hw9

Minci Zhang

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Group member: Minci Zhang

Format: paper

Background:

Forming positive peer relationships and achieving academic success are two important developmental task 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).

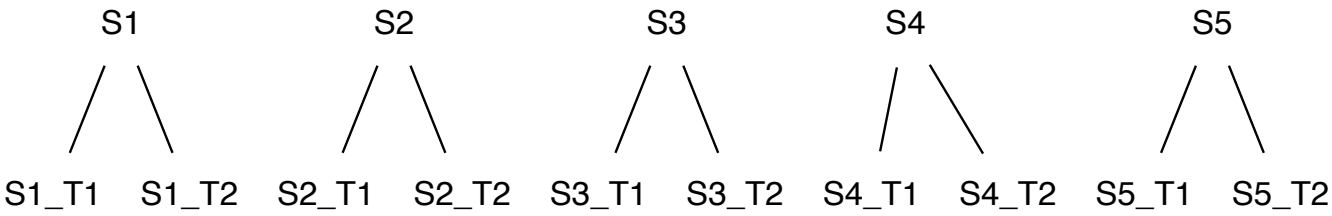
Research questions:

The current project aims to examine the possible ethnic differences in the changes of social status (i.e., popularity, social acceptance and respect) as predicted by changes in 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.

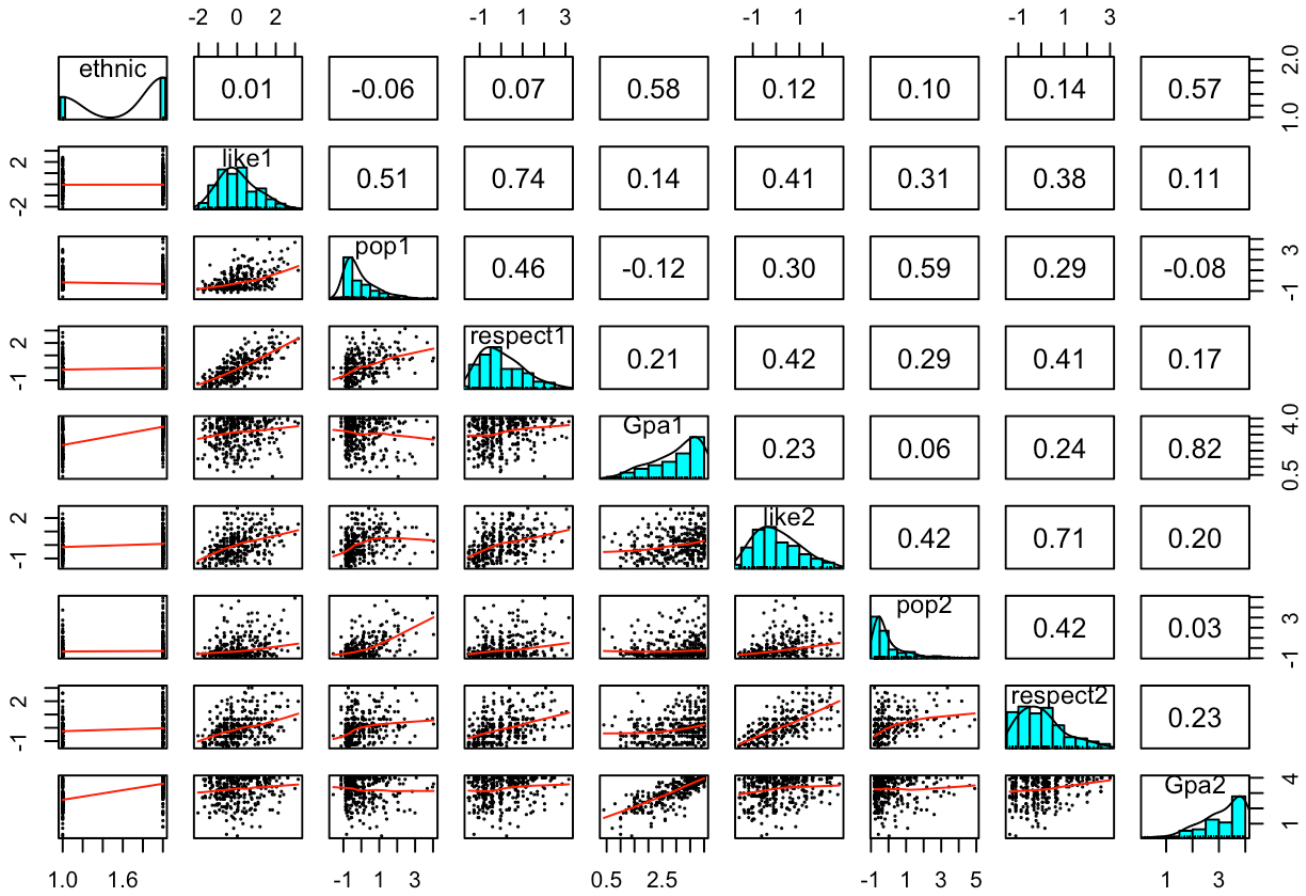
Additional information:

descriptive stats and plots

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

```
##        id            like1               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, like1, 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

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

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)
```

