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# Predisposition to Petty Criminality in Swedish Adoptees

## I. Genetic and Environmental Heterogeneity

Michael Bohman, MD; C. Robert Cloninger, MD; Sören Sigvardsson, PhD; Anne-Liis von Knorring, MD

• The inheritance of criminality was studied in 862 Swedish men adopted by nonrelatives at an early age. If type of offense and association with alcohol abuse were neglected, criminality was heterogeneous and appeared to be largely non-familial. Nevertheless, different genetic and environmental antecedents influenced the development of criminality, depending on whether or not there was associated alcohol abuse. Alcoholic criminals often committed repetitive violent offenses, whereas nonalcoholic criminals were characterized by commission of a small number of petty property offenses. These nonalcoholic petty criminals had an excess of biologic parents with histories of petty crime but not alcohol abuse. In contrast, the risk of criminality in alcohol abusers was correlated with the severity of their own alcohol abuse, but not with criminality in the biologic or adoptive parents. Unstable preadoptive placement was associated with increased risk for petty criminality, whereas low social status was associated with alcohol-related criminality. We discuss the significance of these results in relation to the classification of criminals and current concepts about antisocial personality.

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Until now, little has been known about how clinical heterogeneity among criminals is determined by genetic and environmental antecedents. Are parents with histories of repeated, severe crimes of violence more likely to predispose their children to criminality than are petty property offenders? When criminality is transmitted from parent to child, is the underlying mechanism of transmission determined by

social contact and learning or by genetic predisposition?

Until the past decade, the attempts to answer these basic questions were inconclusive because they were based on study designs<sup>1-3</sup> that were inherently ambiguous because social learning and genetically determined changes in behavioral development can readily simulate one another in both longitudinal<sup>4</sup> and family<sup>5</sup> studies. Nevertheless, it is well known that criminals vary widely in clinical characteristics that are associated with marked differences in their prognosis and family history.<sup>6-9</sup> Accordingly, data about adoptees and other separated relatives are needed to evaluate how genetic and environmental differences influence behavioral development.<sup>10</sup>

In the past decade, a great volume of adoption data have been accumulated about criminality and antisocial behavior.<sup>11-22</sup> Unfortunately, many of these studies are difficult to compare and to interpret because each investigator used different clinical criteria for classifying antisocial behavior, and all failed to take the clinical heterogeneity among criminals into account. Nevertheless, the results of these studies lead to critical questions about the classification of criminality that are relevant to its inheritance.

Crowe studied the adopted-away children of criminal women and reported both their crime records<sup>15</sup> and psychiatric diagnoses.<sup>16</sup> He followed up 37 adoptees and 37 non-adopted controls into adulthood (age range, 18 to 45 years; mean age, 27 years) and found excesses of criminality and antisocial personality, but not alcoholism, in the adopted children of criminal women similar to those observed in comparable nonadoptees.<sup>23</sup> In interpreting data about criminal records and personality diagnoses, it is usually assumed that criminals with a history of early onset of repeated, serious offenses leading to prolonged incarceration are most likely to warrant a diagnosis of antisocial personality.<sup>24,25</sup> In contradiction to this, the adoptees with a diagnosis of antisocial personality in Crowe's study actually had records of only a small number of nonviolent offenses that were mostly petty property crimes: seven of the 37 adult adopted-away children of criminal mothers had a criminal conviction, including one for two felony property

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offenses, two for single felony property offenses, four for misdemeanor property offenses, and one for a misdemeanor sexual offense. There were no crimes of violence. Only three subjects were ever incarcerated as adults (and then only for an average of eight months each), and two had been in juvenile training schools for a mean of nine months each. It is also relevant to note that the adoptees had no excess of alcoholism; such substance abuse is known to be associated with violent, repetitive offenses,<sup>4,6</sup> whereas personality disorders are associated with fewer offenses, largely against property.<sup>26</sup>

The association of alcoholism with commission of violent, repetitive offenses is important when comparing the studies of Hutchings and Mednick<sup>14,17</sup> with reports by Bohman.<sup>20</sup> Hutchings and Mednick<sup>14,17</sup> reported that criminality in both biologic and adoptive parents increased the risk of criminality in Danish adoptees. However, they did not separate criminals with and without associated alcohol abuse because, unlike Sweden, Denmark has no Temperance Board. In contrast, using a similarly broad and unitary definition of crime, Bohman<sup>20</sup> concluded, from a study of Swedish adoptees, that alcohol abuse, but not criminality alone, was genetically inherited. He suggested that criminality may only appear to be inherited because it is often a consequence of alcohol abuse. Neither the Danish studies of Hutchings and Mednick nor the study of Bohman, however, considered the possibility that the predispositions to different types of criminal patterns may not be the same.

