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Genetic and Environmental Factors in Adoptee Antisocial Personality

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Summary. In a sample of 286 adult male adoptees 44 met criteria for antisocial personality (ASP). Two types of biologic parent background were associated with increased incidence of ASP in offspring: those with alcohol problem and those with a criminal conviction or adjudged delinquency. ASP adoptees were also significantly more likely to be alcoholic. Log linear modeling showed that alcohol problems in a biologic parent predicted increased alcohol abuse in the adoptee and that criminality/delinquency in a biologic parent predicted adult adoptee ASP. In the log-linear model two environmental factors significantly increased adoptee ASP: (1) placement in an adoptive home where there was an alcohol problem or antisocial behavior; and (2) placement in a lower socioeconomic home when the adoptee came from a background of criminality/delinquency in a biologic parent. When the adoptee did not have this biologic background socioeconomic level appeared to have little effect on ASP incidence. The results suggest the importance of genetic-environmental interaction in the genesis of adult ASP disorder.

Key words: Antisocial personality – Adoption – Inheritance – Environment

Introduction

Antisocial personality is one of the better researched and defined of the personality disorders (Robins 1966; Cadoret 1986a). Antisocial personality has a wide impact in today's society because of its association with crime (Wilson and Herrenstein 1985), with alcohol abuse (Cadoret et al. 1985, 1987), and with abuse of drugs (Cadoret et al. 1986). Further, antisocials account for a significant number of physician contacts for such conditions as suicide attempts and physical injuries (reviewed in Cadoret 1986b).

Conditions leading to the development of antisocial personality have been widely studied but it is only recently that adoption studies have begun to sort out the genetic and environmental factors which produce antisocial individuals. In the early 1970s Schulsinger (1972) reported evidence for a genetic factor in psychopathy. His definition of psychopathy was "a consistent pattern, lasting a reasonable period beyond adolescence, of impulse-ridden or acting-out behavior which is mainly active, expansive or manipulating, or mainly passive-asthenic." This definition would include those individuals who are antisocial personalities.

About the same period, Crowe (1972, 1974) followed up adopted away children of female felons (most of whom were likely antisocial personalities) and found that significantly more of these offspring were antisocial personalities than a control group of adoptees from a biologic background with no known criminality in parents.

Starting in the early 1980s, Cadoret and collaborators studied in adoptees genetic and environmental factors which led to increased childhood and adolescent antisocial behaviors. The numbers of these behaviors is relevant to an adult diagnosis of antisocial personality, since it has been shown that the higher the number of such adolescent behaviors the higher the probability of an adult antisocial personality diagnosis (Robins 1966). In a study of three independently collected adoption studies involving a total of 515 adoptees, Cadoret et al. (1983) showed that the number of childhood and adolescent antisocial behaviors was significantly increased in those adoptees

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who were placed in an adverse adoptive home environment (mainly characterized by individuals in the environment with psychiatric problems, or antisocial behaviors, or drinking problems). This finding occurred in all three adoption studies (Cadoret 1983; Table 1, p. 307). In addition, two of these three studies showed a significant genetic-environmental interaction: adoptees from a background of alcohol or antisocial behavior problem in biologic parents showed a significantly higher number of adolescent antisocial behaviors when exposed to an adverse adoptive home than would be expected if the genetic and environmental factors operated independently and additively. Thus these studies showed the importance of both genetic and environmental factors in adolescent antisocial behaviors.

A further independent study with a sample of 126 male and female adoptees confirmed the importance of genetic and environmental factors in adolescent antisocial behavior (Cadoret 1985); antisocial behavior in a biologic parent (including criminality) predicted an increase in the numbers of adoptee adolescent antisocial behaviors, and the combination of this genetic factor with an alcohol problem in the adoptive family resulted in a significant genetic-environmental interaction (Cadoret 1985; Table 14–9, p. 172).

