

# hw9

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Format: paper

## Background:

Forming positive peer relationships and achieving academic success are two important developmental tasks during adolescence. Developmental researchers have emphasized the multidimensional nature of peer-group social functioning that incorporates social acceptance, respect and popularity (Duong et al., 2014). Social acceptance refers to the degree to which one is liked by peers (Cillessen & Rose, 2005). Peer respect describes the extent to which one is perceived to have attributes that are highly valued by peers (Graham et al., 1998). Popularity is a reputational construct involving power and status in the group (Mayeux et al., 2011).

Prior work has suggested academic functioning at school may be differentially linked to varied forms of social standing in the peer group (Zhang et al., 2018). While strong academic performance has been positively linked to social acceptance and respect (Graham et al., 2006; Wentzel & Caldwell, 1997), researchers have found that popularity youth are at risk for academic maladjustment (Cairns & Cairns, 1994; Chen et al., 1995). Granted these extant findings, further investigation is warranted to explore the relations between achievement and peer-group social standing among ethnic minority groups (e.g., Asian American and Latinx youth).

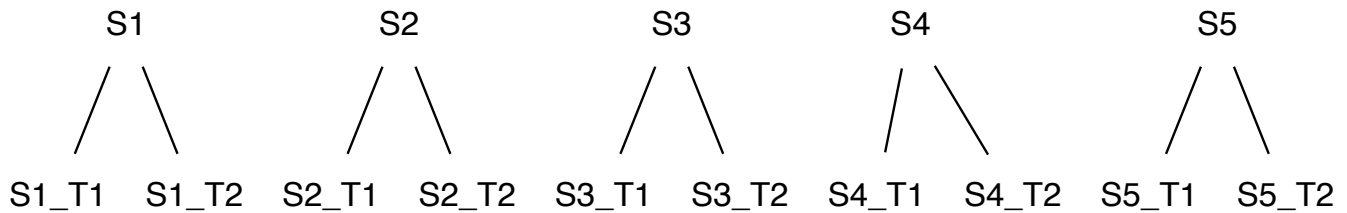
## Research questions:

The current project aims to examine the possible ethnic differences in the growth of social status (i.e., popularity, social acceptance and respect) as predicted by GPA among Asian American and Latinx youth.

## Data structure:

Participants are 335 middle school students (Mage= 12.27 years, SD= 0.71; 52.8% girls) who were followed for two measurement occasions that were one year apart. Among these youth, 64.5% self-identified as Asian American and 35.5% as Latinx. Students' T1 and T2 measures of social status are nested within each student. Therefore, level1 is T1 and T2 social status and level2 is students.

## network chart



## Analysis plan:

- Separate growth models will be created for social acceptance, respect and popularity as the outcomes.
- In each model, there is a level-1 predictors: GPA and a level-2 predictor: ethnicity (in addition to the predictor of time).
- Check ICC for person-level variance of social status, by fitting a random intercept model.
- Random slope tests for GPA across students.
- Fit the growth models with appropriate random slopes.