We describe herein the relationships among the criminal characteristics of a large population of adoptees and the characteristics of their biologic and adoptive parents. In particular, we clarify the relationships between criminality and alcohol abuse and study the significance of a heritable subgroup of criminals with no prominent alcohol abuse.

This article is the first in a three-part series published in this issue of the ARCHIVES that examines the possible inheritance of criminality. It deals with the evidence that subgroups of criminals have different genetic and social backgrounds. The second article (see p 1242) analyzes the interaction of the genetic and environmental factors identified in this first report. The final article (see p 1248) considers sex differences in the antecedents of criminality. In addition, the final report describes an attempt to validate the multivariate classification derived from the sample of parents of adopted men by testing predictions in an independent sample of women.

#### **INHERITANCE OF COMPLEX BEHAVIORS: GENERAL PRINCIPLES**

Inheritance of criminality implies only that there is resemblance between parents and their children, regardless of whether the underlying mechanism is based on genetic or social influences. For example, taxation on the inheritance of wealth diminishes some economic forms of cultural inheritance, and adoption of children into "good" middle-class homes may diminish other aspects of social heritage. Thus, adoption studies provide a means of unraveling the complex interactions of biologic and sociocultural inheritance.

In view of the marked heterogeneity observed among criminals in terms of their own behavior and their biologic and social background, it is clear that criminality is a complex behavior that is likely to involve the interaction of multiple risk factors during development. These risk factors may include either genetic or social variables or both.

In this study, we wished to determine whether we could identify genetic and early environmental antecedents of

adult criminal behavior. Our index of genetic background was the behavior of the biologic parents, whereas the index of the early environment included description of the rearing circumstances before adoption and information about the adoptive parents. The terms *congenital* and *genetic* were used interchangeably to denote information about the biologic parents. Also, the terms *postnatal* and *environmental* were used interchangeably to denote information about the adoptive rearing experience.

Given the behavioral and etiologic heterogeneity among criminals, we also wished to distinguish subgroups of criminals with distinct genetic and social backgrounds. Once criminal subgroups are identified who are more homogeneous in terms of both their biosocial etiology and their observed behavior, then we can evaluate more precisely how different genetic and environmental risk factors interact with one another in the development of a predisposition to criminal behavior.

It is important to realize that there are no genes for criminality, but only genes coding for structural proteins and enzymes that influence metabolic, hormonal, and other physiological processes, which may indirectly modify the risk of "criminal" behavior in particular environments. For example, men with an extra Y chromosome are often tall and have diminished intelligence and poor emotional control, leading to inadequate social adaptive patterns: a minority of XYY men appear to be normal, most are nonviolent petty criminals, and others become aggressive criminals.<sup>27</sup>

Other work suggests that genetic and physiological factors are more critical in predisposing to criminal behavior among individuals who are socioeconomically privileged than in the presence of socioeconomic deprivation.<sup>27</sup> The subjects we studied were all adoptees in a country that is relatively economically prosperous and socially homogeneous. Accordingly, this population is ideal for identifying genetic risk factors, if there are any, that predispose to criminality because such risk factors will be more prominent in this population than in more socially heterogeneous countries like the United States. At the same time, placement of adoptees into "good" homes restricts the range of social risk so that the influence of environmental influences may be diminished in comparison with that on the general population. Nevertheless, since complete information is available about both biologic and adoptive parents, the separate contributions and interactions of genetic and environmental factors can be evaluated, as we have shown in earlier work on alcohol abuse.<sup>28,29</sup>

#### **SUBJECTS AND METHODS Sample Description**

This sample from the Stockholm Adoption Study has been described by us in detail in reference to studies of the inheritance of alcohol abuse.<sup>28,29</sup> Briefly, the subjects included all 862 men born out of wedlock in Stockholm from 1930 through 1949 who were adopted at an early age by nonrelatives. Other subjects included by Bohman in preliminary analyses<sup>20</sup> were excluded because of incomplete data, late placement, or intrafamilial adoption. The age at adoption was less than 3 years in all cases and 8 months on the average. The adoptees ranged in age from 23 to 43 years at the time of last information.

