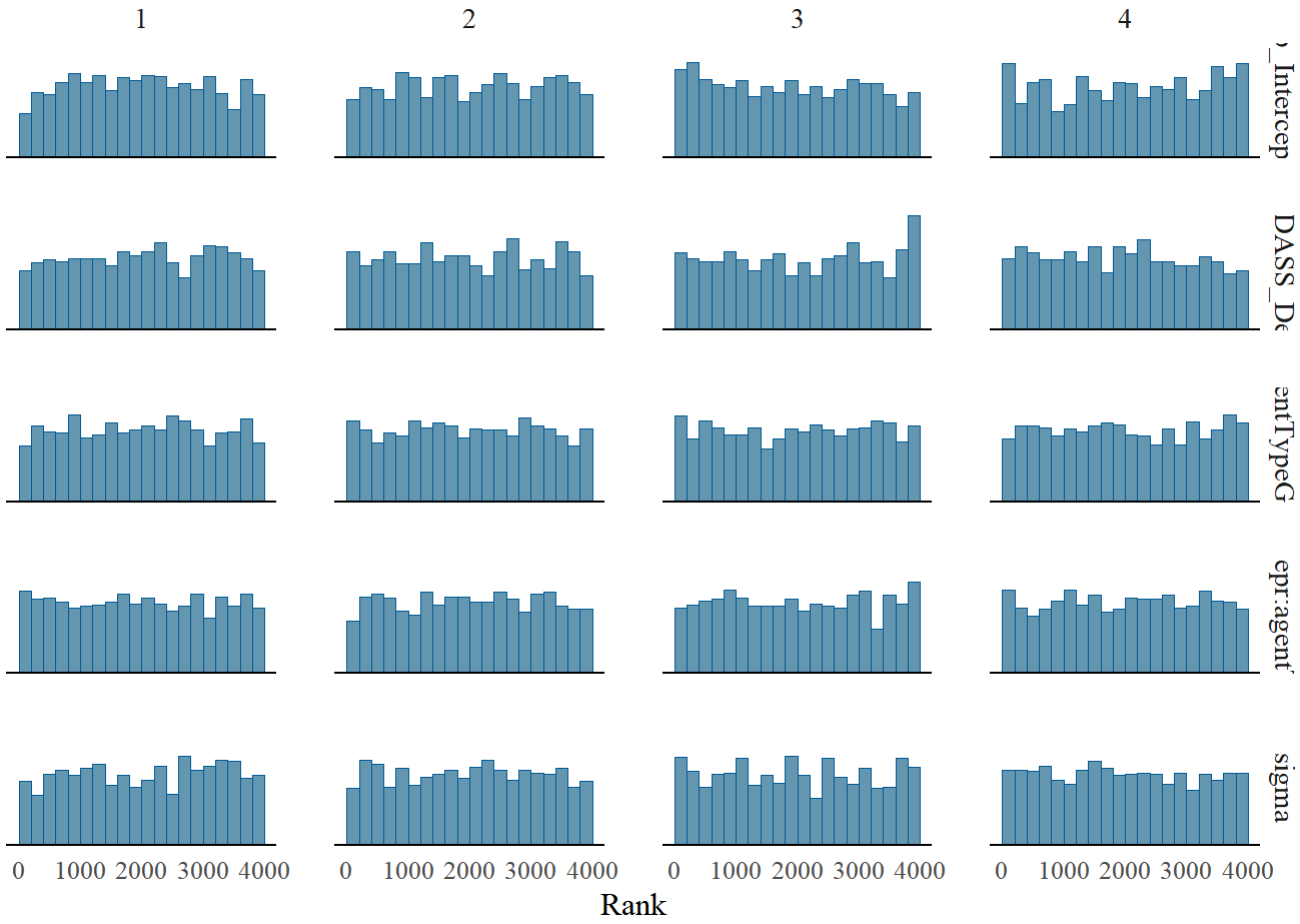


Figure 1: Rank histogram of the posterior distributions of model parameters.

