Brief report: Examining children's disruptive behavior in the wake of trauma — A two-piece growth curve model before and after a school shooting

Yue Liao [a,1], Eleanor T. Shonkoff [a,*,1], Elizabeth Barnett [a], C.K. Fred Wen [a], Kimberly A. Miller [a], J. Mark Eddy [b]

[a] Department of Preventive Medicine, University of Southern California, Los Angeles, CA 90089, USA
[b] Partners for Our Children, School of Social Work, University of Washington, Seattle, WA 98195-9476, USA

ARTICLE INFO

ABSTRACT

School shootings may have serious negative impacts on children years after the event. Previous research suggests that children exposed to traumatic events experience heightened fear, anxiety, and feelings of vulnerability, but little research has examined potential aggressive and disruptive behavioral reactions. Utilizing a longitudinal dataset in which a local school shooting occurred during the course of data collection, this study sought to investigate whether the trajectory of disruptive behaviors was affected by the shooting. A two-piece growth curve model was used to examine the trajectory of disruptive behaviors during the pre-shooting years (i.e., piece one) and post-shooting years (i.e., piece two). Results indicated that the two-piece growth curve model fit the data better than the one-piece model and that the school shooting precipitated a faster decline in aggressive behaviors. This study demonstrated a novel approach to examining effects of an unexpected traumatic event on behavioral trajectories using an existing longitudinal data set.

Introduction

The impact of traumatic events such as Hurricane Katrina, 9/11, and school shootings is multifaceted for children. Retrospective studies of "single-incident traumas" indicate that direct and indirect exposure (including media exposure) can heighten feelings of fear, anxiety, and vulnerability in children (Comer et al., 2010; Eisenberg & Silver, 2011; Gould, Munfakh, Kleinman, Lubell, & Provenzano, 2004; Hoven et al., 2004). School shootings, in particular, heighten feelings of insecurity, feeling too unsafe to attend school, and symptoms of posttraumatic stress (Brener, Simon, Anderson, Barrios, & Small, 2002; Suomalainen, Haravuori, Berg, Kiviruusu, & Marttunen, 2011). Unfortunately, the rate of mass shootings seems to be increasing (Cohen, Azrael, & Miller, 2015). Further, such distressing incidents have the potential to prompt reactionary, aggressive, disruptive behaviors among school children. Witnessing school or community violence has been

* Corresponding author. Health Behavior Research Group, Department of Preventive Medicine, University of Southern California, 2001 N. Soto Street, Los Angeles, CA 90032, USA. Tel.: +1 323 442 8200.
E-mail address: eleanort@usc.edu (E.T. Shonkoff).
[1] These authors contributed equally to this work.

linked to higher adolescent aggressive behaviors (Lambert, Boyd, Cammack, & Ialongo, 2012; O'Keefe, 1997; Schwab-Stone et al., 1999), though findings are mixed (Mrug & Windle, 2010). Due to the unpredictable nature of single-incident traumas, few studies have evaluated consequences using longitudinal data spanning large time windows before and afterward.

Disruptive behaviors have been linked to lower academic achievement (Masten et al., 2005) and higher risk of suicide (Verona, Sachs-Ericsson, & Joiner, 2004). Disruptive behavior tends to decline from elementary school through high school, though subpopulations may maintain elevated levels (Bongers, Koot, van der Ende, & Verhulst, 2004; Nagin & Tremblay, 1999), and some studies indicate behavioral stability over this period (Broidy et al., 2003). Comparing patterns of decline in disruptive behavior during this period could shed light on naturally-occurring development versus changes due to external events (Curran & Muthen, 1999). To our knowledge, no studies have examined whether exposure to a school shooting changes children's disruptive behaviors. This study used data from an existing, prospective longitudinal study during which a local school shooting unfortunately occurred during the middle of data collection years. Using latent growth curve models, this study examined whether exposure to a school shooting was associated with a change in the trajectory of disruptive behaviors during adolescence.

