

# Longitudinal Final Project Report

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## Introduction

Perceived discrimination has increasingly been recognized as a major public health issue, with extensive research documenting its adverse impacts on mental health outcomes. Previous studies consistently demonstrate that frequent experiences of discrimination significantly predict heightened psychological distress, manifesting as increased anxiety and mental worry (Cave et al., 2020; Cruz et al., 2018; Jones et al., 2022). These findings indicate that individuals experiencing chronic discrimination report elevated levels of worry and anxiety symptoms compared to those with fewer discriminatory experiences. Furthermore, evidence highlights significant racial disparities in both the frequency and psychological impacts of discrimination, with racial minority groups reporting higher exposure to discrimination and more pronounced negative mental health outcomes compared to their white counterparts (Bacong et al., 2025; Imari & Read, 2024).

Substance use behaviors are also closely linked to experiences of discrimination and mental health outcomes. Research indicates that individuals exposed to discrimination often resort to substance use, such as marijuana, smoking, and cocaine, as coping mechanisms to manage stress-induced mental health symptoms (Bacong et al., 2025; Cruz et al., 2018). The co-occurring risk theory suggests that discrimination and substance use may jointly affect mental health problems negatively, intensifying the cumulative impact of these stressors over time (Bacong et al., 2025).

Building on the insights from these theories, this longitudinal study aims to examine how experiences of discrimination, as well as substance use behaviors, such as marijuana use, smoking history, and cocaine use, influence the trajectories of mental worry over time, and whether this relationship differs by race. We hypothesize that higher levels of perceived discrimination and substance use behaviors will be associated with increased trajectories of mental worry. Additionally, we anticipate that racial differences will moderate this relationship, with minority racial groups potentially exhibiting stronger associations due to heightened exposure to discrimination. Ultimately, findings from this research could inform targeted interventions and policies designed to mitigate mental health disparities related to discrimination and substance use.

# Methods

Transition to Adulthood Study (TAS) is a part of Panel Study of Income Dynamics (PSID) and its supplement Childhood Development Supplement (CDS). It was initiated in 2005, and biennially collected information about transition through adolescence to adulthood in domains including but not limited to psychological functioning, family formation, fertility-related behavior, childhood adversity, employment and income, education and career goals, and health (University of Michigan, n.d.) .

## I. Survey population

The TAS is a supplement to the representative national longitudinal study PSID. We used 4 waves of data: 2007 (wave II), 2009 (wave III), 2011 (wave IV), and 2013 (wave V) to test our hypothesis that higher level of discrimination and substance use would increase mental worry trajectories, and the minority race would experience stronger associations than the majority groups. For the purpose of this report, wave II will be referred to as baseline (wave 0), and wave III, wave IV and wave V are referred to as wave I, wave II and wave III respectively.

PSID samples consisted of 2 independent samples, one of which featured a probability-based stratified multistage selection and the other one of which was from an unequal probability selection (University of Michigan. 2023). Based on it, participants of TAS at these 4 waves are all: 1) at least 18 years old (at most 28 years old for 2011 and 2013, 2) that are no longer attending high school, 3) that all have attended one of the past CDS interviews (2013 TAS participants should be in one of 1997, 2002/2003, or 2007/2008 interviews of PSID), and 4) whose family has participated the corresponding PSID interview at the same year as an identified family unit member in a household interview (University of Michigan, 2009; University of Michigan, 2011; University of Michigan, 2013; University of Michigan, 2015).

## II. Study Measures

By hypothesis, we chose the outcome-‘mental worry’ (1-7), which is constructed from the average non-missing frequency of being worried about money, future job and of feeling discouraged about the future. The main exposure is discrimination (1-6), which is constructed from the average non-missing responses of questions including how often: 1) treated with less courtesy, 2) receive poorer service, 3) others treat as stupid, 4) others act afraid, 5) others treat as dishonest and 6) others act superior. For variables associated with substance use, we chose: 1) ever use of marijuana (yes or no), 2) ever use of cocaine (yes or no), 3) whether a cigarette smoker (yes or no), and 4) ever use of cigarette (yes or no). We also chose race (White, Black or African-American or Negro, Other) to control as a demographic.

