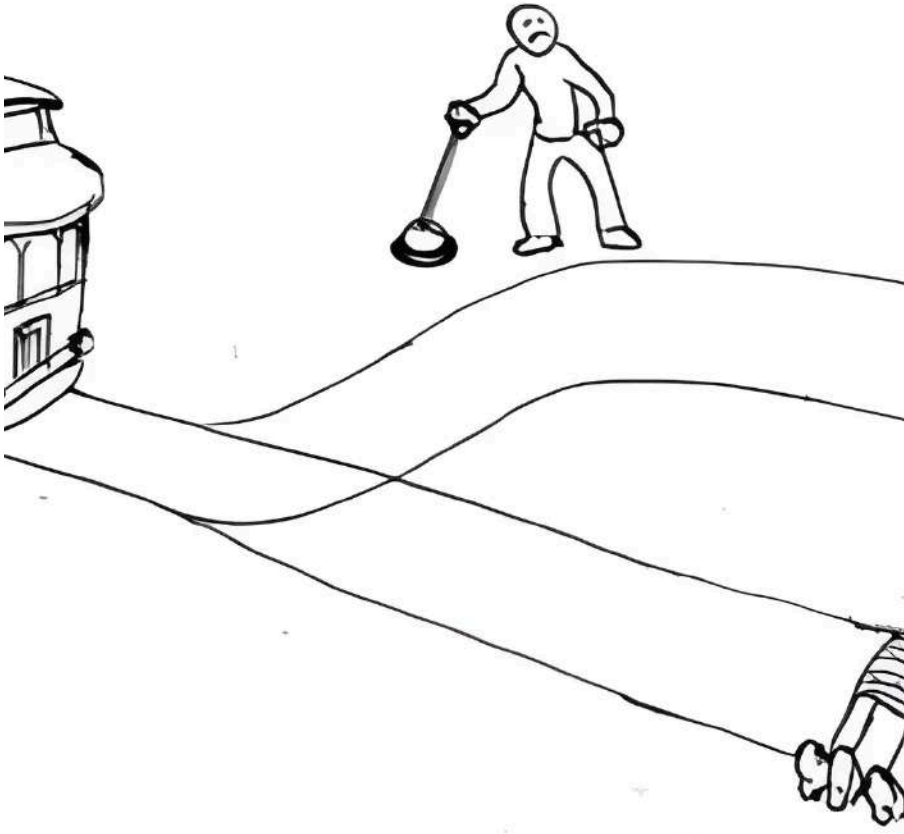
Agenda

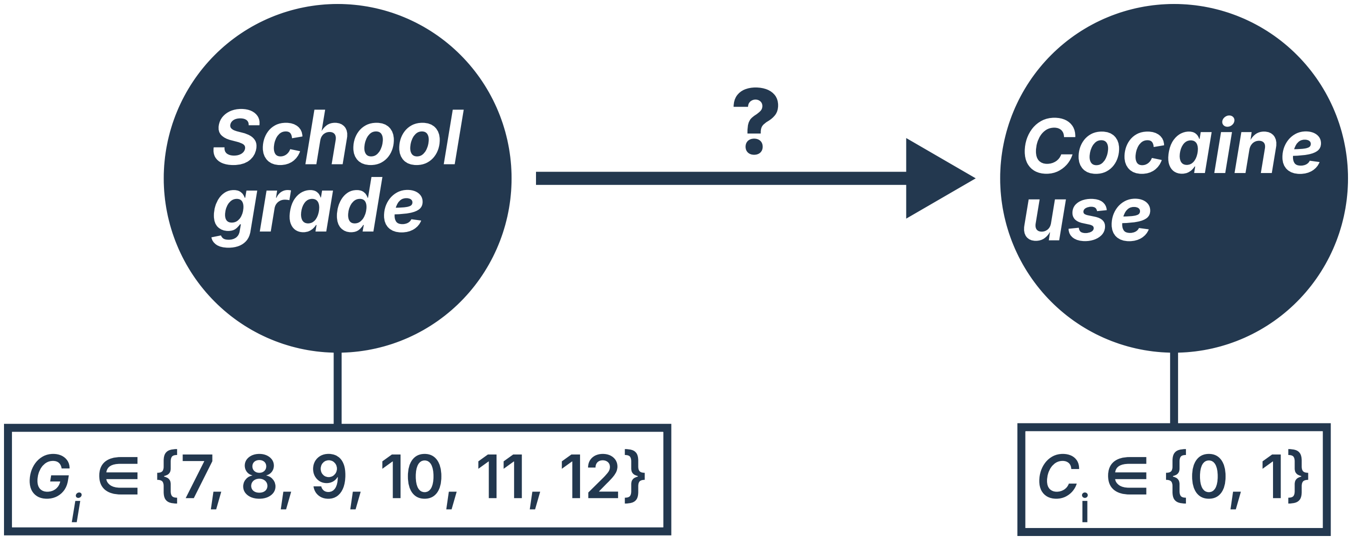
Parsimony & overfitting

1. Logistic with predictors
2. Interpreting coefficients
3. ***Hands on:***
   Prior predictive simulation in R