Whether the same or similar genetic and environmental factors would predict the diagnosis of *adult* antisocial personality is a question addressed by this paper. A further question addressed is whether or not gene-environment interaction predicts an increase in adult antisocial personality as it seems to in adolescent antisocial behaviors. Two independent adoption studies, wherein adolescent antisocial symptoms were increased by genetic and environmental factors, were used in this study to determine if adult antisocial personality was predicted by the same genetic and environmental variables and their interactions.

Method

Adoptees for this study were recruited from two Iowa agencies: Iowa Children's and Family Services (ICFS) and Lutheran Social Services (LSS). Both offer state-wide services and are located in Des Moines, Iowa. Half of the adoptees (probands) were selected because of some evidence in adoption agency records of psychopathology in a biologic parent or biologic second-degree relative. The remaining adoptees were age- and sex-matched to the probands, but according to adoption agency records had no evidence of psychopathology in biologic relatives (Cadoret and Cain 1980; Cadoret et al. 1985). These adoptees from ICFS and LSS had been used in the analyses of gene-environment interaction cited in the introduction to this paper (Cadoret 1983, 1985). However, for this study only male adoptees were used, since the number of female adoptee antisocials was too small for meaningful analyses and analyses had shown that factors predicting antisocial behavior in females were different from those in males (Cadoret 1980).

Detailed criteria for diagnosis of biologic backgrounds such as for alcohol abuse, antisocial behavior or mental retardation were published in previous papers (Cadoret and Gath 1978; Cadoret and Cain 1980; Cadoret et al. 1985). Relevant to this study are criteria for criminality in biologic parents. Biologic parent criminality was diagnosed by adoption agency record of either incarceration for felony, a felony conviction, or record of adjudication as a juvenile delinquent. Criminality was used as a substitute for the diagnosis of antisocial personality in parents, since adoption agency records usually documented delinquency or adult criminal convictions.

For defining adoptee antisocial personality, information came from two sources: (1) an extensive structured interview given adoptive parents, and (2) a structured psychiatric interview personally administered to the adult adoptee. Depending on the time of the study the adoptee interview used either the SADS-L (Spitzer and Endicott 1979), the DIS (Robins et al. 1981) or an earlier structured interview developed at Washington University, St. Louis, which was based on Feighner criteria. In this study antisocial personality was defined according to DSM-III criteria (APA 1980).

Information about adoptive home environmental conditions came from both the adoptee and adoptive parent interview. Environmental variables are described specifically in previous papers and include such conditions as adoptive family member with behavior problems (subdivided into alcohol, antisocial, or psychiatric problems), divorce or separation in adoptive parents, and place of residence (rural or urban) (Cadoret and Cain 1980; Cadoret et al. 1985). Socioeconomic level was based on a modified Hollingshead-Redlich scale which considered the type of job held by the head of the adoptive household (Hollingshead 1965). This modification resulted in a 7-point scale with group 1 represented by professionals, and group 7 by unskilled manual laborers, etc. The modification was necessary because data collection from one agency (ICFS) did not include education level of adoptive parents.

Criminality or delinquency of biologic parents was subdivided into different categories based on age of contact with the law, upon type of crime and seriousness of crime. The type of crime was placed in one of three categories: (1) crime against societal norms such as underage drinking, operating a motor vehicle under the influence (OMVUI), public intoxication, driving without a license, moving traffic violations, running away from home, pranks, breaking curfew, drug possession and selling drugs; (2) crimes against property such as shoplifting, criminal trespass, forgery, passing bad checks, fraud, breaking and entering, car theft, possessing stolen property, vandalism, and nonsupport; (3) crimes against persons such as statutory rape, assault, child neglect, and obscene phone calls.

The other categorization of parental crime or delinquency was by seriousness. This was determined by the potential for penalty or imprisonment of each crime. Three grades of seriousness were recognized: (1) minor, represented by crimes such as possession of beer in car, underage drinking, traffic violations, driving without a license, obscene phone calls, vandalism, and breaking curfew; (2) moderate, such as OMVUI, criminal trespass, shoplifting, stealing gas from cars, illegal drug use, prostitution, AWOL, possessing stolen property; (3) major, such as selling drugs, forgery, car theft, child neglect, fraud, grand larceny, breaking and entering, assault, and cocaine possession.

