Articles

The Cycle of Violence

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Despite widespread belief that violence begets violence, methodological problems substantially restrict knowledge of the long-term consequences of childhood victimization. Empirical evidence for this cycle of violence has been examined. Findings from a cohort study show that being abused or neglected as a child increases one's risk for delinquency, adult criminal behavior, and violent criminal behavior. However, the majority of abused and neglected children do not become delinquent, criminal, or violent. Caveats in interpreting these findings and their implications are discussed in this article.

THE SCHOLARLY LITERATURE ON FAMILY VIOLENCE HAS grown enormously during the last 20 years. One of the most pervasive claims that appears in both academic and popular writings refers to the cycle of violence: abused children become abusers and victims of violence become violent offenders. Over 25 years ago, in a brief clinical note entitled "Violence breeds violence—perhaps?" Curtis expressed the concern that abused and neglected children would "become tomorrow's murderers and perpetrators of other crimes of violence, if they survive" (*1*, p. 386).

Indeed, the notion of an intergenerational transmission of violence has become the premier developmental hypothesis in the field of abuse and neglect. In this article I review the current empirical status of this hypothesis, drawing on data from different disciplines—psychology, sociology, psychiatry, social work, and nursing; comment on methodological problems; and describe new research developments in the field. Although people maintain strong feelings about this topic, they ought to be aware of those aspects of the cycle of violence hypothesis that have received support and of areas where unresolved questions remain.

Literature Review

Researchers and professionals have used the phrases "cycle of violence" and "intergenerational transmission of violence" loosely to refer to assumptions or hypotheses about the consequences of abuse and neglect in relation to a number of different outcomes. Some writers refer exclusively to the hypothesized relation between abuse as a child and abuse as a parent (*2*). Others focus on the relations between child abuse and neglect and later delinquent, adult criminal, or violent behaviors.

Because there are difficult methodological problems confronting social science research, most investigations of child abuse have been criticized as methodologically flawed and limited in how the results can be generalized, their scientific validity, and ultimately their policy relevance (*3–5*). There remains considerable debate about the definition of child abuse (*6*) and, consequently, much uncertainty about its prevalence. Even less is known about its effects. For children who have been abused or neglected, the immediate consequences may involve physical injuries or psychological trauma. In addition, the emotional and developmental scars of these children and those who witness severe family violence may persist. Furthermore, because many other events in the child's life may mediate the effects of child abuse or neglect, the long-term consequences of such childhood victimization are difficult to determine.

Abuse leads to abuse. In a recent review of empirical studies relevant to the intergenerational transmission of violence hypothesis, Widom (*5*) noted that there is surprisingly little empirical evidence to support the claim that abuse leads to abuse. Existing studies suggest that there is a higher likelihood of abuse by parents if the parents were themselves abused as children. Among abusing parents, estimates of a history of abuse range from a low of 7% (*7*) to a high of 70% (*8*). Among adults who were abused as children, between one-fifth and one-third abuse their own children (*9, 10*).

Many studies are methodologically weak and limited because of an overdependence on self-report and retrospective data, inadequate documentation of childhood abuse and neglect, and infrequent use of baseline data from control groups. In a comprehensive review of this literature, Kaufman and Zigler (*2*) concluded that the unqualified acceptance of the intergenerational transmission hypothesis—from abuse as a child to becoming an abusive parent—is unfounded.

Small-scale clinical reports. A number of frequently cited writings describe prior abuse in the family backgrounds of adolescents who attempted or succeeded in killing their parents (*11*), and of murderers (*12*), or of those charged with murder (*13*). These reports, offered as support for the cycle of violence, present provocative clinical accounts by astute observers; yet their own statistical usefulness is limited because of small sample sizes, weak sampling techniques, questionable accuracy of information, and lack of appropriate comparison groups.

As Monahan (*14*) argued, the most important piece of information researchers can have in the prediction of violence is the base rate of violent behavior in the population with which they are dealing. Particularly in the areas of abuse and neglect, there is a tendency to overemphasize individual case information at the expense of base rates. Appropriate control groups are necessary to assess the independent effects of early childhood victimization because many of the same family and demographic characteristics found in abusive home environments also relate to delinquency and later criminality (*15*). Without control groups to provide an estimate of such base rates, it is difficult to assess the magnitude of relationships.

In the United States, for example, groups with different demographic characteristics (males/females, blacks/whites, rural/urban) have different base rates of arrest for violent crimes (*16*). Thus, base rates—from the same general population of people at the same time period—must be taken into account in assessing the cycle of violence.

Delinquency. Another facet of the cycle of violence hypothesis

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refers to the relation between abuse and neglect and delinquency. The majority of studies that address this relation are retrospective ones (*17, 18*) in which the researcher typically asks delinquents about their early backgrounds. Estimates of abuse from these retrospective studies generally range from 9 to 29%. In prospective studies that follow up individuals who had been abused or neglected as children, the incidence of delinquency was between 10 and 17%. Of three prospective studies (*19–21*), two lacked control groups (nonabused comparisons). Most studies of delinquents report that the majority were not abused as children. In at least one study (*21*), rejected children had the highest rates of delinquency. However, without appropriate control groups and improved methodology, any conclusions remain highly ambiguous.

Violent behavior. Several studies involving delinquents (*18, 19, 22, 23*) and psychiatric patients (*24*) suggest that abuse and neglect are related to violent criminal behavior. However, findings are contradictory. Some provide strong support for the cycle of violence hypothesis; in others, abused and nonabused delinquents did not differ; and in at least one study, abused delinquents were less likely to engage in aggressive crimes later. Each of these studies has methodological problems, not the least of which is the universal lack of normal comparison groups providing baseline data. Furthermore, since existing studies focus primarily on violence among delinquents and adolescents, whether these childhood experiences have direct and lasting consequences for the commission of violent crimes into adulthood is unknown.

