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Neighborhood Violent Crime and Academic Growth in Chicago: Lasting Effects of Early Exposure*

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Abstract

A large body of research documents the importance of early experiences for later academic, social, and economic success. Exposure to an unsafe neighborhood is no exception. Living in a violent neighborhood can influence the stress levels, protective behaviors, and community interactions of both parents and children in ways that generate cumulative educational disadvantage. Using nine years (2002–2011) of detailed crime data from the Chicago Police Department and longitudinal administrative data from the Chicago Public Schools, I estimate the influence of early exposure to neighborhood violence on growth in standardized test scores over time. Student fixed-effects are included to remove any bias due to constant differences between students. The results show that children from more violent neighborhoods fall farther behind their peers from safer neighborhoods as they progress through school. These effects are comparable in size to the independent association with socioeconomic disadvantage and an annual measure of more recent neighborhood violence exposure.

A large body of research documents the importance of early experiences for later academic, social, and economic success (Heckman 2006). This is in part because early experiences and skill development create “cascades” of development, in which the effects of early disadvantage accumulate in importance over time and spill over from one domain, such as mental health, to another, such as academic success (Masten and Cicchetti 2010). For example, it is well established in the education literature that around the third grade classroom activity shifts from learning-to-read to reading-to-learn. Students’ reading skills around this time begin to shape their ability to understand material they are supposed to absorb later in their school careers (Chall, Jacobs, and Baldwin 1990). Those who have not become proficient in reading by third grade have lower test scores throughout high school, are much more likely to drop out of high school, and are less likely to attend college (Hernandez 2011, Lesnick et al 2010). Early experiences of parental stress and very early academic failure are also related to drop out of high school (Alexander, Entwistle, and Horsey 1997). Similarly, Sampson and Laub (1997) argue that labeling an individual as a delinquent generates a process of cumulative disadvantage that can lead to additional criminal behavior in the future. This same process can spill over into schools and lead to high school dropout and lower college enrollment (Kirk and Sampson 2013).

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The safety of children's neighborhood environment is no exception to this theory of cascading influence and cumulative disadvantage. Living in a violent neighborhood affects multiple aspects of children's lives and is associated with aggression, cognitive stress, stricter parenting, and mistrust in the educational system (Bell and Jenkins 1993, Bingenheimer, Brennan, and Earls 2005, Furstenburg 1999, Harding 2010b). Current research on neighborhood violence tends to focus only on adolescents and on the short-term impact of cognitive stress (i.e. Sharkey 2010, Harding 2010a). In contrast, I argue that neighborhood violence also has long-term effects on student's engagement in the schooling process that means students exposed to violent neighborhoods during childhood fall farther behind their peers from safer neighborhoods as they progress through school.

To assess the cumulative impact of early exposure to neighborhood violence, I predict differences in test score growth rates from third through eleventh grade based on third grade exposure to neighborhood violence for a full cohort of public school students in Chicago. I use individual student fixed-effects to remove selection bias due to constant differences between students and their families and control for other observed neighborhood characteristics, such as poverty, unemployment, education, and more recent violent crime rates. The results show that the test scores of students who live in violent neighborhoods start third grade approximately equivalent to students in similarly disadvantaged, but less violent neighborhoods, but grow much more slowly as they progress through school. These findings highlight the importance of early neighborhood context and the cumulative nature of academic development. They also shed light on the multiple pathways through which exposure to local violence can influence academic achievement. Not only does living in a dangerous area lead to short-term trauma and distraction (Sharkey et al 2011), but it also shapes students' behavior, engagement, and educational trajectories in ways that build over time.

LITERATURE REVIEW

A growing body of research documents the "collateral consequences" of neighborhood violence, especially its negative relationship with academic outcomes (i.e. Harding 2010a, Kirk and Sampson 2013, Sharkey 2010). Early exposure to a violent environment can shape children's academic skills and engagement in schooling through three simultaneous mechanisms that range from highly individual cognitive functioning to the social fabric of the community. While much of the existing research focuses on adolescents and acute cognitive stress (Harding 2010a, Sharkey 2010, Sharkey et al 2012), I argue that these mechanisms also lead to long-term cumulative disadvantage for children from violent neighborhoods.

Chronic Psychological Stress

Living in a neighborhood with high rates of violent crime increases the risk of direct experience with violent events, the injury or arrest of close friends or relatives, and routinely hearing gun shots near one's home, all of which may induce trauma and emotional stress for both parents and children. Geographic exposure to these types of events is associated with symptoms of posttraumatic stress, such as aggression and depression, regardless of an

individual's direct experiences with violent crime (Garbarino et al 1992, Gorman-Smith and Tolan 1998, Macmillan 2001, Overstreet 2000). These symptoms can affect both parents and children in ways that are detrimental to cognitive development and academic engagement.

One particularly worrying symptom for caregivers is depression. Improvements in maternal mental health are some of the most robust findings for the families that moved out of unsafe, high poverty neighborhoods through the Moving to Opportunity Program (MTO) (Briggs, Popkin, and Goering 2010, Gennetian, Sanbonmatsu, and Ludwig 2011) suggesting a true causal relationship between environmental danger and anxiety, depression, and stress. Distressed and depressed mothers tend to be less responsive to their children and less engaged in creating a stimulating environment for their children (Cummings and Davies 1994), both of which are important foundations for early vocabulary growth and cognitive development (Huttenlocher et al 2010).

For students, symptoms of aggression and depression directly impair learning and performance at school (Bell and Jenkins 1993, Bingenheimer, Brennan, and Earls 2005, Bowen and Bowen 1999, Guerra, Huesmann, and Spidler 2003). Aggressive behavior is particularly problematic because it can lead to suspension or arrest which not only reduce opportunities to learn in the classroom, but can lead to labels that stick with a student throughout his or her educational trajectory (Kirk and Sampson 2013).

