

The author(s) shown below used Federal funds provided by the U.S. Department of Justice and prepared the following final report:

Document Title: A Spatio-Temporal Assessment of Exposure to Neighborhood Violence

Author(s): David S. Kirk, Margaret Hardy, Jeffrey M. Timberlake

Document No.: 243039

Date Received: July 2013

Award Number: 2008-IJ-CX-0011

This report has not been published by the U.S. Department of Justice. To provide better customer service, NCJRS has made this Federally-funded grant report available electronically.

Opinions or points of view expressed are those of the author(s) and do not necessarily reflect the official position or policies of the U.S. Department of Justice.

A Spatio-Temporal Assessment of Exposure to Neighborhood Violence

Grant No. 2008-IJ-CX-0011

FINAL TECHNICAL REPORT

David S. Kirk
University of Texas at Austin

Margaret Hardy
University of Maryland

Jeffrey M. Timberlake
University of Cincinnati

May 15, 2013

Findings and conclusions of the research reported here are those of the authors and do not necessarily reflect the official position or policies of the U.S. Department of Justice. A condensed version of this report (Kirk and Hardy 2013), with the title “The Acute and Enduring Consequences of Exposure to Violence on Youth Mental Health and Aggression,” is forthcoming in *Justice Quarterly*.

A Spatio-Temporal Assessment of Exposure to Neighborhood Violence

ABSTRACT

Research Goals and Objectives

The bulk of “neighborhood effects” research examines the impact of neighborhood conditions cross-sectionally. However, it is critical to understand whether the effects of neighborhood context are situational *and* whether they endure over time. In this study, we take seriously the notion that there are enduring consequences of exposure to deleterious neighborhood conditions, and estimate both the acute and enduring consequences of exposure to neighborhood violence.

Methods and Data

Using a rich set of longitudinal data on adolescents from the Project on Human Development in Chicago Neighborhoods (PHDCN), including the PHDCN Longitudinal Cohort Study (LCS) and the 1994-1995 PHDCN Community Survey (CS), we estimate the effect of exposure to violence on both internalizing (depression and anxiety) and externalizing problems (aggression). We use propensity score matching for this purpose, drawing upon 68 different individual, peer, family, and neighborhood covariates measured at the first wave of the PHDCN-LCS to predict the propensity of exposure to violence. Following estimation of the propensity score, we match each treated subject (i.e., exposed to violence) with a control subject (i.e., non-exposed) with a similar propensity score. Our objective is to produce treatment and control groups that are indistinguishable once we have conditioned on propensity scores.

Results

We find that exposure to violence has both an acute and an enduring effect on aggression, yet no effect on anxiety-depression, net of individual, family, peer, and neighborhood influences. Part of the enduring effect of violence exposure is explained by changes in social cognitions brought on by the exposure, yet much of the relationship remains to be explained by other causal mechanisms.

TABLE OF CONTENTS

ABSTRACT.....	i
EXECUTIVE SUMMARY.....	iv
INTRODUCTION	1
STATEMENT OF THE PROBLEM	1
THEORETICAL FRAMEWORK	3
THE CURRENT STUDY	10
METHODS AND DATA	11
VARIABLES	12
ANALYTIC STRATEGY	16
RESULTS	19
ACUTE EFFECT OF EXPOSURE TO VIOLENCE.....	22
SENSITIVITY ANALYSIS, EFFECT OF EXPOSURE TO VIOLENCE	25
ENDURING EFFECT OF EXPOSURE TO VIOLENCE	26
CONCLUSIONS.....	28
DISCUSSION OF FINDINGS	28
IMPLICATIONS FOR FUTURE RESEARCH	29
IMPLICATIONS FOR POLICY AND PRACTICE	30
REFERENCES	32
APPENDIX.....	39
DISSEMINATION OF RESEARCH FINDINGS.....	49

EXECUTIVE SUMMARY

STATEMENT OF THE PROBLEM

The Moving to Opportunity for Fair Housing Demonstration (MTO) was one of the most ambitious anti-poverty experiments of the past two decades. It was designed to examine whether an individual would behave differently—in terms of crime, education, employment, and other individual outcomes—or realize improvements in mental and physical health if he or she lived in a nonpoor neighborhood instead of a poor neighborhood. Interim findings from the MTO experiment—4 to 7 years after random assignment—indicated that moving male youths out of impoverished neighborhoods had no effect on psychological distress, depression, and anxiety. Moreover, moving out of poverty did not lead to a significant decline in the likelihood of arrest for a violent crime among males, and actually led to more risky behavior (i.e., drug and alcohol use, smoking, and arrest for property crime) (Kling, Liebman, and Katz, 2007; Kling, Ludwig, and Katz, 2005; Sanbonmatsu et al., 2011). These findings suggest that changing individuals' neighborhood environment does not lead to healthier outcomes, at least not immediately. If we assume that residing in poor, violent neighborhoods is detrimental to health and social behavior, how can we explain these findings?

In this study we explore one possible answer: because neighborhood effects endure. Perhaps it is unrealistic to assume that a move to a new neighborhood can remedy the deleterious consequences of a lifetime of exposure to poverty and violence. The bulk of “neighborhood effects” research examines the impact of neighborhoods cross-sectionally, thereby ignoring the possibility that the effect of a neighborhood on an individual may endure even if he or she leaves the neighborhood or if the neighborhood

fundamentally changes. In contrast, in this study we take seriously the notion that neighborhood social contexts have more than just a contemporaneous effect. In particular, we examine both the acute and enduring consequences of exposure to one particular neighborhood condition, namely violence.

METHODS AND DATA

We draw upon data from the Project on Human Development in Chicago Neighborhoods (PHDCN), a multi-wave longitudinal data collection that comprises assessments of individuals and their families throughout child and adolescent development, as well as an assessment of their neighborhood context.

The focus of our analysis is on the 12-year-old and 15-year-old cohorts; these youths were approximately 18 and 21 years-old by the end of the data collection in 2002. These two cohorts responded to questions at each of the three waves of data collection about their exposure to violence and self-reported information about aggression, anxiety, and depression. The PHDCN-LCS data also contains a wealth of information on youth and family characteristics, including data on family structure and supervisory processes, peer characteristics, and criminal offending. The breadth of the PHDCN-LCS data provides a unique opportunity to account for confounding influences when estimating the effect of exposure to violence on youth aggression, anxiety, and depression. The PHDCN data also provide an opportunity to examine mediating mechanisms to explain why exposure to violence might affect youth mental health.

With these data, we use propensity-score matching combined with a sensitivity analysis to identify the independent relationship between exposure to violence and both

internalizing (i.e., anxiety and depression) and externalizing (i.e., aggression) problems. We first examine the acute effect of violence exposure—i.e., exposure in the twelve months immediately prior to the second wave of the PHDCN survey on respondents’ levels of aggression and anxiety-depression measured at wave 2. We then seek to determine if this effect endures over time (i.e., from wave 2 to wave 3 of the PHDCN). Moreover, if the effect of exposure endures, we aim to determine why that might be the case. Specifically, we examine whether exposure to violence adversely affects social cognitions in the form of street efficacy, and whether social cognitions mediate the enduring effect of exposure to violence on youth mental health.¹ We hypothesize that exposure to violence impairs street efficacy because individuals perceive that they have little control over their environment. A response to this lack of control is a heightened level of aggression necessary for protection, and also heightened anxiety and depression brought on by the lack of control and fear associated with exposure to violent situations.

RESULTS

We find the following with respect to the consequences of exposure to neighborhood violence:

- Acute effect: our results indicate that adolescents exposed to violence were significantly and substantially more likely to display clinical levels of aggression than otherwise similar individuals who were not exposed to violence. We find no difference in anxiety and depression.

¹ Sharkey (2006, p. 827) defined street efficacy as “the perceived ability to avoid violent confrontations and find ways to be safe in one’s neighborhood.”

- Enduring effect: exposure to violence during the twelve months prior to wave 2 is predictive of aggression measured over two and a half years later at wave 3.
- Mediating effect: street efficacy is significantly and negatively related to aggression, and street efficacy partially mediates the association between exposure to violence and aggression, albeit by a modest amount.

CONCLUSIONS

Our results indicate that exposure to violence has both acute and enduring effects on aggression and a non-significant effect on anxiety-depression. We examined *why* the effect endures through an investigation of the role of changes in social cognitions, and find that street efficacy mediates the association a fairly minimal amount. Yet, there may be other aspects of cognition that further mediate the relationship between exposure to violence and aggression, including aggressive fantasies, normative beliefs about violence, and subjective alienation. Beyond the effect on social cognitions, exposure to violence may affect youth aggression and mental health through several other causal pathways, including through its effect on parents, their capacity to parent, and conflict in the home. Exposure to violence may also lead to gang involvement and therefore gang-related aggressive behavior, as exposed individuals search for means for protection in a violent neighborhood. We therefore suggest that more research is needed to examine why violence exposure has an enduring effect on youth mental health, particularly externalizing behaviors such as aggression.

The non-significant relationship we found between exposure to violence and anxiety and depression suggests that results from prior studies may have been influenced

by unmeasured confounding influences (e.g., Gorman-Smith and Tolan, 1998). For instance, in this study we control for the confounding influence of neighborhood physical and social disorder by including these measures as predictors of exposure to violence. Prior research has shown that neighborhood disorder is highly predictive of psychological distress, in part because disorderly neighborhoods are subjectively alienating (Ross and Mirowsky, 2009). Disorder may also breed neighborhood violence by signaling to would-be perpetrators that social control processes in the neighborhood have broken down (Wilson and Kelling, 1982). Thus, the relationship between exposure to violence and anxiety-depression may be largely spurious once accounting for neighborhood disorder.

Our findings can help make sense of results from the MTO experiment. As noted, 4 to 7 years after the MTO demonstration began, those male youths who moved out of impoverished neighborhoods (many of which were also violent neighborhoods) showed no improvement in psychological distress and actually engaged in more risky behavior (Sanbonmatsu et al., 2011). One likely reason for these findings—though perhaps not the only reason—is that neighborhood effects endure.

To conclude, we note that much of criminological research on neighborhoods and crime is based upon a single time point of data on neighborhood conditions. Yet neighborhood effects may result not only from where an individual lives in the present, but also where that individual lived in the past (Wodtke, Harding, and Elwert, 2011). And the effect of neighborhood conditions on internalizing and externalizing problems may also depend upon how much time an individual has spent in that neighborhood environment, and at what point in his or her life. In this study we have presented what we regard as an initial assessment of the temporal consequences of neighborhoods. We find

that the effect of exposure to violence endures, but have left unanswered whether it endures more for some individuals than others. It could be that the effect of violence exposure lingers even longer for those individuals exposed early in life, as well as those youths chronically exposed relative to those individuals exposed to isolated incidents. On the other hand, youths chronically exposed to violence may become desensitized to it. Sorting through the complexities of the temporality of neighborhood effects remains a challenge, both conceptually and empirically, yet it is vital to do so in order to develop effective mobility and neighborhood-based programs that are backed by evidence-based science.

INTRODUCTION

STATEMENT OF THE PROBLEM

The Moving to Opportunity for Fair Housing Demonstration (MTO) was one of the most ambitious anti-poverty experiments of the past two decades. It was designed to examine whether an individual would behave differently—in terms of crime, education, employment, and other individual outcomes—or realize improvements in mental and physical health if he or she lived in a nonpoor neighborhood instead of a poor neighborhood. To facilitate this comparison, MTO used the provision of geographically restricted housing vouchers to enable residents of public housing in severely impoverished neighborhoods to move to neighborhoods where fewer than 10 percent of the households lived in poverty.²

Interim findings from the MTO experiment—4 to 7 years after random assignment—indicated that moving male youths out of impoverished neighborhoods had no effect on psychological distress, depression, and anxiety. Moreover, moving out of poverty did not lead to a significant decline in the likelihood of arrest for a violent crime among males, and actually led to more risky behavior (i.e., drug and alcohol use, smoking, and arrest for property crime) (Kling, Liebman, and Katz, 2007; Kling, Ludwig, and Katz, 2005; Sanbonmatsu et al., 2011). These findings suggest that changing individuals' neighborhood environment does not lead to healthier outcomes, at least not

² MTO was authorized by the U.S. Congress in 1992 and initiated by the U.S. Department of Housing and Urban Development in 1994 in Baltimore, Boston, Chicago, Los Angeles, and New York (Katz, Kling, and Liebman, 2001; Kling et al., 2007). MTO families were randomly assigned to one of three groups: (1) an experimental group, which received relocation assistance and a housing voucher that had to be used in areas with under 10 percent poverty; (2) a Section 8 comparison group, which received a geographically unrestricted housing voucher but did not receive relocation assistance; and (3) a control group that received no change in housing assistance. Researchers used a comparison of individual behaviors and health across these three groups to make claims about neighborhood effects.

immediately. If we assume that residing in poor, violent neighborhoods is detrimental to health and social behavior, how can we explain these findings?