Methods

Procedures

Linking the Interests of Families and Teachers (LIFT) is a multimodal, universal preventive intervention for conduct problems (Eddy, Reid, & Fetrow, 2000). All children attending the participating 12 public elementary schools in the Eugene–Springfield, Oregon metropolitan area were invited to participate. Randomization into the LIFT intervention or services as usual control groups was at the level of the school. Detailed study procedures are provided elsewhere (Eddy, Reid, Stoolmiller, & Fetrow, 2003; Reid, Eddy, Fetrow, & Stoolmiller, 1999; Wood et al., 2012). At baseline, most children were in first or fifth grade. Participants were enrolled over a three year period, with data collected between 1991 and 2006. Participants were assessed on a yearly or every other year basis, depending on study phase. In 1998, a school shooting occurred at a local public high school. On campus, two students were killed and 25 were wounded. The parents of the student were killed off campus. At that point in time, most study participants were attending public schools within a 15-mile radius of the high school, including multiple schools within the same school district.

Child disruptive behavior was measured by mothers' report with 14 items from the Child Behavior Checklist (CBCL; Achenbach, 1991; Achenbach & Edelbrock, 1983). The frequency of each behavior was rated with the response options: *1 = Never* to *5 = More than once a day*. Responses were summed to create an overall score. Internal reliability was acceptable ($\alpha = .88$). The distribution of scores on the standardized CBCL scale for Externalizing Behavior at the various time points resembled those for the national normative sample (Achenbach, 1991).

Treatment of missing data

By study design, not all participants were followed for the entire 12 years to adhere to grant funding limitations during follow-up; during the last period of funding, attempts were not made to try to contact participants who had been unreachable for several years (approx. 17% of the sample). Missing rates by wave were: Wave 3, 3.6%, Wave 4, 8.8%, Wave 5, 12.8%, Wave 6, 12.4%, Wave 8, 17.9%, Wave 10, 24.3%, Wave 12, 68.9%. To address missing data, multiple imputation was performed using Mplus (Version 6.11). This method is commonly used to impute missing covariates in longitudinal studies by using information from participants with incomplete sets of observations (Kenward & Carpenter, 2007). Five data sets were imputed, and means of missing data values were used as the final value for analyses (Asparouhov & Muthén, 2010).

Statistical analyses

Two growth curve models (GCMs) were fitted to assess the growth trajectory of disruptive behavior for Cohort 3 of the LIFT study. Only Cohort 3 had multiple waves of data both before and after the shooting. The one-piece GCM captured Wave 3 to Wave 12. The two-piece GCM split the growth trajectory into two parts: the pre-shooting period (Wave 3 to Wave 6), and the post-shooting period (Wave 8 to Wave 12). Although each wave was separated by one year, the CBCL was not administered at all waves (i.e., 7, 9, and 11). Therefore, loadings for the indicators of the TIME variable were fixed at 0, 1, 2, 3, 5, 7, and 9 for the one-piece GCM. In the two-piece GCM, indicators of TIME were fixed at 0, 1, 2, and 3 (pre-shooting), and at 0, 2, and 4 (post-shooting). Using the two-piece GCM, distinct initial status and growth rates were estimated for disruptive behavior separately for the pre- and post-shooting periods. Both GCMs controlled for intervention condition, gender, and grade level. Model fit chi-square test statistics were compared between the one-piece and two-piece GCMs to assess which was a better fit. All analyses were performed using Mplus (Version 6.11).

Results

Descriptive characteristics

The 251 students included in the analysis were balanced by gender (52% female), grade (61% fifth versus first graders), and intervention group (53% intervention). Similar to the local population at the time, the majority were Caucasian (85%). Scores on aggressive behavior ranged from 16 to 66 across all waves (baseline M = 36.1, SD = 6.8).