Experimental psychologists have also found that elevated stress hormones can impair the working memory functions needed to concentrate, access stored memories, and perform well on cognitive tests (Sauro, Jorgensen, and Pedlow 2003, Mattarella-Micke and Beilock 2012). The most extreme effects may fade over a relatively short time period (Sharkey 2010, Sharkey et al 2012). However, Nelson and Sheridan (2011) argue that due to high levels of developmental plasticity, childhood is a particularly sensitive period. Changes in the biological structure of the brain during this period can have long lasting effects on mental health and social behavior as well as memory and cognitive functioning. Therefore, even short disruptions in early learning can have lasting consequences for students' achievement growth over time if future learning is built on a weak foundation.

Protective Behavior

Fear of violence and a desire to protect children from harm on the street also influence parenting styles and children's social development in ways that have academic consequences. Furstenberg argues that one of the goals of successful parenting is not only to foster positive development, but also to protect children from the eminent danger (Furstenberg 1999: 77). As a form of protection, parents in dangerous neighborhoods tend to keep children home as much as possible and maintain stricter household rules (Garbarino et al 1992), both of which have been found to be negatively associated with academic achievement and attainment (Steinberg, Brown and Dornbusch 1996, Shonkoff and Phillips 2000). These parenting strategies are likely to start when children are quite young (Randolph, Koblinsky, and Roberts 1996) and may result in habits and relationships that are hard to change even if the family feels safer later on.

These findings are supported by some of the housing voucher experiments that moved families out of disadvantaged neighborhoods. Interviews with participants indicated that parents in the program were so accustomed to placing safety ahead of academic performance that they often chose not to take advantage of their move to send their children to academically better schools. Instead, they either sent their children to schools with reputations for a safe environment regardless of academic quality or kept them in the same school where at least the dangers were known and therefore seemed more manageable (Briggs, Popkins, Goering 2010).

For children, protecting oneself from a dangerous neighborhood requires social adaptations that may be counter to pro-academic behavior. Anderson (1999) argues that the threat of personal attack in unsafe neighborhoods encourages young men to earn and maintain a reputation for being tough and willing to fight. Jones (2004) and Ness (2004) describe how girls also use similar “tough” behavior to prevent victimization, and how this is often encouraged by young girls’ parents in violent neighborhoods to keep them safe. The same strategies that protect youth from attack can unfortunately be interpreted by teachers and administrators as disrespectful or disengaged in school, leading to more frequent disciplinary action and problematic relationships between students and their teachers (Dance 2002, Devine 1996). While most of this literature focuses on adolescents, it is likely that younger children in the same environments will develop similar protective strategies and continue to use them as they age.

Community Interaction

By definition, all residents of a specific area are exposed to the same unsafe environment. This can lead to aggregate forms of social interaction that can also be detrimental for academic growth. For example, research on the causes and consequences of neighborhood violence indicate that areas with high levels of homicide tend to have low levels of collective efficacy and trust among neighbors (Sampson Raudenbush and Earls 1997). These are dynamic processes in which crime leads to a lack of trust and communication, but a lack of trust and fewer “eyes on the street” can also lead to higher levels of crime. As demonstrated by Sampson, Raudenbush, and Sharkey (2008), this lowered level of community trust and interaction in violent neighborhoods can lead to inhibited speech and verbal isolation that hampers children’s early communication skills.

Paradoxically, high crime neighborhoods may also have dense social networks of criminals that actually allow and encourage violence and delinquency (Browning and Dietz 2004, Pattillo 1999). These peer networks may draw students into violent conflicts and involve them in social obligations that may seem more important than their schoolwork. Harding (2009 and 2010b) documents how older local peers who have dropped out of school transmit and re-enforce norms that devalue academic success and foster mistrust in teachers and school staff to their younger neighbors.

This type of social environment is unlikely to fluctuate over short periods of time. Even as objective violent crime rates go up and down and residents move in and out, the reputation for risk in an area remains relatively stable (Sampson 2012). For example, despite dramatic changes in the violent crime rate on school grounds, students’ reports of perceived school

safety change very little from year to year (Burdick-Will 2013). This suggests that the patterns of social interaction formed in early childhood may be difficult to break. Students and families who develop these behaviors and attitudes early on are likely to have trouble throughout their school careers and students who become disengaged from school are likely to have trouble reengaging as they get older.

In summary, an unsafe environment can be detrimental to children's academic growth and development because chronic psychological stress manifests itself in children's behavior problems and distressed caregivers, protective behavior may minimize the threat of victimization at the expense of academic engagement, and communities may draw children into violent and anti-academic behavior. These mechanisms are specific to unsafe areas and not directly related to the income, education, or employment levels of the neighborhood's residents. Furthermore, they are all mechanisms that build and accumulate over time, influence a students' engagement in the learning process, and shape a child's academic skills and learning in ways that can last for years.

ALTERNATIVE EXPLANATIONS

Isolating the direct effect of early exposure to neighborhood violence on academic growth can be difficult. Violence is correlated with other characteristics of the neighborhood, such as concentrated poverty and unemployment, which may have independent effects on achievement (See Aizer 2009). Therefore, all models will control for these demographic differences. The effect of violent crime will also be compared with that of property crime to test whether there is something about the violence itself that is more important than criminal activity in general or rates of reporting crimes to the police.

In addition to the problem of neighborhood-level confounding, socio-economic constraints and residential choice lead different types of families into different neighborhoods. Since both neighborhood residence and academic achievement are strongly associated with a family's social and economic resources, it is possible that the observed academic differences between students in more or less violent neighborhoods are the result of variation in family resources and not neighborhood violent crime rates. To reduce this potential bias, I include an individual fixed-effect which controls for all constant differences across students or their families, such as parental education, pre-school experiences, or educational expectations.