In our view, the findings from MTO are unsurprising. Any bewilderment associated with the findings may be due to the fact that researchers have traditionally taken a static view of neighborhoods and their effects (for a discussion, see Kirk and Laub, 2010). The bulk of “neighborhood effects” research examines the impact of neighborhoods cross-sectionally, thereby ignoring the possibility that the effect of a neighborhood on an individual may endure even if he or she leaves the neighborhood or if the neighborhood fundamentally changes. Yet, from a public policy standpoint, it is critical to understand whether the effects of neighborhood context are situational *and* whether they endure over time. If effects do endure, then policy-makers must set realistic expectations about the pace of change when enacting programs such as MTO.

For this study, we take seriously the notion that neighborhood social contexts have more than just a contemporaneous effect. In particular, we focus on both the acute and enduring consequences of exposure to one particular neighborhood condition, namely violence. Exposure to violence is a common occurrence in the milieu of urban youths. In fact, more than 40 percent of adolescents aged 14-17 witness some form of assault each year, and 10 percent witness a shooting (Finkelhor et al., 2009). Neighborhood violence is often regarded as an outcome variable in research (e.g., Kirk and Papachristos, 2011; Sampson, Raudenbush, and Earls, 1997), yet neighborhood violence may also be a causal mechanism that both directly and indirectly affects behavior and well-being. For instance, research of Chicago adolescents reveals that exposure to firearm violence in the community doubles the likelihood that an adolescent

will subsequently perpetrate violence (Bingenheimer, Brennan, and Earls, 2005). Research also reveals that exposure to crime and violence leads to an assortment of detrimental youth outcomes including posttraumatic stress disorder (Fitzpatrick and Boldizar, 1993; Margolin and Gordis, 2000). In turn, the mental health consequences of exposure to violence impair cognitive development and hinder educational attainment (Harding, 2009; Margolin and Gordis, 2000).

This study is guided by two specific objectives. First, we seek to identify the acute effect of exposure to neighborhood violence on youth mental health, specifically both externalizing problems (i.e., aggression) and internalizing problems (i.e., depression/anxiety). Second, we seek to determine whether—and correspondingly, why—exposure to violence may have an enduring effect on youth mental health.

THEORETICAL FRAMEWORK

The theoretical framework guiding this study is a sociogenic view of child development, which links variations across individuals in human development and behavior to variations in the social and physical environments in which individuals are embedded (Dannefer, 1984). The influential work of Bronfenbrenner (1979; 1989) is particularly relevant to our research strategy. Bronfenbrenner argued that human development is a joint function of the person and environment, and that researchers must acknowledge that developmental outcomes and contextual effects from the past have a cumulative impact on individuals over the life course. Bronfenbrenner (1989, p. 190) noted, “the characteristics of the person at a given time in his or her life are a joint function of the

characteristics of the person and of the environment over the course of that person's life up to that time.”

While much recent research has examined the influence of neighborhood conditions on various outcomes, fewer studies have employed Bronfenbrenner's (1979; 1989) theoretical framework to consider the importance of the *enduring* consequences of exposure to neighborhood risks. As Buka and colleagues (2001, p. 308) observe, “[T]he dearth of longitudinal studies on children's community ETV [exposure to violence] is a serious limitation on our understanding of causal pathways among ETV, resulting psychiatric and behavioral sequelae, and intervening factors.” In the subsections to follow, we describe prevailing research on the effects of exposure to violence, highlighting theoretical frameworks to explain both acute and enduring effects.

Stress and Strain

Much of the literature on exposure to violence documents the stressful nature of such exposure and the subsequent repercussions. The range of studies in this realm spans numerous disciplines, and extends beyond exposure to neighborhood-based violence. In the psychiatric literature, for example, much research attention has been devoted to disentangling the psychological and emotional repercussions of exposure to wartime stress and violence (see, e.g., Garmezy and Rutter, 1985). Correlates of wartime stress in children include anxiety, depression, sleep disturbances, psychosomatic disturbances, and fear (see Martinez and Richters, 1993). In biomedical research, several recent studies have examined the health consequences from stress associated with the September 11th terrorist attacks. For instance, Eskenazi and colleagues (2007) found that births in the

immediate aftermath of the attacks were significantly more likely to be characterized by low birth weight than babies born in the three weeks prior to September 11th, and suggested that it is because of elevated levels of maternal stress.

In this study we focus on street violence (e.g., assault and shootings), which may nevertheless have significant implications for stress and strain. Agnew's *General Strain Theory* (1992; 2001) provides one theoretical framework for explaining the robust relationship between environmental stressors and the subsequent psychological distress observed in empirical research. One of the major types of strain explored by Agnew is strain from negative or noxious stimuli. Agnew (1992, p. 58) argues, "Noxious stimuli may lead to delinquency as the adolescent tries to (1) escape from or avoid the negative stimuli; (2) terminate or alleviate the negative stimuli; (3) seek revenge against the source of the negative stimuli or related targets...and/or (4) manage the resultant negative affect by taking illicit drugs." Noxious stimuli may take the form of high rates of neighborhood crime and violence (Agnew, 2006) as well as exposure to violence and crime through the victimization of friends or family (Agnew, 2002). Aggression, in particular, presents a means to escape or alleviate the effects of noxious stimuli such as exposure to violence. In fact, one of the most basic ways that exposure to violence leads to aggression is through the activation of the fight-or-flight response in individuals, which is a neuroendocrine response to dangerous and threatening situations (Cannon, 1929; Mirowsky and Ross, 2003).

Besides aggression, Agnew (1992) observes that individuals exposed to strain may have a range of negative emotions in response, including disappointment, fear, and depression. Broidy and Agnew (1997) suggest that responses to strain may vary by

gender, with women more likely to respond to strain with depression than men (but see Mirowsky and Ross, 1995).

Empirically, the link between exposure to violence and strain is perhaps most apparent in investigations of post-traumatic stress disorder (PTSD). Symptoms of PTSD, including flashbacks, irritability, and feelings of detachment, have been found among youths exposed both to single incidences of violence (Pynoos et al., 1987) and multiple or chronic exposures to neighborhood violence (Fitzpatrick and Boldizar, 1993; see also, Scheeringa et al., 1995). Moreover, Giaconia et al. (1995) have found that PTSD resulting from traumatic events, including witnessing homicide, is associated with high rates of suicide attempts, poor academic performance, and internalizing and externalizing behavioral problems—including anxiety, depression, and aggression. Of import, many of these problems persisted nearly four years after youths witnessed violence and developed PTSD, illustrating the enduring effects of exposure to violence.³

Normalization

The normalization thesis suggests that youths exposed to acts of violence, particularly chronic exposure, come to view violence as normative. There is a well-documented link between childhood maltreatment and physical abuse and the emergence of aggressive behavior and violence later in life (Margolin and Gordis, 2000; Smith and Thornberry, 1995; Widom, 1989; Widom and Maxfield, 2001). Through experiencing physical abuse,

³ Beyond neighborhood environments, reports of PTSD and internalizing and externalizing problems have also been found to be much higher among youth exposed to violence in other contexts, such as incarceration. For instance, in a sample of incarcerated youth, Cesaroni and Peterson-Badali (2005) found that perceptions of safety were predictive of internalizing behaviors. Additionally, youth entering custody with pre-existing risk factors (e.g., prior aggression, anxiety, and depression) were found to be adversely affected by imprisonment and reported an increase in their levels of internalizing problems. The effects of past exposure to stressful environments thus influence a youth's ability to cope with future strains.

a child is taught not only aggressive behavior but also that the use of aggression in certain situations is normative (Bandura, 1973; Dodge, Pettit, and Bates, 1997; Margolin and Gordis, 2000). A similar link has also been documented regarding exposure to neighborhood violence. Lorion and Saltzman (1993) found that when exposed to neighborhood violence, youths come to perceive these events as normative.⁴

As a basis for the normalization thesis, researchers point to the robust relationship between exposure to violence and the subsequent perpetuation of violence. Miller and colleagues (1999) prospectively studied the effects of exposure to neighborhood violence in a sample of high-risk boys aged 6 to 10, and found that witnessing violence was significantly related to subsequent increases in antisocial behavior. Similarly, Farrell and Bruce (1997) found in their study of middle-school youths that exposure to violence is significantly predictive of an increase in violent behavior. Gorman-Smith and Tolan (1998) examined two-waves of longitudinal data from a sample of inner-city Chicago youths and found that exposure to violence was related to reported levels of both depression and aggression. Regarding the latter, Gorman-Smith and Tolan suggested that, over time, youths exposed to neighborhood violence may come to see violent or aggressive responses to certain situations as appropriate or even necessary.

The preceding discussion illustrates that there is a close link between the normalization thesis and social learning theory. Youths learn that violence is a normative course of action to use in certain situations. In a similar vein, Anderson (1999) provides qualitative evidence suggesting that exposure to violent disputes among older youths

⁴ That said, even if youth come to view violence as normative, family and neighborhood characteristics—such as having supportive family members and a protected place to go in the neighborhood—often act to buffer exposed individuals from the deleterious effects of violence (Garbarino et al., 1992; Osofsky, 1995; Richters and Martinez, 1993, Widom, 2000). Thus, exposure to violence and subsequent aggression and violent offending may be positively linked, but the relationship may be moderated by social buffers.

leads younger children to internalize a street code that mandates violence under certain circumstances. This cultural code is learned through exposure to violent altercations.

Social Cognition and Street Efficacy

Whereas there are cultural reasons why the use of violence may come to be normalized (i.e., the code of the street), there are also cognitive reasons. In this regard, two prominent streams of thought are Mirowsky and Ross's (2003; Ross and Mirowsky, 2009) conditions-cognitions-emotions theory and Bandura's (1997) social cognitive theory of self-efficacy.

Ross and Mirowsky (2009) argue that subjective alienation is the cognitive link between conditions in the social environment and various forms of psychological distress. Subjective alienation refers to one's perceived disconnect from society. Generally, there are five basic forms of alienation: powerlessness, self-estrangement, isolation, meaninglessness, and normlessness (Seeman, 1959; 1983). Ross and Mirowsky find that living in a dangerous environment produces anger, anxiety, and depression because neighborhood conditions are threatening and alienating. Residents of disorderly, threatening neighborhoods come to view their neighbors with suspicion and to see themselves as powerless to control the circumstances in which they live. In turn, mistrust of others and perceived powerlessness and loss of control increases psychological distress, particularly anxiety and depression (Benassi, Sweeney, and Dufour, 1988; Mirowsky and Ross, 2003; Ross and Mirowsky, 2009).

In contrast to powerlessness, self-efficacy refers to an individual's belief or conviction that he or she has the capacity to achieve a desired outcome or goal. A key

determinant of self-efficacy is social context, and self-efficacy mediates the association between environmental influences and outcomes such as internalizing and externalizing behaviors (Bandura, 1993). That is, neighborhood context affects youth mental health through its impact on cognition (Sharkey, 2006). Support for this proposition has been found in several studies of adult samples, revealing that individuals exposed to stressful neighborhood conditions subsequently show lower levels of self-efficacy (Rosenbaum, Reynolds, and DeLuca, 2002; Ross, Mirowsky, and Pribesh, 2001).

Sharkey (2006) turned the empirical lens towards adolescents, and found that youths exposed to violence have declining levels of one critical form of self-efficacy, what he termed “street efficacy.” Sharkey (2006, p. 827) defined street efficacy as “the perceived ability to avoid violent confrontations and find ways to be safe in one’s neighborhood.” Exposure to violence may erode street efficacy because youths believe that little can be done to avoid violent confrontations (see Farrington, 1995). Moreover, trying to avoid violence may be detrimental to social status in some neighborhoods (Anderson, 1999), and it may be futile anyway. Individuals with low levels of street efficacy may perceive that they have few options for resolving conflicts and threats besides violence. Hence, Sharkey found that youths with a shortage of street efficacy were much more likely to engage in violent behavior.