### **III. Statistical Analysis**

OLS of the outcome against the centered wave variable was conducted to find the general longitudinal trend. Followed was the OLS at the individual level to obtain the between-person heteroscedasticity at baseline and about rate of change. A linear mixed-effect model was built from an unconditional growth model by sequentially adding discrimination and other substance-use-related variables. Whether to stay or to move forward depends on three criteria: 1) whether the significance of fixed effects remained or not, 2) whether the variance of random effects decreased or not, and 3) whether AIC and BIC decreased or not. We additionally used ICC to interpret the proportion of variance explained by between and within-person heteroscedasticity. All analyses were conducted using Rstudio (4.4.2).

# Results

## I. Summary Statistics

The data set to be analyzed after selecting all required measures and filtering balanced observations has 1864 observations that correspond to 466 subjects. And it has 9 variables which consist of PID, time and 7 other variables mentioned (Table 1).

For the outcome 'mental worry', the standard deviations range from 1.49 to 1.57, leaving limited variation. The most reported mental worry score across 4 waves is 3 (22.96% at baseline, 27.04% at wave I, 19.96% at wave II, 22.75% at wave III). For reported discrimination at baseline, nobody reported 6. And among those reported values, 2 was most reported (35.41% at baseline, 34.76% at wave I, 38.84% at wave II, 39.91% at wave III). All substance-use-related variables are binary. For marijuana ever-users, this proportion increased from 38.41% (n=179) at baseline to 55.15% (n=257) at wave II and decreased to 45.49% (n=212) at wave III. For those who reported having ever used marijuana, it was highest at wave II with the percentage 55.15% (n=257) and the proportion was lowest at baseline at 38.41% (n=179). The proportion of cigarette ever-users was cumulative, from 32.83% at baseline (n=153), to 35.62% (n=166) at wave I and wave II, and 36.05% (n=168) at wave III. For those who are cigarette smokers, the proportions across four waves were roughly stable around 21% (n=98). Race is the only variable that is invariant across waves. More than 50% of subjects are White (n=258, 55.36%), and the rest of subjects are basically Black, African-American or Negro (n=195, 41.85%), with 2.79% (n=13) being other races (Table 1).

## II. OLS interpretation

To examine within-person changes in mental worry over time, we selected 12 participants from three racial groups: White, Black or African American, and Other. Their worry scores across four survey waves were plotted with fitted linear trends. These plots revealed a wide range of individual trajectories. Some participants showed increasing worry, others showed decreasing trends, and several remained relatively stable.

When all individual trend lines were overlaid, the average trajectory appeared nearly flat. However, the spread in individual slopes highlighted considerable variation in how worry changed across participants. This heterogeneity suggested that a single average cannot adequately represent the dynamic patterns at the individual level. Race-stratified plots provided further insights. Participants identifying as White tended to have slopes clustering around no change, while those identifying as Black or African American exhibited greater variability, including both increases and decreases in worry. Participants in the Other category showed more scattered trends, which may partially reflect the smaller group size. These patterns raised

the possibility that race might influence worry trajectories—a question we explored further in subsequent modeling.

The sample mean of the estimated intercepts was 3.57, reflecting the average baseline level of psychological worry across individuals. The mean of the estimated slopes was 0.0258, suggesting that, on average, worry levels remained stable over time. The variance of the estimated intercepts was 2.05, and the variance of the estimated slopes was 0.318. These values indicated substantial between-person variability in both initial worry levels and rates of change. Standard deviations would be the square roots of these variances, approximately 1.43 for intercepts and 0.56 for slopes. The estimated correlation between intercepts and slopes was -0.596, suggesting that individuals with higher initial worry tended to experience larger declines over time.

Changes in the estimated intercepts and slopes suggested that the Level 1 model should include both random intercepts and random slopes to capture within-individual changes in worry over time. This structure allowed the model to account for not only individual differences in baseline levels of psychological worry, but also individual differences in rates of change across survey waves. At Level 2, the inclusion of additional predictors may help explain within-individual differences in the intercept and slope. The negative correlation between the two suggests that individuals with higher initial worry levels tended to show greater declines over time, suggesting a possible relationship between levels. These preliminary findings suggested that future models should consider including interaction terms and relevant covariates to better understand the sources of individual differences in worry trajectories.

### **III. Linear Mixed Models**

To evaluate the longitudinal relationship between discrimination, substance use, race, and mental worry, we employed a series of linear mixed-effects models with a random intercept and slope specification for waves, clustered by individual ID (PID). This model structure was selected to appropriately account for the repeated-measures design of our data and to model individual variation in both baseline levels and trajectories of mental worry over time.