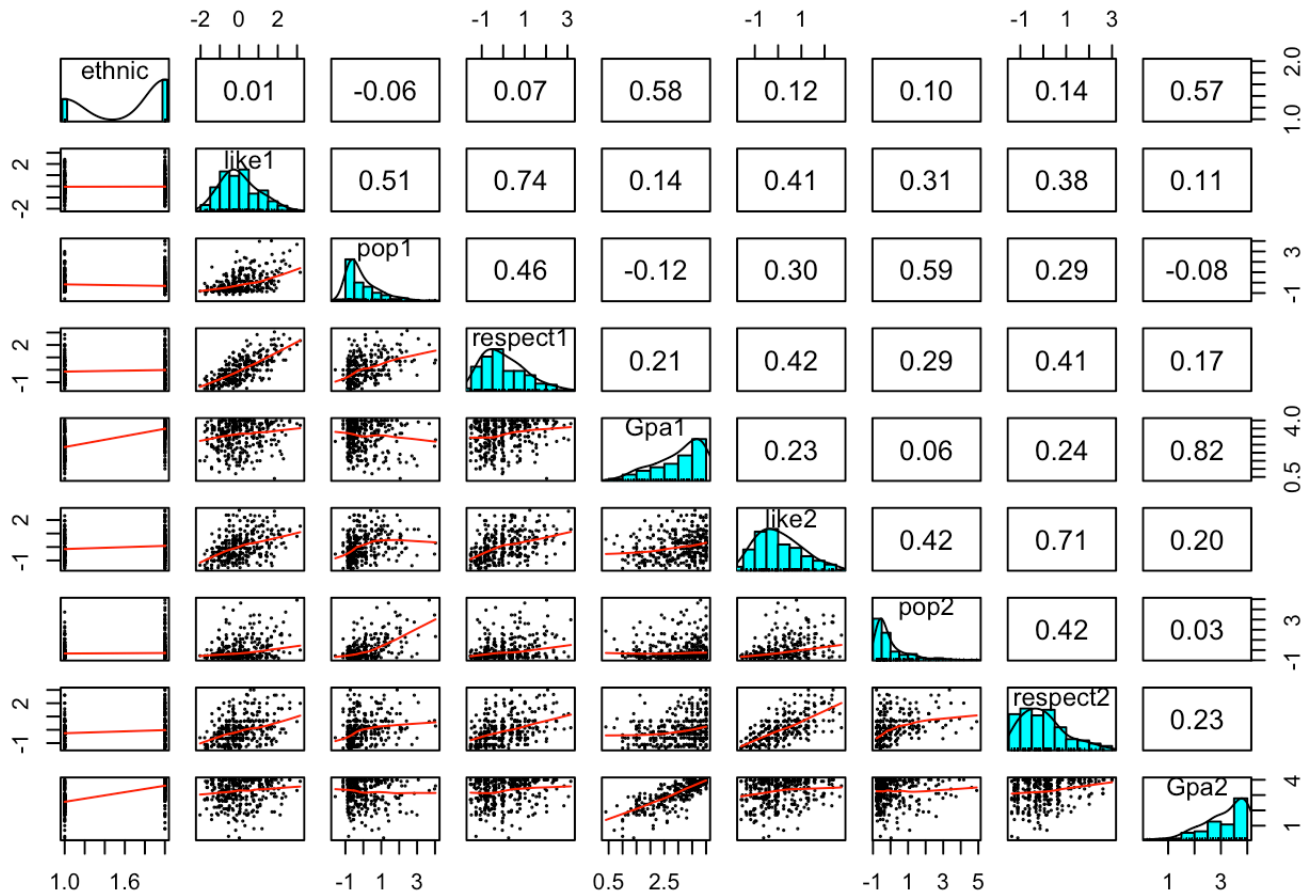
## Additional information:

### descriptive stats and plots

```
# data summary  
summary(dat)
```

```
##          id          likel          pop1          respect1
## Min.      : 3.0      Min.      :-2.03086      Min.      :-1.56525      Min.      :-1.52216
## 1st Qu.:130.0      1st Qu.: -0.67026      1st Qu.: -0.73088      1st Qu.: -0.79781
## Median :280.0      Median : -0.12445      Median : -0.40875      Median : -0.04795
## Mean    :265.2      Mean    : 0.04482      Mean    : -0.03984      Mean    : 0.02311
## 3rd Qu.:387.5      3rd Qu.: 0.66260      3rd Qu.: 0.43487      3rd Qu.: 0.66551
## Max.    :497.0      Max.    : 3.16404      Max.    : 4.02668      Max.    : 3.15635
##          NA's      :11          NA's      :7          NA's      :4
##          Gpa1          gender1          like2          pop2
## Min.      :0.400      Min.      :0.0000      Min.      :-1.58879      Min.      :-0.80051
## 1st Qu.:2.500      1st Qu.:0.0000      1st Qu.: -0.71262      1st Qu.: -0.64805
## Median :3.300      Median :0.0000      Median : -0.06665      Median : -0.36557
## Mean    :3.035      Mean    :0.4716      Mean    : 0.05732      Mean    : 0.03673
## 3rd Qu.:3.800      3rd Qu.:1.0000      3rd Qu.: 0.71112      3rd Qu.: 0.33292
## Max.    :4.000      Max.    :1.0000      Max.    : 2.72277      Max.    : 4.90748
##
##          respect2          Gpa2          ethnic1final          ethnic
## Min.      :-1.3738286      Min.      :0.200      Min.      :1.000      0:117
## 1st Qu.: -0.6571398      1st Qu.:2.700      1st Qu.:1.000      1:218
## Median : -0.1399890      Median :3.400      Median :2.000
## Mean    : -0.0003791      Mean    :3.169      Mean    :1.651
## 3rd Qu.: 0.6155146      3rd Qu.:3.900      3rd Qu.:2.000
## Max.    : 2.9986197      Max.    :4.000      Max.    :2.000
##
```

```
# plot
dat %>%
  # Select six variables
  select(ethnic, likel, pop1, respect1, Gpa1, like2, pop2, respect2, Gpa2) %>%
  psych::pairs.panels(ellipses = FALSE, cex = 0.2, cex.cor = 1)
```