In terms of anxiety and depression, Bandura (1993, p. 132) argues, “People’s belief in their capabilities affect how much stress and depression they experience in threatening or difficult situations...Perceived efficacy to exercise control over stressors plays a central role in anxiety arousal...those who believe they cannot manage threats experience high anxiety arousal.” Generally then, powerlessness and the loss of personal

control from neighborhood violence undermines self-efficacy, which in turn leads to internalizing and externalizing problems in the form of anxiety, depression, and aggression.

THE CURRENT STUDY

Whereas prior research on exposure to neighborhood violence illustrates that exposure can have detrimental effects on mental health and numerous other health and behavioral outcomes, important challenges remain. First, with a few notable exceptions (e.g., Giaconia et al., 1995; Gorman-Smith and Tolan, 1998), the majority of studies examining the effects of exposure to violence on the individual have been primarily based on cross-sectional data, limiting our understanding of the enduring effects of exposure to violence. Second, the observed correlations between exposure to violence and youth mental health (e.g., aggression, anxiety, and depression) may be explained by alternative, unmeasured factors. For example, socioeconomic status is significantly associated with a variety of forms of psychological distress, and also with neighborhood conditions such as disorder and violence (Mirowsky and Ross, 2003). Specific to aggression, a lack of parental supervision and monitoring in childhood may result in the development of aggressive tendencies and also explain why individuals may find themselves in situations where they are exposed to violence or even victimized by violence. In terms of depression, substance abuse is one of the most widely regarded causes of depression, but satisfying an addiction may put people in risky situations where they are exposed to violence. There are surprisingly few studies that account for such confounding, especially in a life course or longitudinal framework. Third, there are relatively few empirical examinations of the

mediating mechanisms between exposure to violence and youth mental health, in part because of data limitations in prior research.

We attempt to meet these challenges by assembling a unique, multi-wave longitudinal data set from a representative sample of urban youths that comprises assessments of individuals and their families throughout child and adolescent development, as well as an assessment of their neighborhood context. With these data, we use propensity-score matching combined with a sensitivity analysis (Rosenbaum, 2002) to identify the independent relationship between exposure to violence and both internalizing (i.e., anxiety and depression) and externalizing (i.e., aggression) problems. We also focus on explaining *why* exposure to violence may lead to internalizing and externalizing problems, specifically examining the role of street efficacy. Drawing upon Sharkey's (2006) work, we hypothesize that exposure to violence impairs street efficacy because individuals perceive that they have little control over their environment. A response to this lack of control is a heightened level of aggression necessary for protection, and also heightened anxiety and depression brought on by the lack of control and fear associated with exposure to violent situations.

METHODS AND DATA

To examine the repercussions of exposure to violence for both aggression and anxiety/depression, this study utilizes individual-level data from the Project on Human Development in Chicago Neighborhoods Longitudinal Cohort Study (PHDCN-LCS) and neighborhood data from both the PHDCN Community Survey (PHDCN-CS) and the 1990 U.S. Census.

For the PHDCN-LCS, longitudinal data was collected on seven cohorts of subjects, defined by age at baseline (0, 3, 6, 9, 12, 15, and 18), with subjects and their primary caregivers interviewed up to three times between 1995 and 2002. Wave 1 of the survey was completed between 1994 and 1997; wave 2 was completed between 1997 and 2000; and wave 3 of the survey was completed between 2000 and 2002. The interval between interviews was approximately 2.5 years.

The focus of our analysis is on the 12-year-old and 15-year-old cohorts; these youths were approximately 18 and 21 years-old by the end of the data collection in 2002. These two cohorts responded to questions at each of the three waves of data collection about their exposure to violence and self-reported information about aggression, anxiety, and depression. The PHDCN-LCS data also contains a wealth of information on youth and family characteristics, including data on family structure and supervisory processes, peer characteristics, and criminal offending. The breadth of the PHDCN-LCS data provides a unique opportunity to account for confounding influences when estimating the effect of exposure to violence on youth aggression, anxiety, and depression (see Tables 1 and 2 for a list of youth, family, and peer characteristics drawn from the PHDCN-LCS).

VARIABLES

In this study we focus explicitly on aggravated forms of violence exposure. Presumably more “noxious” forms of violence are more likely to have acute and enduring effects on mental health and behavior. We measure **exposure to violence** with a binary variable indicating whether the respondent had either: 1) **seen** someone else get attacked with a weapon like a knife or bat, or 2) **seen** someone else get shot in the preceding

twelve months.⁵ If a respondent answered affirmatively to either question, we coded his or her value of exposure as ‘1’ (and ‘0’ otherwise). We focus on incidents that occur to “someone else” in order to focus on violence exposure that is witnessed, as opposed to personal victimizations.

Two dependent variables are utilized in our analyses: **aggression** and **anxiety-depression**. Each measure is derived from the Youth Self Report (YSR) survey instrument, which was developed by Achenbach (1991) to assess emotional and behavioral characteristics of youths. We first summed the responses from the following aggression items: 1) I argue a lot, 2) I try to get a lot of attention, 3) I destroy things belonging to others, 4) I disobey at school; 5) I get in many fights, 6) I scream a lot, 7) I am stubborn, 8) My moods or feelings change suddenly, 9) I tease others a lot, 10) I have a hot temper, and 11) I threaten to hurt people. Response categories for each of these items included: not true (0), somewhat or sometimes true (1), and very or often true (2). Per convention, we then dichotomized the scale at the 90th percentile to correspond to the “clinical” cutoffs (Achenbach, 1991; 1997). Youths who score above clinical cutoffs are categorized as highly aggressive.

We used a similar coding scheme to create the anxiety-depression measure. We summed responses to the following sixteen items (with the same three response categories): 1) I deliberately try to hurt or kill myself, 2) I feel that others are out to get me, 3) I am suspicious, 4) I feel lonely, 5) I cry a lot, 6) I am afraid I might think or do something bad, 7) I feel that I have to be perfect, 8) I feel that no one loves me, 9) I feel worthless or inferior, 10) I am nervous or tense, 11) I am too fearful or anxious, 12) I feel too guilty, 13) I am self-conscious or easily embarrassed, 14) I think about killing myself,

⁵ Does not include shots from a BB gun or from some form of toy weapon like a paint ball gun or air rifle.

15) I am unhappy, sad, or depressed, and 16) I worry a lot. We then dichotomized this scale at the 90th percentile.

In our analyses, we also examine the role of social cognition, specifically **street efficacy** (Sharkey, 2006), as a mediator of the effect of exposure to violence on aggression and anxiety-depression. Our measure of street efficacy represents the mean across responses to the following survey items from wave 3 of the PHDCN-LCS measuring respondents' perceptions of their ability to avoid violent confrontations or to find ways to be safe in their neighborhoods: 1) "Some kids feel they can figure out ways to be in their neighborhood safely," but "Other kids feel no matter what they do, they can not be in the neighborhood safely"; 2) "Some kids feel they can not avoid gangs in their neighborhood even if they try," but "Other kids feel, even if it may not be easy, they can avoid gangs if they try"; 3) "Some kids feel if they work at it, they can go places within a few blocks of their home safely," but "Other kids feel they can not be sure about getting places within a few blocks of their home safely"; 4) "Some kids feel they have trouble avoiding fights in their neighborhood even when they try," but "Other kids feel they can figure out ways to avoid getting into fights in their neighborhood"; 5) "Some kids feel no matter what they do, they aren't safe when they are alone in their neighborhood," but "Other kids feel safe when they are alone in their neighborhood because they know how to take care of themselves." Respondents were asked to select one of the two responses within each item which they most closely resemble. We reverse coded the first and third items. See Sharkey (2006) for a detailed description of the coding scheme.

Data on neighborhood-level culture, disorder, and social-interactive processes come from the 1995 PHDCN-CS, and neighborhood measures of concentrated poverty,

residential stability, and immigrant concentration derive from the 1990 U.S. census. Regarding the latter, all three census-based scales were created via principal components analysis, where items included in each component were weighted by their component loadings. Concentrated poverty refers to a scale of economic disadvantage measured by the following census indicators: the percentage of families below the poverty line, of families receiving public assistance, of unemployed individuals in the civilian labor force, of female-headed families with children, of residents under age 18, and of black residents. Immigrant concentration is derived from two census indicators: the percentage of Latino residents and of foreign born residents. Residential stability is derived from the following census indicators: the percentage of residents five years old and older who lived in the same house five years earlier and of homes that are owner-occupied.

The PHDCN-CS yielded a probability sample of 8,782 Chicago residents, who responded to a series of questions about the characteristics of their neighborhood environments. The PHDCN-CS data was collected on a sample independent of the PHDCN-LCS data collection mentioned previously. Therefore, neighborhood-level measures are not simply aggregated responses from the cohort study. For the purposes of the PHDCN-CS, neighborhood boundaries were operationally defined by combining 847 census tracts into 343 neighborhood clusters, constructed to be "...as ecologically meaningful as possible, composed of geographically contiguous census tracts, and internally homogeneous on key census indicators" (Sampson et al., 1997, p. 919). These census indicators include socioeconomic status, race/ethnicity, housing density, and family structure. An average of 8,000 residents comprises each of the 343 neighborhood clusters. Following conventions utilized in previous empirical analyses with the PHDCN-

CS data (see, e.g., Sampson and Bartusch, 1998; Sampson and Raudenbush, 1999; Sampson et al., 1997), we utilize the following neighborhood-level scales constructed from resident responses to survey questions: Satisfaction with the Police, Legal Cynicism, Physical Disorder, Social Disorder, and Collective Efficacy.

The total sample size at wave 1 for respondents in the 12-year-old and 15-year-old cohorts equals 1,517. Because of attrition, the wave 2 sample totals 1,242, and the wave 3 sample equals 1,067.⁶

ANALYTIC STRATEGY

Our analyses follow three paths. First, we seek to determine what would happen to the internalizing and externalizing behaviors of an individual in two different circumstances, one where the individual had not been exposed to violence and the other where the individual had witnessed an assault via a weapon (knife, bat, or firearm). Of course we only observe one of these potential outcomes at a given point in time—i.e., a youth is either exposed to violence or not. Outside a randomized mobility program such as MTO, it is not conceivable to use randomization to investigate the effects of exposure to violence. Thus, we employ propensity score matching to approximate an experimental design where treated youths (i.e., exposed to violence) are equivalent to control group youths (i.e., not exposed) (Rosenbaum, 2002).

A key issue when attempting to estimate the effect of a treatment in an observational study is a lack of comparability between treatment and control groups.

⁶ To account for any bias associated with attrition from wave 1 to wave 3 of the PHDCN-LCS, we use attrition weights in our analyses of aggression and anxiety-depression. We first estimate the probability of responding to aggression and anxiety-depression questions at wave 3 as a function of the wave 1 covariates displayed in Tables 1 and 2 to follow, and then take the inverse of this probability to use as an inverse probability of attrition weight in our analysis.

Imbalance between the groups occurs if there are differences in the pre-treatment characteristics of each group. In particular, imbalance becomes a problem if there are differences across groups in confounding factors—i.e., characteristics of youths that are related both to the likelihood of violence exposure and mental health. If groups are not balanced, then a comparison of the prevalence of mental health problems across groups will not yield a valid estimate of the effect of exposure to violence. Some other difference between the groups besides exposure to violence may account for differences in aggression, anxiety, and depression.

To resolve any issues of imbalance, we statistically adjust for differences between groups through propensity score matching (Morgan and Winship, 2007). The propensity score is defined as the probability that a given youth is exposed to violence given all that we observe about him and his family, peers, and neighborhood. It is a summary measure of the characteristics which could confound our ability to estimate the effect of exposure to violence on youths' mental health. We estimate the propensity of violence exposure for each youth using a logit model with exposure to violence as the binary outcome variable. We use 68 different covariates measured at the first wave of the data collection (displayed in Tables 1 and 2) as predictors of exposure, including measures of prior exposure, and then calculate the predicted probability of exposure at wave 2 based on these covariates.⁷ By accounting for such an extensive set of potential

⁷ To handle missing data from non-response with our pretreatment covariates, we use the *ice* command in Stata to implement the multiple imputation by chained equation algorithm to create five imputed data sets (see Royston, 2004; van Buuren, Boshuizen, and Knook, 1999). Following Hill (2004, p. 13), we next compute a propensity of exposure to violence for each observation in each of the imputed data sets. We then average the propensity scores for each respondent across the five imputed data sets, and use this average propensity score when performing our matches,

confounders, we seek to eliminate the potential for hidden biases in our estimation of the effect of exposure to violence.