Nevertheless, the problem of selection may be compounded by the fact that students who start with lower academic skills tend to grow more slowly. To address this issue, I will first show that after introducing controls, the third-grade gaps between students from more and less violent neighborhoods are actually rather small. I also include an interaction between baseline achievement and time as a control in my final models.

Individual selection may also shape students' direct experiences with violent events, even in the same neighborhood (Aizer 2009). For this reason, I focus on an ecological measure of violent crime at the census block group level and estimate the effect of exposure to a social environment that may or may not result in the individual experience of victimization. Therefore, all students living in the neighborhood, regardless of their direct involvement,

will have the same exposure level. Methodologically, this is an important difference from other research on the direct effects of victimization or involvement in gang activity.

There is also the issue of timing and accumulation. Since students who begin in violent neighborhoods are more likely to live in similar neighborhoods later on it is possible that what looks like a cumulative effect of early exposure is just a proxy for more immediate stress that becomes more important as students age. Implicit in this alternative explanation is the idea that the only mechanism through which neighborhood violence affects achievement is short-term cognitive stress and trauma. To be sure that the influence of early neighborhood violence is not just a function of repeated later exposure, a final model will include the current level of violence in each student's neighborhood. If the entire effect of early exposure is explained by this mediating variable, then it is clear that short-term psychological stress and distraction are the most important mechanisms linking neighborhood violence and achievement.

DATA AND MEASURES

This study specifically tests for the long-lasting effects of neighborhood violence using data from three sources: incident reports generated by the Chicago Police Department, administrative files from all students enrolled in Chicago Public Schools (CPS), and the neighborhood demographics from the 2000 US Census. The students in the study come from a complete single cohort of third graders in the fall of 2002 (31,013 students). All CPS students are included in the focal cohort if they are first time third graders in that year (the first year of mandatory standardized testing). They are then followed in the administrative data through the spring of 2011, when they should be in their junior year of high school (the last year of testing) if they have not been retained.

Student Variables

The individual student data come from administrative files collected and stored by the Consortium on Chicago School Research. Student demographic variables, such as gender, race, and age, the students' current grade, census block group ids, and current school ids are recorded for every student during every calendar year. 654 different elementary and high schools are represented by the students in this cohort through all years. The test scores used in this study come from the statewide exams given to students every year in third grade through eleventh grade. Since the design and scoring of each year's tests are not entirely comparable, the analysis will use Normal Curve Equivalent (NCE) scores as the outcome. NCE scores are computed by converting the percentile rank of each student in each year to a normal curve distribution with a mean of 50, a standard deviation of 21.06, and a range of 1 to 99. These scores have the same distribution in every year and allow for consistent cross-test comparisons (Mertler 2002).

Neighborhood Demographics

Neighborhood demographic variables come from the 2000 US Census and are calculated at the block group level. Neighborhood level variables include an index of concentrated disadvantage based on the male unemployment rate and the proportion of families living

under the poverty line, and an index of social status based on the average level of adult education and the proportion of adults working in managerial or professional jobs. These indices are standardized for all block groups in the city with a mean of zero and a standard deviation of one. The two indices measure different aspects of neighborhood composition that may influence achievement through different mechanisms (See Chen and Brooks-Gunn 2015 for a review).

Crime Variables

Crime measures for this study come from incident reports produced by the Chicago Police Department. The database includes the date and place of each incident, as well as detailed crime type. Crimes were matched with the corresponding census block group using geocoded address blocks. The census block group is the focus of this analysis because it is the smallest geographic area available for each student's residence. Recent qualitative urban sociology, such as DeLuca et al (2012), Harding (2010), Goffman (2009), suggest that urban youth identify their neighborhoods as small areas around their homes and think about the safety on a block-by-block basis.

Early exposure to neighborhood violent crime is defined as the number of violent crimes in each student's census block group from the end of second grade through the third grade academic year (May of 2002 to May of 2003). Like the census variables, this is a measurement at a single point in time and remains a constant throughout the analysis. While exposure to local violence may go up and down later in life, a student's exposure at this specific age does not change over time. To assess whether the effect of early exposure is truly long-lasting or just an artifact of a high correlation with later exposure, a time-varying measure of neighborhood violence will be included in the final models. This second crime measure captures the count of violent crimes in each students' census block group during the year prior to each of the spring tests. Since the distributions of these counts are highly skewed, the log of the annual counts will be used in all of the models.

The third grade measure of neighborhood violence is highly spatially clustered, with the South and West sides of Chicago much more violent than the rest of the city (Figure 1). These are also areas with generally high concentrations of minorities, low levels of socioeconomic resources, and large numbers of underperforming schools. However, there is also substantial variation between socioeconomic disadvantage and violence at the block group level. The correlation between the two measures is only around 0.56, meaning that violence is not something that only happens in the most disadvantaged neighborhoods and some violent neighborhoods are not as socioeconomically disadvantaged as one might assume.

Missing Data

The final analytic data set includes 216,306 student*year observations. This is substantially less than one observation per student per year. When using complete administrative files, there are two types of missing data to worry about. First, students leave the administrative data when they drop out of school, move out of the city, or transfer out of the public school system. This attrition is substantial. By 2011 only 65 percent of the original third grade

cohort is still enrolled in CPS. Unsurprisingly, those who remain are slightly more likely to be female, slightly less likely to be black and have somewhat higher test scores. However, there is no evidence that leaving the district is related to exposure to neighborhood violence. Discrete time hazard models (Allison 1982, not shown) indicate that neighborhood violence, either in third grade or in any year, is not a significant predictor of leaving the dataset. The number of observations that any student has throughout this nine-year period is also unrelated to any measure of violence. Analysis using only students who remain enrolled every year until eleventh grade also yields almost identical results.