Logistic with predictors



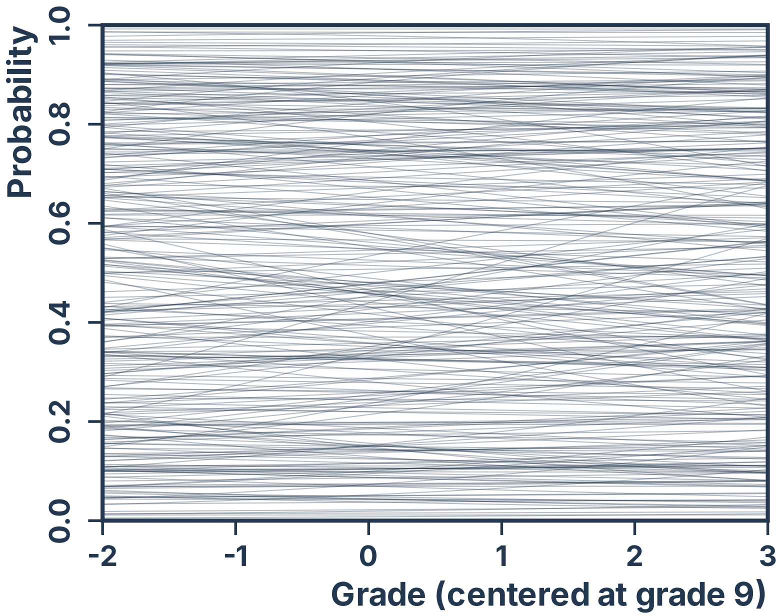
COCAINE USE AMONG ADOLESCENTS



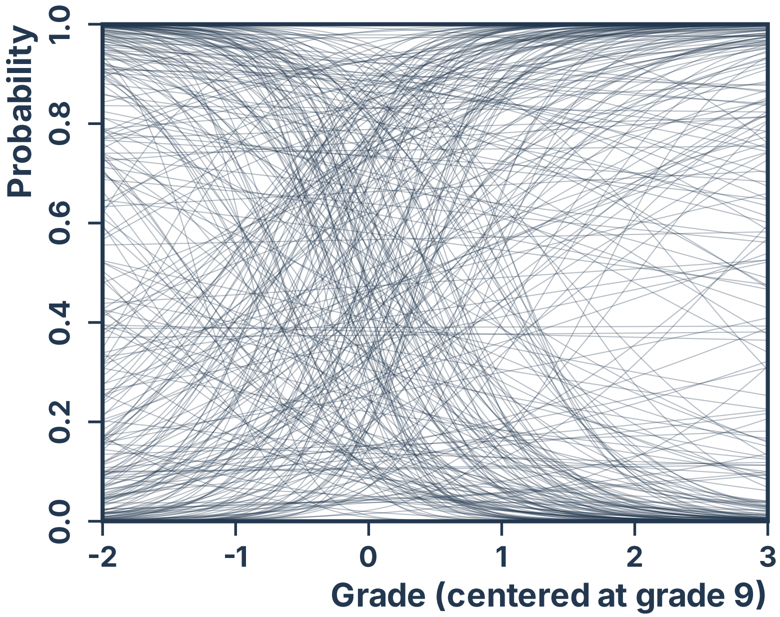
$$C_i \sim \text{Bernoulli}(p_i)$$
$$\text{logit}(p_i) = \alpha + \beta G_i$$