Following estimation of the propensity score, we match each treated subject (i.e., exposed) with a control subject (i.e., non-exposed) with a similar propensity score. Our objective is to produce treatment and control groups that are indistinguishable once we have conditioned on propensity scores. We utilize one-to-one matching without replacement—i.e., each control subject is matched to one treated subject—and do so within a caliper of 0.02 to ensure that the match for each treated subject is suitable (caliper refers to a maximum distance between the propensity scores of the treated and control subjects).

Second, we use Rosenbaum's (2002) bounding approach to examine the sensitivity of our propensity-matched inferences to hidden biases (see also Becker and Caliendo, 2007; DiPrete and Gangl, 2004). This approach allows us to determine how strongly an omitted confounding variable must influence selection into treatment to undermine our inferences about the causal effect of exposure to violence. See Appendix A for further description of this bounding methodology.

Third, if exposure to violence has an acute effect on youth mental health, as we attempt to determine through our first and second analytic phases, we then seek to determine if this effect endures over time (i.e., from wave 2 to wave 3 of the PHDCN-LCS). Moreover, if the effect of exposure endures, we aim to determine why that might be the case. Specifically, we examine whether exposure to violence adversely affects social cognitions, and whether social cognitions mediate the enduring effect of exposure to violence on youth mental health.

RESULTS

Table 1 presents a comparison of individual and demographic characteristics between exposed and unexposed youths, before and after matching on the propensity of exposure to violence. The unadjusted pre-match differences reveal that youths exposed to violence at wave 2 of the PHDCN-LCS are more likely to have been exposed in the past (wave 1) than unexposed adolescents. Initial levels (wave 1) of aggression are higher for exposed individuals, and so is anxiety and depression.

Exposed individuals are more likely to be male and older, less likely to be white, and have lower IQs, on average, than unexposed individuals.⁸ There are marked differences in problem behavior between the groups. Exposed individuals commit more violent, property, public-order crimes. Because of engagement in criminal activity, these individuals likely put themselves into situations and contexts where they will be exposed to violence.

Individuals exposed to violence are also more likely to have been truant, and to engage in the use of various substances (marijuana, alcohol, and cigarettes). Exposed individuals are also more likely to have somatic complaints and to have attention and thought problems, as measured by the Youth Self Report survey instrument (Achenbach, 1991). Youths exposed to violence also tend to have less self-control and persistence, and are more commonly sensation seeking.

⁸ A secondary objective of our study was to explore the race-ethnic differences in exposure to violence in greater detail. Rather than limiting our analysis to estimating race-ethnic differences in exposure at Wave 1 of the data collection, we used life tables to estimate the length of exposure to violence throughout childhood across race and ethnicity. This analysis can be found in the Appendix B. Findings reveal that the average white child can expect to spend the vast majority of childhood residing in neighborhoods where they will experience little to no direct exposure to violence. By contrast, black children can expect to spend less than half of childhood in such a neighborhood, and over 10% of childhood in neighborhoods with high levels of violence exposure. Latino youths fall in the middle ground, and can expect to spend two-thirds of childhood in a neighborhood with little exposure to violence but almost 10% of childhood in a neighborhood where youths are routinely exposed to violence.

The bottom portion of Table 1 displays summary statistics for peer characteristics by group. We find that peers of exposed youths are generally less supportive than peers of unexposed youths, and put more pressure on them to use alcohol or drugs. We also see that youths exposed to violence are significantly and substantially more likely to associate with deviant peers.

	Means		Differences in Means		% Reduction in Absolute Bias	Post-Match Hypothesis Test	
	Exposed	Unexposed	Unadjusted	Post-Match		T-Statistic	P-value
Youth Characteristics							
Exposure to Violence (Wave 1)	0.30	0.12	0.18 ***	-0.04	78.5	-1.05	0.294
Aggression (Wave 1)	5.65	4.26	1.40 ***	-0.04	96.9	-0.14	0.886
Anxiety-Depression (Wave 1)	6.44	5.56	0.88 **	-0.09	89.3	-0.21	0.831
Male	0.58	0.44	0.14 ***	0.00	100.0	0.00	1.000
Race-Ethnicity (versus Black)							
Mexican	0.31	0.36	-0.05	-0.01	85.6	-0.19	0.850
Puerto Rican/Other Latino	0.15	0.14	0.00	-0.02	-406.8	-0.74	0.461
White	0.09	0.16	-0.07 **	0.02	76.6	0.62	0.537
Other Race/Ethnicity	0.02	0.03	0.00	-0.02	-352.5	-1.08	0.279
Age (Wave 1)	13.70	13.39	0.31 **	0.10	65.8	0.78	0.437
Cohort (15-yr-old)	0.52	0.41	0.11 ***	0.04	64.0	0.89	0.375
IQ	98.35	101.02	-2.67 **	-0.58	78.1	-0.45	0.651
Problem Behavior							
Truancy	0.03	0.01	0.02 *	0.01	64.3	0.64	0.523
Ever Retained in Grade	0.17	0.14	0.03	0.00	85.4	0.15	0.880
Violent Offending	0.46	-0.11	0.57 ***	-0.03	93.9	-0.44	0.660
Property Offending	0.21	-0.03	0.24 ***	-0.03	88.7	-0.52	0.606
Public-Order Offending	0.18	-0.09	0.27 ***	0.00	99.9	-0.01	0.994
Drug Distribution	-0.06	0.00	-0.07	0.04	47.0	0.88	0.377
Marijuana Use	1.27	1.07	0.20 ***	0.03	86.7	0.37	0.708
Alcohol Use	1.25	1.10	0.15 ***	0.01	92.1	0.22	0.825
Cigarette Use	1.43	1.15	0.28 ***	-0.03	89.1	-0.35	0.729
Withdrawal	3.70	3.52	0.18	0.19	-3.6	0.84	0.404
Somatic Complaints	4.54	3.63	0.92 ***	0.16	82.4	0.55	0.582
Attention Problems	5.48	4.48	1.00 ***	-0.10	89.8	-0.34	0.736
Thought Problems	3.84	3.16	0.67 ***	0.00	99.4	-0.02	0.987
Temperament							
Lack of Control	2.51	2.36	0.15 *	0.00	99.2	-0.01	0.989
Lack of Persistence	2.52	2.39	0.13 **	-0.05	61.8	-0.59	0.554
Decision Time	3.10	2.92	0.17 **	0.03	84.5	0.36	0.717
Sensation Seeking	2.81	2.70	0.11 *	0.01	93.5	0.10	0.918
Activity	3.67	3.60	0.07	-0.01	91.6	-0.08	0.937
Emotionality	2.76	2.64	0.12	-0.02	83.3	-0.22	0.826
Sociability	3.70	3.63	0.07	0.00	97.7	0.02	0.981
Shyness	2.39	2.46	-0.07	-0.08	-22.1	-1.03	0.303
Peer Characteristics							
Friend Support	0.01	0.08	-0.07 *	-0.02	75.1	-0.41	0.685
Peer Attachment	0.01	0.06	-0.05	0.02	71.5	0.25	0.805
Peer Pressure	0.29	-0.18	0.47 ***	0.05	88.5	0.56	0.576
Deviance of Peers	0.28	-0.13	0.41 ***	-0.01	97.2	-0.17	0.866
Note: Data is drawn from Wave 1 of the PHDCN-LCS.							
* p < 0.05 ** p < 0.01 *** p < 0.001							

Table 2 illustrates differences across groups in terms of family characteristics and neighborhood of residence. We find that youths exposed to violence are less likely to have a primary caregiver who is married. Exposed youths also receive less support and supervision from their families than non-exposed youths, and are subject to more parent-child conflict. In terms of the home environment, exposed youths have less access to reading and their parents are not generally as warm towards them as unexposed youths. The exterior of the home and immediate face block where exposed youths reside tend to be more deteriorated and disorderly, and the interior of the home is less safe and more disruptive and noisy than the residences of non-exposed youths.

	Means		Differences in Means		% Reduction in Absolute Bias	Post-Match Hypothesis Test	
	Exposed	Unexposed	Unadjusted	Post-Match		T-Statistic	P-value
Family Characteristics							
Family Socioeconomic Status	-0.28	-0.14	-0.14	0.00	98.3	-0.02	0.984
Married Parents	0.49	0.59	-0.10 **	-0.02	76.4	-0.55	0.581
Length of Residence	5.23	5.81	-0.58	-0.06	90.3	-0.13	0.893
Extended Family in Household	0.21	0.17	0.04	0.00	89.3	0.11	0.910
Num. of Children in Household	3.32	3.38	-0.06	-0.07	-23.8	-0.45	0.653
Family Supervision	-0.13	0.00	-0.13 *	0.01	90.2	0.18	0.858
Family Control	58.91	58.13	0.78	0.06	92.2	0.08	0.935
Family Conflict	48.31	47.40	0.91	0.19	78.7	0.21	0.832
Family Religiosity	60.74	60.60	0.13	0.21	-59.8	0.34	0.732
Family Support	-0.12	0.09	-0.22 ***	0.01	95.5	0.13	0.896
Paternal Criminal Record	0.13	0.11	0.02	0.00	100.0	0.00	1.000
Paternal Substance Use	0.15	0.14	0.02	0.01	52.1	0.25	0.804
Maternal Substance Use	0.05	0.04	0.01	0.01	-15.6	0.51	0.612
Maternal Depression	0.17	0.14	0.03	0.00	100.0	0.00	1.000
Parent-Child Conflict	0.07	-0.10	0.17 ***	0.05	69.9	0.74	0.462
Home Environment							
Access to Reading	-0.30	0.02	-0.32 *	0.09	71.0	0.56	0.579
Developmental Stimulation	-0.15	-0.04	-0.11	0.03	75.2	0.31	0.760
Parental Warmth	-0.10	0.18	-0.29 **	-0.05	81.2	-0.37	0.713
Hostility	0.65	0.09	0.56	-0.03	95.4	-0.06	0.948
Parental Verbal Ability	0.09	0.04	0.05	-0.11	-140.1	-0.74	0.457
Family Outings	-0.01	0.00	0.00	0.00	-37.4	0.05	0.959
Home Interior	-0.22	0.10	-0.32 *	0.03	90.0	0.19	0.851
Home Exterior	-0.30	0.08	-0.38 ***	-0.06	85.0	-0.48	0.629
Neighborhood							
Concentrated Poverty	0.13	-0.09	0.22 ***	0.00	98.2	0.06	0.951
Immigrant Concentration	0.39	0.54	-0.15 *	-0.01	95.4	-0.07	0.941
Residential Stability	-0.08	-0.07	-0.01	-0.01	43.2	-0.08	0.940
Satisfaction with Police	2.60	2.63	-0.03	0.01	80.6	0.29	0.768
Legal Cynicism	2.52	2.50	0.02 **	-0.01	51.2	-0.97	0.335
Social Disorder	2.08	2.01	0.07 **	0.01	91.1	0.21	0.832
Physical Disorder	1.71	1.66	0.05 *	0.00	93.9	0.12	0.903
Collective Efficacy	3.87	3.89	-0.02	0.01	37.8	0.55	0.581
LN(1995 Violent Crime Rate)	9.03	8.83	0.20 ***	0.02	89.0	0.40	0.686
Note: Data sources include Wave 1 of the PHDCN-LCS, the 1995 PHDCN Community Survey, the 1990 U.S. Census, and the Chicago Police Department.							
* p < 0.05 ** p < 0.01 *** p < 0.001							

In terms of neighborhood characteristics, as expected, there are stark differences between exposed and unexposed youths on many neighborhood characteristics. Exposed youths reside in neighborhoods with more poverty, more cynicism of the law, more disorder, and more reported violence than unexposed youths.