Second, even when a student is enrolled in the district, values may be missing for one or more of the measures. Test scores are the only measure in this dataset with a meaningful number of missing values for actively enrolled students. The other demographic variables and location identifiers are reported for all students every year that the student is enrolled in the public school system. Less than six percent of observations in which the student is listed as enrolled are missing a test score (13,088 out of 229,394). Students with missing test scores are more likely to be male and to be repeating a grade. They are also somewhat more likely to have come from a violent neighborhood and have somewhat lower test scores in non-missing years. One solution to this problem is to predict the probability that any observation is missing from the analysis based on all of the observed characteristics of that student in all years. Models can then be estimated in which each case is weighted by the inverse probability of being included in the analysis. This means that cases that are similar to those who are dropped are over-weighted and those that are unlikely to be excluded are underweighted, essentially recreating what the data set would have looked like were there no missing data (Morgan and Winship 2014). The results of this weighted analysis are identical to those without the weights. For the sake of simplicity, the weighted results will not be reported here.

Descriptive Summary

Table 1 describes the cohort used for the analysis. The first column shows the mean and standard deviation for the cohort's initial third grade year. Here there is just one observation per student (31,013 students). In third grade, the cohort has slightly more males than females (51 to 49 percent). Half are African American and a little over one third are Hispanic. The neighborhoods that students live in experienced, on average, 87 violent crimes during that year and have higher levels of socioeconomic disadvantage and lower levels of social status than the city average.

The second column describes all of the observations used in the analytic dataset. Here each student*year observation ($N = 216,306$) represents a single calendar year for each student in the cohort as long as they are enrolled in CPS. The proportion of males and African American students both decline by around 1 percent in these observations due to the somewhat increased likelihood that these students leave the data in later observations. The mean and standard deviation of grade, age, and test scores all increase as expected when considering all years. Three percent of observations represent a grade repetition.

The final row in this table shows the annual measure of neighborhood violence. Unlike the third grade measure which does not change over time, this measure of violent crime changes

year-to-year based on the crime rate in specific block groups where each student lives each year. Throughout this period, violent crime across Chicago declined steadily. City-wide, the average block group reported more than 57 violent crimes per year in 2002–2003, but only reported around 39 violent crimes in 2010–2011. Public school students tend to live in the more violent areas of the city. For all observations, the average student is exposed to an annual violent crime count of 72, compared to 87 in the earliest year.

METHODS

Many of the prior studies of “neighborhood effects” rely on cross-sectional data to compare the outcomes of students who live in different types of neighborhoods. Experiments designed to test these effects often focus on extraordinarily vulnerable populations. (See Dietz 2002, and Sampson, Morenoff, and Gannon-Rowley 2002 for more detailed reviews of the neighborhood effects literature). In contrast, I follow all students in Chicago’s large urban district, and exploit the longitudinal nature of administrative data to estimate models that compare students only to themselves over time. These models remove large sources of unobserved confounding and provide more plausible causal estimates of the effect of early exposure to neighborhood violence. The results are also generalizable to the population of an entire city rather than only its most disadvantaged residents.

I begin by describing the early gaps between students in more or less violent neighborhoods. To do this, I model third grade NCE scores as a function of individual and neighborhood characteristics using both ordinary least squares regression and school fixed-effects.

Model 1: Ordinary Least Squares

$$Y_{3i} = \beta_0 + \beta_1 X_{3i} + \beta_2 N_{3i} + \varepsilon_i \quad (1)$$

Model 2: School Fixed-Effects

$$Y_{3ij} = \beta_0 + \beta_1 X_{3i} + \beta_2 N_{3i} + s_{3j} + \varepsilon_{ij} \quad (2)$$

Y_{3i} is each student’s test scores at the end of third grade and X_{3i} and N_{3i} are his or her individual and neighborhood characteristics, respectively. Model 2 introduces the school fixed-effects, s_{3j} .

In order to believe that later academic achievement growth rates differ based on third grade neighborhood violence, it is important to show that after introducing controls, students from safe and violent neighborhoods begin with relatively similar test scores. That way it is clear that the growth is not just a function of different starting places. The OLS regressions compare all students in the district, while the school fixed-effects take school attendance into account and compare students who attend the same school in third grade, but live in different neighborhoods. It is not possible to estimate a model with neighborhood-fixed effects because all students who live in the same neighborhood have the same third grade local violence value.

Even with the within-school comparisons, differences in academic performance may be due to selection of more disadvantaged families with lower achieving students into more violent neighborhoods. Without better data on family and individual characteristics than is available in administrative sources, it is not possible to remove this potential selection bias with observed controls alone. Therefore, the analysis of growth in achievement over time will include student fixed-effects. With this model, bias from any constant differences between students is removed from the estimates by comparing students to themselves at different points in time. Any differences between students' family lives or early childhoods that remain constant, such as race, gender, and parents' education, will be wiped out. This includes any of the preferences and constraints that lead families to live in more or less violent neighborhoods in the first place and any characteristics of those neighborhoods that are constant over time. Any experience a child has before the initial third grade observation is also constant. Past experiences in specific years cannot change over time.

Since early exposure to neighborhood violence is constant for each student, the main effect of local violence cannot be modeled in the fixed-effects framework. However, an interaction with time and baseline violence indicates whether test score growth is slower for students who begin school in more violent neighborhoods. Time will be marked by a series of calendar year dummy variables, but the interaction will use a linear measure of year. This will allow the slope of growth to be non-linear, but the relationship between neighborhood violence and that slope to grow linearly over time. This combination allows for a more understandable estimate of the differences in growth rates based on early childhood neighborhoods, without imposing any specific functional form on average academic growth over the whole period. Interactions with each year dummy variable show very similar results, but are much more difficult to interpret and do not fit the data as well as the linear interactions. Similar models were used in Keels, Burdick-Will, and Keene (2013) to test the relationship between gentrification and school-level improvement over a decade long period.