$$\alpha \sim \text{Norm}(0, 1.7)$$
$$\beta \sim \text{Norm}(0, ???)$$

PRIOR PREDICTIVE PLOTS

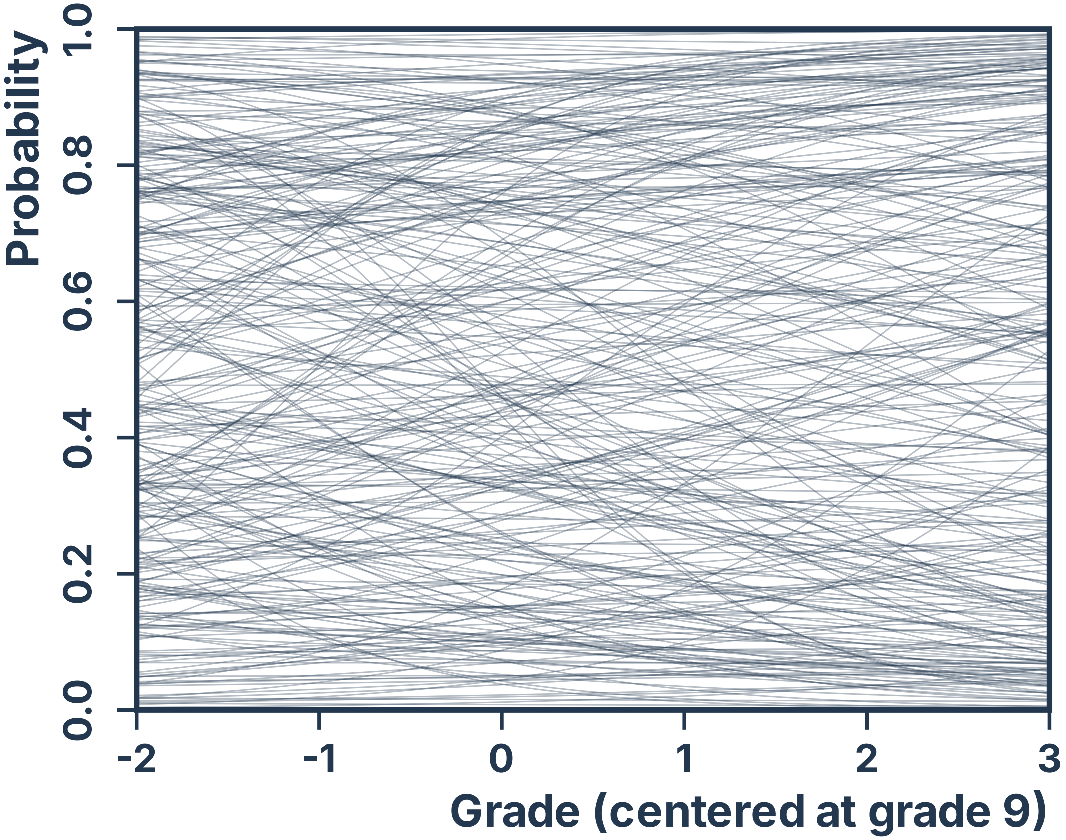


$$\alpha \sim \mathrm{Norm}(0, 1.7)$$
$$\beta \sim \mathrm{Norm}(0, \mathbf{0.1})$$



$$\alpha \sim \mathrm{Norm}(0, 1.7)$$
$$\beta \sim \mathrm{Norm}(0, \mathbf{2.0})$$