ACUTE EFFECT OF EXPOSURE TO VIOLENCE

Comparisons presented in Tables 1 and 2 indicate that exposed and unexposed adolescents, on average, differ on numerous individual, peer, family, and neighborhood characteristics. Many of these differences are also associated with aggression, anxiety, and depression. For instance, family socioeconomic status and neighborhood poverty are predictive of exposure to violence and various aspects of youth mental health (see, e.g., Mirowsky and Ross, 2003). Therefore, it is important to determine if any apparent relationship between exposure to violence and our outcome variables is spurious, with each explained by the same set of causal predictors.

We attempt to isolate the effect of exposure to violence on aggression and anxiety-depression by matching exposed and unexposed sample members who are otherwise similar to each other with respect to the observed characteristics of youths, peers, families, and neighborhoods displayed in Tables 1 and 2. If the distributions of propensity scores across the two groups—exposed and unexposed youths—do not contain sufficient overlap, then the groups are too dissimilar on observable covariates to pursue causal inferences via propensity score matching. We do find considerable overlap in the propensity scores of each group even when using a caliper as narrow as 0.02. We are able to match 83 percent of the exposed youths to a control observation. Most of the

treated group who are not matched fall on the far right tail of the distribution. Their propensities of exposure to violence are so extreme that there are not similar control cases to match.

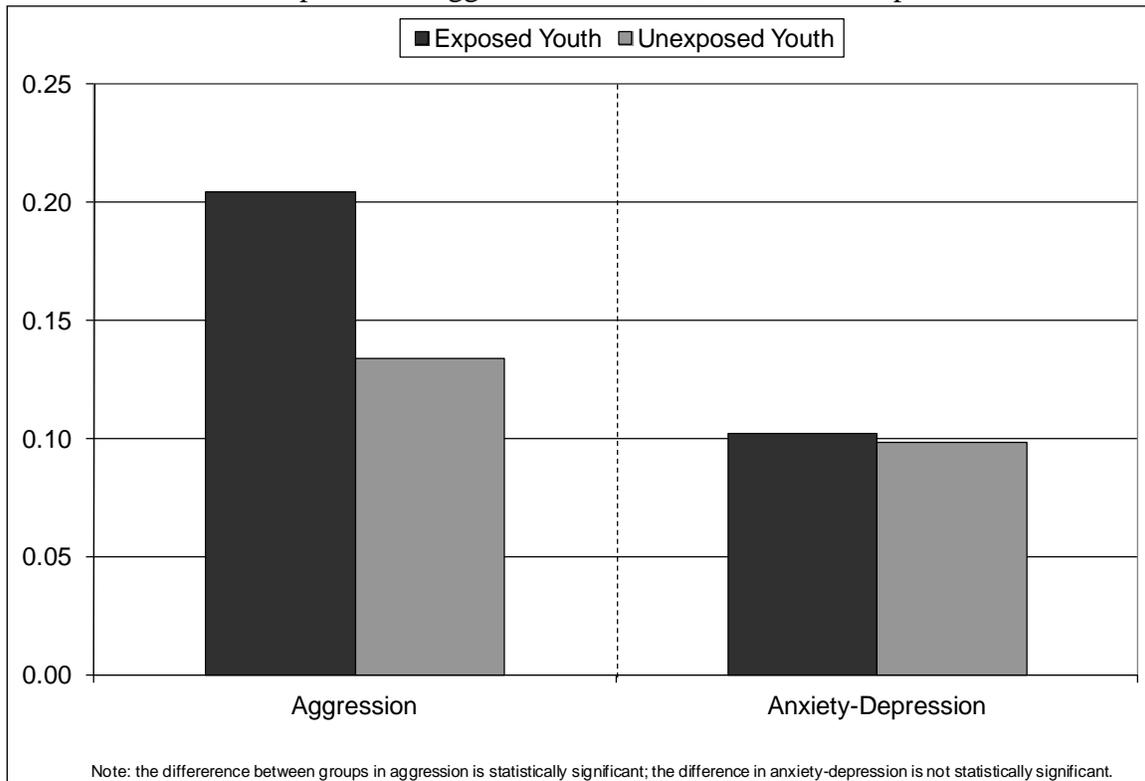
While establishing that we have sufficient overlap in propensity scores is crucial, before proceeding to estimate the effect of exposure to violence we should also determine whether our matching procedure has produced balance across the treatment and control groups on observed covariates. Our objective is to ensure that the treated and control groups are similar, on average, across all observable covariates. In this regard, in Tables 1 and 2 we display the mean differences across groups for each covariate after adjusting for propensity scores. We also display the percent reduction in absolute bias. Bias represents the mean differences across groups as a percentage of the square root of the average of the sample variances: $100 * (\bar{x}_T - \bar{x}_C) / (s_T^2 + s_C^2)^{1/2}$, where \bar{x}_T and \bar{x}_C are the sample means in the treated group and the control group respectively, and s_T^2 and s_C^2 are the respective sample variances (Rosenbaum and Rubin, 1985).

The post-match T-statistics and corresponding p-values in Tables 1 and 2 reveal not one significant difference between treated and controls after matching on propensity score. With few exceptions, matching on propensity score produced decreases in bias. The exceptions, mainly among select family and household variables (e.g., number of children in the household, maternal substance abuse, and family religiosity), occurred because mean values across treated and control groups were nearly identical prior to matching, and matching yielded a slight increase in the difference. Yet increased differences across groups after matching are not statistically significant. Of note in Table 1, we find a 78.5 percent reduction in bias for exposure to violence at wave 1 of the

PHDCN-LCS. Differences between groups on prior exposure to violence are effectively equal to zero. We are thus able to compare aggression and anxiety-depression levels of adolescents who have the same prior (wave 1) experience with exposure to violence, yet some were exposed to violence between waves 1 and 2 and some were not.

With common support and balance, we now turn to an assessment of the *acute* effect of exposure to violence on aggression and anxiety-depression by comparing outcomes across treated and control groups. By acute, we are examining the effect of exposure in the twelve months immediately prior to the wave 2 PHDCN-LCS survey on respondents' levels of aggression and anxiety-depression measured at wave 2.

Figure 1. The *Acute* Likelihood of Aggression and Anxiety-Depression Following Wave 2 Exposure to Aggravated Violence, Matched Comparison.



As depicted in Figure 1, our propensity-based results reveal that adolescents exposed to violence were significantly and substantially more likely to display clinical levels of aggression than otherwise similar individuals who were not exposed to violence. However, we find no difference in anxiety and depression.

SENSITIVITY ANALYSIS, EFFECT OF EXPOSURE TO VIOLENCE

While we have drawn upon an extensive set of potential confounding variables in order to eliminate hidden biases in our estimation of the effect of exposure to violence on youth mental health, it is still possible that there are unobserved confounders that would change the results if included. Therefore, we now estimate a sensitivity analysis based on Rosenbaum's (2002) bounding strategy to address just how substantial unmeasured confounding influences would have to be present to substantially alter our inferences about the effect of violence exposure. Given the non-significant relationship between exposure to violence and anxiety-depression, we limit this analysis of hidden biases to the aggression outcome.

As described in the methodological discussion in Appendix A, Γ in Table 3 refers to the factor increase in the odds of exposure to violence due to unobservable factors beyond the influence of the estimated propensity score. At $\Gamma=1$, we assume there are no hidden biases, and therefore conclude that exposure to violence has a significant positive effect on aggression ($Q^+ = 2.009$, $p < .022$). Positive selection bias would occur if those youths most likely to be exposed to violence tend to be more aggressive even if they had not been exposed to violence. At $\Gamma=1.1$, we are examining the effect of hidden bias which would increase the odds of violence exposure for an exposed individual by an

additional 10 percent relative to an untreated individual, after accounting for the propensity score. Under this scenario, we still find a marginally significant positive effect of exposure to violence on aggression ($Q^+ = 1.610$, $p = .054$). It is not until a Γ equal to 1.2 that unobserved heterogeneity is severe enough to render the treatment effect of exposure to violence no longer significant at $p < .10$. As a comparison, we find that each unit increase in the violent crime rate in a neighborhood increases the odds of exposure in the form of witnessing a violent attack with a knife, bat, or gun an additional 12 percent after controlling for a propensity score that excludes this factor. We believe it is improbable that there is an unobserved factor beyond the 68 we already include in our propensity score estimation that would be drastically more influential than a factor such as neighborhood violence.

Table 3. Rosenbaum Bounds, Effect of Violence Exposure on Aggression		
Γ	Aggression	
	Q^+	p-value
1.00	2.009	0.022
1.05	1.805	0.036
1.10	1.610	0.054
1.15	1.423	0.077
1.20	1.245	0.107
1.25	1.074	0.141

Note: Γ refers to the odds ratio of the effect of unobserved variables on the likelihood of violence exposure for youths who were exposed to violence versus youths who were not.

ENDURING EFFECT OF EXPOSURE TO VIOLENCE

While exposure to violence has an acute effect on aggression, we are also interested in whether this effect might endure and why. Conversely, the effect may dissipate with time

as the initial trauma of the event passes. To adjudicate between these alternative scenarios, we now examine the effect of exposure to violence in the twelve months prior to wave 2 of the PHDCN-LCS on wave 3 aggression. For our analytic strategy, we first regress our dependent variable measured at wave 3 on the wave 2 exposure to violence measure as well as the propensity score. This will establish whether there is an enduring relationship between exposure to violence and aggression. Then we examine the mediating capacity of one particular form of social cognition—street efficacy. Following Sharkey (2006), we suggest that exposure to violence adversely affects street efficacy. And we hypothesize that individuals with higher levels of street efficacy—that is, the perceived ability to avoid violent confrontations and danger—will be less aggressive.⁹

Table 4 presents the results of our analysis of the enduring effect of exposure to violence. Results in Model 1 indicate that exposure to violence during the twelve months prior to wave 2 is predictive of aggression measured over two and a half years later at wave 3, controlling for the propensity of exposure to violence.

Table 4. Street Efficacy as a Mediator of the Effect of Exposure to Violence on Wave 3 Aggression					
	Model 1		Model 2		
	Coef.	Std. Err.	Coef.	Std. Err.	
Intercept	3.963	(0.213) ***	5.621	(0.531) ***	
Exposure to Violence	1.028	(0.350) **	0.978	(0.344) **	
Propensity of Exposure	1.709	(0.988) +	1.259	(0.984)	
Street Efficacy (Wave 3)			-0.714	(0.218) **	
+ p<0.10 * p<0.05 ** p<0.01 *** p<0.001					
Note: Analyses are limited to the 12-year-old cohort.					

⁹ Analyses with street efficacy are limited to the 12-year-old cohort. Data on street efficacy are not available for the 15-year-old cohort at the third wave of the PHDCN-LCS.

Model 2 adds the measure of street efficacy, revealing that street efficacy is significantly and negatively related to aggression. We also find that street efficacy partially mediates the association between exposure to violence and aggression, albeit by a modest amount. The coefficient for exposure to violence declines by just 5 percent (from 1.028 to 0.978).

CONCLUSIONS

DISCUSSION OF FINDINGS

Our results indicate that exposure to violence has both acute and enduring effects on aggression and a non-significant effect on anxiety-depression. We recognize that there is a potential for selection bias in an observational study like ours, yet we have investigated the relationship between exposure to violence and youth mental health with one of the most comprehensive data collections of adolescents—and their multiple social contexts—in the social sciences. Our sensitivity analyses revealed that it would take an unmeasured confounding factor even more consequential than the violent crime rate in a youth's neighborhood of residence to overturn the gap in aggression between those acutely exposed to violence and otherwise similar individuals who were not.

Regarding the enduring effect, those youths who were exposed to violence in the form of aggravated assault via a knife, bat, or gunshot displayed heightened levels of aggression over two and a half years later, net of the propensity to be exposed to violence. We examined *why* the effect endures through an investigation of the role of changes in social cognitions, and find that street efficacy mediates the association a fairly minimal amount.

IMPLICATIONS FOR FUTURE RESEARCH

Despite the fact that street efficacy only mediates the association between exposure to violence and aggression by a modest amount, we are not ready to suggest that social cognitions are unimportant. Rather, there may be other aspects of cognition that further mediate the relationship between exposure to violence and aggression, including aggressive fantasies, normative beliefs about violence, and subjective alienation (Guerra et al., 2003; Ross and Mirowsky, 2009).