# Preliminary analysis

## description of variables

- ethnic: ethnicity of the participants: 0= Latinx, 1= Asian
- time: 2 measurement occasions that were one year apart (0 & 1)
- like: levels of social acceptance measured by peer nomination (standardized scores). Higher levels indicate greater social acceptance.
- pop: levels of popularity measured by peer nomination (standardized scores). Higher levels indicate greater popularity.
- respect: levels of respect measured by peer nomination (standardized scores). Higher levels indicate greater respect.
- GPA: GPA including math, science, social studies and language arts grades on a scale of 0-4.
- GPA\_pmc= person mean centered GPA
- GPA\_pm= person mean for GPA

## model equation

In this assignment, I will present the model for social acceptance (soc).

Level 1: Within-Person

$$\text{soc}_{ti} = \beta_{0i} + \beta_{1i}\text{time}_{ti} + \beta_{2i}\text{GPA\_pmc}_{ti} + \beta_{3i}\text{time} \times \text{GPA\_pmc}_{ti} + e_{ti}$$

Level 2: Between-Person

$$\beta_{0i} = \gamma_{00} + \gamma_{01}\text{ethnicity}_{ti} + \gamma_{02}\text{GPA\_pm}_{ti} + \gamma_{03}\text{ethnicity}_{ti} \times \text{GPA\_pm}_{ti} + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}\text{ethnicity}_{ti} + u_{1i}$$

$$\beta_{2i} = \gamma_{20} + \gamma_{21}\text{ethnicity}_{ti} + u_{2i}$$

$$\beta_{3i} = \gamma_{30} + \gamma_{31}\text{ethnicity}_{ti} + u_{3i}$$

combined:

$$\begin{aligned} \text{soc}_{ti} = & \gamma_{00} + \\ & \gamma_{01}\text{ethnicity}_{ti} + \gamma_{02}\text{GPA\_pm}_{ti} + \gamma_{03}\text{ethnicity}_{ti} \times \text{GPA\_pm}_{ti} + \\ & \gamma_{10}\text{time}_{ti} + \gamma_{20}\text{GPA\_pmc}_{ti} + \gamma_{30}\text{time} \times \text{GPA\_pmc}_{ti} + \\ & \gamma_{11}\text{ethnicity}_{ti} \times \text{time}_{ti} + \gamma_{21}\text{ethnicity}_{ti} \times \text{GPA\_pmc}_{ti} + \\ & \gamma_{31}\text{ethnicity}_{ti} \times \text{time} \times \text{GPA\_pmc}_{ti} + \\ & u_{1i}\text{time}_{ti} + u_{2i}\text{GPA\_pmc}_{ti} + u_{3i}\text{time} \times \text{GPA\_pmc}_{ti} + \\ & u_{0i} + e_{ti} \end{aligned}$$

## codes for analysis

### wide to long and cluster mean center

```
dat_long <- dat %>%
  pivot_longer(
    c(like1, like2, Gpa1, Gpa2),
    names_to = c(".value", "time"),
    names_pattern = "(like|Gpa)([1-2])",
    names_transform = list(time = as.integer)
  )

dat_long <- dat_long %>%
  group_by(id) %>%
  mutate(Gpa_pm = mean(Gpa),
         Gpa_pmc = Gpa - Gpa_pm) %>%
  ungroup()

dat_long <- dat_long %>%
  select(id, ethnic, time, like, Gpa, Gpa_pm, Gpa_pmc)
```