By Swedish practice at the time, the adoptee and the adoptive parents were never informed about the identity or behavior of the biologic parents. Children with medical handicaps, suspected developmental disturbances, or thought to be at high risk for heritable disorders were unlikely to be considered eligible for adoption. The adoptive home was required to be stable, with a good emotional atmosphere. Criminality and alcohol abuse were widely

believed at the time to be largely, but not exclusively, socially determined. Selection against criminality and alcohol abuse, therefore, was carried out more intensely in the adoptive parents than in the biologic parents. This meant that the range of variability observed in adoptive homes was relatively restricted, but it was uncertain whether such restriction was relevant to the traits under study. Furthermore, Swedish policy at the time did not discourage attempts to match the characteristics of the biologic and adoptive parents, but in practice this could seldom be effective because the biologic parents were usually young and often manifested their criminality and alcohol abuse for the first time after the adoption.

Data about the adoptees and each biologic and adoptive parent were obtained from several registers and medical sources, as detailed elsewhere.<sup>20,30</sup> Available data used herein included criminality (number of offenses, months in jail, type of offense, and age at onset of criminality); alcohol abuse (number of Temperance Board registrations, supervision and treatment for alcoholism, psychiatric diagnosis of alcoholism, age at onset of alcohol abuse); and occupational status classified on a reversed five-point scale with 1 indicating the highest or professional group and 5 the lowest or unskilled group. Additional information about adoption was included concerning the number of temporary placements, days spent with the biologic mother, days of hospital care before placement, days of foster care, and the size of the town in which the adoptive family resided. Alcohol abuse among the adoptive parents was used as a postnatal predictor, as previously described,<sup>28</sup> but none of the 862 adopted men had a criminal adoptive parent. With one exception, the coding of variables, described in the "Results" section, was the same as previously described<sup>28</sup> to ensure comparability. The exception was that the number of crimes was also coded as its square root and its square to provide measures of low and high repetitiveness for clinical reasons.

A crime was defined as any conviction leading to either an unconditional or conditional prison sentence, or a criminal conviction with a sentence of more than 60 "day-fines." The severity of the crime determined the number of *day-fines*, which is a fine prorated according to the convict's income. Criminality was further described according to the number and type of offenses, length of time in jail, age at onset, and association with alcohol abuse. Thus, crimes of violence included physical assault and any other criminal act endangering the life or health of others. Fraud included crimes of deceit, such as embezzlement or forgery. Property crimes included the destruction or theft of another's possessions, or receipt of stolen material. Other types of crime denoting special characteristics of the offender, eg, nonviolent sex offenses, were rare. The distribution of offense types, shown in Table 1, was representative of that of criminals in the general population.<sup>31</sup>

### Statistical Analysis

Discriminant function analysis was used to identify personal and background variables that distinguished subgroups of criminal and alcoholic adoptees from one another.<sup>32</sup> The stepwise solution method was used to select variables that minimized Wilk's  $\lambda$  ( $F$  value for inclusion or deletion, 1.0; tolerance level, .001).

A multiway ( $7 \times 4$ ) contingency table was analyzed according to a linear logistic model implemented using the FUNCAT procedure of the Statistical Analysis System.<sup>33</sup> The response functions were the natural logarithms of the ratio of the number of sons with each type of registration (criminality only, alcohol abuse only, or both) to the number of sons with no registration. The predictor variables were the three corresponding types of registration in the parents (criminality only, alcohol abuse only, or both), giving the seven unique combinations of predictors shown in Table 1. The model allowed for an intercept constant and main effects of the three parental predictors for each of four adoptee outcomes ( $3 \times 4 = 12$  parameters shown in Table 2). The residual  $\chi^2$  provided a test of the goodness of fit of the model.

Kendall's  $\tau_b$  was used as a measure of correlation for ordinal data.<sup>31</sup> The Pearson  $\chi^2$  was also used to evaluate strength of association in contingency tables. In these and other statistical tests, results were considered significant only if their probability of occurring by chance was less than 5%.

## RESULTS

### Categorical Analysis of Genetic Heterogeneity

Registered criminality was present in 12% of the 862 adopted men, 26% of the biologic fathers, and none of the adoptive fathers. These risks may be compared with a risk of 11% in the general population of men.