Linear mixed models (LMMs) are well-suited for longitudinal data with unbalanced time points and missingness at random. By including both fixed and random effects, LMMs allowed us to estimate the average population-level effects of predictors while also modeling individual differences in growth trajectories. We fitted models using maximum likelihood estimation to enable model comparisons using AIC and BIC. The results were shown in Figure 6.

Model 1 is the unconditional growth model, as stated in the OLS section, which includes only waves as a fixed effect and allows both intercept and slope for waves to vary by individual. There is no significant trend between waves and mental worry continuously.

Model 2 adds discrimination as a time-varying predictor. Discrimination significantly predicts increased mental worry ( $\beta = 0.224$ ,  $p < .001$ ), supporting our hypothesis that discrimination contributes to elevated worry. Furthermore, Model 3 incorporates marijuana use, which was measured as a binary indicator. Marijuana use is positively associated with mental worry ( $\beta = 0.223$ ,  $p < .05$ ), suggesting that individuals who use marijuana experience greater mental worry, potentially as a result of stress coping behaviors. Additionally, Model 4 adds smoking history (ever smoked), which shows a strong positive association with mental worry ( $\beta = 0.337$ ,  $p < .001$ ). The result suggests that smoking history is an important factor when considering psychological distress (Figure 6).

For the final model, Model 5 introduces race categories for taking count of racial differences. Compared to White individuals, those categorized as “Other” racial identity report significantly lower mental worry ( $\beta = -0.733$ ,  $p < .05$ ), while Black/African-American individuals do not differ significantly. These effects suggest potential variation in stress response by racial identity, though not all differences are statistically significant (Figure 6).

Throughout model development, each step demonstrated improved model fit as assessed by AIC and BIC. The final model (Model 5) had the lowest AIC (6496) and the highest log-likelihood, indicating the best fit to the data overall, which is selected as the final fit model. Although Model 5 had a slightly higher BIC (6557), this increase is attributable to the inclusion of five predictor variables, placing it within the penalization range of the BIC criterion. Given this context, we prioritized AIC as our primary model selection criterion (Figure 6).

In addition to AIC and BIC, we examined the intraclass correlation coefficients (ICCs) for intercept, slope (wave), and residual variance components across models (Figure 7). The ICC for the intercept slightly decreased from 0.452 in the unconditional model to 0.408 in the final model, indicating a modest reduction in between-person variability in baseline mental worry as predictors were added. Meanwhile, the ICC for waves remained stable across models (approximately 0.020), suggesting limited variability in individual slopes for waves. The residual ICC increased slightly from 0.526 in the unconditional model to 0.565 in the final model, reflecting an improved accounting of structured variance at Level 1 with the inclusion of key predictors (Figure 7).

#### **IV. Final Model**

The result of Model 5, our final fit model, indicates that perceived discrimination ( $b = 0.205$ ,  $p < .05$ ), marijuana use ( $\beta = 0.157$ ,  $p < .05$ ), and smoking history ( $\beta = 0.338$ ,  $p < .001$ ) are all significantly associated with greater levels of mental worry, aligning with our hypothesis that these stressors contribute to psychological distress over time. The negative coefficient for the "Other" race category ( $\beta = -0.733$ ,  $p < .05$ ) suggests this group experienced less mental worry than the White reference group, while the coefficient for Black individuals was not statistically significant (Figure 6). The estimated correlation between the random intercept and slope was  $-0.30$ , suggesting that individuals with higher initial levels of mental worry tend to experience slightly decreasing worry over time.

From a fixed effect perspective, these results underscore meaningful average relationships across the population. The random effects, capturing individual variation in baseline mental worry and change over time, remained substantively important. This indicates that, while fixed predictors explain much of the between-person variation, substantial within-person differences remain. Together, these results affirm that Model 5 successfully captures both general trends and individual variability in mental worry trajectories, providing support for our study hypothesis.

## Summary

This study explored how psychological worry changes over time and how it relates to experiences of discrimination and substance use. Using data from four survey waves, we found that individual worry trajectories varied widely, although there was no clear average trend across the sample. This variation suggested the need for models that allow both the starting point and the rate of change to differ between individuals.

