Interaction Between Birth Complications and Early Maternal Rejection in Predisposing Individuals to Adult Violence: Specificity to Serious, Early-Onset Violence

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Objective: *The authors previously reported that birth complications interact with early maternal rejection in predisposing individuals to violence at age 18 years. This study extended the follow-up period for violent offending from 18 years to 34 years, thus increasing the sample of violent offenders threefold and allowing more detailed analyses on onset and type of violence, the form of maternal rejection, and the effect of maternal mental illness.* *Method:* *Complications in the births of 4,269 males in Denmark, maternal rejection of these individuals before the age of 1 year, and their histories of criminal offenses at age 34 years were assessed.* *Results:* *The biosocial interaction previously observed held for violent but not nonviolent crime, was specific to more serious forms of violence and not threats of violence, held for early-onset but not late-onset violence, and was not accounted for by psychiatric illness in the mothers. Being reared in a public care institution in the first year of life and the mother's attempt to abort the fetus were the key aspects of maternal rejection that interacted with birth complications in predisposing a subject to violence.* *Conclusions:* *These findings 1) indicate that the mechanisms underlying early-onset, serious violence differ from those for less serious, late-onset violence, 2) implicate very early factors in the development of violence, 3) highlight the potential importance of integrating psychosocial with biological factors in understanding and preventing violence, and 4) suggest that interventions to reduce birth complications and maternal rejection may help reduce violence.*

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It is being increasingly recognized that the interaction between environmental and biological factors may be particularly important in the development of crime and violence (1–3). Empirical support for such a view is nevertheless surprisingly limited. In a previous study conducted with Danish subjects (4), we found support for the biosocial perspective. That study tested the biosocial interaction hypothesis that birth complications, when combined with early maternal rejection of the infant, predispose to adult violent crime. A highly significant interaction between birth complications and early maternal rejection indicated that individuals who suffered both birth complications and early childhood rejection were most likely to become violent offenders in adulthood. The effect was specific to violence and was not observed for nonviolent criminal offending.

That study had a number of limitations. First, although the sample was initially large, the low base rate of criminal violence in Denmark meant that cell sizes in the four groups based on violence outcome were relatively small. Second, the relatively small group sizes for violence outcome meant that we were not able to examine which types of violent criminal offending the biosocial interaction specifically applied to. There appears to be little research on the differential correlates of threats of violence versus serious physical violence. One important question, therefore, is whether the biosocial interaction applies to all forms of violence including threats or whether it is more specific to serious physical violence.

Third, because subjects' violent offending was assessed at age 18 years, we were not able to analyze whether the interaction effect was specific to early-onset violent offenders or whether it generalizes to offenders who commit violence in adulthood after age 18. Surprisingly little is known about differences between

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early-onset *violent* criminal offenders and late-onset violent offenders (5). On the basis of the notion that early-onset violent offending is more likely to have its roots in early etiological processes, it is hypothesized that birth complications and early maternal rejection interact only with respect to early-onset violent criminal offending and not to violent crime that has a later onset in adulthood.

Fourth, the measure of maternal rejection we used consisted of three components (not wanting the pregnancy, public institutional care of the infant for at least 4 months in its first year, and an attempt to abort the fetus), but it is not clear which of these components accounts for the interaction effect. It could be hypothesized, for example, that not wanting the pregnancy is an attitudinal variable that may change over time, whereas attempt to abort and institutionalization may have more permanent consequences (6, 7).

Fifth, maternal rejection per se may not play a direct role in predisposing to violence. Instead, rejecting mothers may be psychiatrically ill, and violent crime by the offspring may be mediated more by genetic factors that result in both maternal rejection and violence. This article describes attempts to respond to these five issues by extending the follow-up period for violent offending from age 18 to age 34 in the same cohort of subjects and conducting new analyses on the enlarged violence outcome groups.

METHOD

Male subjects (N=4,269) were drawn from a total cohort of 9,125 consecutive births of males and females that took place in the maternity department of the State University Hospital (Rigshospitalet) in Copenhagen between September 1959 and December 1961. Written informed consent for human investigation was obtained from the parents. Further details of the birth cohort used in this study may be found elsewhere (8). Only data from males were analyzed, because the very low rate of criminal violence among females by age 34 years (1.5%) precluded meaningful statistical analyses.