Statistical Analysis of Results

Log-linear models were used for the analysis of data (Fienberg 1980). The computer program was BMDP4F (Dixon 1981). The objective in the log linear analysis is to define an equation that predicts the log of the frequency of occurrence in each cell of a multidimensional contingency table. The general procedure with BMDP4F was as follows: (1) relationships between "independent" variables (such as genetic or environmental factors) were forced into the model to condition the analysis on these variables and control, in part, for selective placement, that is, the tendency to determine the type of home placement on the basis of biologic parent characteristics; (2) with the "dependent" outcome variables in the model (usually parent criminality, substance abuse and antisocial personality) higher-order effects were included by using the ADD = Multiple option, a way of determining potentially significant genetic-environmental interactions; (3) the selection of terms was stopped when no other term had P values less than 0.05, as calculated from the differences in the likelihood chi-square statistic; (4) the DELETE = SIMPLE option was used on the model obtained in step 3 to delete unnecessary higher-order or interaction terms; and (5) estimates of cell frequency and terms to estimate odds ratios were obtained from the final model. Results are presented by means of odds ratios (cross-product ratios) used to describe the relationship between two nominal factors, such as an environmental condition and an adult diagnosis. The odds ratio describes the relationship between two nominal variables, x and y, as follows:

	Factor y	
Factor x	Yes	No
Yes	a	b
No	c	d

For those with a "yes" on factor x, the odds of having a yes on factor y are a/b. Similarly, for "no" on factor x, the odds are c/d. The odds ratio is (a/b) (c/d) or ad/bc.

As an adjunct to the log-linear modeling we used a technique devised by one of the authors (G. W.) for rapidly screening large numbers of variables for inclusion in basic models. This process starts with a basic log-linear model and designates an outcome variable of "interest" in the model – in this case adoptee antisocial personality. A program was then developed which computes weighted correlations of residuals from this outcome variable with a list of candidate variables for inclusion in the model such as genetic and environmental variables and their interactions. Significant factors found by this screening are added to the log-linear model if they prove significant by the likelihood ratio test. The search process is repeated to find additional factors influencing the outcome variable of interest. The advantage of this method is the speed with which an extensive list of candidate variables can be screened.

Wherever possible raw data in the form of contingency tables are presented to demonstrate important findings from the log-linear modeling and the logistic regression modeling, or to present other important sample characteristics.

Results

From the 286 males, a total of 44 were diagnosed as having antisocial personality. Table 1 shows selected characteristics of these 44 antisocials and contrasts them with the remaining male sample. With the exception of age and the diagnosis of major depression,

Table 1. Characteristics of males diagnosed as antisocial personalities compared to remainder of male sample

	Diagnosis	
	Antisocial personality ($n = 44$)	Not antisocial ($n = 242$)
Age (mean ± SD)	24.3 ± 5.4	24.8 ± 6.3
Additional adult diagnoses		
Alcohol abuse	31 (70.5%)[a]	43 (17.8%)
Drug abuse	21 (47.7%)	7 (2.9%)
Major depression	4 (9.1%)	15 (6.2%)
Adult and adolescent antisocial behaviors		
School truancy	40 (90.9%)	59 (24.4%)
Other school problems	27 (61.4%)	32 (13.2%)
Expelled from school	27 (61.4%)	33 (13.6%)
Runaway	26 (59.1%)	16 (6.6%)
Early substance use (drugs or alcohol)	37 (84.1%)	119 (49.2%)
Ever arrested	27 (61.4%)	42 (17.4%)
Physical fights	29 (65.9%)	77 (31.8%)
Associate with bad friends	28 (63.6%)	61 (25.2%)
Member of gang	10 (22.7%)	10 (4.1%)
Job troubles	25 (56.8%)	34 (14.1%)
Non-traffic arrest	10 (22.7%)	1 (0.4%)
Marital problems	14 (31.8%)	8 (3.3%)
Vagrancy	16 (36.4%)	5 (2.1%)

[a] Number with condition followed by percentage of sample in parentheses

all the contrasts shown of the antisocial sample with the remaining males are significant.