As a preliminary analysis, we evaluated how well the registrations of the adopted men could be predicted by the registrations of their biologic parents. The adoptees included 39 (4.5%) registered with criminality only, 87 (10.1%) with alcohol abuse only, and 64 (7.4%) with both. We attempted to predict these outcomes in the adoptees from corresponding data about the type of registration of the biologic parents (ie, whether the parents were registered for criminality only, alcohol abuse only, or both). Overall, 14.3% of these adoptees had their biologic father only ( $N = 81$ ), mother only ( $N = 36$ ), or both ( $N = 6$ ) registered for criminality and not alcohol abuse. Eighteen percent had their biologic father ( $N = 131$ ), mother ( $N = 20$ ), or both ( $N = 4$ ) registered for alcohol abuse and not criminality. Finally, 16.2% had their biologic father ( $N = 132$ ), mother ( $N = 7$ ), or both ( $N = 1$ ) registered for both criminality and alcohol abuse.

As shown in Table 1, the type of registration of the biologic parents accounted for the registration of the adoptees very well according to the predictions of linear logistic model (residual goodness-of-fit  $\chi^2 = 3.0$ ,  $df = 9$ ,  $P = .96$ ). The parameters of the model (Table 2) indicate that criminality only in the biologic parents tended to increase the risk of criminality only in the sons ( $P = .08$ ), but not to increase alcohol abuse, whether alone or in combination with criminality. Alcohol abuse only in the biologic parents increased the risk of alcohol abuse only ( $P = .03$ ), but not criminality. Biologic parents with both criminality and alcohol abuse had significantly more sons with alcohol abuse only ( $P < .01$ ), a trend for more sons with criminality only ( $P = .09$ ), but no excess with both combined in the same individual.

Familial aggregation of alcohol abuse was substantial regardless of any associated criminal convictions. If either biologic parent were registered for alcohol abuse, regardless of any criminal convictions, their 291 adopted-away sons had 1.6 times the risk of registration for alcohol abuse as the 463 sons whose biologic parents were neither criminal nor alcohol abusers (23.0% *v* 14.0%). In contrast, if either biologic parent had any criminal conviction, their 258 adopted-away sons had only 1.3 times the risk for any criminal convictions as the 463 sons whose parents were neither criminal nor alcoholic (13.2% *v* 10.4%). However, the familial aggregation of criminality occurring without associated alcohol abuse was also substantial: if either parent were registered for criminality only, their 123 adopted-away sons had 1.9 times the risk of being registered for criminality only compared with the 463 sons of parents with neither criminality nor alcohol abuse (6.5% *v* 3.5%).

Thus, parents with criminality only or alcohol abuse only produced affected children tending to have the same sort of problems as their own parents. In contrast, those with both criminality and alcohol abuse seemed etiologically heterogeneous, increasing the risk of sons with alcohol abuse alone certainly and perhaps the risk of sons with criminality alone, but not the risk of sons with the combination of both. In view of this heterogeneity, we carried out further analyses of the clinical and family data, described in the next two sections, that demonstrated that the risk of criminality, but not alcohol abuse, was consistently increased by fathers who had no diagnosis of alcoholism but registrations for a small number of petty nonviolent crimes and teenage alcohol abuse. In contrast, the fathers with a diagnosis of alcoholism and/or many registrations for both alcohol abuse and violent crimes had a high risk of sons with alcohol abuse but not criminality.

### Clinical Heterogeneity

We first evaluated the extent to which adopted criminal men with and without alcohol abuse could be distinguished by their criminal characteristics alone (Table 3). Criminals with alcohol abuse were more recidivistic, had received longer jail terms, and had committed more violent crimes compared with the other criminals. Criminals without alcohol abuse, on the other hand, had more often committed property offenses. There were no significant differ-

Table 1.—Prediction of Criminality and/or Alcohol Abuse in 862 Adopted Sons From Their Presence in Biologic Parents