Beyond the effect on social cognitions, exposure to violence may affect youth aggression and mental health through several other causal pathways, including through its effect on parents, their capacity to parent, and conflict in the home (Osofsky, 1995). Exposure to violence may also lead to gang involvement and therefore gang-related aggressive behavior, as exposed individuals search for means for protection in a violent neighborhood. We therefore suggest that more research is needed to examine why violence exposure has an enduring effect on youth mental health, particularly externalizing behaviors such as aggression.

Beyond mediating relationships, it is also important to recognize that there may be heterogeneity in the effect of exposure to violence. Not all adolescents who are exposed to violence or live in a violent neighborhood ultimately become aggressive. Thus, future studies should consider moderating influences—such as the buffering effect of supportive parents (e.g., Brookmeyer, Henrich, and Schwab-Stone, 2005; Gorman-Smith et al., 2004) but also the role of genetic characteristics (e.g., Caspi et al., 2002)—

to help identify under what conditions exposure to violence produces psychological distress.

The non-significant relationship we found between exposure to violence and anxiety and depression suggests that results from prior studies may have been influenced by unmeasured confounding influences (e.g., Gorman-Smith and Tolan, 1998). For instance, in this study we control for the confounding influence of neighborhood physical and social disorder by including these measures as predictors of exposure to violence. Prior research has shown that neighborhood disorder is highly predictive of psychological distress, in part because disorderly neighborhoods are subjectively alienating (Ross and Mirowsky, 2009). Disorder may also breed neighborhood violence by signaling to would-be perpetrators that social control processes in the neighborhood have broken down (Wilson and Kelling, 1982). Thus, the relationship between exposure to violence and anxiety-depression may be largely spurious once accounting for neighborhood disorder.

IMPLICATIONS FOR POLICY AND PRACTICE

Our findings can help make sense of results from the interim MTO evaluation. Four to seven years after the MTO demonstration began, those male youths who moved out of impoverished neighborhoods (many of which were also violent neighborhoods) showed no improvement in psychological distress and actually engaged in more risky behavior (Sanbonmatsu et al., 2011). One likely reason for these findings—though perhaps not the only reason—is that neighborhood effects endure.¹⁰ One cannot simply move and

¹⁰ As a caveat, we recognize that the causes of psychological distress are housed not only in neighborhood conditions, but also individual and family characteristics. Thus, even if neighborhood conditions change, individual and family characteristics may limit the extent to which one's psychological distress abates. Besides the enduring consequences for individuals of past neighborhood environments, members of the

immediately erase the past. Again, one likely reason is because neighborhood conditions affect social cognitions.

With these findings in mind, perhaps the most relevant question to consider is just how long the effects of neighborhoods endure, particularly if the focal individual moves to a qualitatively different neighborhood. Research is needed on this important topic, but results from the final MTO evaluation are instructive on this point. Ten to fifteen years after random assignment, males aged 13 to 20 at follow-up who moved out of poverty at a young age showed no significant difference in levels of psychological distress, depression, and anxiety relative to those youths who remained in highly impoverished neighborhoods (Sanbonmatsu et al., 2011). This finding is alarming, and speaks to the durable effect of past neighborhood conditions. In a similar vein, Sharkey and Elwert (2011) recently found evidence that the characteristics of the neighborhood environment in which a parent was raised when she was a child affects her child's cognitive ability a generation later (through their impact on the parent's educational attainment, occupation, income, marriage, and mental health). Thus, there is evidence that neighborhood effects of various forms endure, even for generations. This is, indeed, an important insight for policy-makers to consider.

MTO experimental group may had have limited improvements in mental health because residential moves were often of a very short distance, and were to slightly less impoverished neighborhoods that were still surrounded by neighborhoods of concentrated poverty (see Sampson, 2008).

REFERENCES

- Achenbach, T. M. (1991). *Integrative guide for the 1991 CBCL/4-18, YSR, and TRF profiles*. Burlington, VT: University of Vermont Department of Psychiatry.
- Achenbach, T. M. (1997). *Young adult self report*. Burlington, VT: University of Vermont Department of Psychiatry.
- Agnew, R. (1992). Foundation for a general strain theory of crime and delinquency. *Criminology*, 30, 47-88.
- Agnew, R. (2001). Building on the foundation of general strain theory: Specifying the types of strain most likely to lead to crime and delinquency. *Journal of Research in Crime and Delinquency*, 38, 319-361.
- Agnew, R. (2002). Experienced, vicarious, and anticipated strain: An exploratory study focusing on criminal victimization and delinquency. *Justice Quarterly*, 19, 603-632.
- Agnew, R. (2006). *Pressured into crime: An overview of general strain theory*. Los Angeles, CA: Roxbury.
- Anderson, E. (1999). *Code of the street*. New York: W.W. Norton & Company, Inc.
- Bandura, A. (1973). *Aggression: A social learning analysis*. Englewood Cliffs, NJ: Prentice Hall.
- Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, 28, 117-148.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman and Company.
- Becker, S. O., & Caliendo, M. (2007). Sensitivity analysis for average treatment effects. *Stata Journal*, 7, 71-83.
- Benassi, V. A., Sweeney, P. D., & Dufour, C. L. (1988). Is there a relationship between locus of control orientation and depression? *Journal of Abnormal Psychology*, 97, 357-366.
- Bingenheimer, J. B., Brennan, R. T., & Earls, F. J. (2005). Firearm violence and serious violent behavior. *Science*, 308, 1323-1326.
- Broidy, L., & Agnew, R. (1997). Gender and crime: A general strain theory perspective. *Journal of Research in Crime and Delinquency*, 34, 275-306

- Bronfenbrenner, U. (1979). *The ecology of human development*. Cambridge, MA: Harvard University Press.
- Bronfenbrenner, U. (1989). Ecological systems theory. In R. Vasta (Ed.), *Annals of Child Development--Six Theories of Child Development: Revised Formulations and Current Issues* (pp. 187-250). Greenwich, CT: JAI Press.
- Brookmeyer, K. A., Henrich, C. C., & Schwab-Stone, M. (2005). Adolescents who witness community violence: Can parent support and prosocial cognitions protect them from committing violence? *Child Development*, 76, 917-929.
- Buka, S.L., Stichick, T. L., Birdthistle, I., & Earls, F. J. (2001). Youth exposure to violence: Prevalence, risks, and consequences. *American Journal of Orthopsychiatry*, 71, 298-310.
- Cannon, W. B. (1929). *Bodily changes in pain, hunger, fear, and rage*. New York: Appleton-Century-Crofts.
- Caspi, A., McClay, J., Moffitt, T. E., Mill, J., Martin, J., & Craig, I. A. (2002). Role of genotype in cycle of violence in maltreated children. *Science*, 297, 851-854.
- Cesaroni, C., & Peterson-Badali, M. (2005). Young offenders in custody: Risk and adjustment. *Criminal Justice and Behavior*, 32, 251-277.
- Dannefer, D. (1984). Adult development and social theory: A paradigmatic reappraisal. *American Sociological Review*, 49, 100-116.
- DiPrete, T. A., & Gangl, M. (2004). Assessing bias in the estimation of causal effects: Rosenbaum bounds on matching estimators and instrumental variables estimation with imperfect instruments. *Sociological Methodology*, 34, 271-310.
- Dodge, K. A., Pettit, G. S., & Bates, J. E. (1997). How the experience of early physical abuse leads children to become chronically aggressive. In D. Cicchetti & S.L. Toth (Eds.), *Rochester Symposium on Developmental Psychopathology* (pp. 263-288). Rochester, NY: University of Rochester Press.
- Eskenazi, B., Marks, A. R, Catalano, R., Bruckner, T., & Toniolo, P. G. (2007). Low birthweight in New York City and upstate New York following the events of September 11th. *Human Reproduction*, 22, 3013-3020.
- Farrell, A.D., & Bruce, S. E. (1997). Impact of exposure to community violence on violent behavior and emotional distress among urban adolescents. *Journal of Clinical Child and Adolescent Psychology*, 26, 2-14.

- Farrington, D. P. (1995). The development of offending and antisocial behavior from childhood: Key findings from the Cambridge study in delinquent development. *Journal of Child Psychology and Psychiatry*, 36(0), 929-964.
- Finkelhor, D., Turner, H., Ormrod, R., Hamby, S., & Kracke, K. (2009). *Children's exposure to violence: A comprehensive national survey*. Juvenile Justice Bulletin. Washington, DC: Office of Juvenile Justice and Delinquency Prevention.
- Fitzpatrick, K. M., & Boldizar, J. P. (1993). The prevalence and consequences of exposure to violence among African-American youth. *Journal of the American Academy of Adolescent Psychiatry* 32, 424-430.
- Garbarino, J., Dubrow, N., Kostelny, K., & Pardo, C. (1992). *Children in danger: Coping with the consequences of community violence*. San Francisco: Jossey-Bass.
- Garmezy, N., & Rutter, M. (1985). Acute reactions to stress. In M. Rutter and L. Hersov (Eds.), *Child and Adolescent Psychiatry: Modern Approaches* (second edition) (pp. 152-176). Oxford: Blackwell.
- Giaconia, R. M., Reinherz, H. Z., Silverman, A. B., Pakiz, B., Frost, A. K., & Cohen, E. (1995). Traumas and posttraumatic stress disorder in a community population of older adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry*, 34, 1369-1380.
- Gorman-Smith, D., Henry, D. B., & Tolan, P. H. (2004). Exposure to community violence and violence perpetration: The protective effects of family functioning. *Journal of Clinical Child and Adolescent Psychology*, 33, 439-449.
- Gorman-Smith, D., & P. Tolan. (1998). The role of exposure to community violence and developmental problems among inner-city youth. *Development and Psychopathology*, 10, 101-116.
- Guerra, N. G., Huesmann, L. R., & Spindler, A. (2003). Community violence exposure, social cognition, and aggression among urban elementary school children. *Child Development*, 74, 1561-1576.
- Harding, D. J. (2009). Collateral consequences of violence in disadvantaged neighborhoods. *Social Forces*, 88, 757-782.
- Heuveline, P., Timberlake, J. M., & Furstenberg, Jr., F. F. (2003). Shifting child rearing to single mothers: Results from 17 Western nations. *Population and Development Review*, 19, 47-71.
- Hill, J. (2004). Reducing bias in treatment effect estimation in observational studies suffering from missing data. Columbia University Institute for Social and Economic

Research and Policy (ISERP) working paper 04-01. Available at:
<http://academiccommons.columbia.edu/catalog/ac:129151>.

- Katz, L. F., Kling, J. R., & Liebman, J. B. (2001). Moving to opportunity in Boston: Early results of a randomized mobility experiment. *Quarterly Journal of Economics*, 116, 607-654.
- Kirk, D. S., & Laub, J. H. (2010). Neighborhood change and crime in the modern metropolis. *Crime and Justice: A Review of Research*, 39, 441-502. Chicago: University of Chicago Press.
- Kirk, D. S., & Papachristos, A. V. (2011). Cultural mechanisms and the persistence of neighborhood violence. *American Journal of Sociology*, 116, 1190-1233.
- Kling, J. R., Liebman, J. B., & Katz, L. F. (2007). Experimental analysis of neighborhood effects. *Econometrica*, 75, 83-119.
- Kling, J. R., Ludwig, J., & Katz, L. F. (2005). Neighborhood effects on crime for female and male youth: Evidence from a randomized housing voucher experiment. *Quarterly Journal of Economics*, 120, 87-130.
- Lorion, R.L., & Saltzman, W. (1993). Children's exposure to community violence: Following a path from concern to research to action. *Psychiatry*, 56, 55-65.
- Mantel, N., & Haenszel, W. (1959). Statistical aspects of the analysis of data from retrospective studies of disease. *Journal of the National Cancer Institute*, 22, 719-748.
- Margolin, G., & Gordis, E. B. (2000). The effects of family and community violence on children. *Annual Review of Psychology* 51, 445-479.
- Martinez, P., & Richters, J. E. (1993). The NIMH community violence project: Vol 2. Children's distress symptoms associated with violence exposure. *Psychiatry*, 56, 23-35.
- Miller, L.S., Wasserman, G. A., Neugebauer, R., Gorman-Smith, D., & Kamboukos, D. (1999). Witnessed community violence and antisocial behavior in high-risk, urban boys. *Journal of Clinical Child and Adolescent Psychology*, 28, 2-11.
- Mirowsky, J., & Ross, C. E. (1995). Sex differences in distress: Real or artifact? *American Sociological Review*, 60, 499-468.
- Mirowsky, J., & Ross, C. E. (2003). *Social causes of psychological distress*. Second edition. Hawthorne, NY: Aldine de Gruyter.
- Morgan, S. L., & Winship, C. (2007). *Counterfactuals and causal inference: Methods*

and principles for social research. New York: Cambridge University Press.

