technische universität
dortmund

# ABDA

## PREDICTORS OF STUDENT PERFORMANCE

**Group#27**

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# 1) Outline

- Research Question
- Data
- Methodology
  - Prior Sensitivity Analysis
  - Model Comparison
- Discussion
- Summary
- References

# 2) Research Question

- What are the predictors of student performance levels across subjects (students) when performance (Grade, GPA) is categorized as ordinal and continuous?

Figure 1: https://www.kaggle.com/datasets/lainguyn123/student-performance-factors

# 3) Data

- Data Source: Kaggle
  https://www.kaggle.com/datasets/rabieelkharoua/students-performance-dataset/data
- **Target:** For Ordinal Grade Class (A-F) for Continuous GPA(0-4)

'A' (GPA >= 3.5 <= 4.0)

'B' (3.0 <= GPA < 3.5)

'C' (2.5 <= GPA < 3.0)

'D' (2.0 <= GPA < 2.5)

'F' (GPA < 2.0)

# 4) Independent Variables

| Category | Variable | Description | Values/Range |
|---|---|---|---|
| **Demographic Details** | StudentID | Unique identifier for each student | 1001 to 3392 |
| | Age | Age of students | 15 to 18 years |
| | Gender | Gender of students | 0: Male, 1: Female |
| | Ethnicity | Ethnicity of students | 0: Caucasian, 1: African American, 2: Asian, 3: Other |
| | ParentalEducation | Parental education level | 0: None, 1: High School, 2: Some College, 3: Bachelor's, 4: Higher |
| **Study Habits** | StudyTimeWeekly | Weekly study time in hours | 0 to 20 hours |
| | Absences | Number of absences (yearly) | 0 to 30 |
| | Tutoring | Tutoring status | 0: No, 1: Yes |
| **Parental Involvement** | ParentalSupport | Level of parental support | 0: None, 1: Low, 2: Moderate, 3: High, 4: Very High |
| **Activity Group** | Extracurricular | Grouping for extracurricular activities | 0: No, 1: Yes |
| | Sports | Participation in sports | 0: No, 1: Yes |
| | Music | Participation in music activities | 0: No, 1: Yes |
| | Volunteering | Participation in volunteering | 0: No, 1: Yes |

Table4.1: Independent Variables

# 5) Prior Sensitivity Analysis

## For Study Habits Cluster

**GPA** ~ Gender + ParentalEducation + ParentalSupport + Extracurricular + Sports + Music + Volunteering + Ethnicity + (1 | StudyHabitsGroup)

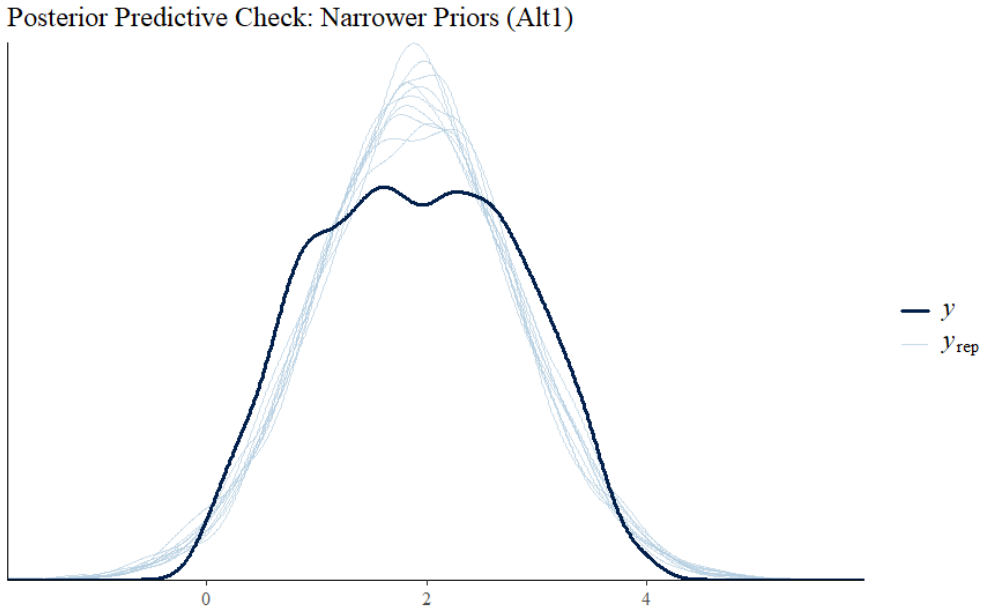


Figure 5.1: Posterior Predictive Check: Narrower Priors

("normal(0, 1)", class = "b"),
("cauchy(0, 1)", class = "sd"),
("student_t(3, 0, 2)", class = "Intercept")