Registration in Biologic Parents				Registration in Adopted Sons†		
Criminality Only	Alcohol Abuse Only	Both*	No. of Adoptees	Type	% Observed	% Predicted
No	No	No	463	Criminality	3.5	3.6
				Alcohol abuse	7.1	7.4
				Both	6.9	6.9
Yes	No	No	108	Criminality	7.4	6.9
				Alcohol abuse	11.1	10.1
				Both	6.5	6.2
No	Yes	No	141	Criminality	5.0	4.8
				Alcohol abuse	12.8	12.2
				Both	9.9	10.1
No	No	Yes	131	Criminality	6.1	6.1
				Alcohol abuse	16.8	16.3
				Both	7.6	8.1
Yes	Yes	No	10	Criminality	0.0	9.0
				Alcohol abuse	10.0	16.1
				Both	0.0	8.8
Yes	No	Yes	5	Criminality	0.0	11.0
				Alcohol abuse	0.0	20.8
				Both	0.0	6.9
No	Yes	Yes	4	Criminality	0.0	11.1
				Alcohol abuse	25.0	22.2
				Both	25.0	22.2

\*This column indicates that a single individual was reported for both criminality and alcohol abuse.

†The values predicted by the three types of biologic parent registration (criminality, alcohol abuse, or both) agree well with those observed (residual goodness-of-fit  $\chi^2=3.0$ ,  $df=9$ ,  $P=.96$ ).

Table 2.—Parameters of Linear Logistic Model Predicting Criminality and/or Alcohol Abuse in Adopted Men

Parental Predictor Variable	Adoptee Response Category	Logistic Function Estimate*	$\chi^2$	df	P
Intercept	Criminality	-2.22	53.2	1	<.01
	Alcohol abuse	-1.43	41.4	1	<.01
	Both	-2.08	58.6	1	<.01
Criminality only	Criminality	+0.36	3.1	1	.08
	Alcohol abuse	+0.19	1.3	1	.26
	Both	-0.02	0.0	1	.92
Alcohol abuse only	Criminality	+0.21	1.0	1	.32
	Alcohol abuse	+0.31	4.5	1	.03
	Both	+0.26	2.6	1	.11
Both criminality and alcohol abuse	Criminality	+0.35	2.9	1	.09
	Alcohol abuse	+0.48	11.2	1	<.01
	Both	+0.17	0.9	1	.34
Residual	...	...	3.0	9	.96

\*The model estimated the natural logarithm of the ratio of the number of sons in the designated response category (criminality, alcohol abuse, or both) to the number of sons with neither criminality nor alcohol abuse.

ences in either age at onset of criminal behavior or occupational status between the two groups.

Next, we evaluated the men with a history of both criminality and alcohol abuse in terms of the age at onset and frequency of each type of behavior. The correlation between age at first crime and age at first alcohol abuse was .61 ( $P<.0001$ ); they usually began within two years of each other and before age 23 (Fig 1). Similarly, the frequency of registrations for alcohol abuse and criminality were moderately correlated ( $r=.45$ ,  $P<.0001$ ; Table 4). Among men with alcohol abuse, the proportion with any criminality increased from 22% of the 64 mild abusers to 44% of the 36 moderate abusers to 67% of the 51 severe abusers, confirming other data about the general population.<sup>31</sup>

Given the high correlation of alcohol abuse with number, type, severity, and age at onset of criminality, it was not possible in many cases to distinguish alcoholic criminals whose crimes were symptomatic of primary alcoholism from those whose alcohol abuse was symptomatic of a personality disorder. In some cases, however, psychiatric assessments had been carried out to distinguish personality disorders and alcoholism, and this helped classify the adoptees.

#### Discriminant Analysis of Genetic Heterogeneity

The results of the prior sections suggested that men with either criminality or alcohol abuse, but not both, represented fairly homogeneous criterion groups. In contrast, men with both types of registration were relatively more heterogeneous. Psychiatric records were available about the adoptees, and were used to purify the classification of men with both types of registration. The 18 adoptees with a diagnosis of alcoholism but not personality disorder included 14 who had been registered for both criminality and alcohol abuse and four with alcohol abuse only. All 18 of these alcoholics were combined with the other 83 adoptees with alcohol abuse only so that they would represent those with alcoholism. The small number of adoptees diagnosed as having an antisocial personality were all registered for criminality only. Therefore, to evaluate the influence of associated alcohol abuse on the inheritance of criminality, we subdivided the adoptees into four groups: with neither criminality nor alcohol abuse (N adoptees), with criminality only (C adoptees), with either a diagnosis of alcoholism or alcohol abuse only (A adoptees), and others with both criminality and alcohol abuse (B adoptees). This classification was made on purely clinical grounds, but later analyses also confirmed that those diagnosed as alcoholics were most like those with only alcohol registration in terms of their biologic parent background.

