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Longitudinal predictions of young adults' weapons use and criminal behavior from their childhood exposure to violence

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Abstract

In this study, we examine whether youth who are exposed to more weapons violence are subsequently more likely to behave violently with weapons. We use data collected with a 3-cohort, 4-wave, 10-year longitudinal study of 426 high-risk youth from Flint, Michigan, who were second, fourth, or ninth-graders in 2006–2007. The data were obtained from individual interviews with the youth, their parents, and their teachers, from archival school and criminal justice records, and from geo-coded criminal offense data. These data show that early exposure to weapons violence significantly correlates at modest levels with weapon carrying, weapon use or threats-to-use, arrests for weapons use, and criminally violent acts 10 years later. Multiple regression analyses, controlling for children's initial aggressiveness, intellectual achievement, and parents' income, education, and aggression, reveal statistically significant independent 10-year effects: (1) more early exposure to weapon use within the family predicts more using or threatening to use a gun; (2) more cumulative early violent video game playing predicts more gun using or threatening to use weapons, and normative beliefs that gun use is acceptable; (3) more cumulative early exposure to neighborhood gun violence predicts more arrests for a weapons crime; and (4) more cumulative early exposure to movie violence predicts more weapon carrying. We argue that youth who observe violence with weapons, whether in the family, among peers, or through the media or video games, are likely to be infected from exposure with a social–cognitive–emotional disease that increases their own risk of behaving violently with weapons later in life.

Keywords

exposure to violence; violent behavior; crime; weapon use; longitudinal study

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CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

1 | INTRODUCTION

Violent behavior and particularly violent behavior with weapons is a major public health concern, especially in the United States. Though mass shootings garner the most publicity, far more people are killed from individual acts of violence. The overall homicide rate in the United States of America (USA) was 5.3/100,000 in 2017 (FBI UCR, 2017), which is far higher than most comparably advanced Western countries. For example, the homicide rate in England and Wales was about 1.25/100,000 in 2017 (Homicide in England/ Wales, 2017). More telling for the issue of gun violence, about 68% of the homicides in the USA were committed with guns (FBI, 2017), that is, about 3.6/100,000, compared to a rate of about 0.01 homicides with guns per 100,000 in England and Wales (Homicide in England/Wales, 2017). That the higher homicide rate in the USA is to a great extent due to more firearms killings is reinforced by the fact that–contrary to popular opinion–the overall rate of violent crimes excluding homicide was about 25% higher in England/Wales (27 per thousand people in England/Wales (Violent Crime in England/ Wales, 2017) versus 20.6 per thousand people in the USA during the same time period (Bureau of Justice Statistics, 2018).

This cross-national comparison illustrates what a serious problem gun violence is in the USA and how easier availability of guns in the USA probably affects the rates. However, there are large individual differences within the population of the USA in the propensity to commit firearm violence. In this paper, we do not address further what policies contribute to differences in the overall incidence of weapon violence between societies. We address the issue of what individual characteristics and experiences contribute to individual differences in the propensity of people to behave violently with guns or other weapons. Why do some people have a much greater propensity to aggress with weapons than do other people?

The hypothesis about individual differences motivating our study is that one important environmental experience contributing both to predisposing a person to behave more violently with weapons in the long run, and to precipitating violent behavior with weapons in the short run, is exposure to other people behaving violently with weapons. The more a person is exposed to others using weapons in the family, among peers, in the neighborhood, or in the media, (1) the more likely he or she will be to carry, use, or threaten to use guns and/or other weapons on others, (2) the more likely he or she will be to be arrested for a crime with weapons, and (3) the stronger will be his or her beliefs that weapon use is acceptable.

There are good empirical and theoretical reasons to hypothesize that prior exposure to others behaving violently with weapons or even severely violently without weapons would increase the propensity of people to behave violently with weapons. First, with well-designed true experiments, exposure to weapons alone has been shown to cause an increased propensity for the observer to behave aggressively in the short run, albeit without weapons (Berkowitz & LePage, 1967; see also Anderson, Benjamin, & Bartholow, 1998; Ariel et al., 2019). Second, there are a number of well-done empirical studies that have shown that a youth's exposure to violence in any of multiple domains increases the risk for concurrent and later violent behavior by that youth, sometimes with weapons (Boxer et al., 2013; Dubow, et al.,

2019). For example, youth exposed to ethno-political violence are more likely to behave aggressively against their peers (Ibid); exposure to family violence increases the risk of violence in children from that family (e.g., Boxer, Gullan, et al., 2009; Dodge et al., 1990); having violent peers increases the risk of a youth behaving violently (e.g., Espelage et al., 2003; Tolan, Gorman-Smith, & Henry, 2003); having violence in the neighborhood increases the risk of youth growing up in that neighborhood behaving violently concurrently and later (Guerra et al., 2003; Schwartz & Proctor, 2000); and exposure to various forms of media violence increases the likelihood of youth behaving violently later in life (sometimes with weapons; Anderson et al., 2007; Eron et al., 1972; Huesmann et al., 2003; Huesmann, 1986). Although the effect of long-term exposure to media violence has been challenged more than the other effects (particularly with regard to serious violence; e.g., Ferguson, 2013), there are now multiple empirical studies showing long-term relations between exposure to media violence in youth and later serious and criminal violence (Boxer et al., 2007; Boxer, Huesmann, et al., 2009; Huesmann et al., 2003; Huesmann, 1986). For example, in the Huesmann et al. (2003) prospective longitudinal study, boys who were exposed to more television violence between ages 6 and 10 were significantly more likely to be arrested for a crime by 15 years later and reported a significantly higher frequency of punching, beating, or choking another adult. In addition, there are some meta-analyses that show violent video game effects on serious violent behavior are as strong or stronger than violent video game effects on milder aggressive behavior (Anderson et al., 2010, p. 161). However, the current study was not intended to focus on the effects of media violence but rather on the effects of exposure to violence in multiple domains. Those wishing to read more about the different interpretations of the media violence research are directed to the many reviews of the topic (e.g., Anderson et al., 2003, 2010, 2017; Bushman & Huesmann, 2014; Elson & Ferguson, 2014; Ferguson & Kilburn, 2009; Ferguson, 2013; Krahe et al., 2012; Krahe, 2014).

Studies showing that exposure to violence in multiple domains is related to subsequent violent behavior are consistent with recent social–cognitive information-processing theories of observational learning. These theories (e.g., Anderson & Bushman, 2002, 2018; Dodge, 1980; Huesmann, 1997, 1998) all reformulate Bandura's (1973) original theory of observational learning of aggression as a more complex process in which social cognitions (particularly social scripts for violent behavior, predispositions to attribute hostility to others, and normative beliefs approving of violence) and diminished anxiety reactions to violence are acquired from repeated exposures to violence and mediate the effects of exposure on later aggression (Huesmann et al., 2017). It is an obvious extension of these principles that the accumulation of repeated exposures to weapons violence would lead to scripts about using weapons to aggress, normative beliefs approving of this use of weapons, and desensitization of anxiety about using weapons aggressively. In the short term, the sight of weapons would prime these cognitions that have been acquired through long-term repeated exposures to weapons violence.