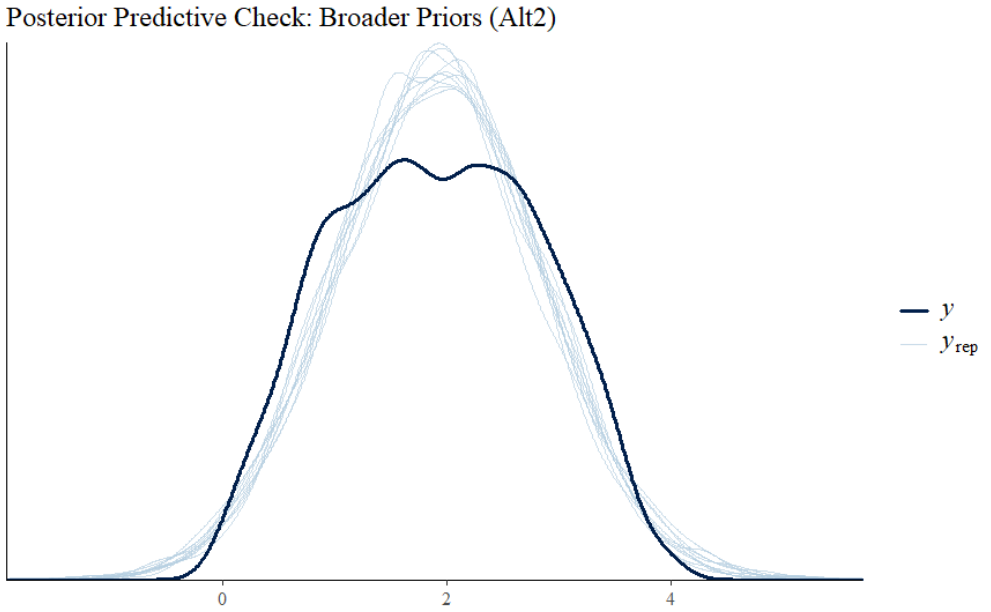


Figure 5.2: Posterior Predictive Check: Broader Priors

("normal(0, 10)", class = "b"),
("cauchy(0, 1)", class = "sd"),
("student_t(3, 0, 2)", class = "Intercept")