PRIOR PREDICTIVE PLOTS

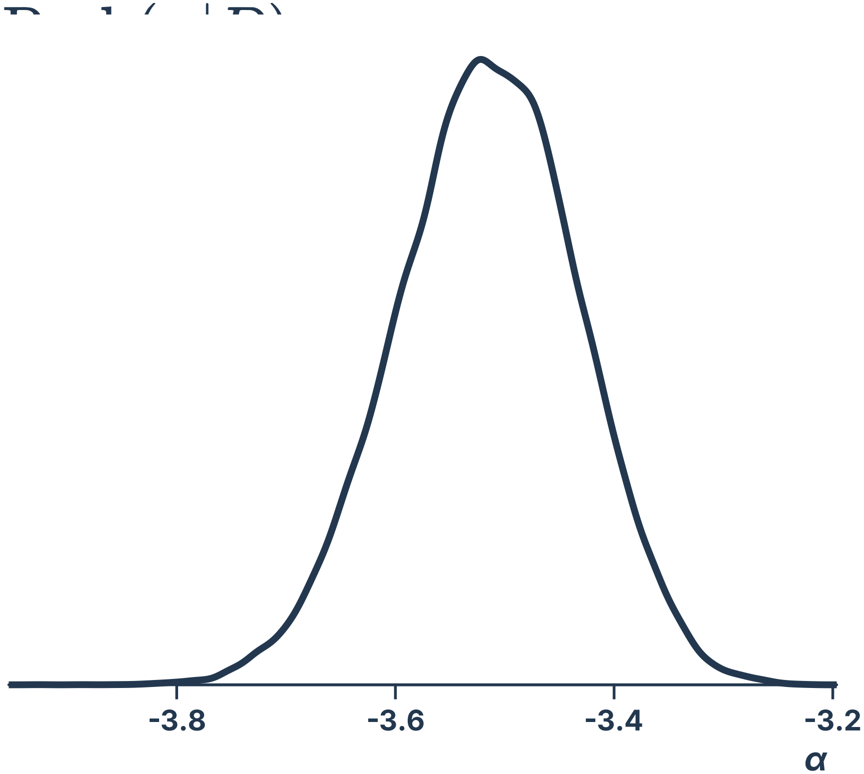


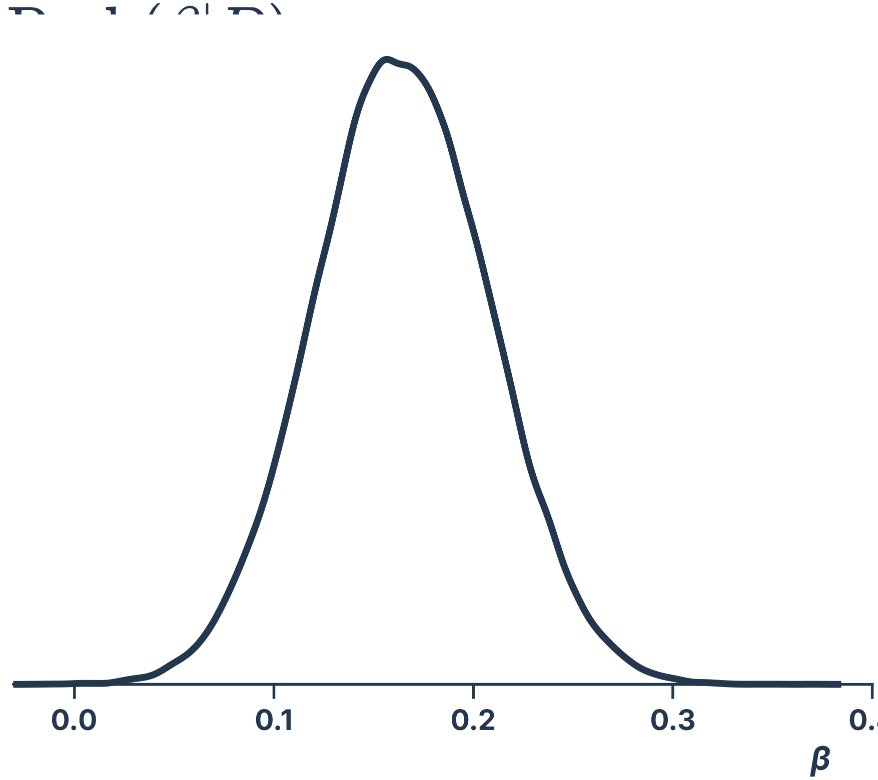
$$\alpha \sim \text{Norm}(0, 1.7)$$
$$\beta \sim \text{Norm}(0, \mathbf{0.4})$$

MODEL ESTIMATES (POSTERIOR)