The main models do not include any time varying controls other than the indicators for year. Controlling for grade retention, special education status, evolving parenting styles, changes in economic resources, or even later exposure to neighborhood violence could lead to bias because these measures are potentially part of the mechanisms that links third grade exposure and later test scores and would lead to a biased estimate of the full "treatment" effect (Morgan and Winship 2014). Similarly, controlling for neighborhood characteristics at later years may also underestimate the impact of early neighborhood experiences. In other words, residential experiences in one year are likely to shape a family's residential preferences in the future. The decision to stay in, move to, or leave a violent neighborhood when the child is in high school (and any impact that may have on his or her achievement) is part of the cumulative effect of living in a certain place earlier on.

Model 3: Student Fixed-Effects

$$Y_{it} = \beta_0 + \beta_1 \log(V_{3i}) * T_t + \beta_2 A_{3i} * T_t + \beta_3 D_{3i} * T_t + \beta_4 S_{3i} * T_t + \beta_5 \log(V_{ti}) + \beta_5 T_1 + \dots + \beta_{12} T_8 + u_i + \varepsilon_{it}$$

(3)

Y_{it} is the outcome, either reading or math NCE scores, in year t for student i . T_t is the calendar year and V_{3i} is the level of violence experienced by student i during the year before the third grade tests. Additional variables will be included to rule out some of the alternative explanations. An interaction with third-grade test scores, A_{3i} , adjusts for the possible correlation between baseline achievement and growth. Interactions with baseline census characteristics (socioeconomic disadvantage, D_{3i} , and social status, S_{3i}) isolate the influence of violence over demographics. The current level of violence in each student's neighborhood, V_{ti} , tests whether the effect is really cumulative and long-lasting or just a function of high correlations with later violence. It should be noted that since there are no time-varying measures of local demographics or family conditions available as controls, this coefficient may contain upward bias. It is included to shed light on the mechanisms linking early violence and achievement, rather than to assess the causal effect of recent exposure directly. u_i are fixed effects for each student and ε_{it} is the observation level error term.

Neighborhoods are not entirely independent units and students may be influenced by things that happen near, but not in their block group. To account for the spatial autocorrelation between block groups one might control for a spatially lagged measure of the test score outcome. However, including the average reading scores of all students in neighborhoods that are adjacent to the focal neighborhood, either as a predictor of the slope or as a time varying control, does not change the relationship between early exposure to neighborhood violence and academic growth and will not be discussed in detail.

RESULTS

Initial Differences

Table 2 shows the OLS regressions predicting third grade test scores. The first model for each subject shows the bivariate relationship with neighborhood violence. One standard deviation difference in the log of neighborhood violence predicts a 3.2-point (or one seventh of a standard deviation) difference in NCE scores for reading and a 2.8-point difference for math. Including race, gender, and age reduces the coefficient by a little more than one point and including the neighborhood socioeconomic and social status indices reduces it by an additional point. In the final model, the coefficients for violent crime is around one NCE point for reading and three-quarters of a point for math.

School fixed-effects results (Table 3) indicate that students from more violent neighborhoods continue to perform worse on their standardized tests than their classmates by around two-thirds and four-fifths of one point. About half of this difference is explained by demographic differences between students. After controlling for the other neighborhood indices the difference is around two tenths of a point and no longer statistically significant. In other

words, within the same elementary school, students from more and less violent neighborhoods, but equal neighborhood demographic levels perform no differently on standardized tests of reading and math in the third grade.

Growth Models

Despite the small initial differences in third grade, the gaps based on neighborhood violence get larger over time. Tables 4 and 5 show the results of growth models with student fixed-effects for reading and math, respectively. The first column in each table shows the difference in growth rates without any student fixed-effects. These models show that students in violent neighborhoods grow substantially slower than those in less violent neighborhoods by about two-thirds of a point per year for reading and three-quarters of a point per year for math.

The next column adds the student fixed-effects and reduces the coefficient for neighborhood violence substantially, but does not eliminate it. For reading, the coefficient is now -0.29 . At the end of eight years, this rate of growth indicates that the gap between students based on one standard deviation difference in log violence will be around 2.25 points on average. The coefficient is even larger for math (-0.48) and reaches 3.83 points by junior year.

One might expect that the influence of neighborhood violence differs for different types of students. However, there are no significant interactions between neighborhood violence and any of the available covariates, such as gender, race, initial achievement, or neighborhood demographics (not shown). This may come as a surprise to those who rightly expect that African American students are the only ones exposed to the most extreme levels of violence. However, it is important to remember that this analysis does not test the effects of only these extremes as Sampson, Raudenbush, and Sharkey (2008) did with concentrated disadvantage. Instead, I base my analysis on a continuous measure of crime that includes all neighborhoods in the city. With this measure, there is substantial overlap between the distributions of the exposure for all racial groups. Furthermore, the students here are all enrolled in the Chicago Public Schools. They do not represent the full population of children in the city. Higher income, white children are much more likely to attend private schools and not be included in these data. Therefore, the white students in this population are likely far more disadvantaged than the average private school student and are much more likely to have neighborhood characteristics in common with their minority peers in public schools.

Alternative Explanations

The rest of the models include additional controls designed to rule out alternative explanations. The third model adds an interaction between baseline achievement and calendar year. Including this control does not change the neighborhood violence coefficient for reading and reduces the coefficient only slightly for math. This indicates that the differences in growth rates between students from more or less violent neighborhoods are likely due to behavioral differences and study skills rather than only differences in early content knowledge and proficiency.