# 5) Prior Sensitivity Analysis (cont.)

**Predictive residuals of Model**

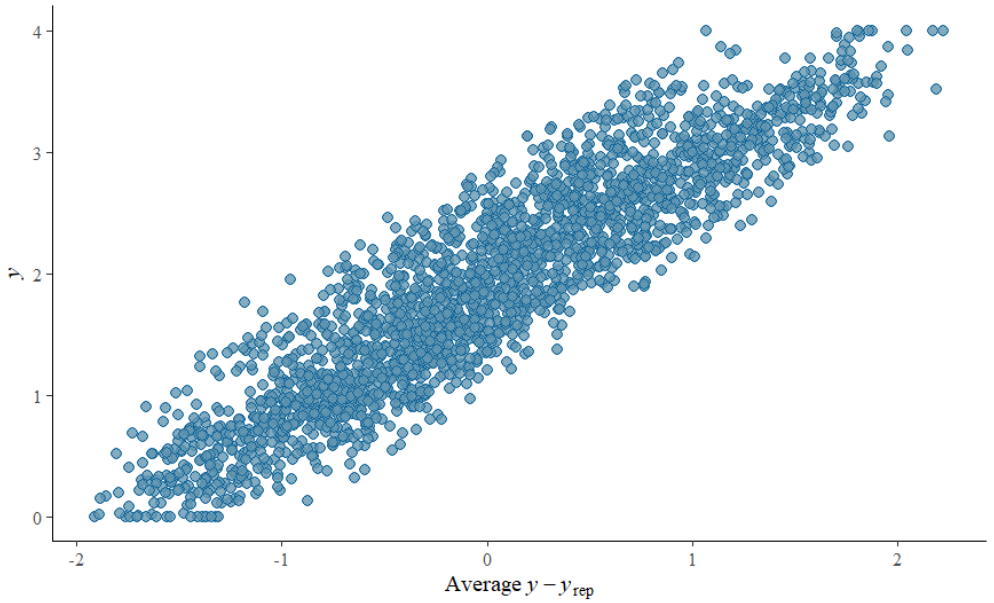


Figure 5.3: Residual Plot: Narrower Priors

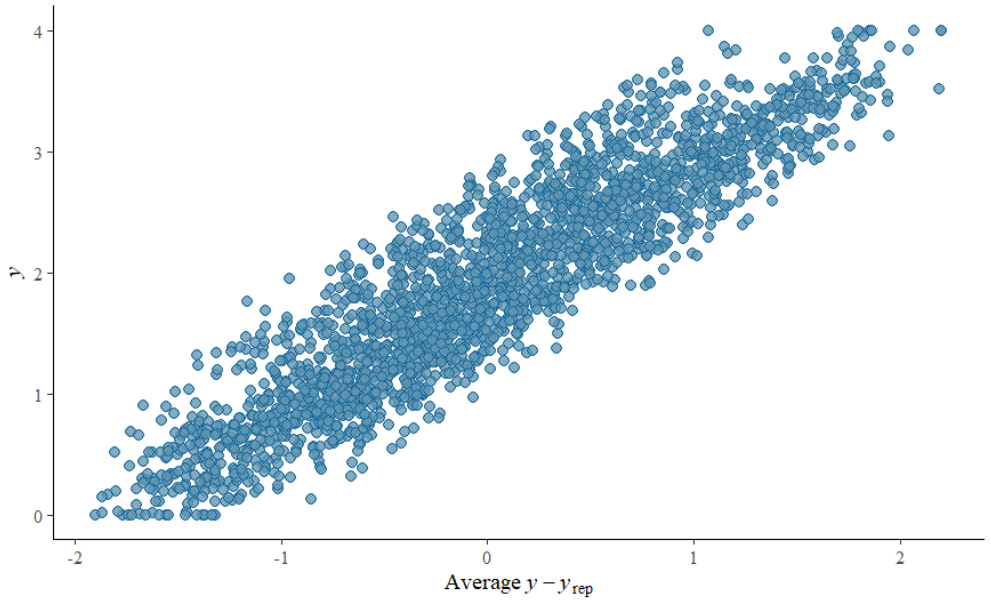


Figure 5.4: Residual Plot: Broader Priors

# 5) Prior Sensitivity Analysis (cont.)

## For Activity Group Cluster

**GPA** ~ Gender + ParentalEducation + ParentalSupport + StudyTimeWeekly + Absences + Tutoring + Ethnicity + (1 | ActivityGroup)