Birth complications and conditions were recorded at the time of delivery by an obstetrician assisted by a midwife. The study used a frequency-of-birth-complications score developed through the collaboration of American and Danish obstetricians and pediatric neurologists (8). Examples of delivery complications on this scale include forceps extraction, breech delivery, umbilical cord prolapse, preeclampsia at the time of delivery, and long birth duration. As in our earlier study (4), subjects were divided into two groups: those with no delivery complications and those with one or more complications.

We used exactly the same procedures for defining early child rejection and poor social circumstances that we used previously (4). Demographic, family, and psychosocial data were collected during pregnancy and when the child was 1 year old. Data collected during pregnancy that were relevant to our analyses included whether the pregnancy was wanted or unwanted, whether the mother attempted to abort the fetus, and the mother's age. Year 1 follow-up interview data included home conditions, marital status, and whether the infant was placed for full-time care in a public institution for more than 4 months of the first year. The socioeconomic status of the family (based on education and occupation levels) when the child was 1 year old was ascertained from the Danish Central Persons Register.

A factor analysis of these measures (4) produced two main factors: poor social circumstances (unmarried mother, low socioeconomic status, poor home conditions, young maternal age, unwanted pregnancy) and early rejection of the child (public institutional care of the infant, attempt to abort the fetus, unwanted pregnancy). Data were complete on all variables in the study except that socioeconomic status was missing for 653 subjects; the large majority of analyses did not concern socioeconomic status. For these analyses the entire sample of 4,269 was included, and the early maternal rejection factor was recomputed with the loading of social class omitted (it did not load significantly on this factor). For the two analyses that involved socioeconomic status, the reduced sample of 3,616 was used.

Maternal psychiatric illness was measured in order to assess whether it mediated the link between birth complications/early maternal rejection and violence outcome. Psychiatric illness was assessed according to lifetime records of psychiatric hospitalization obtained from the Danish Psychiatric Register in 1992. Seven hundred thirty-five (17.2%) of the mothers had histories of mental illness. The ICD-8 diagnoses (1,150 diagnoses for the 735 mothers) were as follows: alcohol abuse (N=150), drug abuse (N=116), schizophrenia (N=35), paranoid psychoses (N=32), other psychoses (N=158), character disorders (N=387), and neuroses (N=272).

In the original study (4), criminal status was assessed when offspring were aged 17–19 years. In this new study, criminal status was assessed at ages 33–35 years (mean=34 years). Criminal status was ascertained by a search of the Danish National Criminal Register, in which all police contacts and court decisions involving Danish citizens are recorded. This is viewed as one of the most comprehensive and accurate registers in the Western world (9). As before (4), we used the definition of violence of the U.S. National Academy of Sciences Panel on the Understanding and Control of Violence ("behaviors by individuals that intentionally threaten, attempt, or inflict physical harm on others") (5, p. 2). Consequently, violent crime was defined by the following offenses: murder, attempted murder, assault (including domestic assault), rape, armed robbery, illegal possession of a weapon, and threats of violence. Nonviolent crime was defined as theft, breaking and entering, fraud, forgery, blackmail, embezzlement, vandalism, prostitution, pimping, and narcotic offenses.

In the original study, 145 subjects (3.4%) were classified as violent criminals, 540 (12.6%) as nonviolent criminals, and 3,584 (84.0%) as noncriminals. In the 1994 update, 466 (10.9%) were classified as violent criminals, 844 (19.8%) were classified as nonviolent criminals, and 2,959 (69.3%) as noncriminals. Consequently, the new update resulted in a more than threefold increase in the number of subjects with violent offenses.

The same statistical procedures used in the previous study (4) were applied to the new data. There were three steps in the data analysis. The primary statistical procedure consisted of logistic regression analysis with the SPSS (10). The dependent variable consisted of dichotomous criminal group membership (e.g., violent offenders versus nonviolent criminals), while the independent variables consisted of a dichotomous variable of birth complications and a continuous measure of maternal rejection derived from factor scores as described above. The Wald chi-square test was used to test the interaction. Second, to illustrate the interaction effect diagrammatically, the continuous measure of maternal rejection was dichotomized into rejection or nonrejection, with rejection defined as a mother's negative attitude toward the pregnancy and either attempted abortion or institutionalization of the child (see reference 4 for full details), and the data were reanalyzed with the use of logistic regression. Third, the interaction was broken down by using chi-square analyses.