The biologic background of the male adoptees appears in Table 2. Delinquency or criminality occurs in 11.5% of fathers and 8.7% of mothers, an insignificant difference in incidence. However, there are significant differences between the parental sexes with regard to age at adjudication, the nature of the charges, and the seriousness of charges. The fathers were more likely to be adults at adjudication, more likely to have more serious charges, with more property offenses. Mothers were more likely to be adjudged juvenile delinquents and to be charged with violations of social norms.

In order to determine whether of sex parent, age at adjudication, nature and seriousness of charges had an effect on incidence of adoptee antisocial personality, the incidence of antisocial personality was checked in adoptee offspring of fathers versus mothers, juvenile parental adjudication versus adult adjudication, etc. No significant difference in incidence of antisocial personality was found, so that in the remaining analyses parental criminality or delinquency will not be subdivided by sex, age of adjudication, seriousness of crime, etc.

The correlation of adoptee antisocial personality with different biologic parent characteristics is shown in Table 3. Two parental backgrounds show increased incidence of antisocial personality in offspring: biologic parents with an alcohol problem and parents who are criminal or delinquent (Table 3, lines 1 and 2).

Table 2. Characteristics of biologic parent criminality or delinquency – by sex of parent

	Fathers ($n = 286$)	Mothers ($n = 286$)
Criminal or delinquent	33 (11.5%)[a]	25 (8.7%)
Age at adjudication		
Juvenile	8 (24.2%)[b]	19 (76%)
Adult	25 (75.8%)	6 (24%)
Nature of charges		
Norms	7 (21.2%)	18 (72%)
Property	19 (57.6%)	7 (28%)
Persons	7 (21.2%)	0 (0%)
Seriousness of charges		
Minor	0 (0%)	1 (4%)
Moderate	12 (36.4%)	20 (80%)
Serious	21 (63.6%)	4 (16%)

[a] Percentage of total male or female sample
[b] Percentage of those with criminality or delinquency ($n = 33$ for fathers; $n = 25$ for mothers)

Environmental factors which were tested for their correlation with adopted antisocial personality are shown in Table 4. Two environmental factors are significant or borderline: having an adoptive family member with a drinking problem, or with antisocial

Table 3. Type of biologic background and adoptee antisocial personality

Characteristics of biologic parent	Incidence of antisocial personality in adoptee when biologic parent characteristic:		
	Present	Absent	*P* diff.
Alcohol problem ($n = 26$)[a]	35%	14%	0.009
Delinquency or criminality ($n = 50$)	36%	26%	<0.001
Mental retardation ($n = 15$)	13%	16%	NS
Affective disorder ($n = 8$)	13%	15%	NS

[a] Number of biologic parents with this characteristic

Table 4. Environmental factors and adoptee antisocial personality

	Incidence of antisocial personality in adoptee when environmental factor:		
	Present	Absent	*P* diff.
Problems in adoptive family			
Alcohol ($n = 51$)[a]	28%	13%	0.15
Antisocial behavior ($n = 22$)	32%	14%	0.057
Psychiatric ($n = 50$)	18%	15%	0.727
Parent with physical illness ($n = 117$)	18%	14%	0.405
Divorce or separation of parents ($n = 13$)	31%	15%	0.122
Death of parent ($n = 20$)	15%	15%	1.000
General Factors			
Rural adoptive home ($n = 89$)	17%	15%	0.775
SES Group III or lower ($n = 187$)	18%	10%	0.103
Adoptee only child ($n = 39$)	18%	15%	0.811
Adoptee > 5 months when placed in home ($n = 91$)	20%	13%	0.218