Higher levels of discrimination were linked to greater psychological worry, supporting the idea that perceived unfair treatment contributes to emotional strain. Substance use, particularly marijuana and cigarette use, was also associated with higher levels of worry, indicating possible links between health behaviors and emotional well-being.

Differences across racial groups were also observed. White participants generally showed more stable worry patterns, while those identifying as Black or African American had more varied trajectories. Participants in the Other group tended to report lower overall levels of financial and future-related worry.

These findings support the hypothesis that both discrimination and substance use are associated with psychological worry. They also highlight the importance of accounting for individual differences and social context in studies of mental health. Future work should examine how these relationships develop over time and whether other factors may explain differences in worry across individuals.



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## Appendix

**Table 1. Summary statistics for variables selected for analysis (n=466).**

Variables	n (%) / Mean (Range, SD)			
	07	09	11	13
<b>Main Exposure</b>				
<b>Discrimination</b>	2.62 (1-5, 0.99)	2.54 (1-6, 0.92)	2.55 (1-6, 0.95)	2.54 (1-6, 0.96)
1	55 (11.80%)	59 (12.66%)	54 (11.59%)	54 (11.59%)
2	165 (35.41%)	162 (34.76%)	181 (38.84%)	186 (39.91%)
3	164 (35.19%)	192 (41.20%)	171 (36.70%)	163 (34.98%)
4	64 (13.73%)	42 (9.01%)	48 (10.30%)	47 (10.09%)
5	18 (3.86%)	10 (2.15%)	7 (1.50%)	15 (3.22%)
6	-	1 (0.21%)	5 (1.07%)	1 (0.21%)
<b>Outcome</b>				
<b>Mental Worry</b>	3.44 (1-7, 1.54)	3.73 (1-7, 1.54)	3.56 (1-7, 1.57)	3.41 (1-7, 1.49)
1	45 (9.66%)	33 (7.08%)	43 (9.23%)	43 (9.23%)
2	101 (21.67%)	69 (14.81%)	93 (19.96%)	100 (21.46%)
3	107 (22.96%)	126 (27.04%)	93 (19.96%)	106 (22.75%)
4	97 (20.82%)	87 (18.67%)	109 (23.39%)	118 (25.32%)
5	65 (13.95%)	81 (17.38%)	69 (14.81%)	54 (11.59%)
6	37 (7.94%)	54 (11.59%)	42 (9.01%)	31 (6.65%)
7	14 (3.00%)	16 (3.43%)	17 (3.65%)	14 (3.00%)
<b>Substance Use</b>				
<b>Marijuana (ever use)</b>	-	-	-	-
Yes	179 (38.41%)	231 (49.57%)	257 (55.15%)	212 (45.49%)
No	287 (61.59%)	235 (50.43%)	209 (44.85%)	254 (54.51%)
<b>Cocaine (ever use)</b>	-	-	-	-
Yes	36 (7.73%)	45 (9.66%)	55 (11.80%)	55 (11.80%)
No	430 (92.27%)	421 (90.34%)	411 (88.20%)	411 (88.20%)

<b>Cigarette (ever use)</b>	-	-	-	-
Yes	153 (32.83%)	166 (35.62%)	166 (35.62%)	168 (36.05%)
No	313 (67.17%)	300 (64.38%)	300 (64.38%)	298 (63.95%)
<b>Cigarette Smoker</b>	-	-	-	-
Yes	101 (21.67%)	104 (22.32%)	100 (21.46%)	94 (20.17%)
No	365 (78.33%)	362 (77.68%)	366 (78.54%)	372 (79.83%)
<b>Other Covariates</b>				
<b>Race</b>	-			
White	258 (55.36%)			
Black, AA, Negro	195 (41.85%)			
Other	13 (2.79%)			

*SD = standard deviation; AA: African-American*

Figure 1.