1.1 | The present study

On the basis of this study and theorizing, we hypothesize that the cumulative effect of repeated *early* exposures to *weapons violence* will specifically increase the propensity of the exposed person subsequently to commit *weapons violence*. Testing such a hypothesis about

weapons violence presents some methodological difficulties. Conducting a randomized trial, that is, “true experiment,” would provide the best causal evidence but is ethically unacceptable and is also impractical for investigating “long-term” effects. A prospective longitudinal study is the next best choice but also presents some challenges because of the relatively low frequency of weapons use against other people in the general population. The solution we chose for the current study was to select a very high-risk (for weapons use) community and conduct a prospective longitudinal study there.

The current study is a prospective 10-year, four-wave longitudinal study of second-, fourth-, and ninth-grade youth growing up in a high-risk urban environment (Flint, Michigan) between 2007 and 2017. Initially, we interviewed the youth and as many as possible of their parents three times at 1-year intervals from 2007 to 2010 to obtain measures of their cumulative exposure to weapons violence over these critical developmental years. Then in 2017, we reinterviewed as many as possible of the participants when they were 18 to 28 years old and accessed their criminal justice records.

2 | METHOD

2.1 | Participants

Participants for this study were children living in and attending schools in Flint, Michigan, in 2007. That year, Flint had a population of approximately 100,000 and one of the highest poverty rates in the nation for cities with at least 65,000 people (median household income was $13,662 less than the USA median according to the 2016 Census). It was the ninth most violent city in the USA in 2016 according to the FBI UCR and topped all US cities in murder rates with 62 murders per 100,000 people. Thus, it fits our requirements for obtaining a high-risk sample of youth for our study of weapons violence.

2.1.1 | Initial sample—The initial 2007 sample consisted of 426 second-grade (n = 126, Med_{age} = 8.2, range = 7–10), fourth-grade (n = 173, Med_{age} = 10.4, range = 9–12), and ninth-grade (n = 127, Med_{age} = 15.5, range = 13.5–17.5) youth from Flint district public schools. The schools were asked to participate by the superintendent and agreed to participate, and all of the youth in those schools were asked to participate. Written parental consent to interview the youth was recorded when we interviewed parents over the phone: 64% of the parents contacted consented to have their child and themselves interviewed and 100% of the children then assented to be interviewed. The resulting sample of 426 youths was 51.2% male. The racial distribution was 72% African American, 7% White, and 21% other or mixed. These figures are similar to Flint school district estimates from the Michigan Department of Education in the closest year available, 2009–10, with 75% Black students. The yearly household income of our sample at the time was less than $30,000 per year for 78% of the sample's parents, with 44% being unemployed and 5.1% not having finished high school. These figures are similar to the citywide Census estimates from 2010 (e.g., median income $28,385, 85% HS diploma or higher). Twenty-eight percent of the sample's parents were married and living with a spouse.

Three waves of interviews (in 2007, 2008, and 2009) were obtained for 69% (n = 292) of this original sample. The major cause of attrition over those waves was that participants moved and could not be located.

2.1.2 | Follow-up sample—In 2017, 10 years after the initial interviews, we attempted to locate and recruit all of the 426 initial participants. We successfully located, recruited, and interviewed 223 (52%) of the original sample (F = 52.5%; M = 47.5%). This follow-up sample was 81% African American, 6% White, and 13% other or mixed race. The sample consisted of n = 57 from the second-grade cohort (Med_{age} = 18, range = 17–20), n = 92 from the fourth-grade cohort (Med_{age} = 20, range = 19–22), and N = 74 from the ninth-grade cohort (Med_{age} = 25, range = 23–28). range = 23–28). Overall 80% had graduated from high school and 6% more still had a chance to graduate. We also obtained the criminal records, which are public records, for each original participant who had one (n = 259) from the Michigan State Police.

The major cause of attrition from the initial sample to the follow-up sample was "un-locatability." The reinterviewed sample differed from those in the initial sample who could not be located and interviewed only in that the "drop-outs" scored as marginally more aggressive than did the follow-up sample (d = 0.18, p = .06) on the composite childhood aggression score computed in the initial wave of interviews in 2007 (see Section 2.2.1 below), but there were no significant differences in attrition related to grade level, gender or Wave 1 scores on academic achievement, exposure to neighborhood violence, parental physical aggression, parental occupational or educational attainment, or family income.

2.2 | Procedures: Wave 1–3

Following parent/guardian consent, each of the 426 youths was interviewed individually in school, in person for about 1 h at three 1-year intervals. In Year 1, we also asked the interviewed youth's parents if one of them would consent to be interviewed by mail and/ or phone. We obtained consent and interviews from a parent of 391 (92%) of the participants. A teacher of 402 (94%) of the interviewed youth was also interviewed in Year 1 and 369 of the youth had both teacher and parent interviews. The interviewers were trained staff and graduate students overseen by a supervisor. Youth who participated received a $40 gift certificate and parents and teachers who participated received a $25 gift certificate.

2.2.1 | Measures: Waves 1–3 Predictors—The childhood measures are summarized below. Table S1 in the Supplemental On-line Materials includes additional detail on scales and their descriptive statistics for the sample.

Youth's initial aggressive behavior: Three well-validated measures of aggressive behavior were employed in Year 1.

First, we administered the 9-item Youth's Self-report of Mild Aggression (α = .85) (e.g., "In the past year, how often did you hit other kids?" 0 = *Never*, 1 = *Sometimes*, 2 = *Often*; "In the past year, how often did you call others names?) (Bjorkqvist et al., 1992).

Second, we gave the youth's teacher the 10-item Teacher's Prediction of Peer-nominated Aggression (α = .96) (Huesmann et al., 1994) (e.g., “What percentage of students would say that this child is someone who pushes or shoves others? 0%, 1%–5%, 6%–10%, 11%–25%, 26%–50%, Over 50%; What percentage of students would say that this child is someone who gets into fights over nothing?) which correlates over .70 with peer nominations of aggression (Huesmann et al., 1994).

Third, for the fourth and ninth graders, we administered the 4-item Youth's Self-report of Severe Physical Aggression (α = .71) (Huesmann et al., 2003, 2017) (e.g., In the last year, how often have you threatened someone with a knife or gun or stabbed or shot someone? (“never” = 0, “once” = 1, “a few times” = 2, “a lot” = 3. In the last year how often have you punched or beaten someone?) (The IRB requested us not to ask second graders these questions).