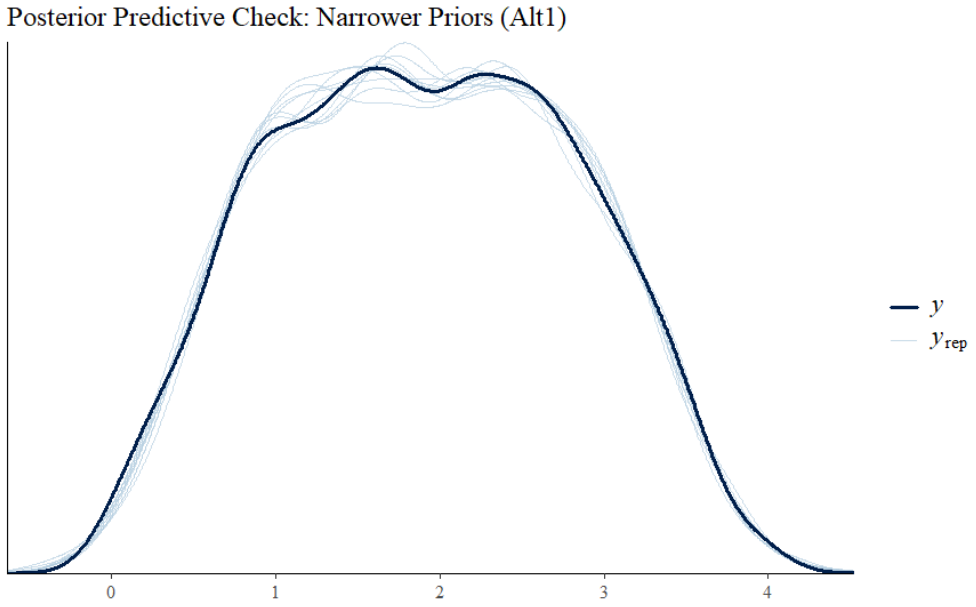


Figure 5.5: Posterior Predictive Check : Narrower Priors

("normal(0, 1)", class = "b"),
("cauchy(0, 1)", class = "sd"),
("student_t(3, 0, 2)", class = "Intercept")

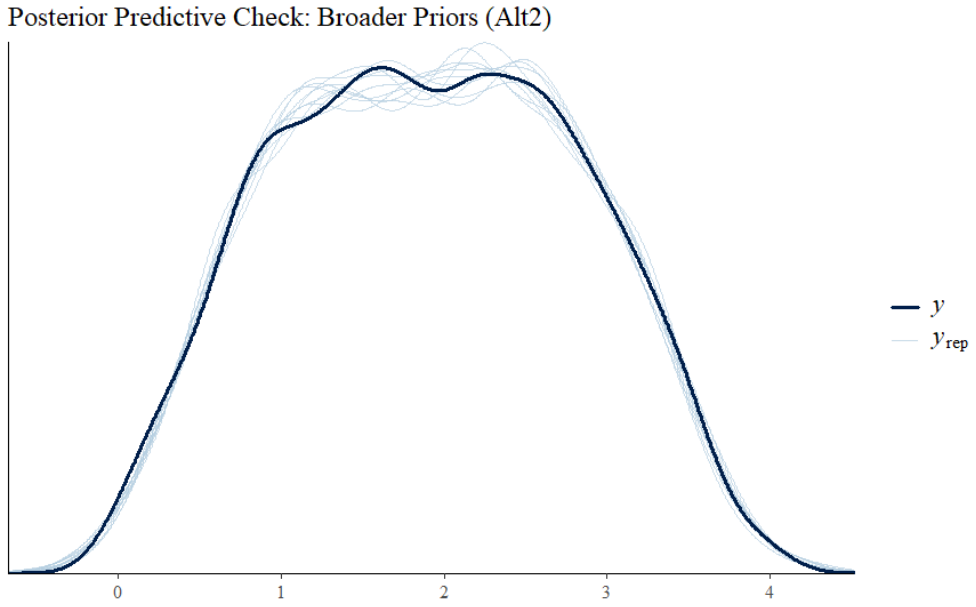


Figure 5.6: Posterior Predictive Check : Broader Priors

("normal(0, 1)", class = "b"),
("cauchy(0, 1)", class = "sd"),
("student_t(3, 0, 10)", class = "Intercept")