RESULTS

Reanalysis of the Original Interaction Effect

Violent offenders were compared with all other subjects. A logistic regression analysis showed a highly significant interaction between birth complications and early rejection of the child at age 1 year in predicting

violence at age 34 years (χ^2=12.3, df=1, p<0.0005), indicating that subjects who experienced both of these variables were most likely to become violent.

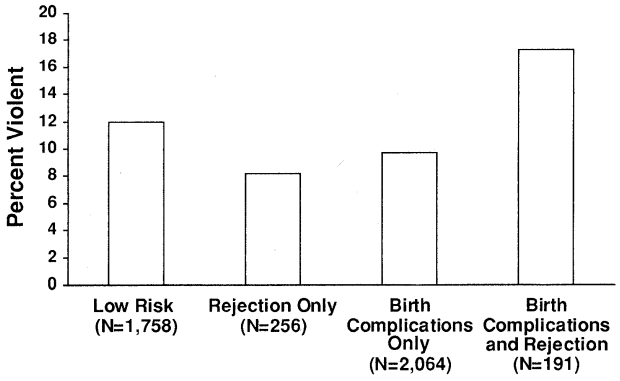
To exemplify this relationship diagrammatically, using the same procedures we used in the earlier study (4), we calculated rates of violence for the subjects who had both risk factors and compared them with the rates of violence in three other groups of subjects: those with neither risk factor, those with maternal rejection only, and those with birth complications only. The results of these analyses are shown in figure 1. In the logistic regression, the interaction was again significant (χ^2=12.1, df=1, p<0.0005). The interaction was broken down with the use of chi-square tests. Subjects with both birth complications and maternal rejection had significantly higher rates of violence than those with neither risk factor (χ^2=4.4, df=1, N=1,949, p<0.04), those with maternal rejection only (χ^2=8.5, df=1, N=447, p<0.004), and those with birth complications only (χ^2=10.7, df=1, N=2,255, p<0.001).

The interaction was specific to early maternal rejection in that no such interaction was observed between poor social circumstances and birth complications in a logistic regression analysis (χ^2=0.04, df=1, N=3,616, p=0.85). A main effect was observed for poor social circumstances (χ^2=85.9, df=1, N=3,616, p<0.0001), but no main effects were observed for birth complications (χ^2=0.4, df=1, N=4,269, p=0.56) or early child rejection (χ^2=0.1, df=1, N=4,269, p=0.70).

The interaction described above was specific to violent offending. A significant interaction between birth complications and early rejection of the child was observed when violent criminals were compared with nonviolent criminals in a logistic regression analysis (χ^2=10.1, df=1, N=1,310, p<0.002). In this comparison of violent with nonviolent criminals, the interaction effect was again specific to maternal rejection. No interaction was observed for poor social circumstances and birth complications according to logistic regression (χ^2=0.2, df=1, N=1,061, p=0.66). In addition, while a main effect was found for poor social circumstances (χ^2=8.7, df=1, N=1,061, p<0.004), main effects were not found for early child rejection (χ^2=0.1, df=1, N=1,310, p=0.81) or for birth complications (χ^2=0.1, df=1, N=1,310, p=0.71).

The interaction between birth complications and early rejection of the child in predisposing to violence cannot be accounted for by the fact that violent offenders commit more crime in general. In the comparison of violent offenders with nonviolent offenders, the interaction between birth complications and early child rejection in predicting violent crime remained significant and in the predicted direction when total number of crimes was entered as a covariate in the logistic regression analysis (χ^2=10.2, df=1, N=1,310, p<0.002). Furthermore, when violent offenders were matched with nonviolent offenders on total number of crimes committed, the interaction again remained significant and in the predicted direction (χ^2=10.6, df=1, N=794, p<0.002). These results indicate that the biosocial interaction applies to violent offending and not recidivism per se.