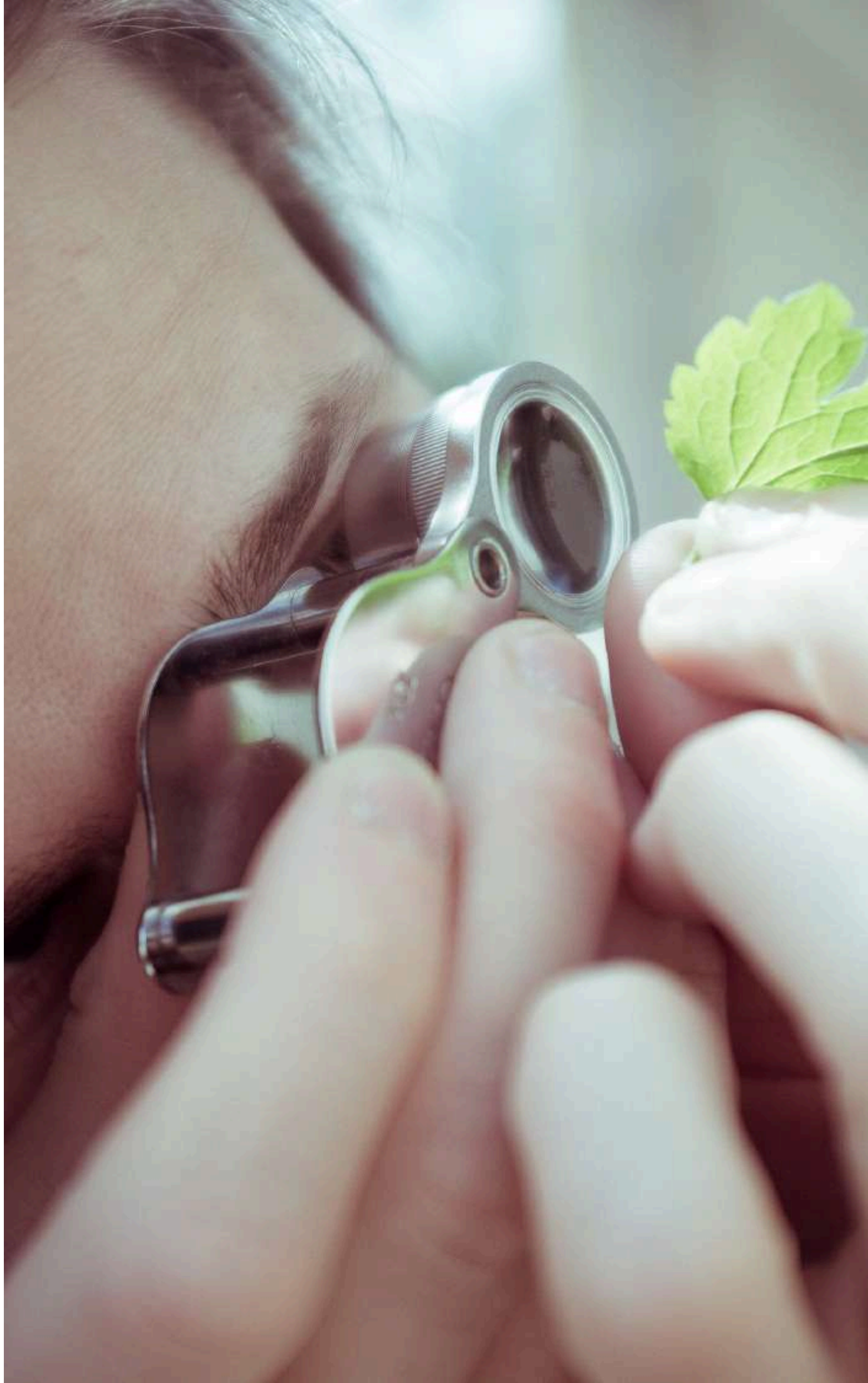
$$C_i \sim \text{Bernoulli}(p_i)$$
$$\text{logit}(p_i) = \alpha + \beta G_i$$

	Mean	95% C.I.
α	-3.52	(-3.68, -3.46)
β	0.16	(0.08, 0.25)





Interpreting logistic regression coefficients



INTERPRETING COEFFICIENTS

$$C_i \sim \text{Bernoulli}(p_i)$$
$$\text{logit}(p_i) = \alpha + \beta G_i$$

	Mean	95% C.I.
α	-3.52	(-3.68, -3.46)
β	0.16	(0.08, 0.25)

Intercept (α)

- The expected probability of having tried cocaine for a student in grade 9 (G_i = 0) is:

  logit^{-1}(-3.52) = 0.029 = 2.9%

- The probability that a student in grade 9 has tried cocaine is **most likely between 2.5% and 3.4%** (95% CI).