# 5) Prior Sensitivity Analysis (cont.)

**Predictive residuals of Model**

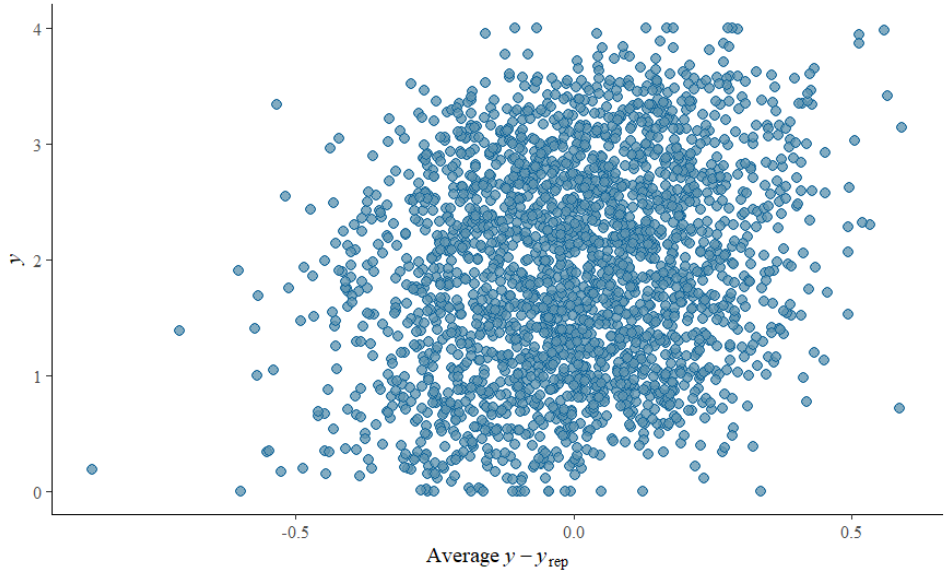


Figure 5.7: Residual Plot: Narrower Priors

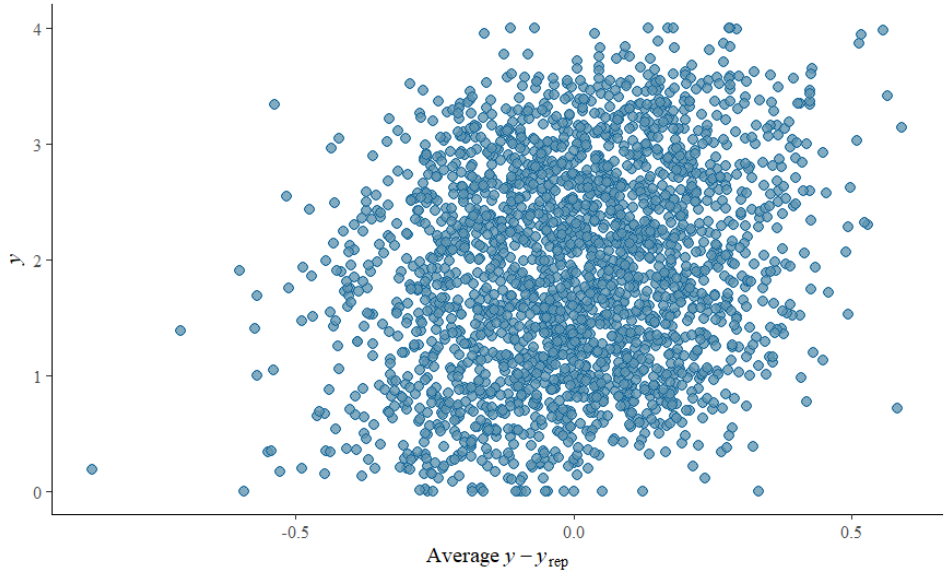


Figure 5.8: Residual Plot: Broader Priors

# 6) Model Comparison

## Continuous (GPA)

GPA ~ Gender + ParentalEducation + ParentalSupport + StudyTimeWeekly + Absences + Tutoring + Ethnicity + (1 | ActivityGroup)

("normal(0, 1)", class = "b"),
("cauchy(0, 1)", class = "sd"),
("student_t(3, 0, 10)", class = "Intercept")