FIGURE 1. Interaction of Birth Complications With Early Maternal Rejection in Predisposing Individuals to Criminal Violence at Age 34 Years



Seriousness of Violence

To assess whether the interaction effect was specific to more serious levels of violence, three groups of violent offenders were defined according to their offenses as follows: (group 1) robbery, rape, or murder; (group 2) assault or domestic violence; and (group 3) threats of violence or illegal possession of weapons. The groups were made mutually exclusive by assigning subjects to groups on the basis of their most serious offense (e.g., a rapist who also committed assault was assigned to the rapist group). Logistic regression analyses were then rerun for each of the three groups to assess the biosocial interaction effect. In the first analysis, individuals in group 1 were compared with all other subjects. In the second analysis, individuals in group 2 were compared with all others except those in group 1, who were excluded from the analysis. In the third analysis, individuals in group 3 were compared with all others except those in groups 1 and 2. Data for these three analyses are illustrated in figure 2.

For the robbery, rape, and murder category, the interaction between birth complications and maternal rejection was significant (χ^2=8.7, df=1, N=4,269, p<0.004). As can be seen in figure 2, rates of robbery, rape, and murder among subjects with both birth complications and maternal rejection were significantly greater than among those with birth complications only (χ^2=6.0, df=1, N=2,255, p<0.02) and maternal rejection only (χ^2=7.4, df=1, N=447, p<0.007), although the results of the comparison failed to reach statistical significance with either risk factor group (χ^2=3.2, df=1, N=1,949, p<0.08).

For the assault and domestic violence category, the interaction effect was also significant (χ^2=7.5, df=1, N=4,079, p<0.006). As indicated in figure 2, the subjects with both risk factors had significantly more assault and domestic violence offenses than those with maternal rejection only (χ^2=4.9, df=1, N=426, p<0.03), they were nonsignificantly more violent than those with birth complications only (χ^2=3.7, df=1, N=2,156, p<0.06), and they did not differ from those with no risk factor (χ^2=0.9, df=1, N=1,849, p=0.34).

FIGURE 2. Interaction of Birth Complications With Early Maternal Rejection in Predisposing Individuals to Robbery, Rape, and Murder, to Assault and Domestic Violence, and to Threats of Violence and Possession of Weapons at Age 34 Years

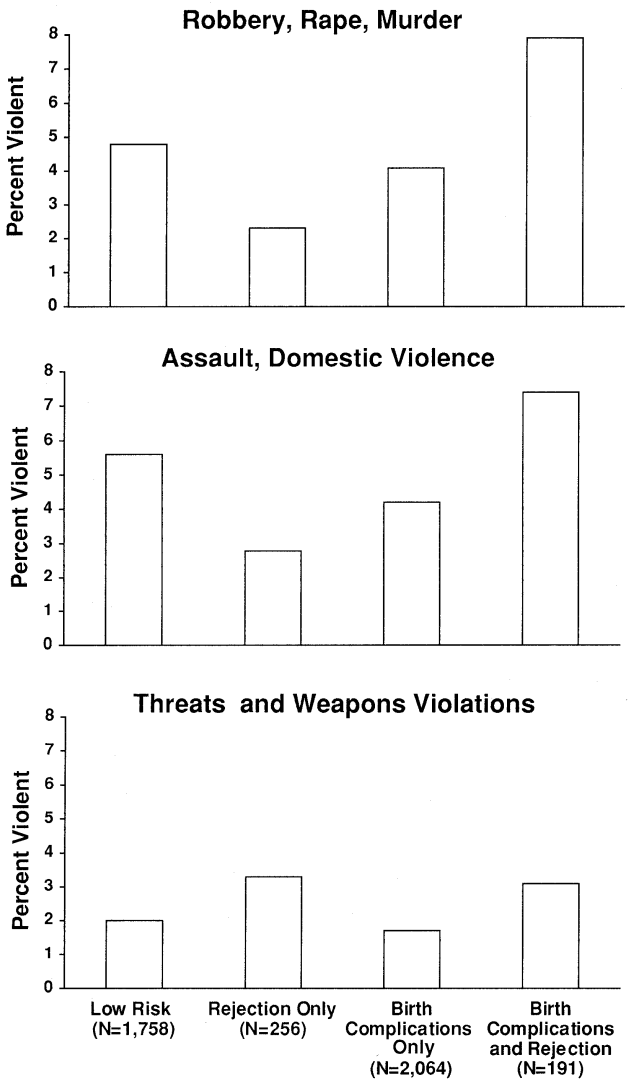
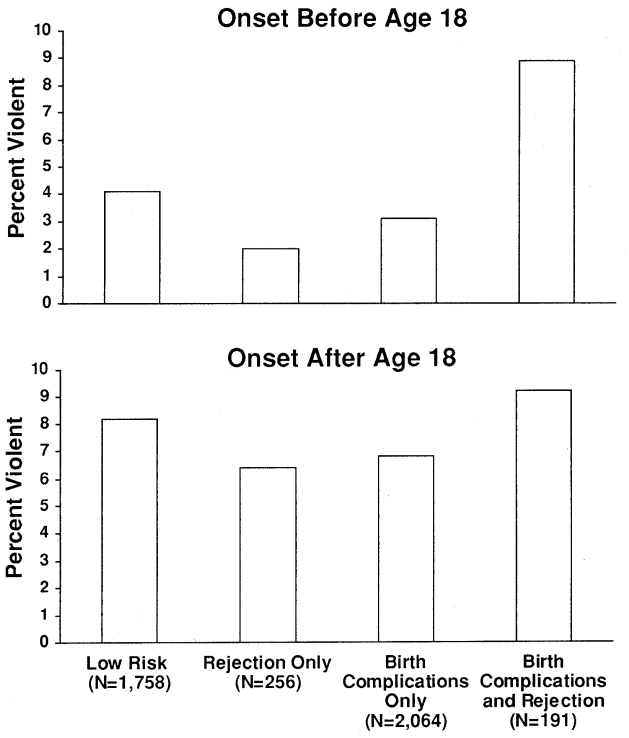