# ICC

```
# fit a random intercept model
m0<- lmer(like ~ 1 + (1|id), data=dat_long)
summary(m0)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: like ~ 1 + (1 | id)
## Data: dat_long
##
## REML criterion at convergence: 1789.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.9819 -0.6111 -0.1127  0.4905  2.5298
##
## Random effects:
## Groups   Name                Variance Std.Dev.
## id      (Intercept)  0.3893     0.6239
## Residual                    0.5722     0.7564
## Number of obs: 659, groups: id, 335
##
## Fixed effects:
##              Estimate Std. Error    df t value Pr(>|t|)
## (Intercept)   0.05304    0.04512 335.27000   1.175   0.241
```

```
ICC<- 0.3893/ (0.3893+ 0.5722 )
ICC
```

```
## [1] 0.4048882
```

## test randome slope

```
# a model with only random slope of time
m <- brm(bf(like ~ (Gpa_pm+ Gpa_pmc* time) * ethnic + (time|id),sigma ~ 0 ), data=dat_long,
        seed = 1150,
        file = "hw9_ma",
        chains = 2L, iter = 1000L)

# test the random slope for GPA_pmc (against model m)
m1 <- brm(bf(like ~ (Gpa_pm+ Gpa_pmc* time) * ethnic + (Gpa_pmc + time|id),sigma ~ 0 ), data=dat_long,
        seed = 1151,
        file = "hw9_mb",
        chains = 2L, iter = 1000L)

summary(m1)
```

```
## Family: gaussian
## Links: mu = identity; sigma = log
## Formula: like ~ (Gpa_pm + Gpa_pmc * time) * ethnic + (Gpa_pmc + time | id)
##          sigma ~ 0
## Data: dat_long (Number of observations: 659)
## Draws: 2 chains, each with iter = 1000; warmup = 500; thin = 1;
##          total post-warmup draws = 1000
##
## Group-Level Effects:
## ~id (Number of levels: 335)
##
```

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS
sd(Intercept)	0.36	0.12	0.09	0.57	1.00	438
sd(Gpa_pmc)	0.16	0.12	0.01	0.45	1.00	788
sd(time)	0.09	0.06	0.00	0.23	1.01	216
cor(Intercept,Gpa_pmc)	0.00	0.48	-0.83	0.84	1.00	2102
cor(Intercept,time)	-0.12	0.49	-0.90	0.80	1.00	1568
cor(Gpa_pmc,time)	-0.02	0.49	-0.89	0.87	1.00	548

```
##          Tail_ESS
## sd(Intercept)      300
## sd(Gpa_pmc)         536
## sd(time)            440
## cor(Intercept,Gpa_pmc) 779
## cor(Intercept,time)  696
## cor(Gpa_pmc,time)    853
##
## Population-Level Effects:
##
```

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS
Intercept	-0.48	0.34	-1.12	0.17	1.00	1452
Gpa_pm	0.27	0.10	0.07	0.47	1.00	1767
Gpa_pmc	0.14	0.76	-1.34	1.61	1.00	950

```
## time -0.14 0.14 -0.43 0.13 1.00 1909
## ethnic1 -0.46 0.49 -1.39 0.49 1.00 1202
## Gpa_pmc:time -0.06 0.49 -1.03 0.93 1.00 1005
## Gpa_pm:ethnic1 -0.00 0.14 -0.28 0.25 1.00 1398
## Gpa_pmc:ethnic1 1.02 1.11 -1.10 3.23 1.00 895
## time:ethnic1 0.24 0.18 -0.10 0.59 1.00 1984
## Gpa_pmc:time:ethnic1 -0.77 0.72 -2.16 0.66 1.00 960
## Tail_ESS
## Intercept 727
## Gpa_pm 920
## Gpa_pmc 875
## time 626
## ethnic1 891
## Gpa_pmc:time 908
## Gpa_pm:ethnic1 660
## Gpa_pmc:ethnic1 815
## time:ethnic1 611
## Gpa_pmc:time:ethnic1 875
##
## 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).
```

```
# the 95% CI of the random effect of GPA_pmc does not include 0
loo(m, m1)
```



```

## Output of model 'm':
##
## Computed from 1000 by 659 log-likelihood matrix
##
##           Estimate    SE
## elpd_loo   -901.6 13.2
## p_loo       62.4  3.0
## looic       1803.3 26.4
## -----
## Monte Carlo SE of elpd_loo is 0.3.
##
## Pareto k diagnostic values:
##
##           Count Pct.    Min. n_eff
## (-Inf, 0.5] (good)    646   98.0%   220
## (0.5, 0.7] (ok)       13    2.0%   251
## (0.7, 1] (bad)         0    0.0%  <NA>
## (1, Inf) (very bad)   0    0.0%  <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
##
## Output of model 'm1':
##
## Computed from 1000 by 659 log-likelihood matrix
##
##           Estimate    SE
## elpd_loo   -903.9 13.3
## p_loo       62.1  3.0
## looic       1807.7 26.6
## -----
## Monte Carlo SE of elpd_loo is 0.3.
##
## Pareto k diagnostic values:
##
##           Count Pct.    Min. n_eff
## (-Inf, 0.5] (good)    637   96.7%   286
## (0.5, 0.7] (ok)       22    3.3%   261
## (0.7, 1] (bad)         0    0.0%  <NA>
## (1, Inf) (very bad)   0    0.0%  <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
##
## Model comparisons:
##   elpd_diff se_diff
## m      0.0      0.0
## m1 -2.2      0.5