Table 3 shows the posterior distributions of the model parameters

```
summ_fit <- as_draws(m1) |>
    subset_draws(variable = c("b_Intercept", "b_DASS_Depr", "b_agentTypeGRGO", "b_DASS_Depr:ag
    summarise_draws()

# Display the summary as a table
knitr::kable(summ_fit, digits = 2)
```

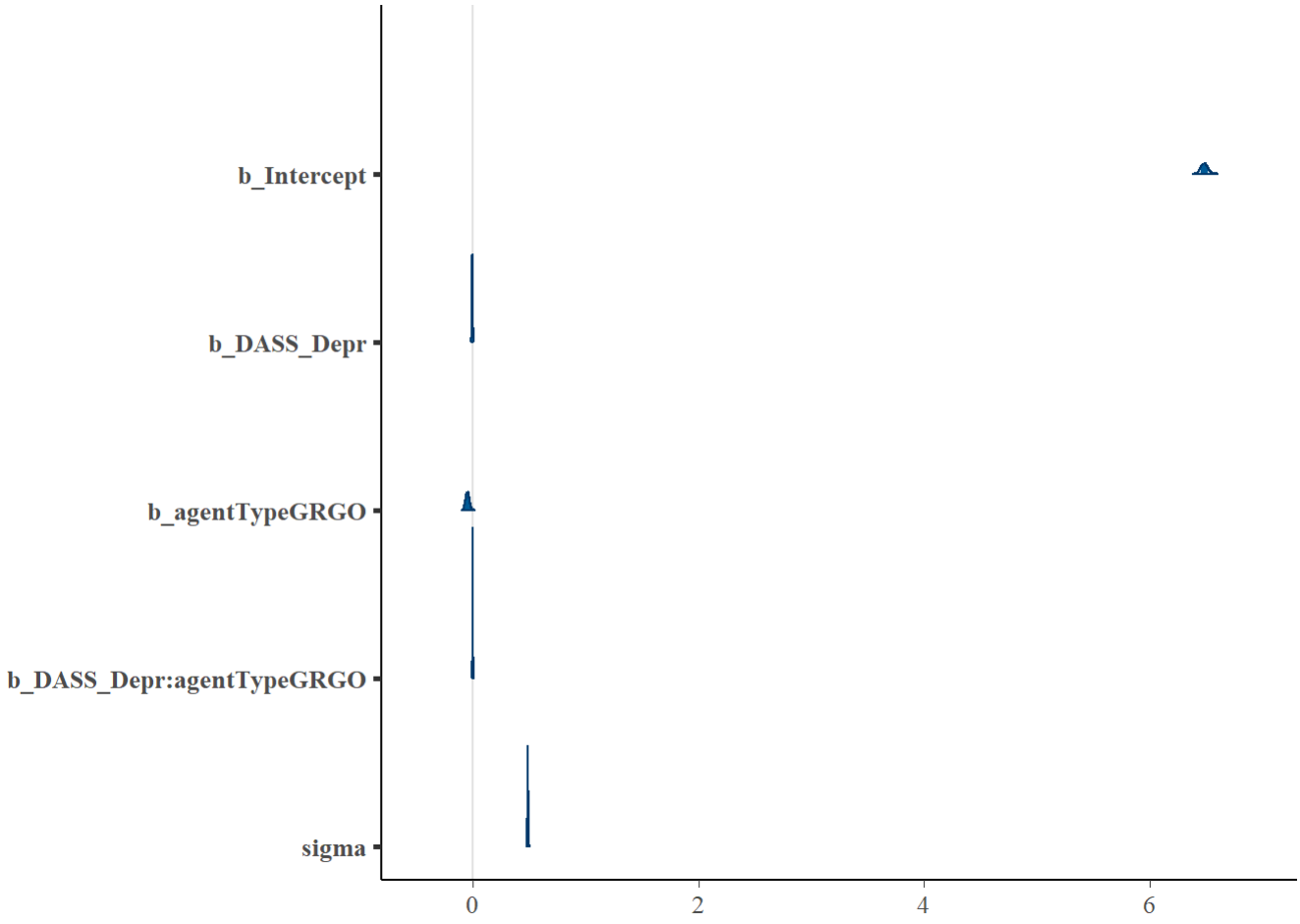
Table 3: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_Intercept	6.49	6.49	0.03	0.03	6.44	6.54	1.01	548.74	1165.21
b_DASS_Depr	0.00	0.00	0.00	0.00	-0.01	0.00	1.01	683.35	1033.94
b_agentTypeGRGO	-0.05	-0.05	0.02	0.02	-0.08	-0.02	1.00	4032.24	3370.69
b_DASS_Depr:agentTypeGRGO	0.00	0.00	0.00	0.00	0.00	0.00	1.00	4088.99	3008.81
sigma	0.49	0.49	0.00	0.00	0.48	0.49	1.00	7722.66	2802.07

Table 4 shows the density plots of the posterior distributions of the model parameters.

```
mcmc_areas(as_draws(m1), pars = c("b_Intercept", "b_DASS_Depr", "b_agentTypeGRGO", "b_DASS_Dep
```

Table 4: Density plot of the posterior distributions.