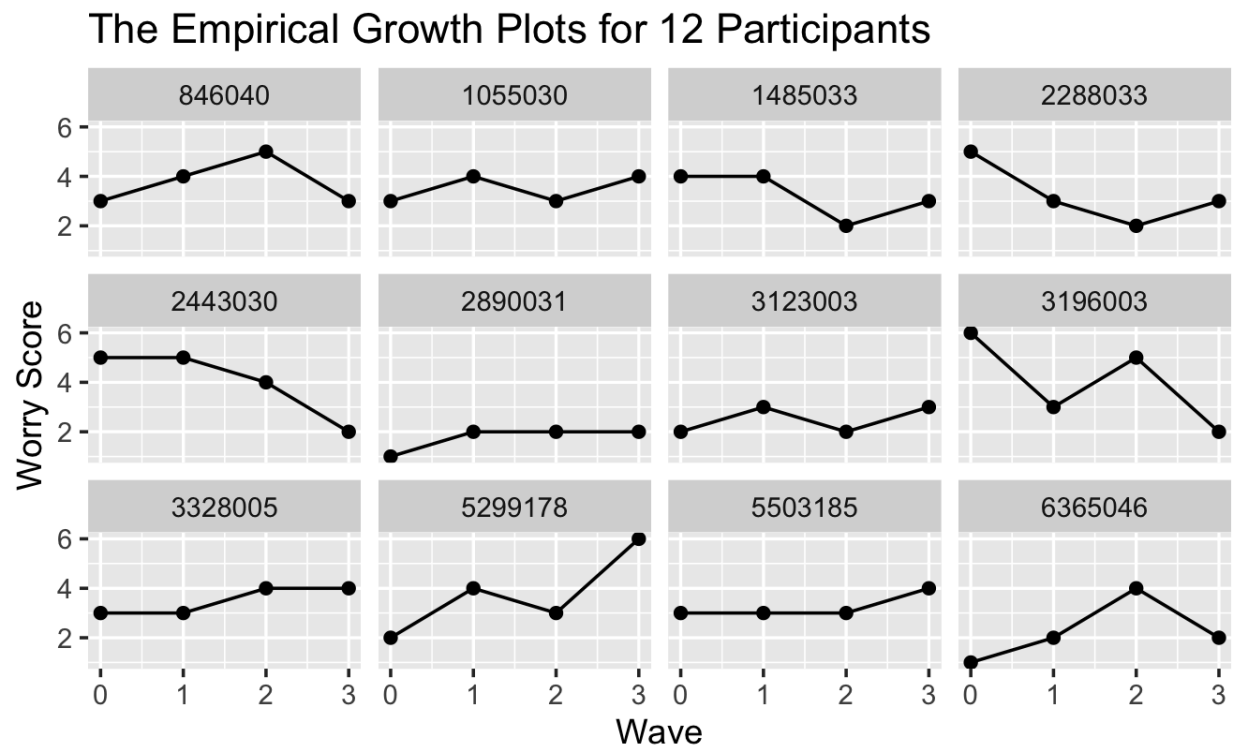


Figure 2.

