

Changes in Bullying During High School: An Application of Markov Models

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Abstract

Bullying is a complex social dynamic that requires innovative analyses to assess the developmental progression of these behaviors. The purpose of this study is twofold. First, we will demonstrate the application of Markov models, a specific type of latent transition analysis useful in exploring transitions between discrete groups, using the Mplus software. Second, we will answer three research questions:

- (1) How does involvement in bullying change during the four years of high school?
- (2) How does involvement in bullying during one year impact involvement in the next year?
- (3) What are the probabilities for transitioning between bullying and non-bullying status in successive years?

Self-report data were collected over a period of 4 years from 361 students in an all-male, private, urban, Midwestern secondary school. Results show self-reported bullying is relatively stable over time and decreases slightly by the end of high school. Involvement in bullying during 10th grade was not found to be a predictor of involvement in bullying during 11th grade. Models with homogeneous transition probabilities fit better than models with heterogeneous transition probabilities. Adding average aggression score as a covariate improved model fit.

Introduction

Several decades of research on bullying has shown that involvement in bullying is associated with a number of negative outcomes such as depression (Vestergaard, Borberg, Arvidsson, 2005; Swearer, Song, Cary, Eagle, & Michelson, 2001), conduct problems (Wolke, Woods, & Bloomfield, 2000), relationship problems (Bollmer, Millich, Harris, & Maras, 2005), and anxiety (Storch, Brassard, & Masia-Warner, 2003; Swearer et al., 2001).

Research on involvement in bullying over time suggests that bullying peaks in middle school with highest involvement occurring during school transitions (Pepler, Craig, Connolly, Yule, McMaster, & Jiang, 2006). Chen & Ysue (2002) surveyed students in elementary, middle and high schools in China and found that 5% of elementary school students, 4.3% of middle school students, and 2.7% of high school students reported bullying.

Schäfer, Korn, Brodbeck, Wolke, and Schulz (2005) followed 283 students from primary school through secondary school in Munich. Their results suggest that being a bully in primary school is a significant risk factor for bullying in secondary school. They also found that 19% of students were bullies in secondary school with an additional 8% being identified as bully-victims (i.e., both bullying others and being bullied), and that bully status was fairly stable over time.

Despite the connection between bullying and psychosocial problems, few U.S. studies have examined participation in bullying longitudinally in secondary school and little is known about how involvement in bullying changes during the high school years.

Markov models

Markov models are a "good option" for modeling changes in discrete states or categories over time (Visser, Schmittman, & Rajmakers, 2007). They have been used to model "physical, biological, social and engineering systems such as population dynamics, queuing networks, and manufacturing systems" (Yin & Zhang, 2005, p. 3), and have been in use since at least the 1950s.

Markov models are useful for manifest or latent data, called "hidden Markov models" (Van De Pol & De Leeuw, 1986), can be used to compare multiple groups (Mooijart & Van Montfort, 2007).

Recent advances in software make Markov models easy to estimate in software programs like Mplus, PANMARK, Latent Gold, R, and others.

Methods

Participants

Data were collected from 361 students at a medium sized, private, all-male, four-year high school in the Midwest. Data were collected from 4 cohorts over a 4 year period from 2003 through 2006. Each cohort began involvement in the study during their freshman year and data were collected each spring. The first cohort participated in 4 survey administrations and the final cohort participated in 1 survey administration.

Instruments

Respondents completed *The Bully Survey-Youth Version* (BS-Y; Swearer, 2001) and the *Aggression Questionnaire* (Bass & Warren, 2000). We used a categorical (yes / no) self-report item from *The Bully Survey-Youth Version* that asked whether or not students had been involved in bullying during the past year. We used each individual's average total aggression score to represent their level of aggression.

Analysis

Mplus was used to analyze the data (see handout). Twelve different Markov models (A–L) are summarized here. The models include manifest and latent models, first- and second-order models, and models with covariates. Results available from each model include the predicted number of students who progress through each of the 16 possible pathways, the odds ratios for being in one group based on group membership at previous time points, the odds ratios for covariates and the proportions of students estimated to be involved in bullying at each time point.

Models

(A) First-order manifest homogeneous and (B) First-order manifest heterogeneous.

U_1 , U_2 , U_3 , and U_4 represent the four time points in this study. The F's represent the transition matrices between each time point. Homogeneous models fix the F matrices to be equal to each other while heterogeneous models estimate the F matrices separately. First-order models use only the immediately preceding time point to predict current status.

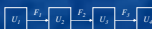


Figure 1: Model (B): First-order manifest homogeneous model

(C) First-order latent homogeneous and (D) First-order latent heterogeneous. In the latent models we allow for the estimation of error (the H matrices) in the measurement portion of the model. In this way bullying can be considered a latent construct (i.e., some students did not answer the survey honestly).

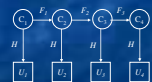


Figure 2: Model (D): First-order latent homogeneous model

(E) Second-order manifest heterogeneous and (F) Third-order manifest heterogeneous.

Second-order models propose that the status at time 'Y' is impacted directly by status at the two previous time points. Third-order models allow for the impact of the three previous time points. Our data do not allow for models beyond the third-order, since we only have four collection points.