We constructed a composite measure of initial aggression for each participant by averaging the standardized scores for these three Wave 1 measures. The composite aggression score represents each youth's initial aggressiveness relative to the other youth in the sample. By standardizing the scores before combining them, we avoided having the three scores influence the composite differentially depending on their scales and by averaging the measured scores, we avoided having the absence of the severe physical aggression score for the second-grade cohort bias that cohorts' scores. The reliability of this composite measure is α = .89.

Youth's exposure to neighborhood gun violence in Waves 1–3: In each wave we asked each youth two questions about gun exposure: “In your neighborhood have you seen or been around people shooting REAL guns? (No = 0, Yes = 1)” and “In your neighborhood have you seen anyone get hit, shot, or really hurt by someone else? (No = 0, Yes = 1).” Overall exposure to neighborhood gun violence for each time frame was then computed as the mean score of the two items (the proportion of “Yes” answers: 0, .5, or 1) then averaged over the three waves to obtain a total score of exposure based on the six questions (two per wave; α = .77).

Youth's exposure to family violence and family weapon violence in Wave 1: In Wave 1, we asked each parent who was interviewed to answer nine questions from the *Straus Spousal Conflict Tactics Scale* (Straus et al., 1996) about how often the parent behaved violently toward his or her spouse in the previous 12 months, with responses scaled “0” to “9 or more” times. Two of the questions (“How many times in the last 12 months have you threatened your spouse with a knife or gun?” and “How many times in the last 12 months have you used a knife on your spouse or fired a gun at your spouse?”) were averaged to form a separate score for “Child's Exposure to Family Weapons Violence” (α = .99), and those with the other seven questions (e.g., “How many times in the last 12 months have you beat-up your spouse?” were averaged to form a total score for “Child's Total Exposure to Family Violence” (α = .91).

Youth's exposure to media violence in Waves 1–3: We assessed each youth's cumulative exposure to video game violence, movie violence, and TV program violence using a

procedure we have validated in a number of other studies (Boxer, Huesmann, et al., 2009; Eron et al., 1983; Huesmann et al., 2003). The details of the procedure are provided in Appendix 1 in the Supplemental On-line Materials. In summary, we asked participants to name their three favorite media titles of each type (video games, TV series, movies) and to rate "how often" they watched or played the title (*Never* = 0, *Only once in a while* = 1, *A lot, but not always* = 2, *Almost all the time* = 3). After these data were collected, we had a large set of independent raters rate each title for the amount of violence to which it would expose a viewer or player on a scale ranging from 0 to 4. The interrater reliability for the final violence ratings of the named media titles was high (α above .90 for each type of title–see Supporting Information Materials for details). We did not restrict ratings of media violence to be only of weapons violence, but assumed that high ratings of violence for a media title would generally be highly correlated with the weapons violence in that game or show, and, also, as argued in our introduction, that exposure to any kind of severe physical violence would prime ideas about weapons violence.

After the violence rating was assigned to each favorite title of each type, we computed each youth's total exposure to each type of media violence by multiplying the violence rating (0 to 4) of each of the youth's three favorite titles of that type by the youth's score for how often the youth played or watched that title (1, 2, or 3), and computed the mean of that product for the three titles of that type. The resulting exposure to video game violence score and the exposure to TV violence score could range from 0 to 12, whereas the exposure to movie violence score could only range from 0 to 4 because participants were not asked how often they watched a movie. In prior studies, we have shown that exposure to media violence measured this way has acceptable test–retest reliability (.75) and validity (see Appendix 1 in Supplemental On-line Materials).

Geo-coded neighborhood gun crime in Waves 1–3: Following Boxer et al. (2014), we also collected geo-coded data on how much "neighborhood gun crime" there was in the youth's neighborhood. We obtained access to the Flint police department crime location database, which specified the exact geo-coordinates of every crime in Flint during the first three waves. We then entered the exact geo-coordinates of each participant's residence during the same year and computed the distance from the residence to each crime scene. Every crime that fell within a one-quarter mile radius of the residence counted as a neighborhood crime incident for that participant (Boxer et al., 2014). We then computed each participant's data on how many criminal incidents with guns had been noted by police in their neighborhood during each wave of data collection. We summed that measure over Waves 1–3 and denoted this measure as "W123 Geo-coded Neighborhood Gun Violence." Most of the incidents contributing to this index were assaults, robberies, or homicides as denoted by the fact that a sum of those separate incidents correlated 0.97 with the index score.

Other childhood risk factors: We assessed a number of other possible childhood risk factors during the Wave 1 parent interviews that could influence later violent behavior and weapons use, including family income, parents' education, and the Buss and Perry (1992) 9-item scale of parent's physical trait aggressiveness (α = .71 in our sample). Finally, we obtained from school records the youth's achievement test percentile on the

Michigan Educational Achievement Test (MEAP) for the Wave 1 year. Its raw score test/retest reliability ranges from 0.67 to 0.97 for reading and math depending on age.

2.3 | Procedures: Wave 4

Ten years after the initial interviews, we reinterviewed most participants in person in their home or in a public space with private rooms (e.g., a library). Two staff conducted the in-person interviews together. About 25% of the participants who had moved out of the district were interviewed over the phone when they were in a private space. All procedures and measures were approved by the University of Michigan IRB. Regardless of where the participant was interviewed, no one else was allowed to be present or to overhear the interview. The participants provided written consent before the interview started. They received $50 for doing the interview.

2.3.1 | Measures: Wave 4 outcome measures—The primary goal of the Wave 4 follow-up was to assess each participant–s propensity to behave violently with guns or other weapons and their social cognitions related to using them in their late teens or 20s, which are the riskiest ages for committing weapons violence. The exact questions we asked are shown in Table S2 in the Supplemental On-line Materials as well as the scales derived from them and the distributions of the scales in the sample.

Weapon-related behavior: During the Wave 4 interviews, we asked participants a number of questions about their use of guns and other weapons. We asked them whether they had carried a gun (except for hunting), whether they had carried other weapons, whether they had shot a gun at someone or threatened to shoot someone, and whether they had used or threatened to use another weapon on someone. From these questions we constructed scales of gun carrying (0–1), any weapon carrying (0–2), gun using/threatening (0–2), any weapon using/ threatening (0–4).