[a] Number of adoptive families with this factor present

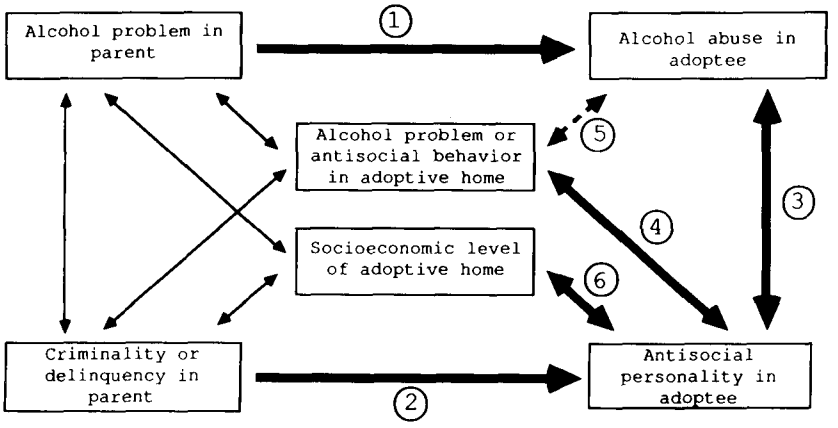

Fig. 1. Log-linear model of relationship between adoptee outcomes of antisocial personality and alcohol abuse and genetic and environmental factors. *(Heavy arrows)* Relationships significant at the 5% level. *(Dotted arrow)* Relationship significant at the 10% level. *(Light arrows)* Relationships in model to control for selective placement. *Circled numbers* identify relationships shown in Table 5

behavior (Table 4, lines 1 and 2). Two other factors are suggestive but are significant only at the 10%–15% level: divorce or separation of adoptive parents, and placement in a lower socioeconomic adoptive home (Table 4, lines 5 and 8). Both factors are associated with higher rates of antisocial personality in the adoptee.

The results so far suggest that adult adoptee antisocial personality incidence is affected by several genetic and environmental factors (Tables 3, 4). Additionally there is the consideration that other clinical diagnoses – notably alcohol abuse and drug abuse – are significantly associated with antisocial personality outcome (Table 1). In order to control for the effects of diagnoses other than antisocial personality, and to control for inter-relationships of the genetic variables with the environmental factors, an analysis was done by entering into a log-linear model the genetic and environmental variables in Tables 3 and 4 which were significantly related to antisocial personality as well as other relevant diagnoses in the adoptee. The best fitting model from this analysis appears in Fig. 1, and Table 5 shows the correlation tables of the significant relationships found in this analysis. Alcohol problem and antisocial behavior in the adoptive home shown in Table 4 as separate items were combined into one factor in the model-fitting, since both variables showed a similar correlation with antisocial personality (Table 4). The log-linear analysis shows that adoptee antisocial personality incidence was increased by two factors acting independently: (1) a criminal or delinquent biologic parent (Fig. 1, relationship 2), and (2) exposure to an adoptive home environment where an alcohol problem or antisocial behavior occurred in a family member other than the adoptee (Fig. 1, relationship 4). Alcohol problem in biologic parent, which in Table 3 correlated with antisocial personality, no longer significantly correlated with that condition but rather with adoptee alcohol abuse, once other important relationships are recognized such as the very strong correlation between alcohol abuse and antisocial personality (Fig. 1; Table 5, relationship 3). One other environmental factor increased the incidence of antisocial personality but only in the presence of a biologic background of criminality or delinquency. This environmental factor is placement in an adoptive home of lower socioeconomic status (Fig. 1; Table 5, relationship 6). High rates of antisocial personality occur in adoptees from adoptive homes of medium to low socioeconomic status: 9 of 21 (43%) in medium status homes and 8 of 12 (67%) in low status homes when the adoptee is from a biologic background of criminality or delinquency. In contrast, the corresponding rates when criminality or delinquency are not in the adoptee background are 9 of 94 (10%) and 8 of 60 (13%).

One relationship is shown in the model diagram (Fig. 1, dotted lines) although it is not significant. The environmental factor of alcohol problem or antisocial behavior comes close ($P = 0.07$) to correlating with adoptee alcohol abuse, but its correlation with adoptee antisocial personality is higher and it is this latter relationship which is put preferentially into the model.