Aggressive behavior in young children. Another body of studies focuses on the relation between abuse, neglect, and aggressive behavior in young children. This work is based on experimental research and laboratory observations. Age groups vary, as do definitions of child abuse and outcome measures. However, these studies indicate with some consistency that abused children, as young as infants and toddlers, manifest significantly more aggressive and problematic behavior than nonabused or neglected children (*25*).

These studies also suggest the need to consider neglect as distinct from abuse, because in some reports (*26*) neglected children appeared more dysfunctional than those abused. With one exception (*21*), only these developmental psychology studies have systematically examined and reported differences between separate samples of abused and neglected children. By combining abused and neglected groups, or by studying only physically abused children, important differences in consequences may be obscured.

Observing violence. In addition to studies of children directly victimized, the indirect effects on children observing family violence have also been investigated in two types of studies. First, large-scale self-report surveys have found a modest, although fairly consistent, association between exposure to family violence and approval of violence or marital violence as an adult (*27*). Second, studies of the children of battered women suggest that observing abuse or extreme marital discord may be as harmful to the development of the child as physical abuse, although other factors might contribute to these findings (*28*).

Despite widespread belief in the intergenerational transmission of violence, methodological limitations substantially restrict our conclusions about the long-term consequences of early childhood victimization (*5*). The research described here was designed to overcome some of the methodological problems that have hindered the empirical documentation of the cycle of violence.

New Research Developments

During a 2-year research project, I examined a number of basic questions about the relationship between child abuse and neglect and later violent criminal behavior. This research was designed to incorporate methodological improvements. These included a relatively unambiguous operational definition of abuse and neglect; a prospective design; separate abused and neglected groups; a large sample to allow for subgroup comparisons and to allow for conclusions with respect to violent criminal behavior; a control group matched as closely as possible for age, sex, race, and approximate social class background; and assessment of the long-term consequences of abuse and neglect beyond adolescence or juvenile court into adulthood.

The purpose of this project was to identify a large sample of substantiated and validated cases of child abuse and neglect from approximately 20 years ago, to establish a matched control group of nonabused children, and to determine the extent to which these individuals and the matched control group subsequently engaged in delinquent and adult criminal and violent criminal behavior. At present, this research involves (and is limited to) the collection, tabulation, and analysis of official records (*29*).

The decision to use official arrest records for the dependent variable was made for several reasons. Arrest records are relatively easy to locate, and reasonably complete information on arrests in official records can be collected retrospectively (*30*). Results of self-report studies and research with the use of official records have been fairly consistent in terms of the correlates of crime (*31*). Although self-reports are basically reliable and valid for relatively minor offenses, more serious offenses are more efficiently revealed (and with fairly little bias) by some official data (*32*). Arrest records were also chosen because interviewing a large number of abused and neglected cases would be extremely costly. Compared to a good survey by interviewers, a register study such as the one described here tends to be much less expensive per case (*33*).

Design. This study is based on a standard design referred to as specialized cohorts (*33*) or observational cohorts (*34*). In a matched cohort design, both groups are free of the "disease" in question (violent or delinquent behavior) at the time they are chosen for the study and, because of matching, are assumed to differ only in the (risk) attribute to be examined (having experienced child abuse or neglect). Because it is not possible to randomly assign subjects to groups, the assumption of equivalency for the groups is an approximation.

In studies of the relation between child abuse and neglect and later delinquency or criminality, it is important to avoid ambiguity in the direction of causality of the events. Specifically, cases occur where delinquency precedes abuse or neglect in time and cases where delinquency itself may actually provoke the abuse or neglect of the child. Thus, to minimize this ambiguity and to maximize the likelihood that the temporal direction is clear (that is, abuse or neglect leading to delinquency or criminality), abuse and neglect cases were restricted to those in which children were less than 11 years of age at the time of the abuse or neglect.

In comparisons of delinquent or violent behavior, it is also difficult to judge what portion of the differences is due to the experience or factors under study and what portion is due to being labeled a delinquent or violent offender. My research does not totally avoid this problem, but by use of a prospective design, with data collection started at the point of abuse or neglect and before the onset of delinquency and violent behavior, the problem is minimized.

Abuse and neglect cases. All cases of physical and sexual abuse and neglect processed during the years 1967 through 1971 in the county juvenile court (situated in a metropolitan area in the Midwest) and validated and substantiated by the court were initially included. Abuse and neglect cases from the adult criminal courts were also included. In these cases, a criminal charge was filed against the adult defendant. During 1967 through 1971, there were 140 cases (physical and sexual abuse and neglect) processed in adult criminal

court in which the victim was 11 years of age or less. After examining 2623 abuse and neglect petitions, a total of 908 cases were retained for this study (*35*).

Definitions. Physical abuse refers to cases in which an individual had "knowingly and willfully inflicted unnecessarily severe corporal punishment" or "unnecessary physical suffering" upon a child or children (for example, striking, punching, kicking, biting, throwing, or burning). Sexual abuse refers to a variety of charges, ranging from relatively nonspecific charges of "assault and battery with intent to gratify sexual desires" to more specific and detailed charges of "fondling and touching in an obscene manner," sodomy, and incest. Neglect refers to cases in which the court found a child to have no proper parent care or guardianship, to be destitute, homeless, or to be living in a physically dangerous environment. The neglect petition reflects the judgment that the behavior represents a serious omission by the parents—beyond acceptable community and professional standards at the time—to provide to children needed food, clothing, shelter, medical attention, and protection from hazardous conditions.

Matched control group. One of the critical elements of this research design is the establishment of a control group, matched as closely as possible on the basis of sex, age, race, and approximate family socioeconomic status during the time period under study (1967 through 1971). To accomplish this matching, the sample of abused and neglected cases was first divided into two groups on the basis of their age at the time of the abuse or neglect incidents: those under school age and those of school age (*36*).