Comparison between one-piece and two-piece GCM

Disruptive behavior decreased over time (slope = −.564, one-piece model). The two-piece GCM showed that the post-shooting slope (s2 = −1.02) was steeper than the pre-shooting slope (s1 = −.47), though the difference did not reach significance (Wald = 2.64, df = 1, p = .10) (see Fig. 1). Notably, higher scores on disruptive behavior at baseline were associated with a faster decline of disruptive behavior during the post-shooting period (B = −.49, p < .001). Table 1 shows the standardized parameter estimates of predictors and covariates for the one- and two-piece GCM trajectories and corresponding model fit statistics. For the two-piece model, disruptive behavior at baseline (i.e., i1) and pre-shooting slope (i.e., s1) both predicted higher initial disruptive behaviors post-shooting (i.e., i2; ps < .01). Children with higher scores on disruptive
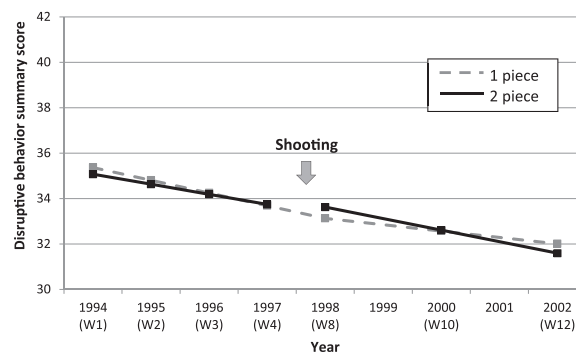

Fig. 1. Trajectories of child disruptive behavior from 1994 (Wave 3) to 2002 (Wave 12) based on a one-piece growth curve model and a two-piece growth curve model.

Table 1
Parameter estimates of the predictors for GCM trajectories and model fit statistics.

	One-piece model	Two-piece model	
		Pre-Shooting Period (Piece 1)	Post-Shooting Period (Piece 2)
Predictors	**Initial status (Intercept)**	**Initial status (i1)**	**Initial status (i2)**
	B (SE)	**B (SE)**	**B (SE)**
Group	.092 (.068)	.095 (.071)	.036 (.056)
Gender	−.185 (.067)**	−.153 (.070)*	−.010 (.053)
Grade	.006 (.077)	−.059 (.071)	−.002 (.077)
i1	−	−	.880 (.032)**
s1	−	−	.366 (.104)**
Predictors	**Growth rate (Slope)**	**Slope (s1)**	**Slope (s2)**
Group	−.129 (.104)	−.126 (.148)	−.056 (.134)
Gender	.056 (.093)	−.167 (.152)	.130 (.137)
Grade	−.251 (.224)	.100 (.150)	−.512 (.163)**
i1	−	−	−.492 (.091)**
s1	−	−	.373 (.239)
Model Fit			
χ^2		45.142	25.205
df		40	29
p		.266	.668
AIC		9796.688	9702.640
BIC		9852.041	9796.049
CFI		.988	1.000
TLI		.988	1.013
RMSEA		.023	.000

Notes: *p < .05, **p < .01. Group: 1 = intervention, 2 = control; gender: 1 = male, 2 = female; grade: 1 = fifth grade, 2 = first grade. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

behaviors at baseline had a faster rate of decline in disruptive behaviors during post-shooting years ($p < .01$). Results from the chi-square model fit comparison showed that the two-piece GCM significantly improved the model fit compared to the one-piece (χ^2 *diff.* = 19.9, *df* diff. = 11, $p = .046$), suggesting that the two-piece model fit the trajectory of disruptive behaviors better.

Discussion

Understanding the impact of tragedies on adolescent behavior can aid communities and schools in mitigating harm and determining appropriate subsequent intervention services. This study demonstrates a two-piece GCM approach for investigating how a school shooting may have affected the trajectory of adolescent disruptive behavior in a population of public school children. In this study, disruptive behaviors appeared to have dropped more quickly than would be expected had the shooting not occurred (Bongers et al., 2004), possibly due to a large outpouring of social support. The two-piece model was a better fit than the one-piece, suggesting that the school shooting influenced the trajectory of disruptive behaviors. Further, dividing the trajectory into two pieces allowed examination of how pre-shooting behaviors may have affected post-shooting behaviors (similar to a pre-vs. post-test for an expected event). While this result should be interpreted with caution due to the amount of missing data at later waves, the two-piece GCM approach lends itself to other applications for examining potential long-term consequences following traumatic events. Including multiple time points can be particularly useful when examining behaviors during developmental periods such as adolescence, when behaviors are expected to shift (Curran & Muthen, 1999).