```

```
# m and m1 have very similar looic (though m has a smaller value)
# Should include random slopes of GPA_pmc

# test the random slope for GPA_pmc * time
m2 <- brm(bf(like ~ (Gpa_pm+ Gpa_pmc* time) * ethnic + (Gpa_pmc * time|id),sigma ~ 0
), data=dat_long,
          seed = 1152,
          file = "hw9_mc",
          chains = 2L, iter = 1000L)

summary(m2)
```

```
## Family: gaussian
## Links: mu = identity; sigma = log
## Formula: like ~ (Gpa_pm + Gpa_pmc * time) * ethnic + (Gpa_pmc * time | id)
##          sigma ~ 0
## Data: dat_long (Number of observations: 659)
## Draws: 2 chains, each with iter = 1000; warmup = 500; thin = 1;
##          total post-warmup draws = 1000
##
## Group-Level Effects:
## ~id (Number of levels: 335)
##
```

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS
## sd(Intercept)	0.36	0.11	0.13	0.57	1.01	294
## sd(Gpa_pmc)	0.21	0.17	0.01	0.66	1.01	322
## sd(time)	0.08	0.06	0.00	0.21	1.01	203
## sd(Gpa_pmc:time)	0.13	0.11	0.00	0.41	1.00	515
## cor(Intercept,Gpa_pmc)	-0.01	0.44	-0.82	0.77	1.00	1229
## cor(Intercept,time)	-0.09	0.45	-0.85	0.78	1.01	788
## cor(Gpa_pmc,time)	-0.04	0.45	-0.81	0.80	1.00	391
## cor(Intercept,Gpa_pmc:time)	0.05	0.46	-0.79	0.85	1.00	892
## cor(Gpa_pmc,Gpa_pmc:time)	-0.21	0.47	-0.92	0.74	1.00	659
## cor(time,Gpa_pmc:time)	0.01	0.45	-0.83	0.81	1.01	656

```
##
## Tail_ESS
## sd(Intercept)      172
## sd(Gpa_pmc)        411
## sd(time)           485
## sd(Gpa_pmc:time)   468
## cor(Intercept,Gpa_pmc) 724
## cor(Intercept,time)  664
## cor(Gpa_pmc,time)    625
## cor(Intercept,Gpa_pmc:time) 724
## cor(Gpa_pmc,Gpa_pmc:time) 794
## cor(time,Gpa_pmc:time) 627
```

```
##
## Population-Level Effects:
##
```