Interpretation

The results of the model suggest that the parameters related to **DASS Depression (b_DASS_Depr)** and the interaction between **DASS Depression** and **agentTypeGRGO** have negligible effects on the outcome variable **trustRTVec**, as their coefficients (mean = 0.00) are close to zero, with very small standard deviations. The **Intercept (b_Intercept)** is significantly greater than zero (mean = 6.49), indicating that the baseline value of the dependent variable is positive. The **agentTypeGRGO** parameter shows a slight negative effect (mean = -0.05), suggesting a small but significant decrease in trust response times for the **GRGO** group compared to the baseline. The **sigma** value (mean = 0.49) represents the residual standard deviation of the log-normal distribution, indicating some variability in the response times not explained by the model. All parameters show good model fit, with Rhat values close to 1 and high effective sample sizes (ESS), indicating reliable estimates.

Overall these results suggest that **DASS Depression** scores do not significantly impact reaction times, and there is a minimal effect of **agentType** on the reaction times, although the baseline is positive. The interaction between depression and agent type does not seem to produce substantial changes in the response variable.

Model 2 using skewnormal family

Let Y_i = trustRTVec, X_1 = DASS_Depr, X_2 = agentType, Z_i = ID

Model:

$$Y_i \sim \text{SkewNormal}(\mu_i, \sigma)$$
$$\mu_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 (X_1 \cdot X_2) + b_{0i} + b_{1i} X_2$$

Prior:

$$\begin{aligned} \beta_0 &\sim N(7, 2) \\ \beta_k &\sim N(0, 1), \quad k \in \{1, 2, 3\} \\ \sigma &\sim N^+(0, 3) \end{aligned}$$

Analysis

Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1; total post-warmup draws = 4000

```
m2 <- brm(trustRTVec ~ DASS_Depr * agentType + (1 + agentType | ID),
          family = skew_normal(),
          data = data,
          prior <- c(
            prior(normal(7, 2), class = "Intercept"),      # Prior for intercept
            prior(normal(0, 1), class = "b"),              # Prior for fixed effects
            prior(normal(0, 3), class = "sigma")           # Prior for residual SD
          ),
          seed = 12345,
          file = "model_skewnormal"
          )
```

Results

Convergence checks

According to the rank histogram in Figure 2 below, the chains mixed well.

```
as_draws(m2) |>
  mcmc_rank_hist(pars = c(
    "b_Intercept",                      # Intercept
    "b_DASS_Depr",                      # Fixed effect for DASS_Depr
    "b_agentTypeGRGO",                  # Fixed effect for agentTypeGRGO
    "b_DASS_Depr:agentTypeGRGO",        # Interaction effect
    "sigma"                             # Residual SD
  ))
```