Discussion

The major new finding in this study involves the interaction between adoptive home socioeconomic level, biologic parent crime or delinquency, and adoptee antisocial personality diagnosis. Analyses (Fig. 1 and Table 5) have shown that adoptees from a biologic parent with crime or delinquent backgrounds placed into lower socioeconomic status (SES) homes had exceptionally high rates of antisocial personality as adults. Such a result might happen if selective placement played a role by having more adoptees from criminal and delinquent backgrounds placed into lower socioeconomic adoptive homes. This could

Table 5. Correlation tables and corrected odds ratios for log-linear model shown in Fig. 1

Relationship[a]	Correlation table	Corrected odds ratio (from model)	*P* value (from model)
1. Alcohol problem in parent (A) versus alcohol abuse in adoptee (B)	Factor A: yes / no; Factor B: yes: 16, 10; no: 58, 202	5.3	0.0001
2. Criminality or delinquency in parent (A) versus antisocial personality in adoptee	Factor A: yes / no; Factor B: yes: 18, 32; no: 26, 210	3.6	0.008
3. Alcohol abuse in adoptee (A) versus antisocial personality in adoptee (B)	Factor A: yes / no; Factor B: yes: 31, 13; no: 43, 199	10.8	0.0001
4. Alcohol or antisocial problem adoptive home (A) versus antisocial personality in adoptee (B)	Factor A: yes / no; Factor B: yes: 17, 27; no: 43, 199	3.3	0.001
5. Alcohol or antisocial problem adoptive home (A) versus alcohol abuse in adoptee (B)	Factor A: yes / no; Factor B: yes: 24, 50; no: 36, 176	[2.3][b]	[0.07][b]
6. Socioeconomic level of adoptive home (A) versus antisocial personality in adoptee (B) (interaction with parent criminality or delinquency)	Parent criminal or delinquent: Factor A: High / Med / Low; Factor B: yes: 1, 9, 8; no: 16, 12, 4	–	χ^2 *P* value: 12.02, $df = 2$* $P < 0.0025$
	Parent neither criminal nor delinquent: Factor A: High / Med / Low; Factor B: yes: 9, 9, 8; no: 73, 85, 52	–	0.53, $df = 2$ P = NS

[a] Number assigned each relationship in column one refers to numbered relationship in interaction diagram of Fig. 1

[b] Odds ratio and *P* value from 2 × 2 table shown in column 2 since this relationship did not enter the model (see Fig. 1)

* *P* value computed directly from 2 × 3 table shown

Table 6. Adoptive home socioeconomic status (SES) by biologic parent criminality or delinquency

Biologic parent criminality or delinquency	Adoptive home SES						
	1	2	3	4	5	6–7	
Absent	45 (19%)[a]	37 (11%)	94 (40%)	20 (8%)	34 (14%)	6 (3%)	236
Present	9 (18%)[a]	8 (16%)	21 (42%)	6 (12%)	3 (6%)	3 (6%)	50
	54	45	115	26	37	9	286
	$\chi^2 = 4.46$		$df = 5$		$P = 0.49$		

[a] Percentage of row total

have occurred because information about parental criminality and adoptive home SES was available to the adoption agency prior to placement and thus could have figured in decisions about placement. However, there is no evidence of selective placement, either in the log-linear model (Fig. 1) or when adoptive home SES is tabulated by presence or absence of criminal biologic parent background. In the latter analysis, shown in Table 6, the chi-square is 4.46 (*d.f.* = 5, $P = 0.49$), an insignificant result which supports the log-linear analysis in not showing evidence for a selective adoptive placement effect based upon knowledge of criminality or delinquency in the biologic background.

It is also possible that selective placement occurred based upon knowledge of biologic parent SES which was also available to adoption agencies at the time of adoption. In the LSS portion of this data set biologic parent SES was available, and analysis revealed that biologic parent crime was associated with a significantly lower average SES in biologic parents. However, the Pearson correlation between biologic family SES and adoptive family SES was 0.085, and the correlation between biologic father SES and adoptive family SES was 0.06. Both of these correlations are nonsignificant and very close to zero, suggesting that biologic family SES did not lead to selective placement, at least in the LSS portion of these data.