Coefficient (β)

- Coefficients are not so simple
- Some options:

  Odds ratio
  Selected cases
  Average marginal effect (AME)
  Posterior visualization

Odds ratio

The ***odds ratio*** is the proportional change in the *odds* of the outcome associated with a one-unit change in the predictor.

$$\frac{\left(\frac{p^{G=1}}{1-p^{G=1}}\right)}{\left(\frac{p^{G=0}}{1-p^{G=0}}\right)} = \exp(\beta)$$

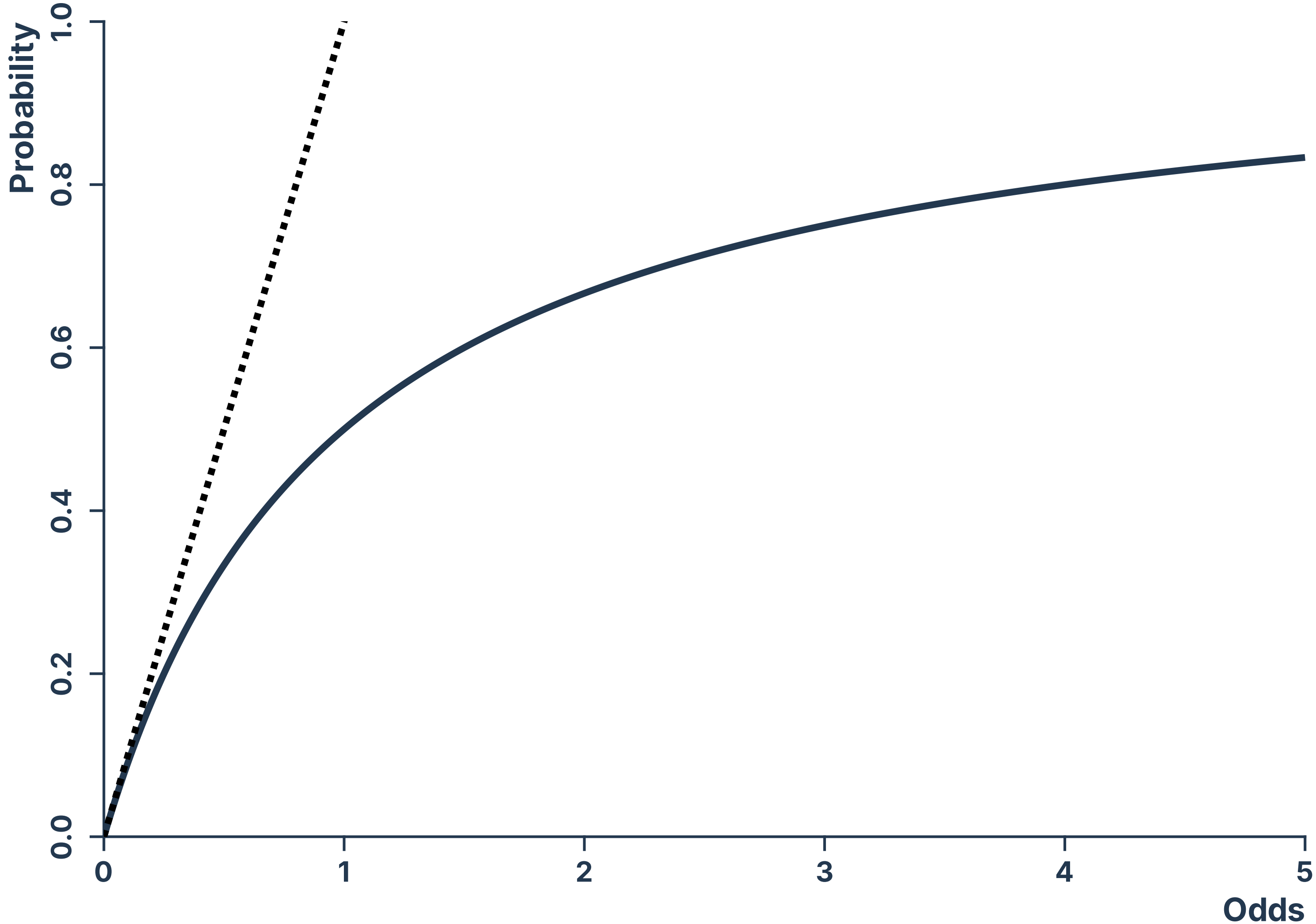
$$\text{logit}(p) = \alpha + \beta G$$
$$\log\left(\frac{p}{1-p}\right) = \alpha + \beta G$$
$$\frac{p}{1-p} = \exp(\alpha + \beta G)$$
$$\frac{p}{1-p} = \exp(\alpha) \times \exp(\beta G)$$