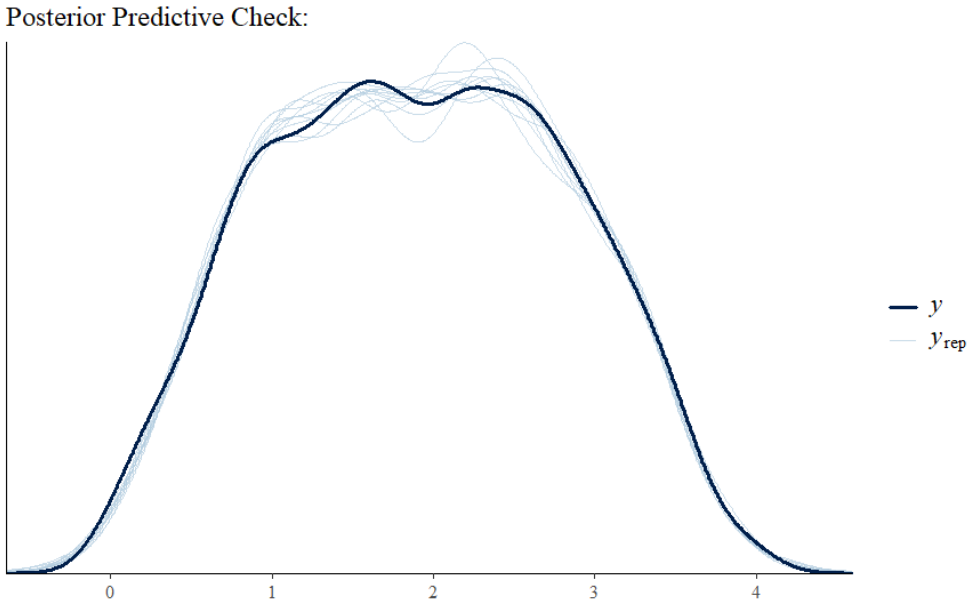


Figure 6.1: Posterior Predictive Check of Continuous model on GPA

## Ordinal (GradeClass)

GradeClass ~ Gender + ParentalEducation + ParentalSupport + StudyTimeWeekly + Absences + Tutoring + Ethnicity + (1 | ActivityGroup)