Osofsky, J. D. (1995). The effects of exposure to violence of young children. *American Psychologist*, 50, 782-788.

Pynoos, R.S., Frederick, C., Nader, K., Arroyo, E., Steinberg, A., Eth, S., Nunex, F., & Fairbanks, L. (1987). Life threat and posttraumatic stress in school-age children. *Archives of General Psychiatry*, 44, 1057-1063.

Richters, J. E., & Martinez, P. (1993). The NIMH community violence project: Vol. 1. Children as victims of and witnesses to violence. *Psychiatry*, 56, 7-21.

Rosenbaum, J. E., Reynolds, L., & DeLuca, S. (2002). How do places matter? The geography of opportunity, self-efficacy and a look inside the black box of residential mobility. *Housing Studies*, 17, 71-82.

Rosenbaum, P. R. (2002). *Observational studies.* New York: Springer.

Rosenbaum, P. R., & Rubin, D. B. (1985). The bias due to incomplete matching. *Biometrics*, 41, 103-116.

Ross, C. E., & Mirowsky, J. (2009). Neighborhood disorder, subjective alienation, and distress. *Journal of Health and Social Behavior*, 50, 49-64.

Ross, C. E., Mirowsky, J., & Pribesh, S. (2001). Powerlessness and the amplification of threat: Neighborhood disadvantage, disorder, and mistrust. *American Sociological Review*, 66, 568-591.

Royston, P. (2004). Multiple imputation of missing values. *Stata Journal*, 4, 227-41.

Sampson, R. J. (2008). Moving to inequality: Neighborhood effects and experiments meet social structure. *American Journal of Sociology*, 114, 189-231.

Sampson, R. J., & Bartusch, D. J. (1998). Legal cynicism and (subcultural?) tolerance of deviance: The neighborhood context of racial differences. *Law and Society Review*, 32, 777-804.

Sampson, R. J., & Raudenbush, S. W. (1999). Systematic social observation of public spaces: A new look at disorder in urban neighborhoods. *American Journal of Sociology*, 105, 603-651.

Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science*, 227, 918-924.

- Sampson, R.J., & Wilson, W. J. (1995). Toward a theory of race, crime, and urban inequality. In J. Hagan and R.D. Peterson (Eds.), *Crime and Inequality*. Stanford, CA: Stanford University Press.
- Sanbonmatsu, L., Ludwig, J., Katz, L. F., Gennetian, L. A., Duncan, G. J., Kessler, R. C., Adam, E., McDade, T. W., and Lindau, S. T. (2011). *Moving to Opportunity for Fair Housing Demonstration Program: Final impacts evaluation*. Washington, DC: U.S. Department of Housing and Urban Development, Office of Policy Development and Research.
- Scheeringa, M. S., Zeanah, C. H., Drell, M. J., & Larrieu, J. A. (1995). Two approaches to the diagnosis of post-traumatic stress disorder in infancy and early childhood. *Journal of the American Academy of Child and Adolescent Psychiatry*, 34, 191-200.
- Seeman, M. (1959). On the meaning of alienation. *American Sociological Review*, 24, 783-791.
- Seeman, M. (1983). Alienation motifs in contemporary theorizing: The hidden continuity of classic themes. *Social Psychology Quarterly* 46, 171-184.
- Sharkey, P. (2006). Navigating dangerous streets: The sources and consequences of street efficacy. *American Sociological Review*, 71, 826-846.
- Sharkey P., & Elwert, F. (2011). The legacy of disadvantage: Multigenerational neighborhood effects on cognitive ability. *American Journal of Sociology*, 116, 1934-1981.
- Smith, C., & Thornberry, T. P. (1995). The relationship between childhood maltreatment and adolescent involvement in delinquency. *Criminology*, 33, 451-481.
- Timberlake, J.M. (2007). Racial and ethnic inequality in the duration of children's exposure to neighborhood poverty and affluence. *Social Problems*, 54, 319-342.
- Timberlake, J.M. (2009). Effects of household and neighborhood characteristics on children's exposure to neighborhood poverty and affluence. *Social Science Research*, 38, 458-476.
- van Buuren, S., Boshuizen, H. C., & Knook, D. L. (1999). Multiple imputation of missing blood pressure covariates in survival analysis. *Statistics in Medicine*, 18, 681-694.
- Widom, C. S. (1989). Child abuse, neglect, and violent criminal behavior. *Criminology*, 27, 251-271.
- Widom, C. S. (2000). Understanding the consequences of childhood victimization. In R. M. Reece (Ed.), *Treatment of child abuse: Common ground for mental health*,

medical, and legal practitioners (pp. 339-361). Baltimore, MD: Johns Hopkins University Press.

Widom, C. S., & Maxfield, M. G. (2001). *An Update on the Cycle of Violence*. National Institute of Justice, Washington, D.C.

Wilson, J. Q., & Kelling, G. (1982). The police and neighborhood safety: Broken windows. *The Atlantic Monthly*, 127, 29-38.

Wodtke, G. T., Harding, D. J., & Elwert, F. (2011). Neighborhood effects in temporal perspective: The impact of long-term exposure to concentrated disadvantage on high school graduation. *American Sociological Review*, 76, 713-736.

**APPENDIX A:
BOUNDS FOR THE TREATMENT EFFECT OF EXPOSURE TO VIOLENCE**

We use Rosenbaum’s (2002) bounding approach to examine the sensitivity of our statistical inferences to hidden biases (see also Becker and Caliendo 2007; DiPrete and Gangl 2004). If there is hidden bias, then two individuals with the same observed characteristics will have differing likelihoods of being exposed to violence because of unobserved factors.

The odds that an individual will receive treatment is given by the following:

$$\frac{\Pr(\text{Exposed} = 1)}{1 - \Pr(\text{Exposed} = 1)} = \exp(\alpha + \beta X + \gamma U),$$

where X represents observed variables and U represents one or more unobserved variables. In this case, the variable U increases the probability of violence exposure by a factor equal to γ . For a pair of individuals i and j matched on propensity score (i.e., the same observed covariates X), where i ultimately witnesses violence and j does not, the ratio of odds of receiving treatment is given by:

$$\frac{\frac{P_i}{1 - P_i}}{\frac{P_j}{1 - P_j}} = \frac{\exp(\alpha + \beta X_i + \gamma U_i)}{\exp(\alpha + \beta X_j + \gamma U_j)}$$

Because i and j have the same set of observed covariates, X cancels out:

$$\frac{\exp(\gamma U_i)}{\exp(\gamma U_j)} = \exp[\gamma(U_i - U_j)]$$

If there are no differences in unobserved variables ($U_i = U_j$ for all matched pairs) or if unobserved variables have no influence on the probability of treatment ($\gamma=0$), then there is no hidden bias. Since we do not have direct information on unobservables, we use a

sensitivity analysis to evaluate whether our statistical inferences pertaining to the effect of violence exposure on youth mental health would change under different values of γ . Per Rosenbaum (2002), the bounds on the odds ratio that either of the two matched individuals will receive treatment is given by:

$$\frac{1}{e^\gamma} \leq \frac{P_i(1-P_j)}{P_j(1-P_i)} \leq e^\gamma,$$

where $\Gamma = \exp(\gamma)$. Use of this bounding approach is suitable if pairwise matching is done without replacement (Becker and Caliendo, 2007).

We use the *mhbounds* routine in Stata to implement our sensitivity analysis. The *mhbounds* command uses the Mantel and Haenszel (MH; 1959) test statistic. The Q^+ test-statistic adjusts the MH statistic downward in the event of positive unobserved selection. Positive selection occurs when exposed individuals are more likely to have mental health problems (aggression and anxiety-depression) for reasons other than their exposure to violence. In this case, we would overestimate the treatment effect of violence exposure.

**APPENDIX B:
RACE-ETHNIC DIFFERENCES IN DURATION OF EXPOSURE TO
VIOLENCE**

A secondary objective of our study is to compare exposure to neighborhood violence throughout childhood and adolescence across race and ethnicity. Prior studies of neighborhood context have been instrumental in demonstrating that inequality in neighborhood conditions explains significant proportions of behavioral and health differences across racial and ethnic groups (e.g., Sampson and Wilson 1995). We extend such analyses by focusing on racial and ethnic inequality in the duration of exposure to violence. We hypothesize that, compared to their white and Latino peers, black youths can expect to spend a much longer share of childhood in high-violence neighborhoods, even after controlling for household, family, and neighborhood characteristics.

Whereas the focus of our main analysis is on the 12- and 15-year-old PHDCN cohorts, for this subsidiary analysis we expand the focus to also include the 3, 6, and 9-year-old cohorts. Using the same exposure to violence measure as in the main analysis, measured at Waves 1 and 2 of the PHDCN, we split the distribution of exposure to violence into three categories: low, medium, and high exposure to violence. Low exposure means that the respondent did not witness any of the forms of violence in the year preceding the survey interview. Medium is defined as witnessing between 1 and 3 instances of these violent acts in the last year, and high is 4 or more. Data on exposure to the three forms of violence were provided by youth respondents for the 9, 12, and 15-year-old cohorts while responses are provided by the primary caregiver for cohorts 3 and 6. In this latter case, caregivers responded about whether their child was exposed to violence, not whether they personally had been exposed.

In order to describe the duration of exposure to neighborhood violence, we adapt a demographic method recently employed by Timberlake (2009) to estimate durations of exposure to neighborhood poverty for black and white children. We construct period increment-decrement life tables (IDLTs) to estimate racial and ethnic inequality in “childhood expectancy” in three neighborhood violence types (i.e., low violence, medium, and high). The term “childhood expectancy” denotes the percentage of childhood (birth to age 18) that the average Chicago-area child from a given racial or ethnic group is expected to spend in each of the three neighborhood types (Heuveline, Timberlake, and Furstenberg 2003).

Our approach first predicts group-specific probabilities of birth in one of the three neighborhood types, as well as transition probabilities from each type to all others. These predicted probabilities then become inputs into an IDLT estimation procedure (Heuveline et al. 2003; Timberlake 2007). The resulting life tables provide information on children’s expected duration in the three neighborhood violence types and the effects of family, household, and neighborhood characteristics on those durations.

Step 1: predicted birth distributions. We first predict the probability of birth into one of the three neighborhood violence types by running logistic regressions of each of the three types (where $y_i = 1$ if a child lives in neighborhood type i in wave 1 of the PHDCN study, 0 otherwise) on child age at wave 1, race/ethnicity, and the interaction of the two independent variables. More formally, the models are specified as follows:

$$\ln \left[\frac{\Pr(y_i = 1)}{1 - \Pr(y_i = 1)} \right] = \beta_0 + \beta_1(Age1) + \beta_2(Black) + \beta_3(Latino) + \beta_4(Age1 \times Black) + \beta_5(Age1 \times Latino) + \varepsilon, \quad (1)$$

where i indexes neighborhood types 1 through 3 at wave 1. The intercept in equation (2) is interpreted as the log odds of a white child being born in neighborhood type i (i.e., in neighborhood type i at age 0). The associated probability is derived as shown below:

$$\Pr(y_i = 1 | Age1 = 0) = \frac{\exp(\beta_0)}{[1 + \exp(\beta_0)]}. \quad (2)$$

For black and Latino children, respectively, the equivalent birth probabilities are derived by adding the group-specific coefficients from equation (1) to the intercept and exponentiating as in equation (2).