Biased reporting of antisocial behavior by adoptees or their adoptive parents could also account for the finding of increased rates of antisocial personality in adoptees from lower SES adoptive homes. Such a biased reporting factor cannot account for the finding that there is no relationship between adoptive home SES and adoptee antisocial personality in those adoptees from a non-criminal biologic background. This is apparent in Table 5 (relationship 6).

These findings relating antisocial behavior to social class are compatible with observations made by a large Danish adoption cohort (Van Dusen et al. 1983). These investigators found increased registration for criminality among adoptees of lower socioeconomic adoptive homes and were able to demonstrate that the social class effect was related to the experience of lower social class upbringing. They also reported a correlation between social class of biologic parents and criminal outcome in adoptees (lower parental SES predicted increased adoptee criminality). There was no interaction found between biologic parent social class and adoptee criminality. Unfortunately, Van Dusen et al. did not report any analysis to detect interaction between biologic parent criminality, adoptive home SES, and adoptee crime. Thus a more direct comparison with our study's finding of SES-parent crime-antisocial adoptee interaction is not possible, but our findings suggest a mechanism to explain the Danish report of increased crime in lower SES environments: genetic-environmental interaction resulting in increased numbers of antisocials and concomitant criminal behavior.

Other Scandinavian adoption studies have related crime to environmental factors. Low social status of adoptive father has been reported to be associated with criminality in adoptee alcohol abusers, while unstable preadoptive placement has been associated with petty criminality in adoptees who are not characterized as alcohol abusers (Bohman et al. 1982). These investigators did report a suggestive interaction of genetic predisposition to petty criminality with certain postnatal environmental conditions which predicted a very high rate of petty criminality in adopted away sons. Unfortunately, these results do not bear directly on our findings but do further suggest that gene-environment interaction is an important factor in petty criminality and antisocial personality.

The other finding of interest is the increase in adoptee antisocial personality in adoptive households with alcohol problems (Fig. 1, relationship 4). This

environmental variable is significant even when controlling for alcohol abuse in the adoptee (Fig. 1). An analagous finding has been reported from a Danish adoption cohort by Baker (1986), who found an environmental effect predicting an increase in property crime committed by adoptees: having an adoptive parent with either a criminal conviction, a hospital admission for a personality disorder, a drug, or an alcohol problem. Whether this environmental effect was mediated by the social class effect or interacted with social class was not determined (Van Dusen et al. 1983). The effect could also have been mediated through antisocial personality, as suggested by our study.

Mode of reporting also enters into the finding of class differences in antisocial personality and crime. Some studies have questioned the validity of more crime associated with lower social classes (Tittle et al. 1978), especially when crime self-report data are used (Elliott and Ageton 1980; Kleck 1982), but recent evidence is stronger for a correlation between crime and social class. For example, the data presented by Van Dusen et al. based upon an entire Danish adoption cohort show a clear relationship of SES to officially reported criminality (Van Dusen et al. 1983). Another population study from Denmark and several recent American studies also support the SES-crime correlation (Moffit et al. 1981; Wolfgang et al. 1972; Elliott and Huizinga 1983). It is unlikely that differential reporting of antisocial or criminal behavior can account for the differences, since there is little evidence of a social class correlation with antisocial personality in adoptees from non-criminal and non-delinquent parents. It is also unlikely that the present result is confounded with race, since there were only several non-Caucasian adoptive families in the entire sample.

Social class measure requires some comment. The occupational portion of the Hollingshead-Redlich socioeconomic scale was used because in some of the data collected early in the study, educational level was not asked of adoptive parents (Hollingshead 1965). This modified scale is similar to that used by Van Dusen et al. in the Danish adoption study where an 8-point SES scale was derived from prestige ratings of the various occupations, and income was not part of the evaluation (Van Dusen et al. 1983). Comparison of Table 1 of the Van Dusen article (reference 4, p. 255) which gives examples of occupations associated with different social status is very similar to the hierarchy found in the Hollingshead-Redlich scale.