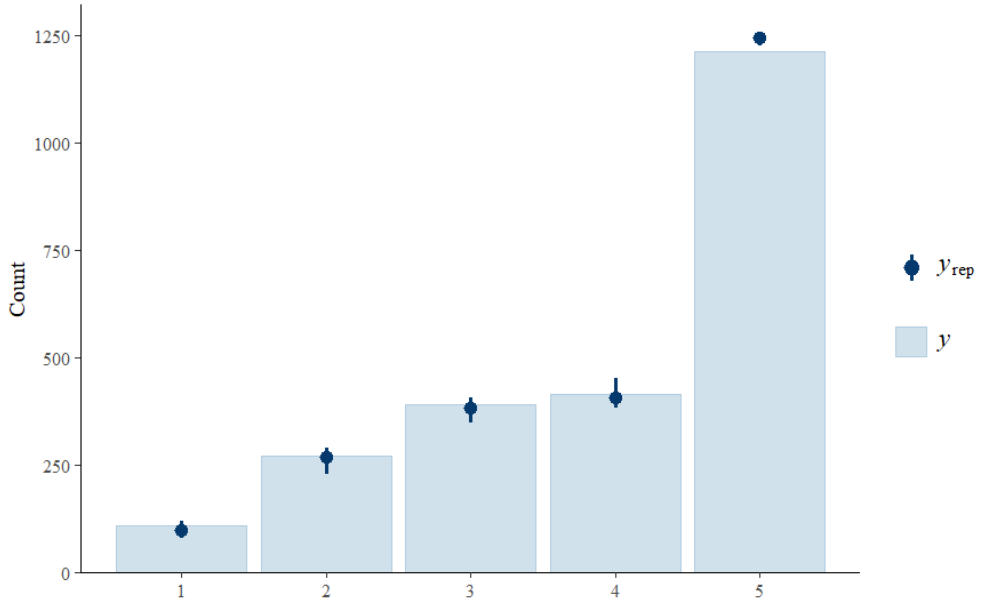


Figure 6.2: Posterior Predictive Check of Ordinal model on GradeClass

# 7) Conditional Effects (Ordinal)

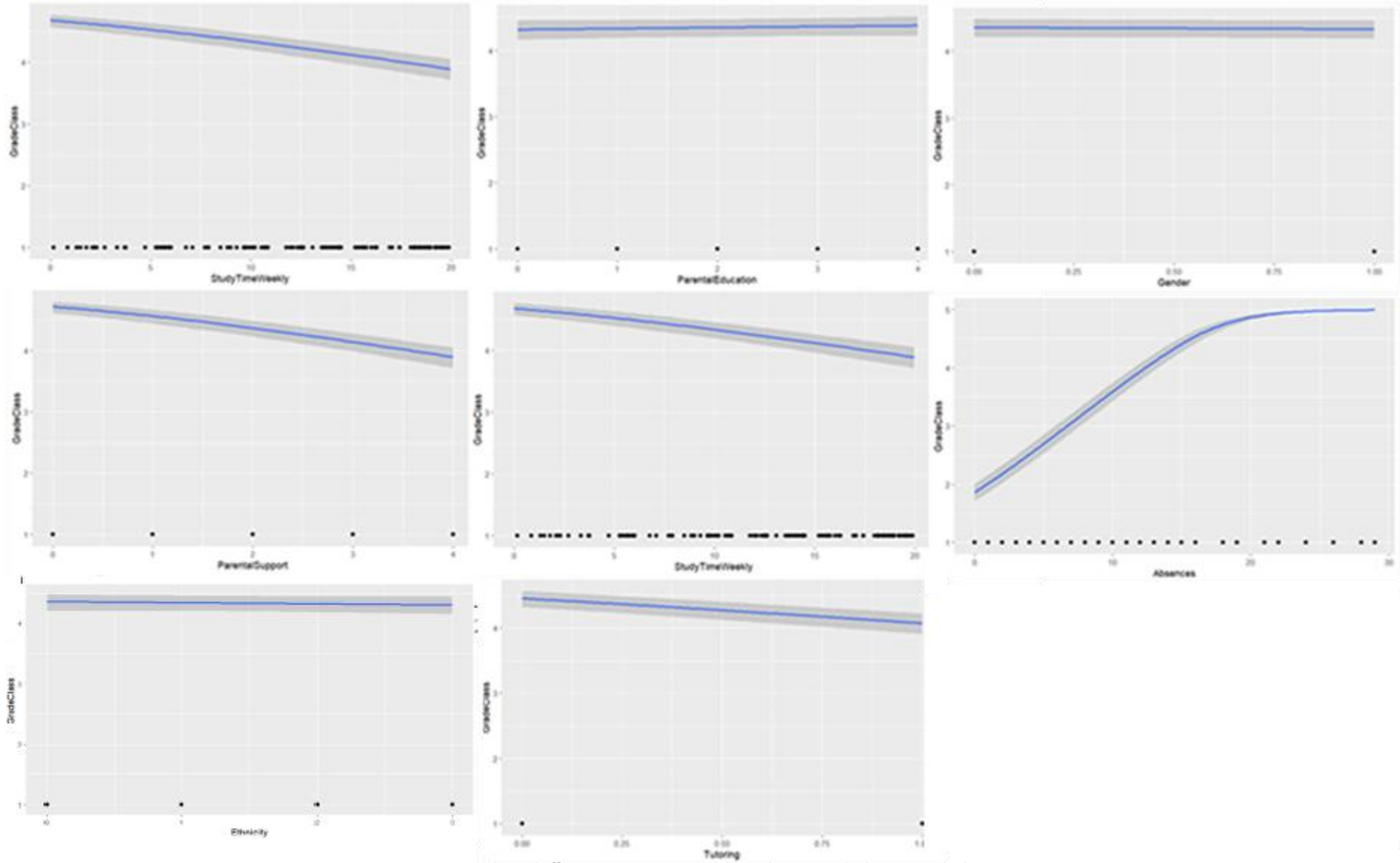


Figure 6.3: Conditional Effects on continuous model. Gender, Parental Education and Ethnicity have very low effect.