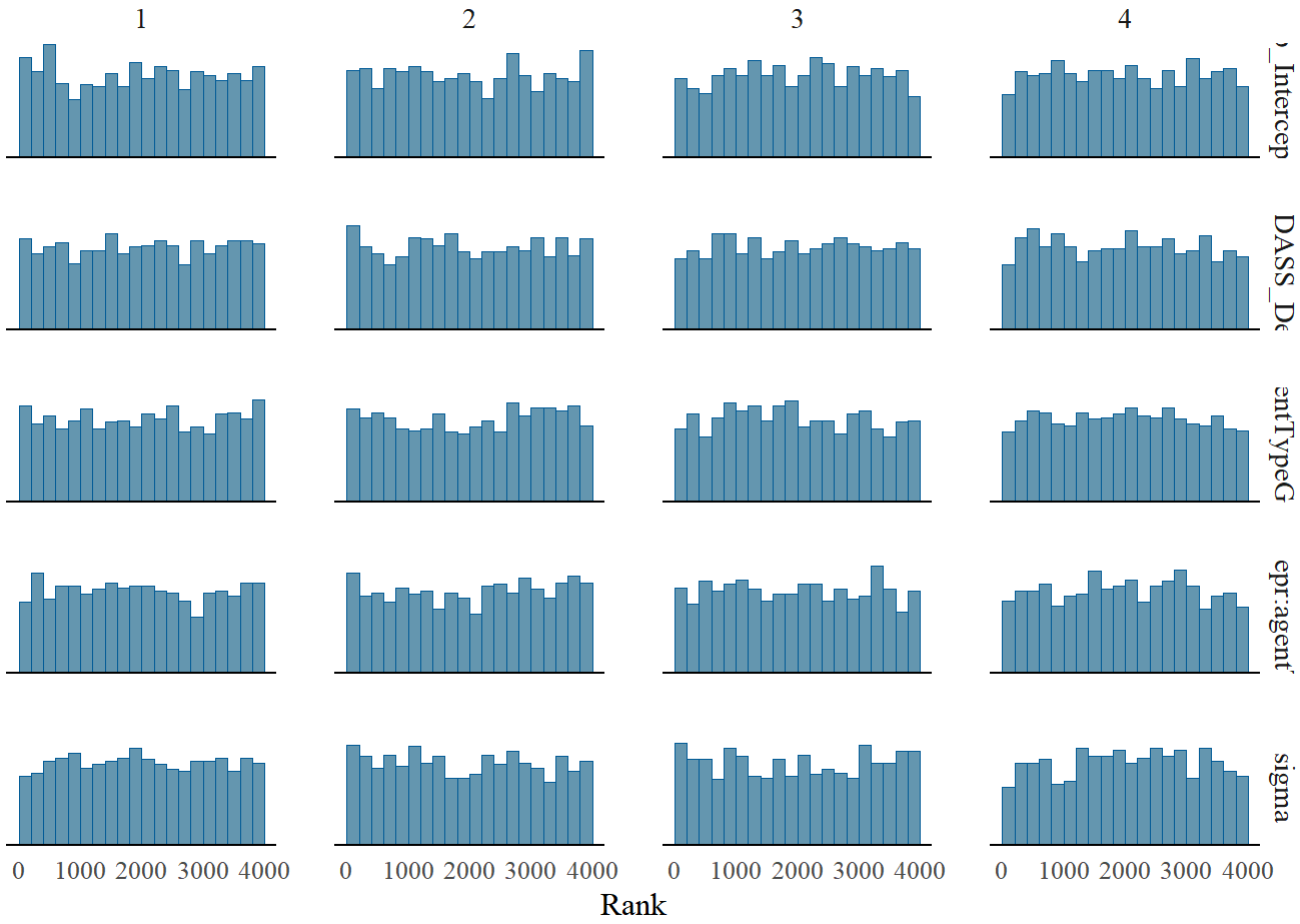


Figure 2: Rank histogram of the posterior distributions of model parameters.

Table 5 shows the posterior distributions of the model parameters

```
summ_fit <- as_draws(m2) |>
    subset_draws(variable = c("b_Intercept", "b_DASS_Depr", "b_agentTypeGRGO", "b_DASS_Depr:ag
    summarise_draws()

# Display the summary as a table
knitr::kable(summ_fit, digits = 2)
```

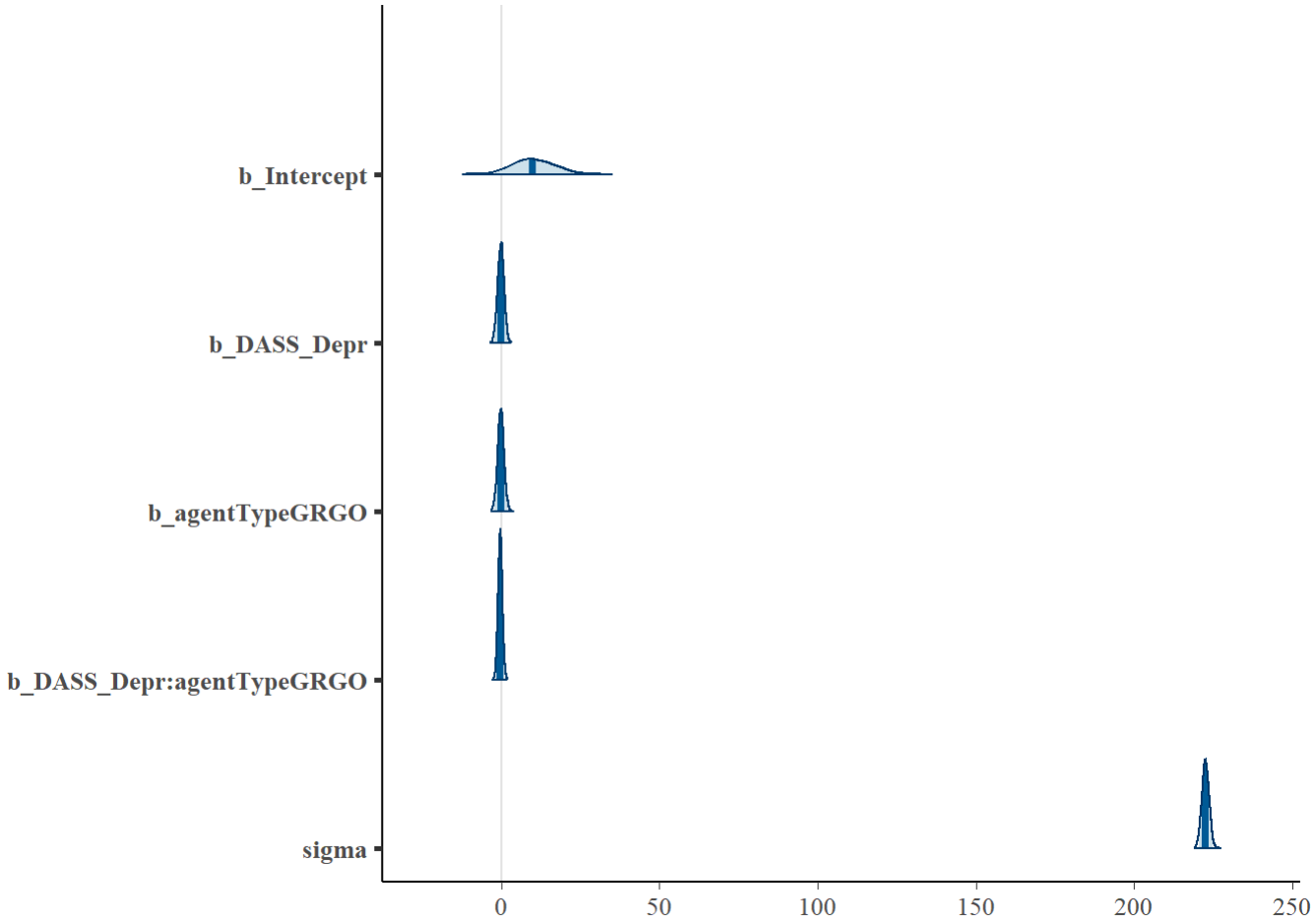
Table 5: Posterior summary of the model parameters.