The fourth model adds slopes for neighborhood socioeconomic disadvantage and social status. Interestingly, despite predicting larger differences in initial third grade test scores,

neighborhood social status (education and professional occupations) does not independently predict substantially faster growth in scores over time. Since neighborhood violence and disadvantage are moderately correlated ($R = 0.56$), including disadvantage reduces the coefficient for violence substantially to -0.16 for reading and -0.22 for math. However, despite their correlation, both disadvantage and violence predict around the same magnitude of slower growth. This shows that there is something about the violence alone that influences achievement growth, above and beyond any confounding by neighborhood demographics.

The causal relationship between early exposure to neighborhood violence and test score growth is also supported by the coefficients of two different measures of neighborhood crime (not shown in tables). First, when defining neighborhoods as a larger area by including the set of contiguous block groups surrounding each student's block group, the coefficient is less than half the size. This supports the qualitative evidence that neighborhoods are quite small and that there is something about very local violence that is generating the slower academic growth, not just living in a larger generally high crime area. Second, when block group property crime counts are used instead of violent crime, the slope is quite small and not statistically significant, suggesting that safety is a more important mechanism than reporting bias or crime in general.

Finally, it is possible that third grade exposure to neighborhood violence is simply a proxy for later experiences that are closer to the test dates. The final model includes a time varying annual measure of neighborhood violence for one year prior to each test. The coefficient for current neighborhood violence is negative and significant (around -0.24 for reading and -0.39 for math). This is approximately the size of the third grade gap estimated using the school fixed-effect in Table 3 and indicates that in years where students experience more violence around their homes they perform worse on standardized tests. Remember, however, that without other time-varying controls, this may represent an over estimate of the direct effect of recent neighborhood violence. More importantly, adding this control does not change the growth coefficient for early exposure. Therefore, the mechanisms driving the two effects appear to be different, perhaps stress and distraction in the short-term, but behavior and educational engagement in the long-term.

Limitations

The most important limitations come from the use of administrative data to track students over time. These data provide a broad picture of the district as a whole and allow for regular repeated observations of each student. However, without information on family background, classroom behavior, or individual exposure to violent events, it is difficult to tease apart anything more specific about the mechanisms that are driving these average effects. It is also not possible to know exactly whether the way a family reacts to local violence shapes the size of the effects (i.e. Randolph, Koblinsky, and Roberts 1996), whether chronic symptoms of post-traumatic stress lead to behavior that results in disciplinary action at school (i.e. Gorman-Smith and Patrick Tolan 1998), or whether it is neighborhood peers that distract from academic behavior (i.e. Harding 2010b). In addition, since these coefficients represent averages across all students in the school system, it is very possible that these average effects

are a reflection of a large effect for the relatively few students with the most direct contact with violence and no effect for other students.

Similarly, these data are unable to provide a picture of what is going on at school where most of the learning actually takes place and are unable to differentiate between students who attend a school with a supportive environment and with teachers and staff who are able to help students cope with trauma and loss and those who do not (Garbarino et al 1992, Patton and Johnson 2010). These school-level differences are important because there is some evidence that school quality and climate may drive some of the differences between students from more or less violent neighborhoods. Specifically, the coefficients for neighborhood violence predicting growth are actually somewhat smaller when comparing students in the same schools with a school fixed-effect than with the student fixed-effect (not shown). This suggests that at least some of the slower growth rate seen across students is due to different schooling environments. In addition, students from more violent neighborhoods appear to have less stable residential and school environments. Logistic regressions indicate that third grade neighborhood violence predicts small, but significantly increased log odds (around 0.1) of changing schools and neighborhoods, even after controlling for demographics, achievement, and other neighborhood conditions. To be clear, this does not mean that neighborhood experiences do not matter, only that they are potentially mediated by the quality and instability of school attendance patterns.

To address these issues of mechanisms and interactions, future research should link survey data about individual experiences with violence and school climate with longitudinal assessment and detailed geographic crime data. As administrative school and crime data become more readily available in a wider variety of cities, it may become more feasible to link these records to the individual surveys necessary to examine mechanism more directly. The important implication from this research is that these data must be longitudinal. Simply looking at a cross-section of violence exposure and achievement will likely miss lingering effects of earlier experiences.

DISCUSSION

The results of this study show that elementary school students in more violent neighborhoods have lower early test scores than their peers from less violent neighborhoods, but that these differences are largely explained by demographics and school attendance. More importantly, the test scores of students who live in violent neighborhoods as young children grow more slowly over time. This holds even after controlling for unobserved differences between students, other neighborhood characteristics, and more recent exposure to violence.

The size of these effects may at first seem small, but it is meaningful. By the end of junior year, the gap based on one standard deviation of neighborhood violence has grown to approximately one tenth of a standard deviation for reading and more than one sixth of a standard deviation for math. This is comparable to the effects of MTO experimental moves on test scores in the most violent cities, Chicago and Baltimore (Burdick-Will et al 2011). Considering the rigorous controls, this represents a real difference in learning for students

based on childhood exposure to neighborhood violence. There is no evidence of interactions by gender, race, initial achievement, or neighborhood demographics, indicating that the mechanisms linking exposure to unsafe areas and achievement are not particular to any specific group or exacerbated by other forms of disadvantage.

With these findings, this study contributes to a growing body of literature that documents “collateral consequences” of crime and violence on academic outcomes (i.e. Harding 2010a, Kirk and Sampson 2013, Sharkey 2010). These studies highlight the importance of moving beyond demographic markers and economic resources when considering how neighborhoods shape life chances. While correlated with socioeconomic disadvantage, the effects of neighborhood violence operate independently, and when both are included in the model, their influence on academic growth is around the same magnitude.