Social cognitions about weapons: We also asked the participants to report two of their social cognitions concerning weapons. First, we asked about the extent to which they fantasized about using a gun or other weapon on someone on a scale of 0 = “never” to 3 = “often”; 17.5% scored >0 (Rosenfeld et al., 1982). Second, we asked about the degree to which they believed using guns on others was OK in various circumstances (1 = “really wrong” to 4 = “perfectly OK”; 44.1% scored >1) (Huesmann, 1997). The exact questions asked are shown in Table S2 in the Supplemental On-line Materials along with more descriptive statistics for the scores from the reinterviewed sample.

Criminal behavior: In addition to these questions on weapons use and social cognitions about weapons, we collected data on the participants' contacts with the law since they were legally considered adults in Michigan (we could not obtain juvenile records) both by asking them to self-report offenses since high school and by collecting official arrest and conviction data from the Michigan State Police. We coded crimes for weapons use and for seriousness using the scheme developed by Rossi et al. (1974) that we have used previously (Huesmann et al., 2003). The specific questions we asked, records we collected and coded, and scales

we created are shown in Table S2 in the Supplmental On-line Materials along with their descriptive statistics.

3 | RESULTS

Our theoretical position is that it is the *cumulative* exposure to weapons violence for a youth during the youth's early years that will increase the long-term risk of the youth committing violence with weapons. To examine the relation of the youths' cumulative exposure to weapons violence in Waves 1–3 with their adult behaviors and beliefs assessed in Wave 4, we first computed the mean of each exposure-to-weapons-violence variable over Waves 1–3 and used that mean as the best single indicator of cumulative exposure to that type of violence, as we have done previously (Dubow et al., 2012). This effectively performed a mean-imputation of any missing score of a participant in Waves 1, 2, or 3 from their observed scores in those waves. Consequently, we could analyze each measure of exposure to violence for every participant who was interviewed on the exposure measure in at least one of the first three waves. The descriptive statistics for the sample on these variables as well as on the Wave 1 basic demographic and initial behavioral measures are shown in Table S1 in the Supplemental On-line Materials.

The youth exposure to violence scores in this sample are high–73% of the sample had been exposed to some neighborhood gun violence in Waves 1–3, 32% had been exposed to some family violence, and 1.7% had been exposed to some weapons violence within their family. Over 95% of the sample had lived within a quarter-mile of a police-reported gun crime incident. Over 98% had some exposure to media violence in childhood. Equally important for analyses of individual differences in exposure and their relation to later behavior, the standard deviation of most of these measures was at least one-third or more as large as the mean. In other words, there was a lot of variation in exposure.

The descriptive statistics for the Wave 4 measures, when the participants were between age 18 and 28, are shown in Table S2 in the Supplemental On-line Materials. They confirm that the sample is at high risk for weapons violence and crime. Forty-four percent of the sample had been arrested for a crime and 41.3% had been convicted since they were in high school according to Michigan State Police records and 8.11% had been arrested for a weapons crime; 17% self-reported that they had carried a gun and 31% reported that they had carried either a gun or another weapon. Finally, 2.7% self-reported that they had shot, tried to shoot, or threatened to shoot another person with a gun. As for the social cognition measures in Wave 4, 44.1% thought it “was not really wrong” to use a gun on another person in some situations, and 17.5% admitted that they fantasized about using a gun or other weapon to hurt another person.

The correlations of the self-reported outcome variables about weapons use in Wave 4 with the exposure to violence variables in Waves 1–3 are shown in Table 1. There are significant positive correlations between most of the childhood/adolescent exposure to violence variables and 10-year-subsequent young-adult self-reports of carrying, using, and threatening to use weapons on others. In particular, carrying a gun and using or threatening to use a gun on another person are both significantly positively correlated with the 10

years prior childhood/adolescent self-reports of exposure to neighborhood gun violence, the 10-year-prior self-reports of the amount of playing of violent video games and the amount of exposure to movie violence, and the 10-year-prior parent reports of weapons violence within the family. The correlations also show that males are significantly more likely than females to employ guns and other weapons as young adults. However, youths' initial aggressiveness, their parents' aggressiveness, and their parents' income and education did not significantly predict their later gun or other weapon use. A youth's initial intellectual ability as measured by the MEAP in Wave 1 was the only other significant longitudinal predictor, and, as expected, higher MEAP scores in childhood predicted less gun or other weapon carrying 10 years later as a young adult.

What predicted a young adult's beliefs about whether gun use was OK? Only the youth's extent of violent video game play 10 years earlier significantly predicted this belief. Those who played violent video games more frequently as a youth also believed it was more OK to use guns on others or threaten others with guns when they were adults. The correlations also show that males were more approving of gun use than females, but that, unexpectedly, the number of police reports of gun violence incidents within one-quarter mile of a youth's residence (geo-coded NGV) was significantly *negatively* correlated ($r = -.14$, $p < .05$) with the youth's acceptance of using guns 10 years later (normative belief that gun use is OK). In fact, for the 53 youth who said they had never directly observed neighborhood gun violence as a youth, the number of gun violence incidents in the vicinity of their residence was correlated even more negatively ($r = -.29$, $p < .05$) with their later beliefs in the acceptability of gun violence. Apparently, having gun violence nearby, but not observing it, is related to greater beliefs that using guns is not appropriate. We also found that, contrary to expectations, fantasizing about using weapons on others when an adult was not significantly correlated with childhood exposure to weapons violence.

Table 2 shows that there are also significant, though less strong correlations, between the childhood/adolescent exposure to weapons violence and 10 years later criminal behavior in general and criminal behavior involving weapons in particular. For example, having been arrested for a weapons crime according to official police records is significantly positively correlated with 10 years earlier exposure to neighborhood gun violence, amount of playing of violent video games, and amount of exposure to movie violence. Self-reports of the number of arrests since high school are similarly correlated with these three exposures to violence measures. Also, self-reports of serious criminally violent behavior such as stabbing, shooting, beating, or choking another are correlated significantly with the amount of prior exposure to video game violence. Of the other risk factors measured, the participant–s general aggression in Wave 1 also predicted later criminal behavior, whereas higher scores for a participant in Wave 1 on the MEAP achievement test predicted a lower likelihood of criminal behavior with weapons measured with official records. Again males were more at risk to be arrested for any crime and in particular for weapons-related crimes, and again, the amount of gun violence in the vicinity of the participant's residence was not positively correlated with the participant's later criminal behavior.

A clearer determination of the relation between early exposure to violence and the dichotomous adult outcome variables of weapon use–gun carrying or not, gun threatening/

shooting or not, and being arrested or not for a weapons crime–is obtained by comparing the means on each early exposure to violence variable for those never employing weapons and those who have employed weapons at least once. The bar graphs shown in Figure 1 display these relations. The first panel of the figure shows those participants who have *carried guns;* those participants who have *used or threatened to use guns on people;* and those who have *arrest records for weapons crimes*, all had significantly more mean *exposure to neighborhood gun violence* 8–10 years earlier in Waves 1 to 3 when they were in the second- to fourth-grade (second-grade cohort), fourth- to sixth-grade (fourth-grade cohort), or ninth to 11th-grade (ninth-grade cohort). Similarly, as panel 2 of the figure shows, these same groups all had significantly greater childhood and adolescent exposure to video game violence. Finally, as panel 3 of the figure shows, those who have carried guns and those who have used or threatened to use guns on people were exposed to significantly more family weapon violence 8–10 years earlier.