Children who were under school age at the time of abuse or neglect were matched with children of the same sex, race, date of birth (±1 week), and hospital of birth through the use of county birth record information. Of the 319 abused and neglected children under school age, there were matches for 229 (72%).

For children of school age, records of more than 100 elementary schools for the same time period were used to find matches with children of the same sex, race, date of birth (±6 months), same class in same elementary school during the years 1967 through 1971, and home address, preferably within a five-block radius of the abused or neglected child. Out of 589 school-age children, there were matches for 438, representing about 74% of the group. Overall, there were 667 matches (73.7%) for the abused and neglected children (*37*).

This cohort design involves the assumption that the major difference between the abused and neglected group and the controls is in the abuse or neglect experience. Official records were checked to determine if the proposed control subject had been abused or neglected. If there was evidence that a control subject had been abused, then he or she was excluded from the control group. This situation occurred in 11 cases (*38*).

Demographic characteristics of the groups. Among the abused and neglected group, there are about equal numbers of males and females (49 versus 51%) and more whites than blacks (67 versus 31%). The mean age for the abused and neglected subjects is 25.69 years (SD = 3.53 years). The majority of the sample are currently between the ages of 20 and 30 years (85%), with about 10% under age 20 (the youngest is 16) and 5% older than 30 (the oldest is 32). The current age distribution of the sample indicates that our design has allowed sufficient time for most of the subjects to come to the attention of authorities for delinquent, adult criminal, and violent behavior (*23, 39*).

The controls are well matched to the abused and neglected subjects in terms of age, sex, and race. Controls are equally divided between males and females. The racial composition of the group is quite similar to that of the abused and neglected group, although slightly more controls are black (35%). Their mean age is 25.76 years (SD = 3.53 years; range, 16 to 33 years).

Data collection. Detailed information about the abuse or neglect incident and family composition and characteristics was obtained from the files of the juvenile court and probation department, the authority responsible for cases of abused, neglected, or dependent and delinquent children. Juvenile court and probation department records were also examined for the control subjects. Detailed delinquency and detention information was recorded for both groups. Adult criminal histories for all subjects were compiled from searches at three levels of law enforcement: local, state, and federal. Searches also extended to the Bureau of Motor Vehicles and (for all females) marriage license records to find social security numbers to assist in tracing subjects through criminal records.

The Cycle of Violence: Findings

Abused and neglected children have a higher likelihood of arrests for delinquency, adult criminality, and violent criminal behavior (*40*) than the matched controls. Table 1 presents the percentage of individuals in the abused and neglected and control groups who have official records for delinquency, adult criminality, and violent criminal behavior (*41*). In comparison to controls, abused and neglected children overall have more arrests as a juvenile (26 versus 17%), more arrests as an adult (29 versus 21%), and more arrests for any violent offense (11 versus 8%).

In addition to the extent of involvement, criminality is often described in terms of the number of offenses committed, the age at first arrest, and the repetitiveness (or chronicity) of a person's criminal activity. In comparison to controls, abused and neglected children as a group have a larger mean number of offenses (2.43 versus 1.41, $t = 4.49$, $P < 0.001$); an earlier mean age at first offense (16.48 versus 17.29, $t = 2.38$, $P < 0.05$); and a higher proportion of chronic offenders, that is, those charged with five or more offenses [17 versus 9%; χ^2 (1) = 28.86, $P < 0.001$].

Differences related to demographic characteristics. To illustrate the independent effects of demographic characteristics, the results of separate analyses for sex and race are included in Table 1.

Sex. Males have higher rates of delinquency, adult criminality, and violent criminal behavior than females (Table 1). Within each sex, a history of abuse or neglect also significantly increases one's chances of having an official criminal record. Thus, despite the fact that women generally have lower rates of arrests for criminal behavior, abused or neglected females are significantly more likely to have an adult arrest (15.9%) than control females (9.0%), although the difference for females in these groups is not significant for violent crimes.

Race. Although blacks are statistically more likely to have official criminal records than whites (*16*), the same pattern exists across the abused and neglected and the control group for all three levels of criminal activity (delinquency, adult criminal, and violent criminal behavior). For blacks and whites, being abused or neglected increases the likelihood of having a criminal record as a juvenile and as an adult. However, for whites, being abused or neglected does not significantly increase the risk of an arrest for violent criminal behavior (*42*).

Age. Dividing our sample (ages 16 to 33 years) into four age groups of equal size, older subjects in both groups have higher frequencies of an adult criminal record than younger subjects [χ^2 (3) = 36.17, $P < 0.001$] and of violent criminal behavior [χ^2 (3) = 14.05, $P < 0.01$]. Although this finding may simply reflect the number of years available for the subjects to accumulate criminal records, it also illustrates the complexity of dealing with criminal behavior and the need to control for age.

Continuity. As seen so far, victims of early child abuse and neglect

differ from nonabused and nonneglected children on a number of indices of delinquency, adult criminality, and violent criminal behavior; however, not all aspects of criminal activity differentiate the groups. One example of such a similarity between the groups is provided by findings about the continuity between antisocial behavior as a juvenile and criminal behavior as an adult.

Of those with juvenile offenses, roughly the same proportion of abused and neglected children and controls go on to commit offenses as an adult (53 versus 50%). Similarly, of those with violent offenses as juveniles, approximately the same proportion go on to commit violence as an adult in the abused and neglected group (34.2%) as in the controls (36.8%). Thus, despite significant differences in the extent of involvement in criminal activity, nonabused and nonneglected subjects are just as likely as abused and neglected individuals to continue criminal activity once they have begun.