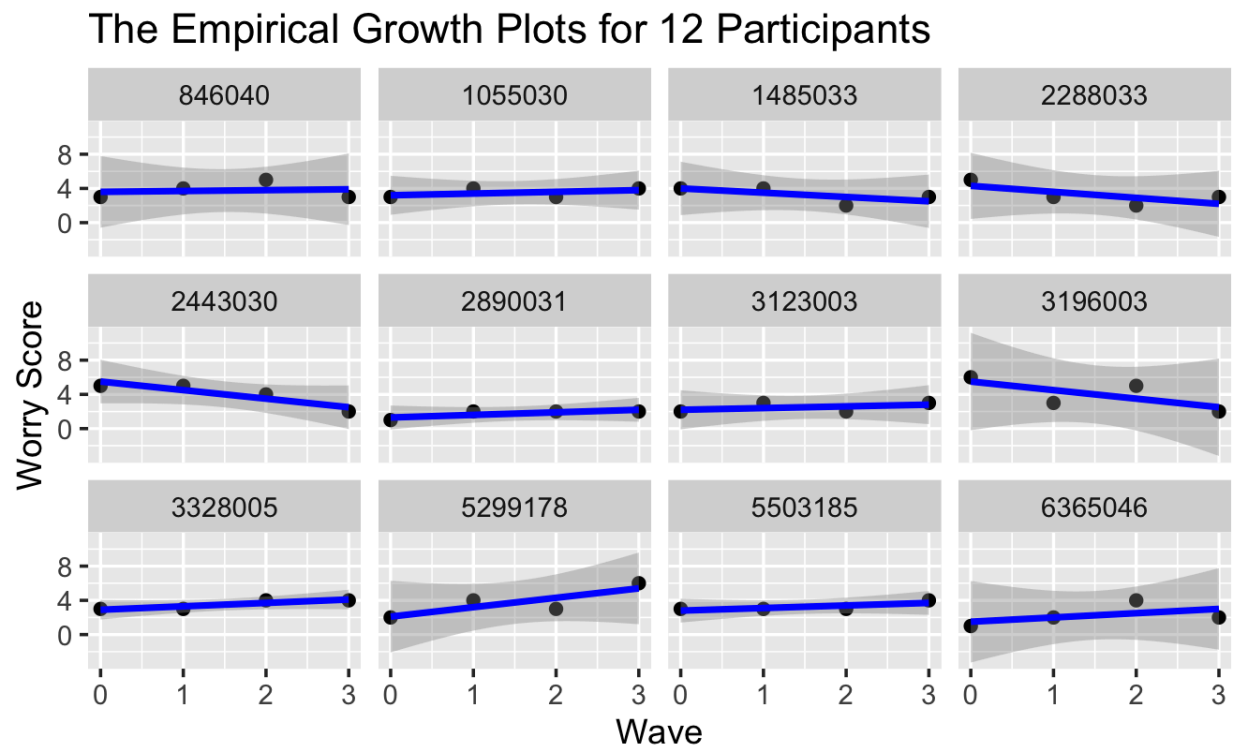


Figure 3.

The Individual OLS Plots with Mean Trajectory.

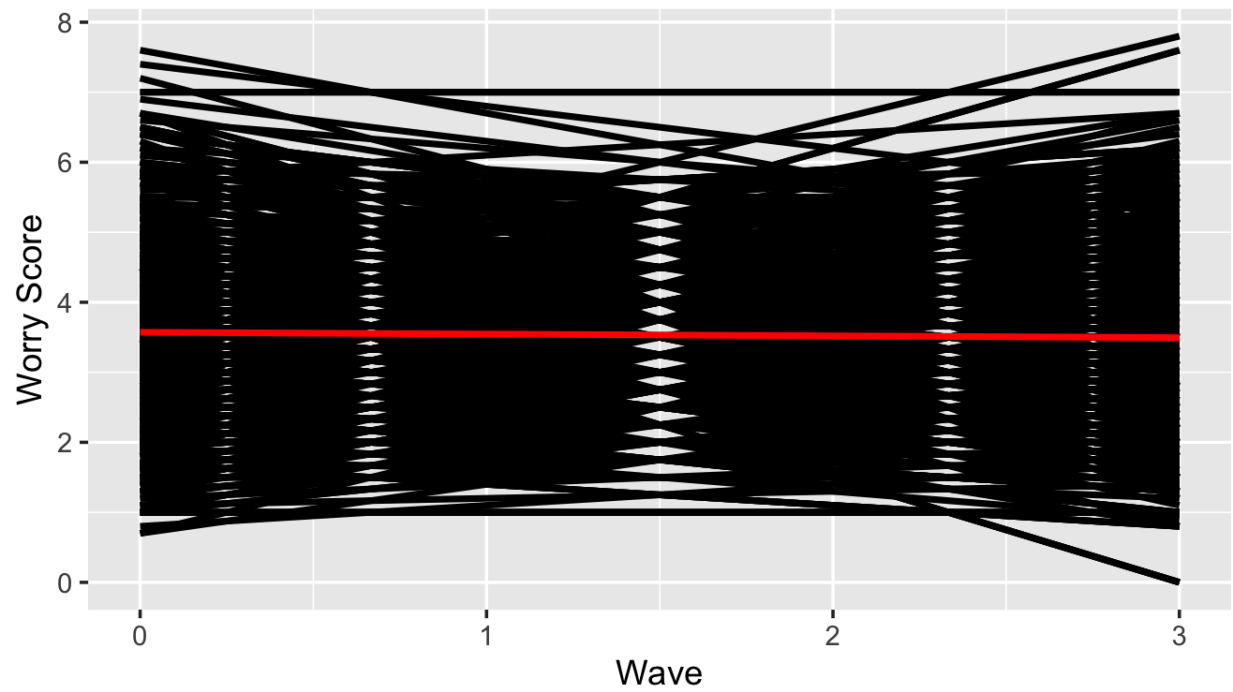


Figure 4.