Of course, the various exposure to violence measures are intercorrelated and potentially related to some of the other risk measures assessed, and it is difficult to know from the correlations which predictors have independent effects. To address this question, we conducted multiple regression analyses to predict Wave 4 self-reported weapons usage, arrests for weapons crimes, and normative beliefs that gun use is OK from the Wave 1–3 exposure to violence variables and the other risk and demographic variables we assessed.

Because the three exposure to media violence variables were significantly inter-correlated ($r_{\text{vgvl, tvvl}} = .47$; $r_{\text{vgvl, mvvl}} = .32$; $r_{\text{mvvl, tvvl}} = .39$) and would introduce multicollinearity if all were included in multiple regression, we included only the two media exposure variables–exposure to violent video games and exposure to violent movies–which showed the highest longitudinal correlations with weapons-related outcomes. Also to reduce multicollinearity and because the focus of the study is on whether a youth's specific exposure to weapons violence predicts later weapons-related behaviors, we only included as a predictor the parents' report of family weapons violence and not their reports of total family violence.

A number of control covariates in Waves 1–3 were only assessed for subsets of participants (e.g., the MEAP test, parent reports of income, education, and family violence). Ordinary least-squares regression analysis would have reduced the sample size to a small portion of the total sample with complete data, that is, to $n < 150$. Consequently, we employed a full information maximum likelihood (FIML) regression approach (Enders & Bandalos, 2001; Enders, 2001) available with the AMOS structural equation modeling program (Arbuckle, 2017). Similar to a multiple imputation approach, this FIML regression analysis utilized the observed correlations of the variables assessed in Waves 1–3 for all 426 Wave 1 participants to yield unbiased maximum likelihood estimates of the regression parameters predicting Wave 4 outcomes. FIML regressions also yield unbiased estimates of the standard errors of the regression slopes as long as the missing data are “missing at random.” Our attrition analysis indicates that though our missing data are certainly not “missing completely at random,” the data in our data set do seem to meet the technical criterion of “missing at random” (Allison, 2002).

These regression results are shown in Table 3. One can see that the amount of exposure to video game violence 8–10 years earlier in childhood or adolescence significantly predicted young adult gun carrying, using or threatening to use a gun on another, carrying any weapon, using or threatening to use any weapon on another, and normative beliefs that gun use is OK. Exposure to weapon use within the family (as reported 10 years earlier by the parents) also predicted using or threatening to use a gun on another, or using or threatening to use any weapon on another. Exposure to neighborhood gun violence 8–10 years earlier significantly predicted being arrested for a weapons crime, and exposure to movie violence 8–10 years earlier significantly predicted weapon carrying. All of these effects are independent of the other exposures evaluated, independent of the initial aggressiveness of the child at Wave 1, independent of the cohort of the child (initial grade), and independent of the parent's income, the parent's education, the parent's own trait aggression, and the child's early intellectual achievement score (MEAP score). Particularly notable are the effect sizes for violent video game playing on young adult gun use. A one *SD* increase in the exposure to video game violence variable predicts a 0.161 *SD* increase in the risk of gun carrying, predicts a 0.218 *SD* increase in the risk of using or threatening to use a gun on someone, and predicts a 0.277 *SD* increase in normative beliefs approving of gun use. It is worth noting that the correlational analyses with Wave 4 outcomes in Tables 1 and 2 and the FIML multiple regression analyses in Table 3 all have sufficient power to detect very modest relations ($r > .15$, $R^2 > .10$), so it is unlikely that any population relation between early exposure to violence and Wave 4 outcomes was not detected (see Appendix 2 in the Supplemental On-line Materials for details).

An obvious follow-up question is whether the longitudinal effects of exposure to violence vary with the cohort, that is, vary with the age at which Wave 1, 2, and 3 exposure occur and the age at which the Wave 4 criterion measures are assessed. The Waves 1–3 age differences across cohorts were substantial–age 7–10 for the second-grade cohort, age 9–12 for the fourth-grade cohort, and age 14–18 for the ninth-grade cohort. Wave 4 age differences spanned an equal range–just 10 years older–age 18–28. Though the correlations in Tables 1 and 2 show some overall relation of the cohort to Wave 4 outcomes, with older cohorts being more prone to carry weapons and more prone to be arrested, the analyses thus far do not examine whether cohort (age of exposure to violence) moderates the effect of the exposure on later violent behavior. To answer this question, we compared a multigroup AMOS FIML regression analysis with the regression slopes constrained to be the same for each cohort to a multigroup analysis with slopes allowed to be different for each cohort. Though the FIML regression analysis we reported above for the entire sample dealt optimally with the missing at random data, it could not be used alone for these multi-group analyses because FIML multigroup regression estimation does not work if there is completely missing data in a group on even one predictor, and indeed, there is completely missing data for the Michigan Education Achievement percentile for the second-grade cohort. Consequently, we first conducted multiple imputations of such missing data in Waves 1 to 3 and then followed that by a multi-group (3-cohort) FIML regression analysis on the resulting pooled data. We conducted multiple imputations by chained equations (MICE), and imputation equations include all of the analysis variables as well as auxiliary variables (e.g., callousness) from Waves 1–3. MICE (White et al., 2011) uses an iterative regression procedure to impute

plausible values for each missing observation based on observed and imputed values of other variables and can incorporate different types of variables (e.g., normal, categorical). We imputed 20 data sets using MICE.

Using pooled mean data from these 20 imputed data sets, we predicted each Wave 4 outcome again with a 3-group FIML regression model in which all the regression parameters were constrained to be the same in each cohort and then with a 3-group model in which all the regression parameters were allowed to vary across cohorts. We found that the unconstrained parameter 3-group regression model fits the data better than the constrained parameter model according to the Akaike Information Criteria (AIC = 540.0 vs. AIC = 548.4; Akaike, 1987; Kline, 1998, pp. 137–138) *only* on predicting gun carrying (see Table S3 in the Supplemental On-line Materials). The unconstrained model's parameters suggest that the significant effect of exposure to video game violence on later gun carrying shown in Table 3 is greater for Cohort 2 (second graders at Wave 1; $\beta = .544$, $p = .004$), whereas the significant negative relation of gun carrying with educational achievement is greater for Cohort 9 (ninth graders at Wave 1; $\beta = -.242$, $p = .013$). The unconstrained results also show two other cohort-specific effects: for Cohort 9 there is an effect of exposure to neighborhood violence on gun carrying ($\beta = .293$, $p = .003$) and for Cohort 9, higher family income diminishes the likelihood of later gun carrying ($\beta = -.196$, $p = .033$).