These findings are interesting in light of recent literature in criminology, particularly the current debates on criminal careers (*30, 43*). Although my findings indicate that officially recorded abuse and neglect increase one's likelihood of having an official criminal record and speed up the age at entrance into officially recorded delinquent activities, early childhood victimization does not appear to place one at increased risk for continuing in a life of crime. These findings reinforce the notion (*30*) that it is important to distinguish factors that may stimulate an individual to become involved in crime from the factors that affect whether the person continues or desists in a criminal career.

Does Violence Beget Violence?

In a direct test of the cycle of violence hypothesis, violent criminal behavior was examined as a function of the type of abuse or neglect experienced as a child. According to the cycle of violence hypothesis, individuals who experienced childhood physical abuse only should show higher levels of violence than individuals victimized by other forms of abuse or neglect. Table 2 shows the percentage of subjects in each abuse group who have an arrest for any violent offense (*40*) (juvenile or adult record). As expected, victims of physical abuse had the highest level of arrests for violent criminal behavior, followed by victims of neglect. However, types of abuse and neglect are not distributed randomly in the sample across age, sex, and race groups, and thus bivariate analyses present an overly simplistic picture.

Need for multivariate models. Since sex, race, and age are independently related to differences in rates of violent criminal behavior, it is necessary to control for the effects of these factors in examining the hypothesized cycle of violence. Thus, data analysis and interpretation of these findings must incorporate and control for sample demographic characteristics.

One statistical technique for analyzing the influence of a set of explanatory variables on a "response" variable that takes a binary form is logistic regression or linear logistic response models. This technique models the log-odds of the presence or absence of a response as a linear function of the independent variable. Models were estimated with the use of iterative maximum likelihood methods (*44*), with any arrest for a violent crime as the response variable and race, sex, age, and group status (physical abuse, sexual abuse, neglect, and controls) as explanatory variables.

The estimated coefficients in the resulting fitted model for predicting the log-odds of an arrest for any violent crime are presented in Table 3. Group contrasts are with the control group, so that each pure type of abuse (omitting cases with more than one type of abuse) is compared to the control group, holding other factors constant. The results of this analysis indicate that, controlling for age, sex, and race, the physical abuse and neglect groups have a significantly higher likelihood of having an arrest for a violent offense than the controls (*45*). Thus, in the most direct and stringent test of the cycle of violence hypothesis, being physically abused as a child does increase one's propensity to commit further criminal violence. Although being neglected also increases one's likelihood of violent behavior, the type of abuse or neglect is not as powerful a predictor of violent criminal behavior as the demographic characteristics of sex, race, and age.

Table 1. Extent of involvement in delinquency, adult criminality, or violent criminal behavior among abused and neglected (n = 908) and control (n = 667) groups. NS, not significant.

Demographic characteristic	Abused and neglected (%)	Controls (%)	χ^2	P
	Juvenile record (delinquency)			
Overall	26.0	16.8	18.91	<0.001
Sex				
Male	33.2	22.2	11.38	<0.001
Female	19.1	11.4	8.66	<0.01
Race				
Black	37.9	19.3	21.29	<0.001
White	21.1	15.4	5.36	<0.05
	Adult criminal record			
Overall	28.6	21.1	11.38	<0.001
Sex				
Male	42.0	33.2	6.18	<0.05
Female	15.9	9.0	8.16	<0.01
Race				
Black	39.0	26.2	9.46	<0.01
White	24.4	18.4	5.26	<0.05
	Any violent criminal record			
Overall	11.2	7.9	4.68	<0.05
Sex				
Male	19.4	13.5	4.79	<0.05
Female	3.4	2.4	0.72	NS
Race				
Black	22.0	12.9	7.22	<0.01
White	6.5	5.3	0.70	NS

Caveats

My research was explicitly designed to examine the relation between abuse, neglect, and later violent behavior and to overcome methodological shortcomings in previous literature. However, this research has limitations because of its exclusive reliance on official records. Thus, one should be circumspect about these findings (*3, 4*) and not generalize inappropriately.

Much child abuse and neglect that occurs does not come to the attention of welfare departments, police, or courts. This fact especially applies to official data from the late 1960s and early 1970s, when it is generally believed that only a fraction of all maltreatment cases were reported. The abuse and neglect cases studied here are those in which agencies have intervened and those processed through the social service systems (*46*). These cases were dealt with before most states had adopted mandatory child abuse reporting laws and before the Federal Child Abuse Treatment and Prevention Act was passed.

Child abuse researchers have argued that there is bias in the labeling and reporting of child abuse cases and that lower income and minority groups are overrepresented in official reports of child abuse and neglect (*47*). The design discussed here does not generally include instances of abuse in higher level socioeconomic families in which such abuse may be more likely to be labeled an accident. On the other hand, national surveys of family violence have found that

Table 2. Does violence breed violence? Any arrest for a violent offense as function of type of abuse [χ^2 (5) = 13.85, P = 0.02].

Abuse group	n	Arrest for any violent offense (%)
Physical only	76	15.8
Neglect	609	12.5
Physical and neglect	70	7.1
Sexual and other abuse	28	7.1
Sexual only	125	5.6
Controls	667	7.9

those with the lowest income are more likely to abuse their children (*10*). Even though most poor people do not abuse or neglect their children, there is a greater risk of abuse and neglect among the lowest income groups (*48*). Regardless, one cannot generalize from these findings to unreported cases of abuse and neglect, such as those cases handled unofficially by private medical doctors (*4*). Similarly, because of the exclusions (*35*), these findings are not generalizable to abused and neglected children who were adopted in early childhood.

Other potential biases may be introduced by relying on official records for exposure to abuse or neglect and criminality. Pagelow (*49*) suggested that the process of intervening and labeling abused and neglected children, disrupting their residence with their family, and stigmatizing the parents (who often received little or no assistance to improve), may create a self-fulfilling prophecy that can be difficult to resist or overcome. This implies that it is the official response to abuse, rather than the abuse itself, which begets later criminal behavior. On the basis of this reasoning, strong evidence for the long-term ill-effects of childhood victimization would be expected because the children in our abused and neglected sample were processed through the courts and presumably suffered all the negative effects associated with such a process.