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS
## Intercept	-0.51	0.34	-1.16	0.14	1.01	509
## Gpa_pm	0.28	0.10	0.08	0.49	1.01	560
## Gpa_pmc	0.05	0.80	-1.45	1.61	1.00	461
## time	-0.14	0.14	-0.39	0.15	1.01	597
## ethnic1	-0.43	0.50	-1.39	0.49	1.02	399
## Gpa_pmc:time	-0.00	0.51	-0.98	1.01	1.00	462
## Gpa_pm:ethnic1	-0.01	0.14	-0.29	0.29	1.01	439
## Gpa_pmc:ethnic1	1.14	1.16	-1.09	3.49	1.00	455
## time:ethnic1	0.23	0.17	-0.12	0.55	1.01	562
## Gpa_pmc:time:ethnic1	-0.84	0.75	-2.35	0.64	1.00	447

```
##
```

	Tail_ESS
## Intercept	556
## Gpa_pm	632
## Gpa_pmc	451
## time	662
## ethnic1	612
## Gpa_pmc:time	419
## Gpa_pm:ethnic1	483
## Gpa_pmc:ethnic1	450
## time:ethnic1	591
## Gpa_pmc:time:ethnic1	527

```
##
## 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).
```

```
# the 95% CI of the random effect of GPA_pmc*time includes 0
loo(m, m2)
```

```

## Output of model 'm':
##
## Computed from 1000 by 659 log-likelihood matrix
##
##           Estimate    SE
## elpd_loo   -901.6 13.2
## p_loo       62.4  3.0
## looic       1803.3 26.4
## -----
## Monte Carlo SE of elpd_loo is 0.3.
##
## Pareto k diagnostic values:
##
##           Count Pct.    Min. n_eff
## (-Inf, 0.5] (good)    646   98.0%    220
## (0.5, 0.7] (ok)       13    2.0%    251
## (0.7, 1] (bad)         0    0.0%    <NA>
## (1, Inf) (very bad)   0    0.0%    <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
##
## Output of model 'm2':
##
## Computed from 1000 by 659 log-likelihood matrix
##
##           Estimate    SE
## elpd_loo   -903.6 13.2
## p_loo       63.3  3.0
## looic       1807.2 26.3
## -----
## Monte Carlo SE of elpd_loo is 0.3.
##
## Pareto k diagnostic values:
##
##           Count Pct.    Min. n_eff
## (-Inf, 0.5] (good)    645   97.9%    308
## (0.5, 0.7] (ok)       14    2.1%    346
## (0.7, 1] (bad)         0    0.0%    <NA>
## (1, Inf) (very bad)   0    0.0%    <NA>
##
## All Pareto k estimates are ok (k < 0.7).
## See help('pareto-k-diagnostic') for details.
##
## Model comparisons:
##   elpd_diff se_diff
## m    0.0      0.0
## m2 -1.9      0.5

```

```
# m and m2 have very similar looic ( m has a smaller value)
# should not include random slope of GPA_pmc* time

# opt for m1 (random slopes of time and GPA_pmc)
```