Researchers can take advantage of existing data to answer important research questions in cases where the event or situation is unethical to manipulate. This study demonstrated the use of a pre-existing longitudinal dataset with multiple time points before and after a school shooting to examine the trajectory of adolescent disruptive behaviors. Given the substantial negative impact such tragic events have on adolescents and their families, knowledge gained from similar approaches may increase understanding of how adolescents react following such tragedies, and suggest ways to improve resiliency to subsequent problematic outcomes or prevent further tragedy.

Acknowledgments

References

Achenbach, T. M. (1991). *Manual for the child behavior checklist/4–18 and 1991 profile*. Burlington, VT: University of Vermont Department of Psychiatry.

Achenbach, T. M., & Edelbrock, C. S. (1983). *Manual for the child behavior checklist and revised child behavior profile*. Burlington, VT: University of Vermont Department of Psychiatry.

Asparouhov, T., & Muthén, B. (2010). *Multiple imputation with Mplus*.

Bongers, I. L., Koot, H. M., van der Ende, J., & Verhulst, F. C. (2004). Developmental trajectories of externalizing behaviors in childhood and adolescence. *Child Development, 75*(5), 1523–1537. http://dx.doi.org/10.1111/j.1467-8624.2004.00755.x.

Brener, N. D., Simon, T. R., Anderson, M., Barrios, L. C., & Small, M. L. (2002). Effect of the incident at columbine on students' violence- and suicide-related behaviors. *American Journal of Preventive Medicine, 22*(3), 146–150. http://dx.doi.org/10.1016/s0749-3797(01)00433-0.

Broidy, L. M., Nagin, D. S., Tremblay, R. E., Bates, J. E., Brame, B., Dodge, K. A., et al. (2003). Developmental trajectories of childhood disruptive behaviors and adolescent delinquency: a six-site, cross-national study. *Developmental Psychology, 39*(2), 222.

Cohen, A., Azrael, D., & Miller, M. (2015). *Rate of mass shootings has tripled since 2011, Harvard research shows*. Retrieved from http://www.motherjones.com/politics/2014/10/mass-shootings-increasing-harvard-research.

Comer, J. S., Fan, B., Duarte, C. S., Wu, P., Musa, G. J., Mandell, D. J., et al. (2010). Attack-related life disruption and child psychopathology in New York city public school children 6-months post-9/11. *Journal of Clinical Child and Adolescent Psychology, 39*(4), 460–469. http://dx.doi.org/10.1080/15374416.2010.486314.

Curran, P. J., & Muthen, B. O. (1999). The application of latent curve analysis to testing developmental theories in intervention research. *American Journal of Community Psychology, 27*(4), 567–595. http://dx.doi.org/10.1023/a:1022137429115.

Eddy, J. M., Reid, J. B., & Fetrow, R. A. (2000). An elementary school-based prevention program targeting modifiable antecedents of youth delinquency and violence: linking the interests of families and teachers (LIFT). *Journal of Emotional and Behavioral Disorders, 8*(3), 165–176. http://dx.doi.org/10.1177/106342660000800304.

Eddy, J. M., Reid, J. B., Stoolmiller, M., & Fetrow, R. A. (2003). Outcomes during middle school for an elementary school-based preventive intervention for conduct problems: follow-up results from a randomized trial. *Behavior Therapy, 34*(4), 535–552. http://dx.doi.org/10.1016/s0005-7894(03)80034-5.