On the other hand, because individuals in the control group could have been abused, but not officially reported as abused, the extent of the differences between the abused and neglected group and the controls might be suppressed. Thus, the findings here may represent an underestimate because the differences between the abused and neglected group and the control group may be smaller than would be the case for a "pure nonabused and nonneglected" control group.

In the case of the dependent variable, reliance on official arrest records for violent criminal behavior also represents an underestimate of potential violent behavior. These findings do not describe violent behavior, but rather violent criminal behavior. Whether these findings extend to violence in general, to spousal violence, and to violence directed at children is unknown at this time.

Therefore, it is important to locate and conduct a follow-up study with these individuals to determine the extent to which the abused and neglected subjects and the controls report having experienced child abuse or neglect and to determine the extent of delinquency, criminality, and violent criminal behavior not disclosed in official records. Eventually, further intergenerational transmission of violence to the offspring of these individuals (currently in their 20s and 30s) should be examined.

Conclusions and Implications

Early childhood victimization has demonstrable long-term consequences for delinquency, adult criminality, and violent criminal behavior. The results reported here provide strong support for the cycle of violence hypothesis. The experience of child abuse and neglect has a substantial impact even on individuals with otherwise little likelihood of engaging in officially recorded criminal behavior. My findings are consistent with previous empirical data; however, there is now baseline data with which to assess the significance and magnitude of the association, and there is an assessment of the consequences of childhood victimization beyond adolescence into adulthood.

In a direct test of the violence breeds violence hypothesis, physical abuse as a child led significantly to later violent criminal behavior, when other relevant demographic variables such as age, sex, and race were held constant. However, being neglected as a child also showed a significant relation to later violent criminal behavior, and type of abuse was not as powerful a predictor of this behavior as demographic characteristics.

These findings indicate that abused and neglected children have significantly greater risk of becoming delinquents, criminals, and violent criminals. These findings do not show, however, that every abused or neglected child will become delinquent, criminal, or a violent criminal. The linkage between childhood victimization and later antisocial and violent behavior is far from certain, and the intergenerational transmission of violence is not inevitable. Although early child abuse and neglect place one at increased risk for official recorded delinquency, adult criminality, and violent criminal behavior, a large portion of abused or neglected children do not succumb. Twenty-six percent of child abuse and neglect victims had juvenile offenses; 74% did not. Eleven percent had an arrest for a violent criminal act, whereas almost 90% did not. These findings mean that prevention programs and intervention strategies aimed at buffering at-risk children play a potentially important role in the reduction of further violent criminal behavior.

In addition, alternative manifestations of the consequences of these early abusive experiences should be examined. For example, the effects of early abusive experiences may be manifested in different ways from those already discussed, in particular in withdrawal or self-destructive behavior (*50*). Thus, one possible explanation for the lack of a more substantial relation between childhood victimization and later delinquency, adult criminality, or violent criminal behavior may lie in more subtle indications of emotional damage such as depression, withdrawal, or more extreme behavior, as in suicide. Given the attrition that typically occurs in longitudinal studies, examination of cases lost because of early death would be particularly revealing. In some ways, studies that focus on violence and criminal behavior may be shortsighted.

Most likely, the long-term consequences of child abuse and neglect for females are manifest in more subtle ways. Abused and neglected females may be more prone to suffer depression and perhaps undergo psychiatric hospitalization as a consequence of these early childhood experiences, rather than direct their aggression "outwardly." Interpretation of results is also complicated because the type of abuse and neglect suffered by females and males differs (more females are sexually abused than males), which in turn may

Table 3. Predictors of any violent crime: coefficients from linear logistic response model. Likelihood ratio χ^2 (3) = 10.28, P = 0.016. Number of subjects was 1455.

Predictor variable	Coefficient	Z value*
Sex (male)	2.08	8.32
Race (black)	1.35	7.11
Age	0.11	3.67
Sexual abuse	0.54	1.20
Physical abuse	0.94	2.47
Neglect	0.53	2.65
Constant	−7.48	−0.84

*Z values are computed by dividing the coefficient by the standard error. Values of Z greater than 2.0 are regarded as statistically significant.

differentially affect the long-term consequences.

Abused and neglected children are generally at "high risk" for social problems. It is important to understand the potential protective factors that intervene in the child's development and to compare the development of those who succumb and those who are "resilient" and do not. Although one can speculate on why child abuse and neglect should have various outcomes, the substance of what is learned and the intervening linkages that transpire to produce aggression and violent criminal behavior are not well understood. For example, child abuse or neglect may not directly cause delinquency or violent criminal behavior. Rather, these outcomes may be an indirect by-product of these early abusive experiences. There are suggestions in the empirical literature about possible intervening variables (*51*). [A discussion of possible pathways and some of the potentially relevant variables is presented by Widom (*5*).] However, more research is needed to look at possible mediating variables that act to buffer or protect abused or neglected children from developmental deficits and later delinquent and adult criminal behavior. Studies must be undertaken to examine the role of what Garmezy (*52*) has called protective factors—dispositional attributes, environmental conditions, biological predispositions, and positive events—that act to mitigate against early negative experiences.

The scientific issue should not be the "box score" (the magnitude of the association between childhood victimization and later delinquent or criminal behavior), but rather the goal should be further knowledge of the processes involved (*53*). Research should be directed at understanding how these early experiences relate to later violent behavior, recognizing the likelihood of multiple pathways, and noting how possible protective factors act to buffer some children from the long-term negative effects of these early childhood experiences.