## table

```
tab_model(m1)
```

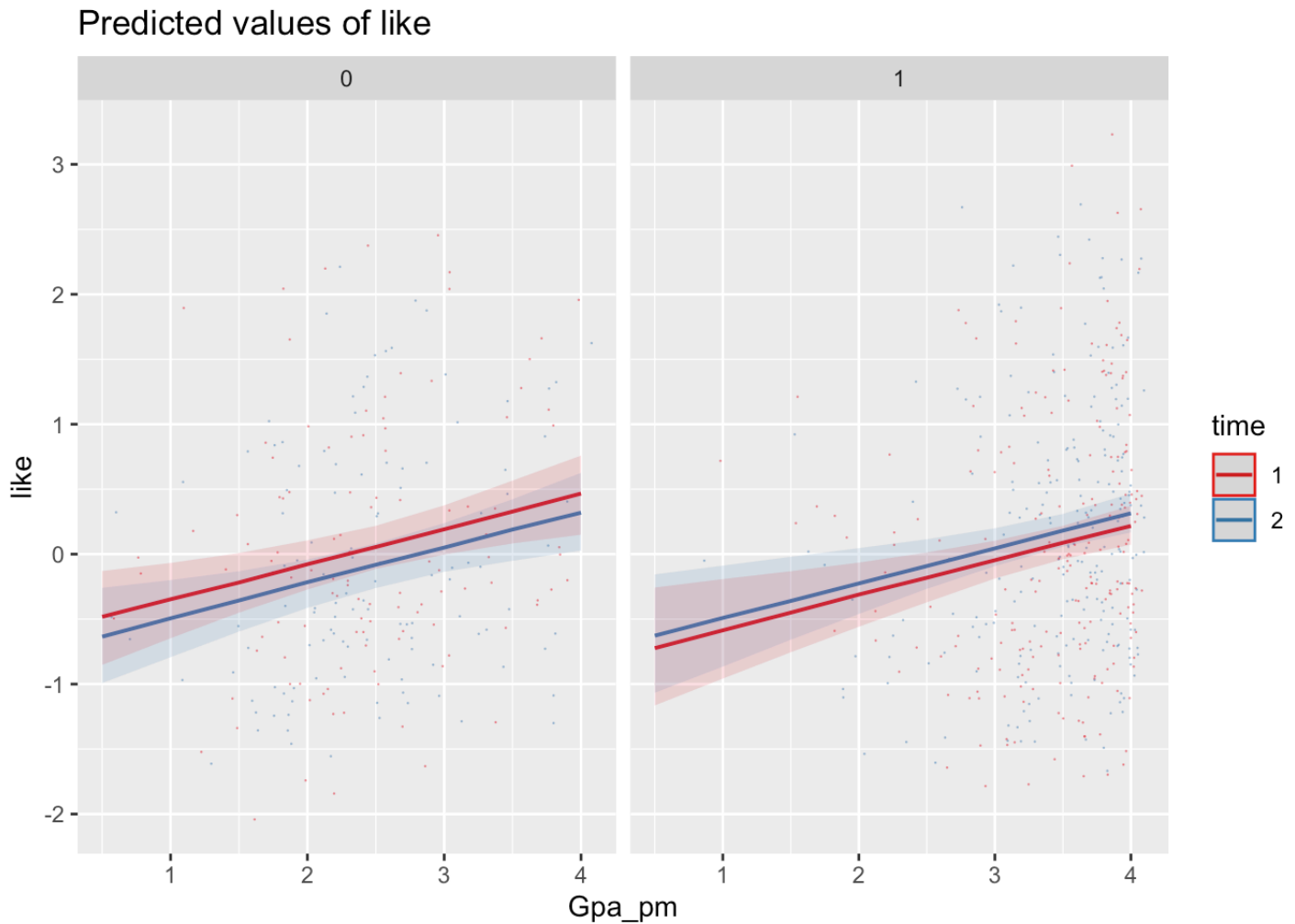
<i>Predictors</i>	<b>like</b>	
	<i>Estimates</i>	<i>CI (95%)</i>
Intercept	-0.50	-1.12 – 0.17
Gpa_pm	0.27	0.07 – 0.47
Gpa_pmc	0.14	-1.34 – 1.61
time	-0.14	-0.43 – 0.13
ethnic: ethnic1	-0.47	-1.39 – 0.49
Gpa_pmc:time	-0.04	-1.03 – 0.93
Gpa_pm:ethnic1	-0.01	-0.28 – 0.25
Gpa_pmc:ethnic1	1.02	-1.10 – 3.23
time:ethnic1	0.23	-0.10 – 0.59
Gpa_pmc:time:ethnic1	-0.78	-2.16 – 0.66
<b>Random Effects</b>		
$\sigma^2$	1.00	
$\tau_{00}$ id	0.14	
$\tau_{11}$ id.Gpa_pmc	0.04	
$\tau_{11}$ id.time	0.01	
$\rho_{01}$		
$\rho_{01}$		
ICC	0.13	

N <sub>id</sub>	335
Observations	659
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.057 / 0.198

## figure

```
plot_model(m1,
  type = "pred", terms = c("Gpa_pm", "time", "ethnic"),
  show.data = TRUE, jitter = 0.1,
  dot.alpha = 0.5, dot.size = 0.1,
)
```

```
## Note: uncertainty of error terms are not taken into account. You may want to use `
rstantools::posterior_predict()`.
```



## interpretation:

The results indicates one unit of difference in different students' average GPA across is associated with 0.27 (95% CI [0.07,0.47]) unit of difference in their average social acceptance. The effect is the same across the tow ethnic groups.

- The data analytic scripts and supplemental materials for this project will be available at [ <https://github.com/mincizhang/575project> (<https://github.com/mincizhang/575project>) ]