The Individual OLS of the 12 Plots with Mean Trajectory.

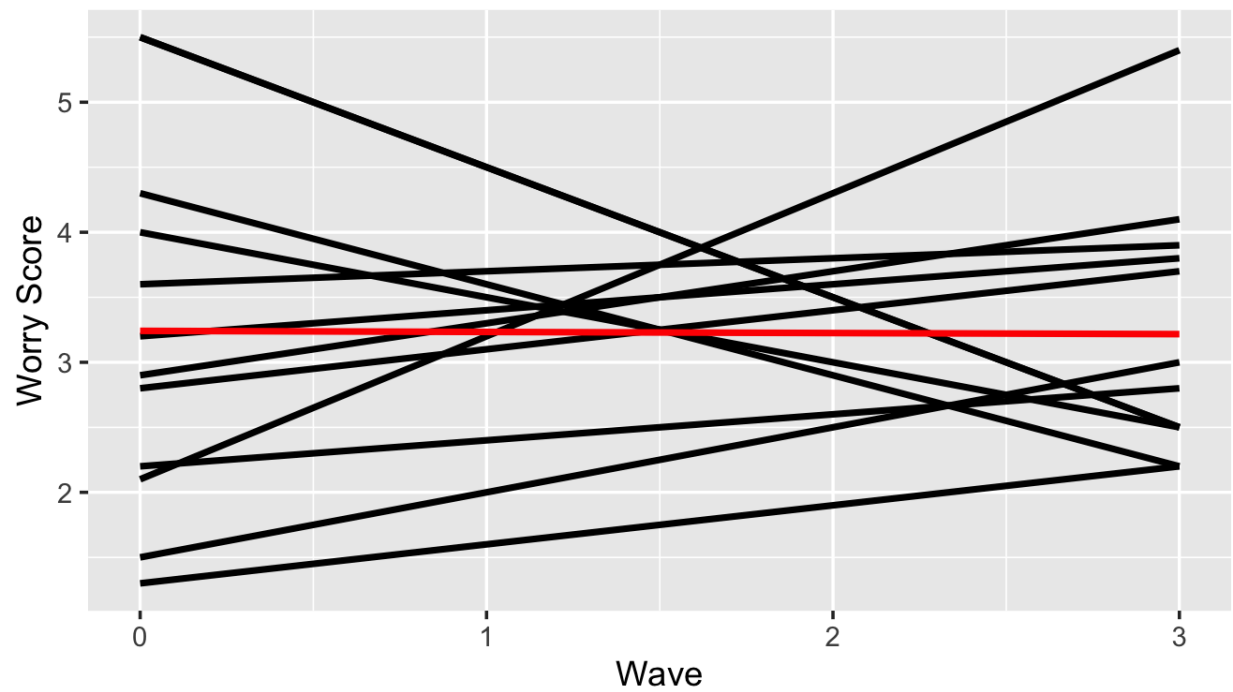


Figure 5.