REFERENCES AND NOTES

1. G. C. Curtis, *Am. J. Psychiatry* **120**, 386 (1963).
2. J. Kaufman and E. Zigler, *Am. J. Orthopsychiatry* **57**, 186 (1987).
3. D. J. Besharov, *Child Abuse Negl.* **5**, 383 (1981).
4. C. S. Widom, *Am. J. Orthopsychiatry* **58**, 260 (1988).
5. ——, *Pathways to Criminal Violence*, N. Weiner and M. E. Wolfgang, Eds. (Sage, Newbury, CA, 1989).
6. The literature on child abuse and neglect encompasses several different phenomena: physical abuse, sexual abuse, neglect, severe physical punishment, and psychological maltreatment. Despite occasional references to the destructive impact of psychological abuse, the focus here is primarily on physical abuse and neglect. Excluded are medical reports that describe immediate or long-term physical consequences of early childhood trauma.
7. D. Gil, *Violence Against Children: Physical Child Abuse in the United States* (Harvard Univ. Press, Cambridge, MA, 1973).
8. B. Egeland and D. Jacobvitz, "Intergenerational continuity of parental abuse: Causes and consequences," presented at the conference on BioSocial Perspectives on Abuse and Neglect, York, ME, 1984.
9. L. R. Silver, C. C. Dublin, R. S. Lourie, *Am. J. Psychiatry* **126**, 152 (1969); J. J. Spinetta and D. Rigler, *Psychol. Bull.* **77**, 296 (1972); B. J. Steele and C. B. Pollock, in *The Battered Child*, R. E. Helfer and C. H. Kempe, Eds. (Univ. of Chicago Press, Chicago, 1974), pp. 103–147; R. S. Hunter and N. Kilstrom, *Am. J. Psychiatry* **136**, 1320 (1979); E. C. Herrenkohl, R. C. Herrenkohl, L. J. Toedter, in *The Dark Side of Families*, D. Finkelhor, R. J. Gelles, G. T. Hotaling, M. A. Straus, Eds. (Sage, Beverly Hills, CA, 1983), pp. 305–316.
10. M. Straus, R. Gelles, S. K. Steinmetz, *Behind Closed Doors: Violence in the American Family* (Anchor, Garden City, NY, 1980).
11. W. M. Easson and R. M. Steinhilber, *Arch. Gen. Psychiatry* **4**, 27 (1961); E. Tanay, *Austr. N.Z.J. Psychiatry* **7**, 263 (1973); C. H. King, *Am. J. Orthopsychiatry* **45**, 134 (1975); I. B. Sendi and P. G. Blomgren, *Am. J. Psychiatry* **132**, 423 (1975); J. M. Sorrells, *Crime Delin.* **23**, 312 (1977).
12. J. W. Duncan and G. M. Duncan, *Am. J. Psychiatry* **127**, 74 (1971); R. K. Ressler and A. W. Burgess, *FBI Law Enforc. Bull.* **54**, 2 (1985).
13. M. Rosenbaum and B. Bennett, *Am. J. Psychiatry* **143**, 367 (1986).
14. J. Monahan, *Predicting Violent Behavior* (Sage, Newbury, CA, 1981).
15. W. H. Friedrich and A. J. Einbender, *J. Clin. Child Psychol.* **12**, 244 (1983); R. Loeber and T. Dishion, *Psychol. Bull.* **94**, 68 (1983); R. Loeber and M. Stouthamer-Loeber, in *Crime and Justice*, M. Tonry and N. Morris, Eds. (Univ. of Chicago Press, Chicago, 1986), vol. 7, pp. 219–339.
16. Department of Justice, *Crime in the United States—1985* (Government Printing Office, Washington, DC, 1986), pp. 166–67 and 182–184.
17. S. Glueck and E. Glueck, *Unraveling Juvenile Delinquency* (Cambridge Univ. Press, Cambridge, 1950); D. O. Lewis and S. S. Shanok, *Am. J. Psychiatry* **134**, 1010 (1977); C. M. Mouzakitis, in *Exploring the Relationship Between Child Abuse and Delinquency*, R. J. Hunner and Y. E. Walker, Eds. (Allanheld, Osmun, Montclair, NJ, 1981), pp. 220–232; S. C. Wick, *ibid.*, pp. 233–239.
18. P. C. Kratcoski, *Child Welf.* **61**, 435 (1982).
19. J. Alfaro, in *Exploring the Relationship Between Child Abuse and Delinquency*, R. J. Hunner and Y. E. Walker, Eds. (Allanheld, Osmun, Montclair, NJ, 1981), pp. 175–219.
20. F. G. Bolton, J. Reich, S. E. Gutierres, *J. Fam. Iss.* **2**, 531 (1981).
21. J. McCord, *Child Abuse Negl.* **7**, 265 (1983).
22. R. L. Jenkins, *Am. J. Psychiatry* **124**, 1440 (1968); D. O. Lewis, S. S. Shanok, J. H. Pincus, G. H. Glaser, *J. Am. Acad. Child. Psychiatry* **18**, 307 (1979); S. Gutierres and J. A. Reich, *Child Welf.* **60**, 89 (1981); M. Geller and L. Ford-Somma, *Violent Homes, Violent Children* (Report to National Center for Child Abuse and Neglect, Washington, DC, 1984); D. O. Lewis *et al.*, *Am. J. Psychiatry* **142**, 1161 (1985).
23. E. Hartstone and K. V. Hansen, in *Violent Juvenile Offenders: An Anthology*, R. A. Mathias, Ed. (National Council on Crime and Delinquency, San Francisco, CA, 1984), pp. 83–112.
24. C. E. Climent and F. R. Ervin, *Arch. Gen. Psychiatry* **27**, 621 (1972); H. T. Blount and T. A. Chandler, *Psychol. Rep.* **44**, 1126 (1979); M. Monane, D. Leichter, D. O. Lewis, *J. Am. Acad. Child Psychiatry* **23**, 653 (1984); R. E. Tarter, A. M. Hegedus, N. E. Winsten, A. I. Alterman, *ibid.*, p. 668.
25. T. J. Reidy, *J. Clin. Psychol.* **33**, 1140 (1977); R. L. Burgess and R. D. Conger, *Child Dev.* **49**, 1163 (1978); C. George and M. Main, *ibid.* **50**, 306 (1979); E. M. Kinard, *Am J. Orthopsychiatry* **50**, 686 (1980); R. M. Barahal, J. Waterman, H. P. Martin, *J. Consult. Clin. Psychol.* **49**, 508 (1981); M. A. Perry, L. D. Doran, E. A. Wells, *J. Clin. Child Psychol.* **12**, 320 (1983); D. A. Wolfe and M. D. Mosk, *J. Consult. Clin. Psychol.* **51**, 702 (1983); D. M. Bousha and C. T. Twentyman, *J. Abnorm. Psychol.* **93**, 106 (1984).