This study has shown that genetic-environment factors and their interaction are important in the etiology of adult antisocial personality. These factors are similar to those that predicted childhood and adolescent antisocial behaviors in the same data used in this study (Cadoret et al. 1983; Cadoret 1985). In order to clarify this point we have reanalyzed the factors predicting adolescent antisocial behaviors in these data (LSS and ICFS data sets). Adolescent antisocial symptoms were defined to contain behaviors documented to be present prior to age 18 years and included the following: truancy, trouble with teachers, expelled or suspended from school, ran away from home, early substance use (alcohol, drugs or tobacco), contact with the police or juvenile authorities, and fighting. A count of these symptoms was used as a dependent variable in a multiple regression analysis with the genetic and environmental factors (shown in Tables 3, 4) as independent variables. Factors which predicted antisocial behavior significantly are shown in Table 7. Some of the factors are insignificant (see lines 3, 5, 6) but are included in the model as main effects only because interactions involving these factors are significant. The *P* value shown in the table reflects the significance of that factor when all other factors are in the model. The two major factors predicting adult antisocial personality also predict the number of childhood and adolescent antisocial behaviors: (1) the environmental factor of an alcohol problem in the adoptive family (Table 2, line 2) and (2) the interaction between a criminal/delinquent parent and adoptive home SES (Table 7, line 8). The interaction between late age of final adoptive placement and an adoptive home with a psychiatrically disturbed individual (Table 7, line 9) is significant in predicting number of adolescent antisocial behaviors. However, this interaction does not predict adult antisocial personality. The other factor which predicts adolescent antisocial behavior is an alcohol problem in a biologic parent (Table 7, line 1). In the log-linear model shown in Fig. 1, this biologic variable

Table 7. Genetic and environmental factors correlating with number of childhood and adolescent antisocial behaviors

	P value
Variable	
(1) Alcohol problem in biologic parent	0.004
(2) Alcohol problem in adoptive family	0.0002
(3) Criminality/delinquency biologic parent	0.72
(4) Adoptive family socioeconomic level	0.003
(5) Age of final placement $\geq$ 5 months age	0.85
(6) Psychiatric problem in adoptive family	0.95
(7) Adoptive parents divorced	0.92
(8) Interaction (3) $\times$ (4)	0.0001
(9) Interaction (5) $\times$ (6)	0.005

appears but is more highly correlated with adoptee adult alcohol abuse and not with adult antisocial personality. Thus biologic parent alcohol problems may predict adolescent antisocial behavior but in adults appear to correlate more with alcohol abuse.

In previous analyses of these data no interactions between environmental factors were tested so that the interaction between age of placement and a psychiatric problem in the adoptive family (Table 7, line 9) was not found. This particular interaction was tested in our log-linear modeling but did not reach significance in predicting adult antisocial personality. Thus to answer the question posed in the introduction of whether similar or different genetic and environmental factors predict adolescent antisocial behaviors and adult antisocial personality, the results suggest that similar factors appear to be mainly involved.

It is interesting that recent assessments of causes of crime for the most part do not specifically mention gene-environment interaction as an important factor (Wilson and Herrnstein 1985, Rowe and Osgood 1984), although a genetic or constitutional factor in crime appears to be more generally accepted (Mednick and Christiansen 1977; Marsh and Katz 1985). Indeed, one recent author's review states that "no prominent contemporary criminological theories at this time specifically predict that both genetic and environmental variables are involved in criminal behavior etiology" (Ellis 1985). The present study suggests that gene-environment interaction could be very important in the "production" of individuals with antisocial personality and thus contribute to crime. Furthermore, the association of adoptive families with alcohol and antisocial behavior problems with increased incidence of antisocial personality is also relevant to SES because of the increased incidence of such problems often reported in lower SES populations. The present study would suggest that the alcohol and antisocial behavior factors act independently of SES and that some other factor associated with SES is responsible for the interaction noted here.

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