Step 2: predicted transition probabilities. We derive predicted transition probabilities from neighborhood type i to neighborhood type j by estimating three logistic regression models where the three dependent variables y_j denote that a child lives in neighborhood type j at wave 2 of the PHDCN. These models are specified as follows:

$$\begin{aligned} \ln \left[\frac{\Pr(y_j = 1)}{1 - \Pr(y_j = 1)} \right] &= \beta_0 + \beta_1(Age1) + \beta_2(Black) + \beta_3(Latino) + \sum_{i=2}^3 \beta_{(2+i)}(y_i) \\ &+ \beta_6(Age1 \times Black) + \beta_7(Age1 \times Latino) + \sum_{i=2}^3 \beta_{(6+i)}(Age1 \times y_i) \\ &+ \sum_{i=2}^3 \beta_{(9+i)}(Black \times y_i) + \sum_{i=2}^3 \beta_{(12+i)}(Latino \times y_i) + \sum_{i=2}^3 \beta_{(15+i)}(Age1 \times Black \times y_i) \\ &+ \sum_{i=2}^3 \beta_{(18+i)}(Age1 \times Latino \times y_i) + \varepsilon. \end{aligned} \quad (3)$$

Step 3: life table construction. Results from equation (1) yield a starting distribution of q_0^i (the predicted race/ethnicity-specific probabilities of birth (i.e., age $x = 0$) into y_i , the three neighborhood types at wave 1), which can be written in matrix form as follows:

$$\mathbf{Q}_0^i = [q_0^1 \quad q_0^2 \quad q_0^3] \quad (4)$$

Results from equation (3) yield three sets (for whites, blacks, and Latinos) of predicted transition probability matrices from age x to $x + 2$, where $x = 0, 2, 4 \dots 16$. We denote birth type probabilities and transition probabilities with the letter q to conform to standard IDLT notation. Thus, ${}_n q_x^{ij}$ refers to the conditional probability of transitioning from origin state i into destination state j from age x to $x + n$. These matrices take the following form:

$${}_2 \mathbf{Q}_x^{ij} = \begin{bmatrix} {}_2 q_x^{11} & {}_2 q_x^{12} & {}_2 q_x^{13} & {}_2 q_x^{1LTF} \\ {}_2 q_x^{21} & {}_2 q_x^{22} & {}_2 q_x^{23} & {}_2 q_x^{2LTF} \\ {}_2 q_x^{31} & {}_2 q_x^{32} & {}_2 q_x^{33} & {}_2 q_x^{3LTF} \end{bmatrix}, \quad (5)$$

where LTF indicates that an observation was “lost to follow-up,” either due to child death or family attrition from the PHDCN.¹¹

We then generate three sets of ${}_2 \mathbf{L}_x^j$, which are 1×3 vectors of expected durations in neighborhood type j from age x to $x + 2$. The first such vector is calculated by post-multiplying the birth distribution vector by the first transition matrix ${}_2 \mathbf{Q}_0^{ij}$ and then post-multiplying by the scalar 2 (because the average duration from wave 1 to 2 of the PHDCN was two years), as shown below:

$${}_2 \mathbf{L}_0^j = \mathbf{Q}_0^i \times {}_2 \mathbf{Q}_0^{ij} \times 2 \quad (6)$$

Subsequent ${}_2 \mathbf{L}_x^j$ vectors are derived by pre-multiplying each transition probability matrix ${}_2 \mathbf{Q}_x^{ij}$ by the preceding ${}_2 \mathbf{L}_x^j$ vector. Finally, we sum all of the ${}_2 \mathbf{L}_x^j$ vectors, which yields \mathbf{E}_0^j , a 1×3 vector of elements e_0^j , representing the group-specific number of years children

¹¹ The q^{ij} in these matrices sum to 1.0 within rows, but because LTF is an absorbing state, we will construct the life tables by excluding children transitioning into the LTF state. The dimensions of the resulting matrices are therefore 3×3 . We will apportion the LTF children into the 3 observed neighborhood types by multiplying the LTF predicted probabilities by the share of each predicted transition probability into the three non-absorbing states (i.e., destination states 1 through 3). This approach makes the assumption that the destination neighborhood type for a residentially mobile LTF child would be the same as the destination type if they had not been lost to follow-up. See Timberlake (2009) for further discussion.

can expect to spend in the three neighborhood types j from birth to age 18. Dividing each element in \mathbf{E}_0^j by 18 and multiplying by 100 yields quantities which we have defined as “childhood expectancy.”

Covariate-adjusted IDLTs. An important benefit of our method is its ability to include multiple covariates in the models shown in equations (1) and (3) above. To do this, we rescale all family and neighborhood covariates so that they are expressed in deviation units (i.e., each control variable X_c is centered around its mean). The resulting intercepts and coefficients on race/ethnicity, age, origin neighborhood type, and their interactions are interpreted as effects on the log odds of transitioning from neighborhood type i to j for children whose family and neighborhood characteristics are average for the whole sample. We then re-estimated the IDLTs with covariate-adjusted predicted transition matrices. This analysis enables us to assess the extent to which racial and ethnic inequality in the duration of exposure to neighborhood violence is due to group differences in family, household, and neighborhood characteristics.

Focusing on Figure 2, we see that white children can expect to spend the vast majority of childhood, over 80%, in neighborhoods where they are not exposed to any or hardly any violence. By contrast, black children can expect to spend less than half of childhood in such a neighborhood, and over 10% of childhood in neighborhoods with high levels of violence. Latino youths fall in the middle ground, and can expect to spend two-thirds of childhood in a neighborhood with little violence but almost 10% of childhood in a neighborhood where youths are routinely exposed to violence.

Figure 2. Unadjusted Childhood Expectancy in Subjective Exposure to Neighborhood Violence, by Child Race/Ethnicity: PHDCN Children, 1995-1997

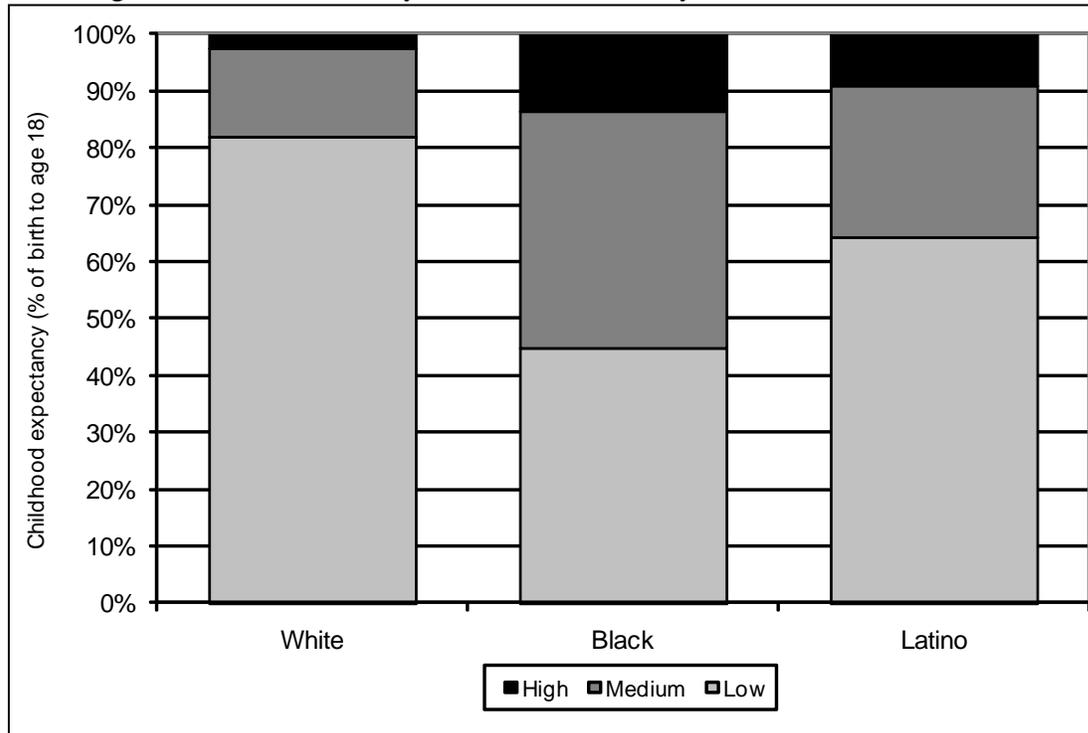


Table 5 to follow shows estimates of childhood expectancy in the three neighborhood types. The far left panel (Model 1) shows the findings from the unadjusted analyses depicted in Figure 2—i.e., analyses of race-ethnic differences unadjusted by family/household- or neighborhood-level characteristics. The middle left panel (Model 2) shows the findings after controlling for household and family characteristics, the middle right panel (Model 3) controls for neighborhood characteristics, and the far right panel (Model 4) shows the results with all controls included. Within each column, the figures sum to 100 percent, showing how children’s expected duration in each of the three neighborhood types is distributed across those types.

Focusing on Model 4 in Table 5, we see that controlling for differences in household, family, and neighborhood characteristics across groups explains almost half

of the black/white difference in exposure to violence, 38.4% of the white/Latino difference, and 58.1% of the black/Latino difference. Considerable inequality still remains, even after controlling for family structure, socioeconomic status, and neighborhood characteristics. Most of the inequality occurs with respect to expected time spent in low violence neighborhoods. After adjusting for covariates, white children can expect to spend roughly three-quarters of childhood in neighborhoods where they will be exposed to very little or no violence. Black youths can expect to spend about half of childhood in such neighborhoods, and Latino youths almost two-thirds of childhood.

In summary, the preceding analyses have been used to describe and account for differences across racial and ethnic groups in the extent of exposure to violence in childhood. Household and neighborhood factors substantially influence the amount of time white, black, and Latino youths can expect to live in violent neighborhoods, yet considerable differences in exposure still remain after accounting for numerous family, household, and neighborhood covariates.

Table 5. Childhood Expectancy in Subjective and Objective Exposure to Neighborhood Violence States, By Child Race and Model Covariates: PHDCN Children, 1995 to 1997

	Model																							
	(1) Bivariate						(2) Child and household covariates						(3) Neighborhood covariates						(4) All covariates					
	Absolute differences						Absolute diff.						Absolute diff.						Absolute diff.					
	White	Black	Hispanic	W - B	W - H	B - H	White	Black	Hispanic	W - B	W - H	B - H	White	Black	Hispanic	W - B	W - H	B - H	White	Black	Hispanic	W - B	W - H	B - H
Exposure to Violence																								
Low	81.8	44.8	64.3	37.1	17.5	19.5	80.1	51.3	62.1	28.9	18.0	10.8	73.5	47.6	66.1	26.0	7.4	18.6	73.3	54.3	62.5	19.0	10.8	8.2
Medium	15.6	41.7	26.6	26.1	10.9	15.2	17.3	38.0	28.6	20.7	11.3	9.4	21.9	40.2	25.4	18.3	3.5	14.8	23.0	35.8	28.6	12.8	5.6	7.2
High	2.5	13.5	9.2	11.0	6.6	4.3	2.6	10.7	9.3	8.2	6.7	1.4	4.6	12.2	8.5	7.6	3.9	3.7	3.7	9.9	8.9	6.2	5.2	0.9
Sum of absolute differences				74.1	35.1	39.0				57.8	36.1	21.7				51.9	14.8	37.1				38.0	21.6	16.4
% explained vs. model 1				—	—	—				22.1	-2.8	44.4				30.0	57.9	4.8				48.8	38.4	58.1

Notes: Figures in "White," "Black," and "Hispanic" columns derived from IDLT estimation procedures and sum to 100 percent within columns, indicating the distribution of childhood (birth to exact age 18) expectancies across the exposure to neighborhood violence categories.

DISSEMINATION OF RESEARCH FINDINGS

PUBLICATIONS

Kirk, David S., and Margaret Hardy. 2013. "The Acute and Enduring Consequences of Exposure to Neighborhood Violence on Youth Mental Health and Aggression." *Justice Quarterly*. Forthcoming.

CONFERENCE PRESENTATIONS

Kirk, David S., and Margaret Hardy. 2011. "The Acute versus Enduring Effects of Exposure to Neighborhood Violence on Youth Mental Health." Presented at the 2011 American Society of Criminology Annual Conference, Washington, DC.

Timberlake, Jeffrey M., and David S. Kirk. 2011. "A Spatio-Temporal Assessment of Exposure to Neighborhood Violence." Presented at the 2011 Population Association of America Annual Conference, Washington.

Pendzich-Hardy, Margaret, and David S. Kirk. 2010. "The Situational versus Cumulative Consequences of Exposure to Neighborhood Violence." Presented at the 2010 American Society of Criminology Annual Conference, San Francisco.