26. C. A. Rohrbeck and C. T. Twentyman, *J. Consult. Clin. Psychol.* **54**, 231 (1986).
27. D. J. Owens and M. A. Straus, *Aggressive Behav.* **1**, 193 (1975); D. Kalmuss, *J. Marriage Fam.* **46**, 11 (1984); P. C. Kratcoski, *J. Adolesc.* **8**, 145 (1985).
28. D. A. Wolfe, P. Jaffe, S. K. Wilson, L. Zak, *J. Consult. Clin. Psychol.* **53**, 657 (1985); P. Jaffe, D. A. Wolfe, S. Wilson, L. Zak, *Am. J. Orthopsychiatry* **56**, 142 (1986).
29. A complete description of the design of this study and details of the subject selection criteria are given by C. S. Widom (*Am. J. Orthopsychiatry*, in press).
30. A. Blumstein, J. Cohen, D. P. Farrington, *Criminology* **26**, 1 (1988).
31. T. Hirschi, *Causes of Delinquency* (Univ. of California Press, Berkeley, 1969).
32. M. J. Hindelang, T. Hirschi, J. G. Weis, *Measuring Delinquency* (Sage, Beverly Hills, CA, 1981).
33. F. Schulsinger, S. A. Mednick, J. Knop, *Longitudinal Research: Methods and Uses in Behavioral Sciences* (Nijhoff, Boston, 1981).
34. J. M. Leventhal, *Child Abuse Negl.* **6**, 113 (1982).
35. Excluded were juvenile court cases that represented: (i) adoption of the child as an infant (n = 322), (ii) "involuntary" neglect only (n = 319), (iii) placement only (n = 72), and (iv) cases of "failure to pay child support" (FTPCS) (n = 898). "Involuntary neglect" refers to cases in which the mother or other legal guardian is temporarily unable to provide for child (children) because of institutionalization in a girls' school, jail, prison, mental hospital, or medical facility. In FTPCS, there was no indication of neglect on the part of the caretaking parent. These cases represented a necessary step in seeking financial support from the noncustodial parent. There were 76 other exclusions, for the same and one additional reason (a morals charge against a mother with no evidence of abuse or neglect). Cases that involved adoption of an abused or neglected child were also excluded. Because of name changes concurrent with adoption and moves away from the county and state, the ability to locate official criminal histories for these individuals was seriously impaired. Thus, these 162 cases involving adoption were eliminated from the final sample. These findings, then, are not generalizable to adoptive cases of abused or neglected children.
36. Matching for social class is important in this study because it is theoretically plausible that any relation between child abuse or neglect and later delinquency or adult criminality is confounded or explained by social class differences. It is difficult to match exactly for social class because higher income families could live in lower social class neighborhoods and vice versa. The matching procedure used here is based on a broad definition of social class that includes neighborhoods in which children were reared and schools they attended. Similar procedures, with neighborhood school matches, have been used in studies of schizophrenics [for example, N. F. Watt, *J. Nerv. Ment. Dis.* **155**, 42 (1972)] to match approximately for social class. Busing was not operational at this time, and students in elementary schools in this county were from small, socioeconomically homogeneous neighborhoods. After inspecting the home addresses of abused and neglected children and their matches, often the same street a few houses apart, it appeared as if the school matches might be closer than the birth record matches in terms of social class. To determine whether this matching procedure produced groups not evenly matched (hospital and school record matches), the analyses were repeated for the two subsets (abused and neglected children and their birth record matches and abused and neglected children and their school record matches), and they yielded essentially the same results. Although it would be surprising if social class had no effect on these results (arrest rates), given the matching procedure used here, there are good grounds for supposing that social class cannot explain all or possibly even most of the disparity in crime rates between the abused and neglected and the control groups.
37. The goal was to have a control group of approximately 700 subjects and to start with two matches (the second was backup in case the first was eliminated) for as many of the abused and neglected children as possible (up to 700). Non-matches occurred for a number of reasons. For matches through birth records, non-matches occurred in situations where the abused or neglected child was born outside the county or state or when date of birth information was missing. For school records,