"For every unit increase in the covariate, the expected **odds** of the outcome is multiplied by exp(β)"

"For every grade a student completes, the expected **odds** of having tried cocaine is multiplied by 13% (multiplied by 1.13)"

ODDS RATIOS ARE UNINTUITIVE

The probability scale of the odds ratio depends on "initial" probability

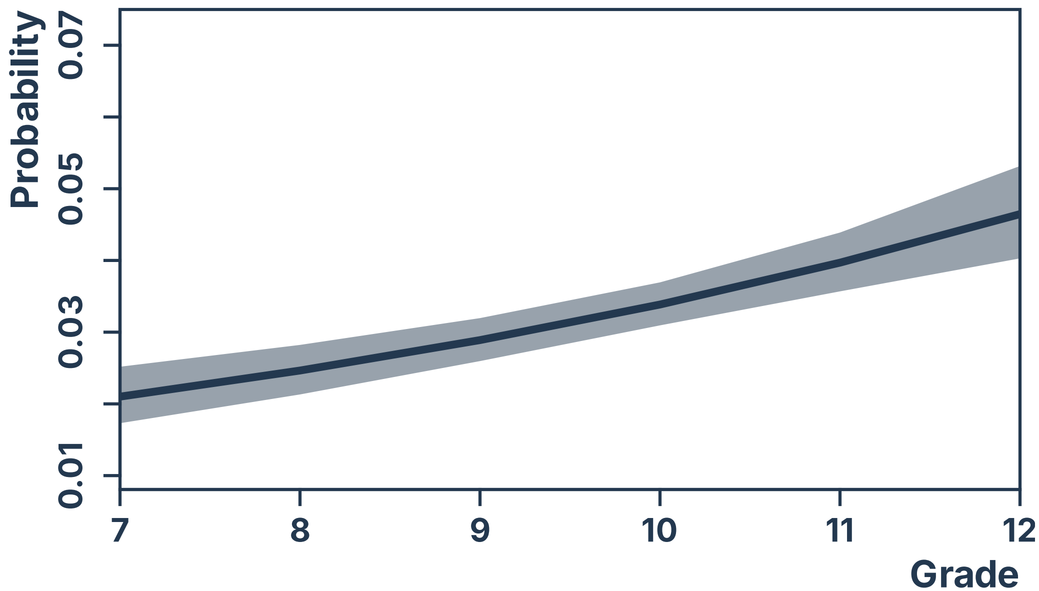


INTERPRETING *WITHOUT* ODDS RATIOS

Cases

An average 7th grade student has about a 2.1% (1.6%, 2.8%) chance of having tried cocaine, while for an average 12th grader, that probability is about 4.7% (3.7%, 5.7%)

Posterior visualization



Average marginal effects

Among the students in our sample, completing a grade is predicted to increase the probability of having tried cocaine by about 17.3% (17.1%, 17.4%) *on average*

Multiplicative on posterior probability

ADDING COVARIATES

$$C_i \sim \text{Bernoulli}(p_i)$$
$$\text{logit}(p_i) = \alpha + \beta_G G_i + \beta_D D_i + \beta_W W_i$$

$$\alpha \sim \text{Norm}(0, 1.7)$$
$$\beta_G, \beta_D, \beta_W \sim \text{Norm}(0, 0.4)$$

G_i: Grade in school (centered at grade 9)

D_i: Delinquency (standardized)

W_i: White (indicator)

	Mean	**95% C.I.**
α	-4.48	(-4.81, -4.16)
β_G	0.22	(0.13, 0.32)
β_D	0.89	(0.78, 1.00)
β_W	0.62	(0.32, 0.94)