FIGURE 3. Interaction of Birth Complications With Early Maternal Rejection in Predisposing Individuals to Violence With Onset Before 18 Years of Age and Onset After 18 Years of Age



For the threats and weapons category, the interaction effect was nonsignificant (χ^2=0.02, df=1, N=3,881, p=0.89). As illustrated in figure 2, the groups did not differ significantly from one another (χ^2=3.7, df=3, N=3,881, p=0.30).

Early- Versus Late-Onset Violence

The subjects were divided into early-onset violent offenders (first violent offense occurring before age 18 years) and late-onset violent offenders (first violent offense after age 18 years) to assess whether the interaction between birth complications and maternal rejection was specific to early-onset violent offenders. In the first logistic regression analysis, early-onset offenders were compared with all others. In the second analysis, late-onset offenders were compared with the rest of the sample after exclusion of the early-onset offenders. These analyses indicate a significant interaction between birth complications and maternal rejection in predicting violence with onset before age 18 (χ^2=11.5, df=1, N=4,269, p<0.0008) (figure 3, top part) but not violence with onset after age 18 (χ^2=2.5, df=1, N=4,110, p>0.12) (figure 3, bottom part). For early-onset violent offenders, those with both risk factors were significantly more violent than those with neither risk factor (χ^2=9.1, df=1, N=1,949, p<0.003), those with maternal rejection only (χ^2=11.3, df=1, N=447, p<0.0008), and those with birth complications only (χ^2=16.5, df=1, N=2,255, p<0.0001).

Components of Maternal Rejection

To assess which components of maternal rejection accounted most for the biosocial interaction, chi-square analyses were conducted on each of the three components of maternal rejection: not wanting the pregnancy, attempt to abort the fetus, and institutionalization of the infant. In the analysis of each of the three individual components, the two components not under scrutiny were entered as covariates to control for interrelationships among the components.