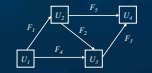


Figure 3: Model (E): Second-order manifest heterogeneous model

Models (continued)

(G) First-order manifest homogeneous with aggression as a covariate and (H) Second-order manifest heterogeneous with aggression as a covariate. The addition of covariates, continuous or categorical, can help explain the transition between membership groups. The G matrix is constrained to be equal in our example, but can also be estimated separately.



Figure 4: Model (G): First-order manifest homogeneous with aggression as a covariate

(I) Adjusted second-order manifest heterogeneous with aggression as a covariate and (J) Adjusted second-order manifest homogeneous with aggression as a covariate. Non-significant relationships can be removed from the model, shown in figure 5.

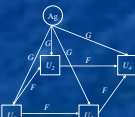


Figure 5: Model (I): Adjusted second-order manifest homogeneous with aggression as a covariate

(K) Adjusted third-order manifest homogeneous with aggression as a covariate and (L) Adjusted third-order latent homogeneous with aggression as a covariate. Model L was the best fitting model based on having the lowest Akaike's Information Criterion (AIC).

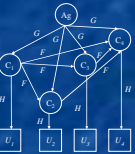


Figure 6: Model (L): Adjusted third-order latent homogeneous with aggression as a covariate (best fitting model)

Results

The raw count of students answering "yes" and "no" to the "did you bully this year" question each year is shown in table 1.

The mean on the *Aggression Questionnaire* was 80.17 and the standard deviation was 16.83. These values are similar to those reported by Bass and Warren (2000) of 73.3 and 24.9, respectively. Table 2 shows the AIC and BIC values for the models described earlier.

Grade	Frequency		Total	Model Comparison of models	
	Yes	No		AIC	BIC
9th	144 (41%)	208 (59%)	352	3066.023	3093.246
10th	87 (35%)	161 (65%)	248	3059.129	3076.796
11th	51 (21%)	108 (68%)	159	3051.291	3068.733
12th	23 (38%)	36 (62%)	59	3045.769	3067.896

Results (continued)

Table 3 shows the predicted pattern of bullying behavior for all of the students who participated in the study.

Grade	Predicted pattern of bullying behavior for all of the students who participated in the study			
	Yes	No	Total	%
9th	144	208	352	100%
10th	87	161	248	100%
11th	51	108	159	100%
12th	23	36	59	100%

Table 4 shows the probability for transitioning between bullying or not bullying categories in successive years based on model L. These values can be interpreted in the same way as conditional probabilities.

From	Probability for transitioning between bullying or not bullying categories in successive years based on model L	
	To	Probability
Bullying	Bullying	0.820
Bullying	Not Bullying	0.180
Not Bullying	Bullying	0.020
Not Bullying	Not Bullying	0.980

Table 5 shows the odds ratios for the best fitting model. Controlling for aggression, the odds of being a bully in 10th grade are between 3.37 and 42.43 times larger if you were a bully during 9th grade. Controlling for prior bully status, the odds of being a bully are between 1.11 and 1.35 times larger for a 5 point increase in aggression total score.

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	To	Odds Ratio
Bullying	Bullying	3.37
Bullying	Not Bullying	42.43
Not Bullying	Bullying	1.11
Not Bullying	Not Bullying	1.35

Discussion

(1) How does involvement in bullying change during the four years of high school? Consistent with previous research, many high school students, 44% in our study, do not report bullying others. Our data also indicate that bullying is relatively stable, with 85% of the students predicted to remain in either the bully or non-bully categories during their entire high school career. The data also indicate a slight decrease in bullying over time.

(2) How does involvement in bullying during one year impact involvement in the next year? Involvement in bullying during 9th grade is a significant predictor of involvement in bullying during 10th, 11th, and 12th grade. However, involvement in bullying during 10th grade is not a significant predictor of involvement in bullying during 11th grade. Involvement in bullying in 12th grade was predicted by involvement during 11th, 10th and 9th grade. Student aggression was a significant predictor of bullying behavior at all four time points.

(3) What are the probabilities for transitioning between bullying and non-bullying status in successive years? The probability of becoming a bully in successive years was the highest between 10th and 11th grade. The probability of moving into the non-bully category was also the highest between 10th and 11th grade. The probability of staying a bully in successive years ranged from 0.651 to 0.812 and the probability of staying a non-bully in successive years ranged from 0.709 to 0.833.

Future research

Additional research is necessary to determine if the results found in this study hold in public, mixed-gender schools. Researchers should also explore the 10th to 11th grade transition to better understand how the shift from underclassman to upperclassman relates to bullying behavior. More research needs to be done to better understand why some students bully in one year and not the next. Finally, additional work should be done to find interventions that will help keep non-bullies in from transitioning to bullying and find better ways to move bullies to the non-bully category.

Limitations

This study has several limitations. First, the data are based on self-report. Second, involvement with bullying was measured dichotomously and did not allow for a range of bullying behavior along a continuum. Finally, a larger sample size would allow for the fitting of more complex Markov models.

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