This study also contributes to the neighborhood effects literature by addressing the appropriate scale of geographic influence. Many studies of neighborhood effects use children’s census tracts, community areas, or even zip codes as proxies for their neighborhood (Chen and Brooks-Gunn 2015). Here, the strongest effects were for the smallest available definition of a neighborhood. Figure 1 shows that while there are generally safer and more violent areas of the city, there are also relatively small hot spots of violent crime. These findings are consistent with qualitative research on how families think about residential options (DeLuca et al 2012) and should be taken into account in future studies of residential context and child development.

Finally, and most importantly, the lasting effects of early exposure have implications for the mechanisms that link neighborhoods and academic development. Many of the earliest theories that sparked the current interest in neighborhood effects hypothesized that adolescents would be the most influenced by their neighborhood context (Brooks-Gunn et al 1993, Wilson 1987). The idea was that older children would have more freedom to explore outside their homes and therefore have more contact with the streets and their neighbors. Many of the subsequent studies of neighborhood effects, including neighborhood violence, have been cross-sectional, and therefore unable to explicitly test this hypothesis (i.e. Harding 2010a). These results show that differences among adolescents may in fact be the cumulative result of much earlier exposure.

Some of our best evidence on the importance of local violence comes from studies of very short-term effects. Sharkey and colleagues (2010 and 2012) have shown that recent violent events can trigger acute stress and trauma that decrease attention-spans and lead to substantially lower test scores. Their results show that the majority of this large effect fades in a matter of days. While these results are important, they cannot address whether these students fully recover from geographic exposure to violence. This study adds to our understanding by highlighting the multiple mechanisms and time-scales in which local context shapes achievement and emphasizing that early experiences shape schooling outcomes for years. Short-term trauma is important and evident in the time-varying measure of neighborhood violence, but it is not the only reason that a dangerous environment generates academic disadvantage.

In this way, the results are consistent with the recent re-evaluation of the long-term follow up surveys from the Moving to Opportunity experiment. Chetty, Hendren, and Katz (2015) find that while there were no effects of moving out of poor and dangerous neighborhoods for older children, those who moved to safer, less poor neighborhoods before the age of 13 did substantially better in life as measured by their adult income, the characteristics of their adult neighborhoods as adults, and their likelihood of becoming a single parent than those who were not offered special housing vouchers. This suggests that the influence of neighborhood conditions is quite long-lasting and that where children spend their early years matters at least as much as where they spend their adolescence. More specifically, these results suggest that neighborhood violence likely shapes the social structure of the neighborhood and parents' early interactions with their children in ways that alter academic engagement, behavior, and learning throughout their educational experiences. This cumulative perspective should shape the ways that future research attempts to identify potential neighborhood effects mechanisms. We need to consider not only the immediate impact of local context, but the ways in which exposure to certain residential locations sets children and families up with a weak foundation for later development through patterns of behavior, adaptation, and instability that persist over time.

CONCLUSION

High rates of neighborhood violent crime are a serious problem for many Chicago Public School students and youth across the country. The results presented here show that the effects of this violence are long lasting, accumulate over time, and will have implications for learning gaps for many years to come. Learning is a cumulative process, in which future gains are determined (at least in part) by the social and academic groundwork established in earlier years. Early problems in one domain can also cascade from one aspect of development to another. The acute mental health problems that parents and children experience in unsafe environments spill over into social and academic development and therefore leave lasting effects long after any specific psychological symptoms may have subsided.

These findings underscore the potential for a lag between changes in the social environment and changes in behavior and learning. Despite dramatically declining crime rates in most cities nation-wide (Zimring 2006), it may take years before the full benefits of relative safety are evident in local children's academic achievement. Nevertheless, if reducing violent crime can improve students' learning, even a little, then a substantial improvement in safety in the city's most dangerous neighborhoods could not only improve the quality of life in those areas, but may have long-term benefits for the overall public school system as well.

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Biography

Julia Burdick-Will is an Assistant Professor in the Department of Sociology and the School of Education at Johns Hopkins University. She received her PhD from the University of Chicago, where she was an Institute for Education Sciences Predoctoral Fellow. Her research combines the sociology of education and urban sociology to examine the dynamic connections between communities and schools that shape opportunities to learn both in and out of the classroom.

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Figure 1. Log Violent Crime in Chicago by Block Group, May 2002–May 2003
SOURCE: Author's calculation based on data from the Chicago Police Department.

Table 1

Student and Neighborhood Characteristics:

	Third Grade	All Years
Female	0.49 (0.50)	0.50 (0.50)
African American	0.52 (0.50)	0.51 (0.50)
Hispanic	0.37 (0.48)	0.39 (0.49)
Grade	3.00 (0.00)	6.38 (2.50)
Age	8.12 (0.40)	11.61 (2.53)
Retained	0.00 (0.00)	0.03 (0.18)
Observations per student	1.00 (0.00)	8.03 (1.76)
Reading	39.91 (13.01)	50.15 (18.30)
Math	39.48 (10.35)	50.32 (17.43)
Socioeconomic Disadvantage	0.32 (0.80)	0.28 (0.79)
Social Status	-0.40 (0.80)	-0.39 (0.80)
Third Grade Violence	86.78 (78.12)	86.96 (78.42)
Annual Violence	86.78 (78.12)	72.01 (61.90)
N	31,013	216,306

SOURCE: Author's calculation based on data from the Chicago Police Department and the Consortium on Chicago School Research.