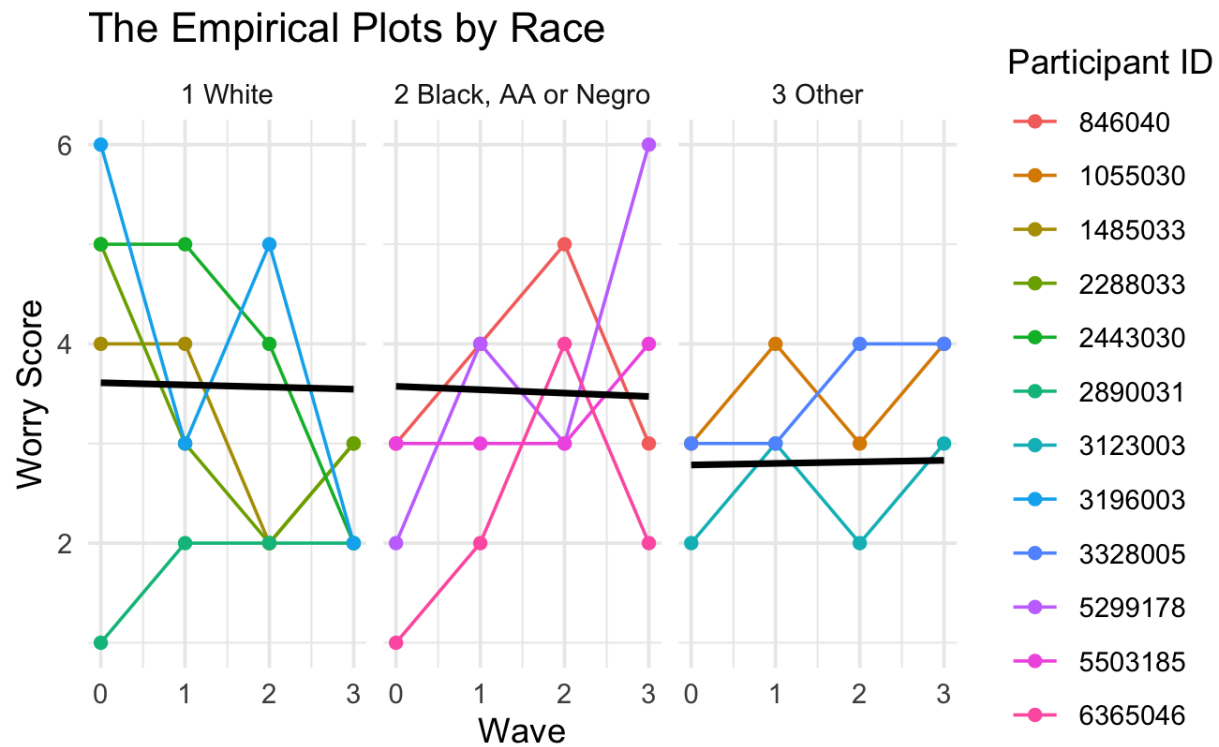


Figure 6. Estimates of fixed effects, variance (SE) of random effects and model fits.

Parameter	Model 1 (Unconditional growth)	Model 2 (+ Discrimination)	Model 3 (+ Marijuana)	Model 4 (+ Ever smoking)	Model 5 (Final) (+ Race)
<b>Fixed Effects</b>					
Intercept	3.572 (0.066)	2.990 (0.117)***	2.930 (0.118)***	2.858 (0.119)***	2.890 (0.128)***
Wave	-0.026 (0.026)	-0.020 (0.026)	-0.033 (0.026)	-0.032 (0.026)	-0.033 (0.026)
Discrimination	-	0.224 (0.038)***	0.212 (0.038)***	0.207 (0.038)***	0.205 (0.038)***
Marijuana use	-	-	0.2227 (0.079)**	0.154 (0.081).	0.157 (0.081).
Ever Smoking	-	-	-	0.337 (0.093)***	0.338 (0.093)***
Race (ref: White)	-	-	-	-	-
Black, AA, or Negro	-	-	-	-	-0.020 (0.104)
Other	-	-	-	-	-0.733 (0.310)*
<b>Random Effects</b>					
Residual (Level 1)	1.314 (1.146)	1.317 (1.147)	1.315 (1.147)	1.311 (1.145)	1.311 (1.145)
Intercept (Level 2)	1.129 (1.063)	1.023 (1.011)	1.003 (1.001)	0.962 (0.981)	0.986 (0.972)
Wave (Level 2)	0.054 (0.233)	0.046 (0.214)	0.045 (0.211)	0.048 (0.219)	0.048 (0.219)
<b>Model Fit</b>					
AIC	6547	6514	6508	6497	<b>6496</b>
BIC	6580	6553	6552	<b>6547</b>	6557
Log-Likelihood	-3267	-3250	-3246	-3240	<b>-3237</b>
Deviance	6535	6500	6492	6479	<b>6474</b>

AA = African-American. \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$ , .  $p < .1$ .

**Figure 7. ICC of intercept, slope, and residual, and total adjusted ICC for each model.**

<b>Model</b>	<b>ICC Intercept</b>	<b>ICC Wave</b>	<b>ICC Residual</b>	<b>ICC Total Adjusted</b>
Model 1 (Unconditional growth)	0.452	0.0217	0.526	0.447
Model 2 (+ Discrimination)	0.429	0.0193	0.552	0.427
Model 3 (+ Marijuana)	0.424	0.0188	0.557	0.424
Model 4 (+ Ever Smoke)	0.414	0.0207	0.565	0.417
<b>Model 5 (Final: + Race)</b>	<b>0.408</b>	<b>0.0207</b>	<b>0.565</b>	<b>0.413</b>