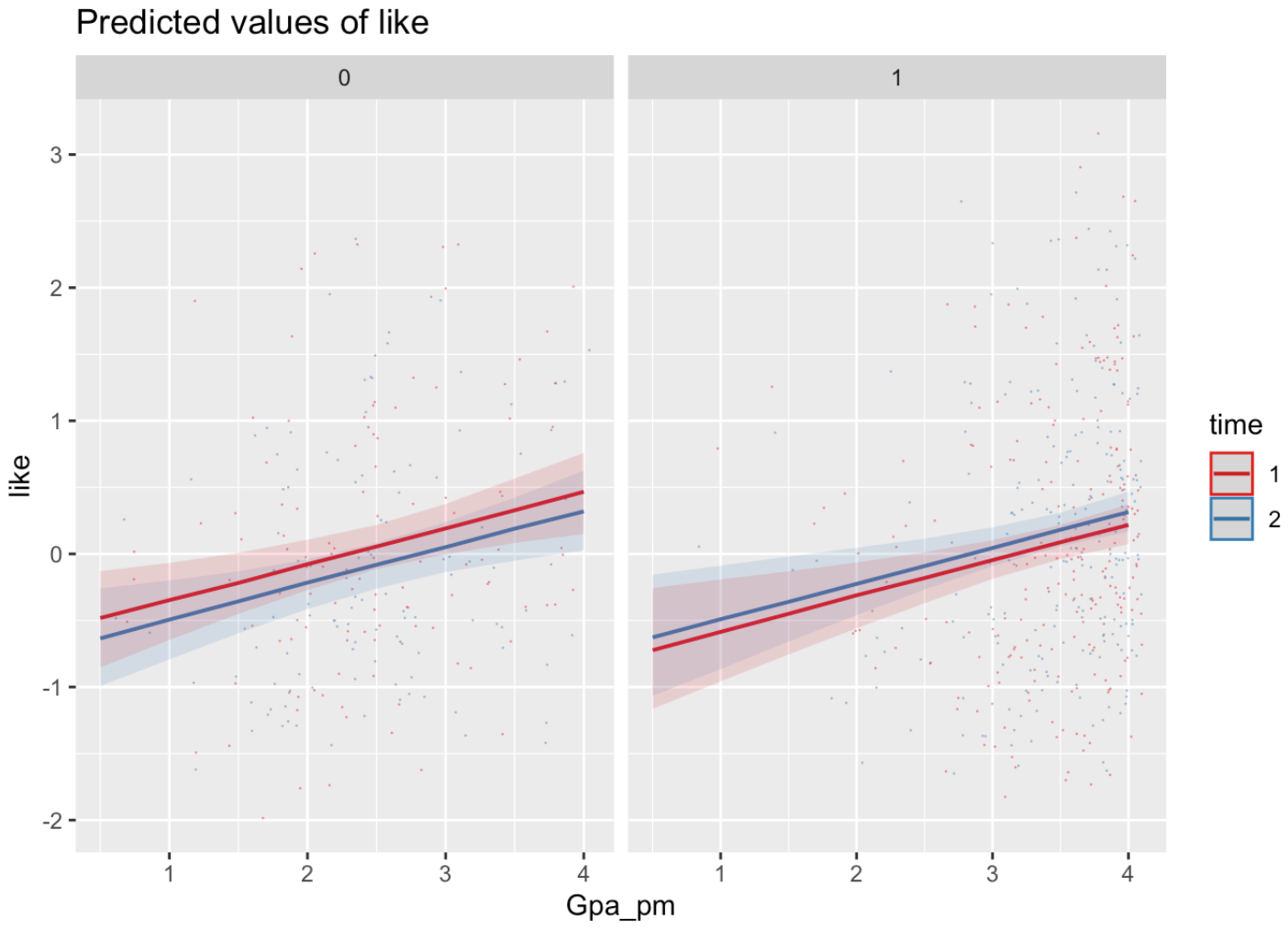
	like	
Predictors	*Estimates*	*CI (95%)*
Intercept	-0.50	-1.12 – 0.17
Gpa_pm	0.27	0.07 – 0.47
Gpa_pmc	0.14	-1.34 – 1.61
time	-0.14	-0.43 – 0.13
ethnic: ethnic1	-0.47	-1.39 – 0.49
Gpa_pmc:time	-0.04	-1.03 – 0.93
Gpa_pm:ethnic1	-0.01	-0.28 – 0.25
Gpa_pmc:ethnic1	1.02	-1.10 – 3.23
time:ethnic1	0.23	-0.10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

N_{id}	335
Observations	659
Marginal R^2 / Conditional R^2	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 increase in different students' average GPA across is associated with 0.27 (95% CI [0.07,0.47]) unit of increase in their average social acceptance. The effect is the same across the two 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)]