For all other Wave 4 outcomes other than Gun Carrying, the constrained multicohort model fit as well or better than the unconstrained model according to the AIC, suggesting that the relation between early exposure to violence and the other violent behavior outcomes was not moderated much by age of exposure for these outcomes.

We also used pooled data from the 20 imputed data sets to cross-validate the original FIML regression in Table 3. The results are shown in Table S4 in the Supplemental On-line Materials. None of the regression slopes changed significantly from those in Table 3. The implications from the regressions remain the same.

4 | DISCUSSION

4.1 | Importance of empirical findings

The results of this 10-year prospective, longitudinal study of a high-risk population of ethnically diverse youth show that *greater* exposure to weapons violence between ages 7 and 18 predicts *greater* risk 8–10 years later for (1) carrying, using, or threatening to use a gun and/or other weapons on another, (2) being arrested for a weapons crime, and (3) believing that using a gun is OK in many situations. The effects seem to emanate from violence exposure in multiple domains, including the neighborhood, the family, and the media. Of particular note is the finding that youth (especially those in the youngest cohort) who played more violent video games more frequently as a child showed a greater propensity 8–10 years later as a young adult to carry a gun, to use a gun or threaten to use a gun on someone, and to believe that using a gun is OK in many situations. These increases in the risk of violent behavior with weapons 10 years after exposure to weapons violence remained even when we controlled statistically for the youth's sex and age cohort, the youth's early

aggressiveness, the youth's early intellectual achievement, the parents' education, income, and aggressiveness, and the geo-coded proximity of gun crime incidents to the youth's home.

4.2 | Theoretical explanations

Recently, a perspective on violent behavior has emerged that violence should be considered as a contagious disease (Bond & Bushman, 2017; Huesmann, 2012, 2018; Patel et al., 2013; Slutkin, 2017). Certainly, one of the best-established findings in the psychological literature on aggressive and violent behavior is that violence begets violence. People seem to “catch” the violence bug by being exposed to other people who are violent. However, describing violent behavior as contagious does not explain how it is transmitted from one individual to another, nor is the description intended to do that. It is a valuable description because it conveys easily an understanding of the fact that exposure to violence increases the risk of the exposed person behaving violently. Unlike contagious diseases caused by germs, one does not need to be physically proximate to a violent person to be infected by it; one only needs to observe the violent person. Nevertheless, just like most biologically transmitted diseases, repeated exposures to violence make infection more likely, some youth are more resistant to being infected than others, and various situational factors may moderate the risk of infection. The question is what psychological processes explain this phenomenon. Why is violent behavior so contagious and how does it spread?

Severe violent behavior, like most social behaviors, is almost always the product of predisposing individual differences and precipitating situational factors (Huesmann, 2017). The perspective that motivated the study reported in this paper is that one important environmental experience that contributes both to predisposing a person to behave more violently with weapons in the long run and to precipitating violent behavior with weapons in the short run is exposure to other people behaving violently with weapons.

Psychological theories that have emerged over the past few decades now explain the short-term precipitating effects of exposure to violence on violent behavior mostly in terms of priming, mimicry, and excitation transfer. The long-term predisposing effects of observing violence, however, involve more complex processes of observational learning of cognitions and desensitization of emotions (Huesmann & Kirwil, 2007; Huesmann, 2018). Although the fundamental psychological and neurological processes explaining how exposure to violence infects the observer with a long-run propensity toward violent behavior were discovered decades ago (see Bandura et al., 1961; Bandura, 1973; Berkowitz, 1962; Eron et al., 1971), more complete explanations have emerged more recently that emphasize social–cognitive, information-processing operations (e.g., Anderson & Bushman, 2002; Anderson & Huesmann, 2003; Dodge, 1980; Huesmann & Kirwil, 2007; Huesmann, 1986, 1988, 1997, 1998). Although these models differ in their details, all view the social problem-solving process as one in which situational factors are evaluated, attributions are primed and made, social scripts are primed and retrieved, and these scripts are evaluated for outcomes and compliance with normative beliefs until one script is selected to guide behavior.

According to this theoretical perspective, the short-term precipitating effects of exposure to violence with weapons on violent behavior with weapons are mostly due to the priming of violent cognitions about weapon use and the immediate mimicry of violent scripts

for weapon use. However, repeated exposure to weapons violence increases the long-run propensity of the exposed person to solve social problems violently with weapons for four reasons. First, humans automatically encode the social scripts they see used successfully by others and cognitively rehearse the scripts that are highly salient to them. Second, exposure to weapons violence increases a person's perception that the world is a hostile place and thus increases the tendency to make hostile attributions about others. Third, repeated exposure to weapons violence makes weapons violence seem more normative and acceptable. Finally, the negative emotional reactions that weapons violence induces habituate with repeated exposures to weapons violence (a desensitization to weapons violence) making it less aversive to think about performing weapons violence. Of course, these are all “long-run” processes.

Because we did not assess key social cognitions and emotional reactions at multiple times between exposures to violence and the outcome behavior with weapons, we could not formally test the mediational processes described above with the current data. However, our observed results are certainly consistent with our theoretical perspective that normative beliefs approving of weapon use are engendered by exposure to weapons violence in childhood and promote weapons violence in adulthood. In contrast, our observed results are not consistent with our theorizing that fantasizing about weapon use is stimulated by exposure to weapons violence and subsequently promotes actual weapons violence in adulthood.

A few expected longitudinal empirical relations were not statistically significant when considered in the multivariate context of a multiple regression (e.g., exposure to neighborhood gun violence's prediction of gun carrying and use), but were significant when considered bivariately. Given the significant inter-correlations of neighborhood gun violence exposure with media violence exposure, with exposure to family violence, and with geo-coded neighborhood violence exposure ($r_{NGVL,\ vGVL} = .12^*$, $r_{NGVL,\ MVVL} = .13^*$, $r_{NGVL,\ GeoNGVL} = .15^*$), we do not consider that this lack of an independent relation in the multivariate regression context definitively contradicts our theory. Given the multiple familial and socioeconomic factors related to exposure to weapons violence, it is not surprising that exposure to weapons violence in different domains is correlated enough to make detecting independent effects difficult (Schisterman et al, 2009).