Table 2

OLS Regressions Predicting Third Grade Scores

	Reading		Math			
Log Neighborhood Violence	-3.239*** (0.144)	-2.043*** (0.151)	-0.923*** (0.148)	-2.836*** (0.114)	-1.455*** (0.121)	-0.767*** (0.119)
Female		2.081*** (0.142)	2.102*** (0.141)		0.533*** (0.113)	0.546*** (0.112)
Black		-7.868*** (0.339)	-7.339*** (0.328)		-7.111*** (0.253)	-6.781*** (0.258)
Hispanic		-8.309*** (0.309)	-6.817*** (0.306)		-5.448*** (0.224)	-4.542*** (0.231)
Age (centered at 8)		-5.288*** (0.262)	-5.115*** (0.257)		-3.975*** (0.221)	-3.870*** (0.218)
Neighborhood Socioeconomic Disadvantage			-1.077*** (0.169)			-0.671*** (0.145)
Neighborhood Social Status			1.850*** (0.137)			1.122*** (0.113)
Constant	40.408*** (0.085)	44.272*** (0.377)	44.367*** (0.373)	39.886*** (0.069)	43.691*** (0.291)	43.730*** (0.292)
R-squared	0.045	0.113	0.128	0.055	0.112	0.121
Observations	31,023	31,023	31,023	31,023	31,023	31,023

SOURCE: Author's calculation based on data from the Chicago Police Department and the Consortium on Chicago School Research.

NOTE:

p<0.001,**
p<0.01,*
p<0.05. Robust standard errors in parenthesis, clustered at the census block group level.

Table 3

Predicting Third Grade Scores with School Fixed-Effects:

	Third Grade Reading			Third Grade Math		
Log Neighborhood Violence	-0.812 *** (0.137)	-0.497 *** (0.128)	-0.199 (0.135)	0.663 *** (0.111)	-0.334 ** (0.102)	-0.203 (0.107)
Female		1.985 *** (0.141)	1.988 *** (0.141)		0.443 *** (0.119)	0.444 *** (0.119)
Black		-5.304 *** (0.476)	-5.204 *** (0.471)		-5.075 *** (0.363)	-5.029 *** (0.364)
Hispanic		-4.534 *** (0.408)	-4.471 *** (0.406)		-3.084 *** (0.310)	-3.058 *** (0.310)
Age (centered at 8)		-5.039 *** (0.248)	-5.018 *** (0.247)		-3.794 *** (0.205)	-3.785 *** (0.205)
Neighborhood Socioeconomic Disadvantage			-0.637 *** (0.168)			-0.286 * (0.133)
Neighborhood Social Status			0.381 * (0.157)			0.157 (0.127)
Constant	40.408 *** (0.085)	44.272 *** (0.377)	44.367 *** (0.373)	39.886 *** (0.069)	43.691 *** (0.291)	43.730 *** (0.292)
R-squared: within	0.001	0.047	0.048	0.001	0.038	0.039
between	0.289	0.415	0.451	0.273	0.321	0.338
overall	0.045	0.100	0.113	0.055	0.103	0.109
Observations	31,013	31,013	31,013	31,013	31,013	31,013
Number of Schools	483	483	483	483	483	483

SOURCE: Author's calculation based on data from the Chicago Police Department and the Consortium on Chicago School Research.

NOTE:

p<0.001,**
p<0.01,*
p<0.05. Robust standard errors in parenthesis, clustered at the school level.

Table 4

Predicting Growth in Reading Scores with Student-Fixed Effects:

	Reading				
Log Neighborhood Violence * Year	*** -0.644 (0.016)	*** -0.286 (0.015)	*** -0.287 (0.016)	*** -0.164 (0.020)	*** -0.177 (0.021)
Third Grade NCE Score * Year			-0.006 (0.022)	-0.023 (0.023)	-0.025 (0.023)
Socioeconomic Disadvantage * Year			-0.209 (0.022)	*** -0.205 (0.022)	*** -0.205 (0.022)
Social Status * Year			-0.021 (0.017)	-0.021 (0.017)	-0.021 (0.017)
Log Current Neighborhood Violence				*** -0.236 (0.070)	*** -0.236 (0.070)
R-squared: within		0.231	0.231	0.232	0.232
between		0.0699	0.0670	0.0689	0.0732
overall	0.123	0.1100	0.1080	0.1097	0.1126
Student Fixed-Effect		X	X	X	X
Observations	216,306	216,306	216,306	216,306	216,306
Number of Students		31,013	31,013	31,013	31,013

SOURCE: Author's calculation based on data from the Chicago Police Department and the Consortium on Chicago School Research.

NOTE:

p<0.001,**
p<0.01,*
p<0.05. All models include year fixed-effects. Robust standard errors in parenthesis, clustered at the individual level.

Table 5

Predicting Growth in Math Scores with Student-Fixed Effects:

	Math				
Log Neighborhood Violence * Year	-0.737*** (0.015)	0.482*** (0.015)	-0.360*** (0.015)	-0.218*** (0.020)	-0.240*** (0.020)
Third Grade NCE Score * Year			0.938*** (0.028)	0.908*** (0.028)	0.903*** (0.028)
Socioeconomic Disadvantage * Year				-0.244*** (0.021)	-0.238*** (0.021)
Social Status * Year				-0.027 (0.016)	-0.026 (0.016)
Log Current Neighborhood Violence					-0.390*** (0.063)
R-squared: within		0.300	0.311	0.313	0.313
between		0.1120	0.5248	0.5222	0.5136
overall	0.160	0.1530	0.4029	0.4040	0.4039
Student Fixed-Effect		X	X	X	X
Observations	216,306	216,306	216,306	216,306	216,306
Number of Students		31,013	31,013	31,013	31,013

SOURCE: Author's calculation based on data from the Chicago Police Department and the Consortium on Chicago School Research.

NOTE:

p<0.001,**
p<0.01,*
p<0.05. All models include year fixed-effects. Robust standard errors in parenthesis, clustered at the individual level.