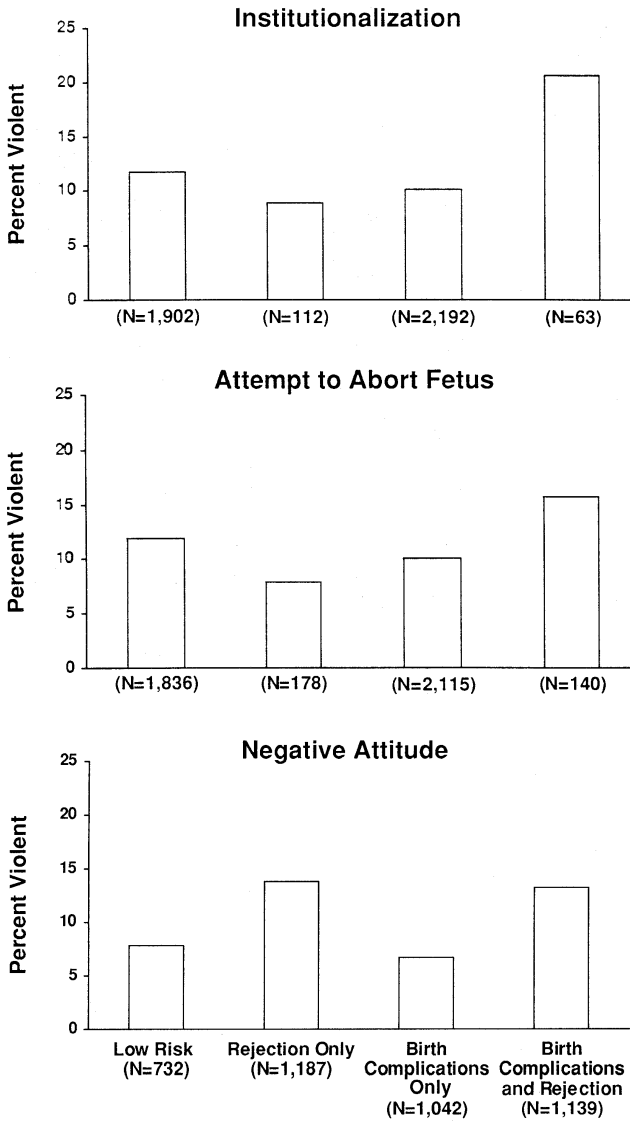
With respect to institutionalization, the interaction with birth complications in predisposing to adult violence was significant (χ^2=5.6, df=1, N=4,269, p<0.02). As indicated in figure 4, subjects with both risk factors had a rate of violence that was significantly higher than

the rate for those with neither risk factor (χ^2=4.6, df=1, N=1,965, p<0.04), those with maternal rejection only (χ^2=4.8, df=1, N=175, p<0.03), and those with birth complications only (χ^2=7.3, df=1, N=2,255, p<0.007).

For attempt to abort the fetus, the interaction with birth complications was again significant (χ^2=6.5, df=1, N=4,269, p<0.01). As indicated in figure 4, subjects with both risk factors had significantly higher rates of adult violence than those with maternal rejection only (χ^2=4.8, df=1, N=318, p<0.03) and those with birth complications only (χ^2=4.6, df=1, N=2,255, p<0.04). Results of the comparison between those with both risk factors and those with neither risk factor did not, however, reach statistical significance (χ^2=1.8, df=1, N=1,976, p<0.17).

With respect to the attitudinal variable of not wanting the pregnancy, the interaction with birth complications was nonsignificant (χ^2=0.4, df=1, N=4,269, p>0.54). As indicated in figure 4, there was a main effect only of negative attitude (not wanting the pregnancy) in predicting adult violence (χ^2=42.3, df=1, N=4,269, p<0.0001).

FIGURE 4. Interaction of Birth Complications With Early Institutionalization of the Infant, Attempt to Abort the Fetus, and Negative Attitude Toward the Pregnancy in Predisposing Individuals to Violence at Age 34 Years



Maternal Psychiatric Illness

Three analyses were undertaken to assess whether maternal psychiatric illness accounted for the link between birth complications/maternal rejection and violence outcome. First, mothers with psychiatric illness were compared with those without illness on the two risk factors by means of t tests. The two groups did not differ on either birth complications (t=1.1, df=4267, p>0.28) or maternal rejection (t=–0.3, df=3614, p>0.77). Second, logistic regression analyses were recomputed after removing from the sample all mothers with psychiatric illness. The interaction between birth complications and maternal rejection remained significant (χ^2=5.2, df=1, N=3,693, p<0.03). Third, maternal psychiatric illness was entered as a factor into the logistic regression analysis alongside birth complications and early maternal rejection. The three-way interaction was nonsignificant (χ^2=0.06, df=1, p>0.81). These three analyses suggest that maternal psychiatric illness does not account for the biosocial interaction effect.

DISCUSSION

A key finding is that our original finding of an interaction between birth complications and maternal rejection in predicting adult violence (4) was also observed when the group size for violent outcome was tripled from 145 to 466 subjects. An important caveat is that the interaction effect was found to be specific to violent offending and did not generalize to nonviolent crimes or recidivism per se. This is a potentially important finding. Surprisingly little is known about the unique determinants of violence because most risk factors associated with violence are also risk factors for crime in general (5). These results therefore provide specific knowledge about some of the very early risk factors unique to violent offending. To our knowledge, these are the first biosocial findings showing specificity to violence and independence from recidivism.