5 | LIMITATIONS

The longitudinal relations unveiled in this study should be taken particularly seriously because the study was a *prospective* longitudinal study showing significant *predictive* relations over about 10 years between childhood or adolescent exposure to gun and weapon violence and the young adult outcomes of gun or other weapon use, beliefs about weapon use, and actual weapon crimes. Some prior *retrospective* longitudinal studies have shown relations between youth's exposure to violence and their young adult aggression, violence, and criminality (e.g., Boxer et al., 2007) or young adult gun carrying (e.g., Ybarra et al., 2014), but such studies can always be criticized for bias in retrospective reports. The present study provides a major step beyond retrospective studies of weapons violence. Nevertheless, the results of this study do not establish a causal relation between early exposure to violence

and subsequent gun or other weapon use. Only a true experiment (or randomized trial) could establish that, and such a study is not likely to be done because of the ethical issues it would involve.

One limitation of the current study is that we did not collect information on general gun/ weapon use or normative beliefs about gun/ weapon use from the parents of the children during the early waves of the study. If we had, we could compare the relative plausibility of our observational learning theory about the acquisition of normative beliefs that gun use is OK from observing gun use in peers, media, or family with the alternative theory that parents who believe gun use is OK have children who believe gun use is OK.

Another limitation of the current study is the attrition we experienced in our participant sample over the early waves and between them and the final wave. Of the 426 initial participants in Wave 1, we managed to collect complete data over the first three waves on 292 of them (69%) and reinterview 223 (52%) 10 years later. As with most studies of aggressive behavior, attrition was predicted by initial aggressiveness; so the range of scores on violent behaviors using weapons was undoubtedly restricted at the top end. The major consequence, however, would be a reduction in the values of the correlations obtained and a potential increase in the likelihood of Type II errors, but *not* an increase in the likelihood of Type 1 errors of falsely concluding a relation existed between early exposure to violence and later weapons use when it really did not.

6 | IMPLICATIONS FOR RESEARCH AND PREVENTION POLICIES

Various types of legislation limited federal funding for firearm-related research over the past 20 years, but in 2013, in the wake of December, 2012, shooting at Sandy Hook elementary school in Connecticut, President Obama issued an executive order charging the Centers for Disease Control and federal agencies to identify critical research areas to improve our knowledge about the causes and prevention of gun violence. Among the five areas of research needs identified by the Institute of Medicine/National Research Council (2013), as well as the American Psychological Association (2013), were the identification of risk and protective factors for firearm violence and an analysis of the effects of media (primarily video games) on firearm violence. Our prospective findings document the converging impact of exposure to neighborhood violence (including gun violence), media violence (including video game violence), and family weapon violence on risk for violent behavior with weapons in adolescence and young adulthood, as well as on normative beliefs approving of weapons violence. Reducing exposure to weapons violence across multiple contexts (family, neighborhood, media, and video games) and addressing normative beliefs approving of weapons use (e.g., Boxer & Dubow, 2002; Huesmann & Kirwil, 2007) would seem to be critical to enhancing the impact of family-, community- and school-based prevention programs targeting firearms violence specifically and youth violence more generally.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY STATEMENT

Data are available from the corresponding author upon reasonable request and data use agreement.

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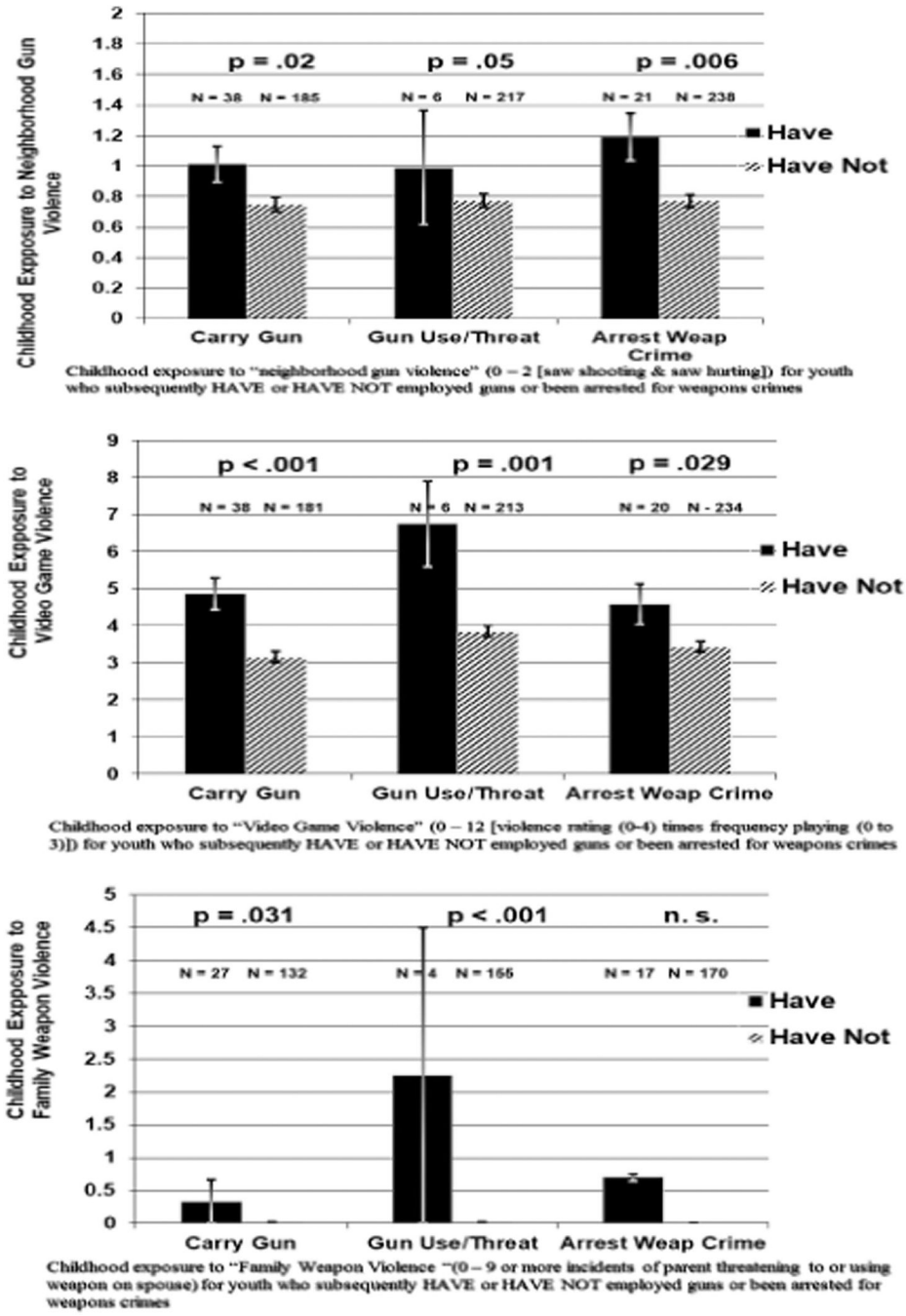

FIGURE 1.