Eisenberg, N., & Silver, R. C. (2011). Growing up in the shadow of terrorism youth in America after 9/11. *American Psychologist, 66*(6), 468–481. http://dx.doi.org/10.1037/a0024619.

Gould, M. S., Munfakh, J. L. H., Kleinman, M., Lubell, K., & Provenzano, D. (2004). Impact of the september 11th terrorist attacks on teenagers' mental health. *Applied Developmental Science, 8*(3), 158–169.

Hoven, C. W., Duarte, C. S., Wu, P., Erickson, E. A., Musa, G. J., & Mandell, D. J. (2004). Exposure to trauma and separation anxiety in children after the WTC attack. *Applied Developmental Science, 8*(4), 172–183.

Kenward, M. G., & Carpenter, J. (2007). Multiple imputation: current perspectives. *Statistical Methods in Medical Research, 16*(3), 199–218. http://dx.doi.org/10.1177/0962280206075304.

Lambert, S. F., Boyd, R. C., Cammack, N. L., & Ialongo, N. S. (2012). Relationship proximity to victims of witnessed community violence: associations with adolescent internalizing and externalizing behaviors. *American Journal of Orthopsychiatry, 82*(1), 1–9. http://dx.doi.org/10.1111/j.1939-0025.2011.01135.x.

Masten, A. S., Roisman, G. I., Long, J. D., Burt, K. B., Obradovic, J., Riley, J. R., et al. (2005). Developmental cascades: linking academic achievement and externalizing and internalizing symptoms over 20 years. *Developmental Psychology, 41*(5), 733–746. http://dx.doi.org/10.1037/0012-1649.41.5.733.

Mrug, S., & Windle, M. (2010). Prospective effects of violence exposure across multiple contexts on early adolescents' internalizing and externalizing problems. *Journal of Child Psychology and Psychiatry, 51*(8), 953–961. http://dx.doi.org/10.1111/j.1469-7610.2010.02222.x.

Nagin, D., & Tremblay, R. E. (1999). Trajectories of boys' physical aggression, opposition, and hyperactivity on the path to physically violent and nonviolent juvenile delinquency. *Child Development, 70*(5), 1181–1196. http://dx.doi.org/10.1111/1467-8624.00086.

O'Keefe, M. (1997). Adolescents' exposure to community and school violence: prevalence and behavioral correlates. *Journal of Adolescent Health, 20*(5), 368–376.

Reid, J. B., Eddy, J. M., Fetrow, R. A., & Stoolmiller, M. (1999). Description and immediate impacts of a preventive intervention for conduct problems. *American Journal of Community Psychology, 27*(4), 483–517. http://dx.doi.org/10.1023/a:1022181111368.

Schwab-Stone, M., Chen, C. S., Greenberger, E., Silver, D., Lichtman, J., & Voyce, C. (1999). No safe Haven II: the effects of violence exposure on urban youth. *Journal of the American Academy of Child and Adolescent Psychiatry, 38*(4), 359–367. http://dx.doi.org/10.1097/00004583-199904000-00007.

Suomalainen, L., Haravuori, H., Berg, N., Kiviruusu, O., & Marttunen, M. (2011). A controlled follow-up study of adolescents exposed to a school shooting — psychological consequences after four months. *European Psychiatry, 26*(8), 490–497. http://dx.doi.org/10.1016/j.eurpsy.2010.07.007.

Verona, E., Sachs-Ericsson, N., & Joiner, T. E. (2004). Suicide attempts associated with externalizing psychopathology in an epidemiological sample. *American Journal of Psychiatry, 161*(3), 444–451. http://dx.doi.org/10.1176/appi.ajp.161.3.444.

Wood, J. J., Lynne-Landsman, S. D., Langer, D. A., Wood, P. A., Clark, S. L., Eddy, J. M., et al. (2012). School attendance problems and youth psychopathology: structural cross-lagged regression models in three longitudinal data sets. *Child Development, 83*(1), 351–366. http://dx.doi.org/10.1111/j.1467-8624.2011.01677.x.