# 7) Conditional Effects (Continuous)

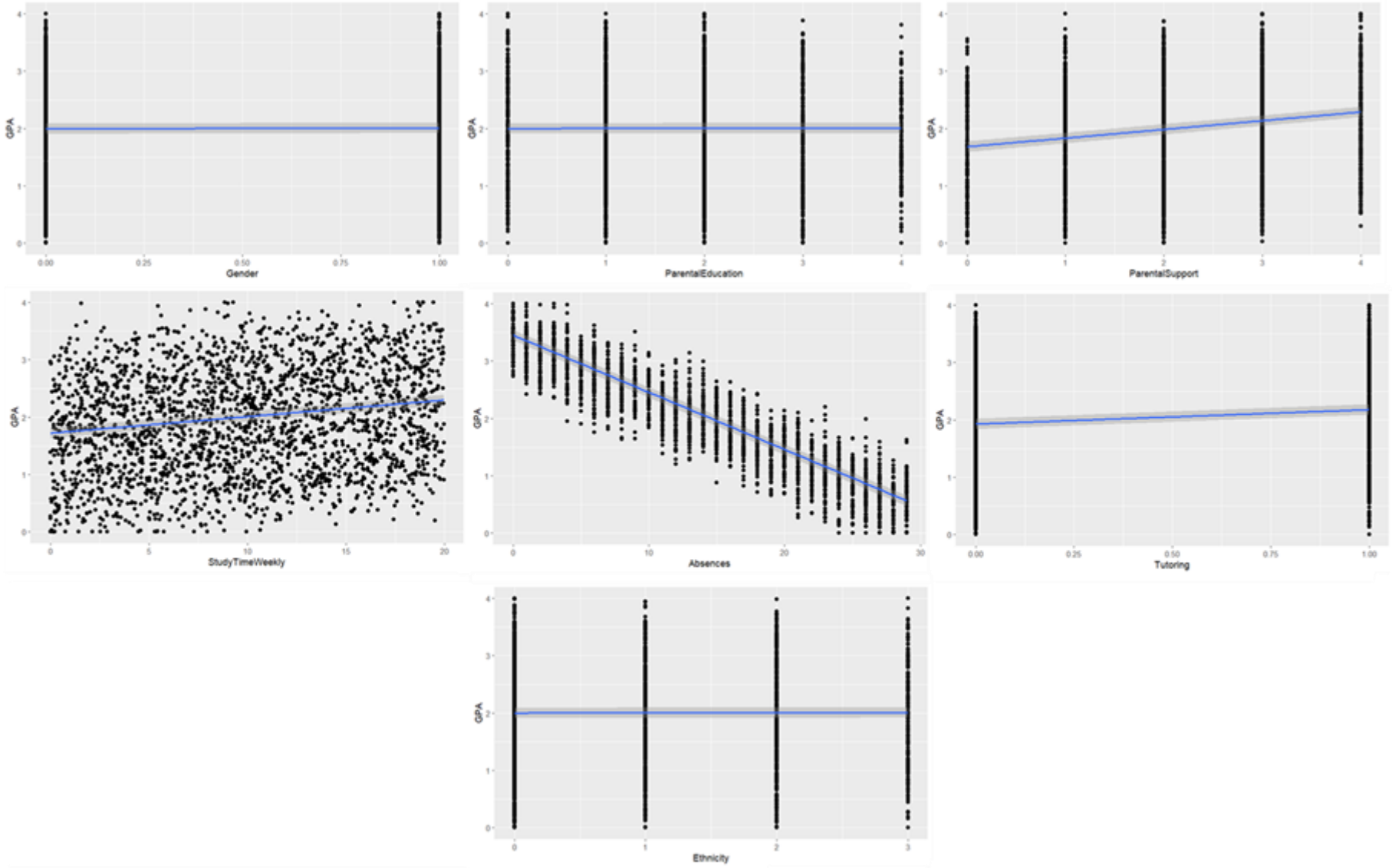


Figure 6.4: Conditional Effects on continuous model. Gender, Parental Education and Ethnicity have very low effect.

# Discussion

## Model Comparison (LOO)

| Continuous | Estimae | SE | | Ordinal | Estimate | SE |
|---|---|---|---|---|---|---|
| **elpd_loo** | *483.4* | *34* | | **elpd_loo** | *-1898.1* | *64.6* |
| **p_loo** | *24.4* | *1.3* | | **p_loo** | *19.3* | *0.9* |
| **looic** | *-966.7* | *68.1* | | **looic** | *3796.1* | *129.2* |

Table: Model Comparison

# Summary

- **Objective:** Predict student performance (Grades & GPA).
- **Methodology:** Hierarchical models (logit & continuous).
- **Key Findings:**
  - Continuous model outperformed ordinal (higher $elpdloo$, lower $looic$).
  - Significant predictors: Parental Support, Study Time, Tutoring, Absences.
  - Minimal effects: Gender, Parental Education, Ethnicity.
- **Implications:** Focus on impactful predictors to enhance performance.

# References


- https://paulbuerkner.com/software/brms-book/brms-book.pdf
- https://cran.r-project.org/web/packages/brms/vignettes/brms_overview.pdf

# Any Questions