Bar graphs showing mean child/adolescent exposures to different types of violence in Waves 1–3 for those who *have or have not* employed weapons as adults in Wave 4

TABLE 1

Correlations of Wave 1–3 childhood exposure to violence measures with Wave 4 violent behavior with weapons and social cognitions about weapons

		Wave 4 (2017)						
		Violent behaviors with weapons (*n* = 223)					**Social cognitions (*n* = 223)**	
	N	**Gun carry**	**Gun use/threat**	**Any weapon carry**	**Any weapon use/ threat**	**Any weapon carry/use/ threat**	**Norm-Believes gun use ok**	**Fantasize about weapon use**
Childhood W123 (2007–2009) exposure to violence								
Neighborhood gun violence	426	**.15** **	**.14** **	**.13** **	.11	**.15** **	.00	−.06
Family violence	303	**.18** **	**.29** ****	.07	.11	.11	.02	.03
Family weapon violence	297	**.17** **	**.49** ****	.09	**.23** ****	**.14** *	.05	.12
Video game violence	416	**.29** ****	**.25** ****	**.33** ****	**.22** ***	**.31** ****	**.26** ****	.07
TV violence	416	0.05	**.14** **	**.14** **	.09	**.12** *	.04	.00
Movie violence	425	**.24** ****	**.12** *	**.35** ****	.08	**.27** ****	.06	.08
Geo-coded neigh. gun crime	426	.10	.03	.03	.01	.00	**−.14** **	−.03
Other childhood risk factors								
Youth's W1 aggression	426	.08	.00	.04	.00	.03	.00	.08
Youth's W1 MEAP score	262	**−.20** **	−.03	**−.16** **	.02	−.10	.12	.01
Family's W1 income	335	−.02	.03	.00	.08	−.03	.09	.06
Parent's W1 education	353	−.03	−.03	.01	−.03	.00	−.09	−.04
Parent's W1 trait aggression	355	.05	.00	.02	.00	.02	.09	.04
Sex (0 = female, 1 = male)	426	**.29** ****	**.18** ***	**.34** ****	**.16** **	**.30** ****	**.23** ****	.09
Cohort (starting grade 2, 4, 9)	426	**.15** **	.06	**.15** **	.03	**.15** **	−.08	−.02

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .001$.

TABLE 2

Correlations of Wave 1–3 childhood exposure to violence measures with Wave 4 criminally violent behavior

	Wave 4 (2017)						
	Official Reports Michigan State Police					**Self-report**	
	Ever arrested	**Ever arrested weapon crime**	**# times arrested weapon crime**	**# times convicted any crime**	**Ave. seriousness all arrests**	**Total arrests since high school**	**Ser. crim. violence: stab, shoot, beat, choke**
Childhood W123 (2007–2009) exposure to violence							
Neighborhood gun violence	**.11** *	**.17** ***	**.13** **	**.15** **	**.13** *	**.18** ***	.11
Family violence	**.14** *	−.05	−.06	.05	**.15** **	.10	.08
Family weapon violence	.09	−.03	−.02	.03	.07	.13	**.14** *
Video game violence	**.12** *	**.14** **	**.12** *	**.10** *	**.10** *	**.27** ***	**.19** **
TV violence	**.14** *	.08	.08	.04	**.12** *	.06	.08
Movie violence	**.22** ****	**.20** ***	**.18** **	**.16** *	**.17** **	**.24** ***	.05
Geo-coded neigh gun crime	.00	.02	.04	.01	.00	.01	.03
Other childhood risk factors							
Youth's W1 aggression	**.18** **	.10	.06	**.17** **	**.17** *	**.26** ***	.06
Youth's W1 MEAP Score	**−.21** **	**−.25** ***	**−.25** ***	**−.25** ***	**−.21** **	−.09	.01
Family's W1 income	−.09	−.04	−.04	−.04	−.07	−.03	.08
Parent's W1 education	−.03	−.03	−.04	−.08	.00	−.04	−.11
Parent's W1 trait aggression	**.18** **	.00	−.02	.02	**.16** *	.03	−.01
Sex (0 = female, 1 = male)	**.12** *	**.20** ***	**.19** **	**.11** *	**.12** *	**.25** ***	**.16** *
Cohort (starting grade 2, 4, 9)	**.16** *	.10	.09	**.17** **	**.15** *	**.19** **	−.04

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .001$.

TABLE 3

Regressions predicting Wave 4 weapon carrying, use/threat, crimes, and approval weapon use from Wave 1–3 exposures to violence

	Standardized regression coefficients						
	W4 self-reported violent behaviors with weapons					**W4 official records**	**W4 social cognitions**
	Gun carry	**Gun use/threat**	**Any weapon carry**	**Any weapon use/threat**	**Ser. crim. viol.: stab, shoot, beat, choke**	**Ever arrested weapon crime**	**Norm-beliefs gun use OK**
Childhood W123 (2007–2009) cumulative exposure to violence							
Neigh. gun violence	–	–	.070	–	–	**.144** *	–
Video game violence	**.161** *	**.218** ***	**.157** *	**.207** **	**.191** *	–	**.277** ****
Movie violence	–	–	**.203** ***	–	–	.095	–
Family weapon violence	.088	**.366** ****	–	**.152** *	–	–	–
Geo coded neigh. gun crime	–	–	−.072	–	–	−.074	**−.177** ***
Other childhood W1 risk factors							
Family's W1 income	–	.075	–	.083	.119	–	.081
Parent's W1 education	–	–	–	–	**−.143** *	–	**−.138** *
Parent's W1 trait aggression	–	–	–	–	–	–	**.158** *
Child's W1 MEAP score	**−.154** *	–	−.119	–	–	**−.265** ***	**.180** *
Child's W1 aggression	–	–	–	–	–	.074	–
Sex (0 = female, 1 = male)	**.167** *	–	**.182** **	–	–	**.183** *	.120
Cohort (starting grade 2, 4, 9)	–	–	–	–	–	−.120	–
R^2	**.169**	**.206**	**.232**	**.092**	**.096**	**.149**	**.235**
F(12,413)	**7.00** ****	**8.93** ****	**10.40** ****	**3.49** ****	**3.65** ****	**46.03** ****	**10.57** ****

Note: The regressions were computed with the Full Information Maximum Likelihood regression procedure of the AMOS program (Arbuckle, 2017) that yields unbiased estimates of the regression parameters despite some data being missing "at random." Regression coefficients with Critical Ratios less than 1 are not shown.

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .001$.