Results of the second set of analyses indicate that the biosocial interaction effect best applies to severe forms of violence (robbery, rape, and murder) and not less serious threats of violence such as verbal threats and possession of firearms. To our knowledge, these are the first findings from biosocial research to show specificity to a distinct category of violence. These findings in turn raise the important question of whether different forms of violence have different etiological pathways.

The third set of analyses indicate that the biosocial interaction effect only holds for those who are first ar-

rested for violent crimes before age 18 years and does not hold for those first arrested for violence after age 18 years. The findings are also broadly consistent with a theory of persistent antisocial behavior through the life course, developed by Moffitt (11), which suggests that a relatively small group of early-onset offenders with neuropsychological deficits, pathological interpersonal relationships, and lifelong antisocial personality are violent and have an early onset of their antisocial behavior.

The fourth set of analyses show that the components of early maternal rejection that interact with birth complications consist primarily of institutionalization of the infant in the first year and an attempt to abort the fetus during pregnancy. Conversely, not wanting the pregnancy did not interact with birth complications in predisposing to adult violence, possibly because some mothers who initially do not want the pregnancy go on to become affectionate, caring mothers. At least in interaction with birth complications, it seems that institutionalization and attempts to abort the fetus may have a more permanent deleterious impact on the developing fetus than negative attitudes, possibly because the former factors may have relatively strong and sustained effects (6, 7). From a biopsychosocial perspective, disruption of the mother-infant bonding process early in the child's life is thought to result in more callous, affectionless, unempathic, psychopathic-like interpersonal behavior, which in turn may increase the likelihood of violent interpersonal behavior (6, 7). This may be especially true in persons who also suffer birth complications that may result in neuropsychological and cognitive deficits and lack of self-control, which in turn may result in explosive, impulsive aggression (12).

The fifth set of analyses show that the interaction between birth complications and early maternal rejection in predisposing to violence is not influenced by psychiatric illness in the mother. It does not seem, therefore, that the genetic link between mental illness and violence that has been suggested by other research (13) can account for the biosocial effect. Nevertheless, it is possible that less extreme mental disturbances may contribute to physical child abuse, which in turn could predispose to later violence. Furthermore, we did not assess the role of paternal rejection of the child and paternal psychiatric illness, because the mother-infant bonding process is viewed as critical in the first year of life. Nevertheless, paternal influences are not unimportant, and these findings should not be construed as attributing the causes of offspring violence solely to bad mothering.

If the biosocial effect is causally related to violence, the implication is that providing better antenatal and perinatal health care to underserved mothers might help reduce birth complications and thus reduce violence. Alternatively, rather than attempting to reduce birth complications, interventions could focus on the psychosocial half of the biosocial equation and attempt to reduce early maternal rejection. Consideration might be given to multiple efforts across time to reduce maternal rejection by, for example, 1) making classes in parenting skills compulsory in high school for the next generation of mothers with unwanted pregnancies, 2) providing more antenatal visits from nurses to monitor both the pregnancy and the parent's attitude toward the unborn baby, and 3) providing home visits by pediatricians specifically to mothers who suffer birth complications to monitor the mother-infant bonding process, assess the physical and cognitive development of the infant, and provide appropriate remediation of cognitive and physical deficits that are known to follow from perinatal complications (14).

Conceivably, interventions that attempt to attack *both* sources of the biosocial interaction effect may be most likely to succeed in reducing violence in the next generation. There is already some evidence that such interventions can be effective (15). In a variety of studies, subjects in experimental and control groups have been provided with home visits during pregnancy and the child's first few years, with interventions supplying information on nutrition, drug use, general health issues, early infant care and development, and parenting skills. These experimental interventions have been found to result in higher birth weight and fewer preterm deliveries (16), less child neglect and abuse (17), fewer injuries in the first year of life (18), more affectionate, less critical mothering of the child at age 3 and a positive emotional atmosphere in the family when the child was aged 10 (19, 20), higher intelligence and fewer behavior problems at 2–3 years (21), less aggression at 10 and 11 years (19, 20), and less delinquency at age 15 (22). With respect to future research, it is argued that such interventions appear to be effective and should receive more intensive application and assessment. The present findings further indicate that if such interventions are to be maximally successful, they should begin before birth, rather than during childhood and adolescence as is currently the case (23, 24).

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