non-matches occurred because class registers were unavailable because of the closing of the elementary school over the last 20 years or lack of adequate identifying information for the abused and neglected children.

38. An obvious limitation of this study is that the number in the control group who were actually abused, but not reported as such, is unknown. If the control group included subjects who had been officially reported as abused, at some earlier or later time period, this would jeopardize the design of the study. Thus, any child who had an official record of abuse or neglect was eliminated from the study, regardless of whether the abuse or neglect occurred before or after the time period of the study. An alternative was to include these subjects and treat them as a separate group in the analyses. However, because the number of these subjects was small (n = 11), this was not done.
39. M. E. Wolfgang, R. M. Figlio, T. Sellin, *Delinquency in a Birth Cohort* (Univ. of Chicago Press, Chicago, 1972); P. Strasburg, *Violent Delinquents* (Monarch, New York, 1978); D. Rojek and M. Erikson, *Criminology* **20**, 5 (1982).
40. Violent crimes include arrests for robbery, assault, assault and battery, battery with injury, battery, aggravated assault, manslaughter/involuntary manslaughter/reckless homicide, murder/attempted murder, rape/sodomy, and robbery and burglary with injury.
41. A reanalysis of these findings was done, excluding abuse and neglect cases who did not have matches. Thus, the number of individuals in each group was 667. The results do not change with this smaller sample size. In cases where differences were significant, they became even more significant. In the few cases where differences were not significant, these results remained the same.
42. Because these findings are based on official records and official records overrepresent minority groups, the most obvious explanation for the higher rates of arrests for violent crimes among blacks would be the bias and discriminatory treatment by the criminal justice system. However, this explanation does not seem to explain the differences among blacks and the lack of difference for the whites, unless we postulate a "double jeopardy" theory. Another possible explanation is that parental violence is more severe among blacks than whites or that nonwhites are more physically abusive with their children and within their homes than whites; however, the data indicate that this is not the case. Among whites, approximately 20% suffered physical abuse, compared to less than 9% for blacks. Blacks suffered more neglect, relative to whites in the sample.
43. M. Gottfredson and T. Hirschi, *Criminology* **26**, 37 (1988).
44. R. J. Baker and J. A. Nelder, *The GLIM System. Release 3.77: Generalised Linear Interactive Modeling Manual* (Numerical Algorithms Group, Oxford, 1986).
45. Separate logit analyses were done by using different methods of dividing the abuse and neglect groups in addition to the one presented here, which is based on pure groups. In these analyses, the same pattern emerged, indicating the importance of physical abuse only and neglect. One exception was in replicating the logit analysis by using only those abused or neglected cases with matches. Here, in addition to physical abuse and neglect as significant predictors, sexual abuse only was also significant.
46. L. P. Groeneveld and J. M. Giovannoni, *Soc. Work Res. Abstr.* **13**, 24 (1977).
47. R. J. Gelles, *Am. J. Orthopsychiatry* **45**, 363 (1975); E. H. Newberger, R. B. Reed, J. H. Daniel, J. N. Hyde, M. Kotelchuck, *Pediatrics* **60**, 178 (1977).
48. R. J. Gelles and C. P. Cornell, *Intimate Violence in Families* (Sage, Beverly Hills, CA 1985).
49. M. D. Pagelow, "Child abuse and deliquency: Are there connections between childhood violence and later deviant behavior?" Presented at the Tenth World Congress of the International Sociological Association, Mexico City, Mexico, 1982.
50. G. Bach-y-Rita and A. Veno, *Am. J. Psychiatry* **131**, 1015 (1974); J. Kagan, *Daedalus (Boston)* **106**, 33 (1977); H. P. Martin and P. Beezley, *Dev. Med. Child Neurol.* **19**, 373 (1977); A. H. Green, *Am. J. Psychiatry* **135**, 579 (1978).
51. A. Frodi and J. Smetana, *Child Abuse Negl.* **8**, 459 (1984); M. A. Lynch and J. Roberts, *Consequences of Child Abuse* (Academic Press, London, 1982).
52. N. Garmezy, in *Further Explorations in Personality*, A. I. Robin, J. Aronoff, A. M. Barclay, R. A. Zucker, Eds. (Wiley, New York, 1981), pp. 196–269.
53. K. Heller, personal communication.
54. Supported in part by the National Institute of Justice grant 86-IJ-CX-0033, by Indiana University Biomedical Research grant S07 RR07031, and by a Talley Foundation grant while the author was a visiting scholar in the Psychology Department at Harvard University, Cambridge, MA. I thank A. Ames, J. Lindsay, B. Rivera, and B. Tshanz for assistance with the data collection and B. Ross for assistance with the data analysis.

Light Reflection Models for Computer Graphics

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During the past 20 years, computer graphic techniques for simulating the reflection of light have progressed so that today images of photorealistic quality can be produced. Early algorithms considered direct lighting only, but global illumination phenomena with indirect lighting, surface interreflections, and shadows can now be modeled with ray tracing, radiosity, and Monte Carlo simulations. This article describes the historical development of computer graphic algorithms for light reflection and pictorially illustrates what will be commonly available in the near future.

IN RECENT YEARS, THERE HAS BEEN AN ENORMOUS DEMAND for realism in computer imagery. Automobile designers would like to evaluate their new car designs without having to construct the full-size clay models commonly used in industry. Graphics simulations of dynamic systems are basic to today's aerospace, mechanical, and structural engineers. Modern pilot training is now conducted with real-time flight simulators, where the views from the cockpit are changing scenes simulating the landing at a specific airport. The display of biological organs, reconstructed from information obtained from tomographic scans, x-rays, or other noninvasive methods, greatly benefits the medical professions. And, of course, architects and interior designers would like to show their clients design concepts before they are constructed. The variety of uses of computer graphics are infinite, but all will require the ability to generate synthetic pictures of increasingly greater realism at increasingly greater speeds. Furthermore, as the complexity of these simulations increases with the inevitable availability of computer processing power, the ability to provide the visual cues such as shade, shadows, and motion and depth perception, will become necessary.

In general, to create a typical computer graphics image, it is necessary to perform the following five steps sequentially, in what is frequently called the graphics "pipeline".

1) *Three-dimensional model.* The initial step in the process is the modeling of the physical environment, including the geometry, the positions and orientations of all objects, and the material characteristics, textures, and finishes of all surfaces. The illumination, including the geometry of the light sources, the distribution of the light energy, and the color or spectral characteristics of the emission, must

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