variable	mean	median	sd	mad	q5	q95	rhat	ess_bulk	ess_tail
b_Intercept	10.10	9.93	6.45	6.65	-0.22	20.70	1	3031.28	2447.92
b_DASS_Depr	-0.09	-0.07	1.00	1.00	-1.74	1.54	1	2656.05	3050.69
b_agentTypeGRGO	-0.09	-0.09	0.99	0.96	-1.75	1.55	1	7363.62	2686.66
b_DASS_Depr:agentTypeGRGO	-0.29	-0.28	0.68	0.68	-1.40	0.85	1	4763.72	2971.75
sigma	222.61	222.59	1.15	1.13	220.73	224.46	1	6319.70	3086.33

Table 6 shows the density plots of the posterior distributions of the model parameters.

```
mcmc_areas(as_draws(m2), pars = c("b_Intercept", "b_DASS_Depr", "b_agentTypeGRGO", "b_DASS_Dep
```

Table 6: Density plot of the posterior distributions.



Interpretation

The results from the **skew-normal** distribution model suggest that the parameters related to **DASS Depression (b_DASS_Depr)** and the interaction between **DASS Depression** and **agentTypeGRGO** have negligible effects on the outcome variable **trustRTVec**. The coefficients for these parameters are close to zero (mean = -0.09 for **DASS_Depr**, mean = -0.29 for the interaction), with large standard deviations, indicating substantial uncertainty and minimal impact on the outcome.

The **Intercept (b_Intercept)** is positive (mean = 10.10), with a wide range of possible values (from negative to large positive), suggesting that the baseline value of **trustRTVec** is on average higher but with significant variability.

The **agentTypeGRGO** parameter shows a slight negative effect (mean = -0.09), implying a small but uncertain decrease in trust response times for the **GRGO** group compared to the baseline. However, the wide credible intervals make this effect uncertain.

The **sigma** parameter (mean = 222.61) represents the residual standard deviation, indicating considerable unexplained variability in the response variable. This suggests that other unmeasured factors may be influencing **trustRTVec**, contributing to the variability that is not accounted for in the model.

All parameters show good model fit, with Rhat values close to 1 and high effective sample sizes (ESS), indicating reliable estimates despite the wide uncertainties in some parameters.

Overall, these results suggest that **DASS Depression** scores do not significantly impact **trustRTVec**, and the effect of **agentType** is small and uncertain. The interaction between **DASS Depression** and **agentType** does not seem to substantially affect the outcome variable. The model indicates significant unexplained variability, implying that other factors may be influencing **trustRTVec**. The results are similar to the log normal model m1.