Using this classification, we carried out a discriminant analysis using characteristics of the biologic parents to distinguish the four groups of adoptees. Each of the four groups had a distinct congenital (ie, genetic or biologic parent) background: the complement of Wilk's  $\lambda$ , a measure of discrimination among groups, was .111 ( $P<.0001$ ) for the biologic parent variables. Each of the three possible discriminant functions was significant ( $r_1=.21$ ,  $P<.0001$ ;  $r_2=.21$ ,  $P<.0001$ ;  $r_3=.16$ ,  $P<.02$ ), showing that the parents of each

Table 3.—Distinction of Adopted Criminal Men With and Without Alcohol Abuse by Discriminant Analysis

Criminal Characteristic*	Value on Discriminant Function	Variable Means of Each Adoptee Group†	
		Criminality Only (n = 39)	Criminality and Alcohol Abuse (n = 64)
Type of offenses			
Violent crime (0,1)	+ .75	0.26↓‡	0.78†
Property crimes (0,1)	− .39	0.82†	0.69↓
Fraud (0,1)	0	0.49	0.53
No. of offenses			
Additive effect (n)	+ .30	1.69↓	3.08†
High repetitivity (n <sup>2</sup> )	0	4.62	15.95
Severity of offenses			
Months in jail per offense (n)	+ .27	1.64↓	3.39†
Age at first offense			
Age, yr (n)	0	21.05	21.67
Teenage onset (0,1)	0	0.36	0.42
Occupational status			
Reversed rating of skill (1-5)	0	3.26	3.30

\*Coding of variables is indicated in parentheses. Categorical (0,1) variable means indicate the proportion of men who have the specified factor.

†The four variables with nonzero values distinguished the two groups significantly: the canonical correlation, a measure of strength of discrimination, was .56 ( $P < .00001$ ), and 79% of cases could be correctly classified using these four variables alone. High positive values on the discriminant function indicate criminals with alcohol abuse, and high negative values indicate those without alcohol abuse.

‡For the significantly discriminating variables, the higher group mean is followed by an upward arrow and the lower by a downward arrow to aid inspection.

group had a distinct profile of characteristics.

The biologic parent characteristics that distinguished the four groups are summarized in Table 5. Paternal criminality, alcohol abuse, and low occupational status accounted for nearly all the discrimination. The combination of alcohol abuse and low occupational status in the mother also contributed, but no measure of maternal criminality made a significant difference. No interaction between paternal variables improved group discrimination.

The biologic fathers of C adoptees had an excess of criminality, but not alcohol abuse. The biologic fathers of C adoptees had the same risk of alcohol abuse as did other nonalcoholic N adoptees. If the father did abuse alcohol, he usually began during adolescence. The criminality of the C fathers was also similar to the criminality of their adopted-away sons; they had a small number of nonviolent offenses. Similarly, the biologic mothers of C adoptees had the highest frequency of criminality among the groups (7.7% v 5.7%) and the lowest frequency of alcohol registration (2.6% v 10.7%), but the differences were not significant. Thus, criminality unassociated with alcohol abuse was partly inherited by the adopted-away sons from their biologic parents. Occupational status of the biologic parents did not appear to be important in this transmission.

In contrast, the biologic fathers of A adoptees had an excess of both alcohol abuse and criminality. Unskilled occupational status in both parents increased the risk of alcoholism in the adopted-away sons. The combination of alcohol abuse and unskilled occupational status in the mother also contributed significantly ( $P < .05$ ).

The biologic parents of B adoptees had frequencies of both criminality and alcohol abuse intermediate to those of C and A adoptees. Comparing the B adoptees, who had a history of both alcohol abuse and criminality but no diagnosis of alcoholism, and A adoptees, who had either alcohol abuse only or a diagnosis of alcoholism (Table 5), the latter alcoholics had biologic fathers with both more alcoholism and more criminality than the former. Moreover, the greater risk of parental alcohol abuse and crime was not due to the parents of the adoptees with a diagnosis of alcoholism: the biologic fathers of these 18 adoptees had the fewest number of criminal registrations of all groups (means, 0.28 v 0.83 for all others) and no more alcohol abuse than the parents of the other alcohol abusers. Overall, if the adoptee had alcohol abuse, criminality in his parent was correlated with the severity of alcohol abuse in the parent, not with the presence of criminality in the son. This indicates that when an adoptee or a parent had both criminality and alcohol abuse, the criminality was usually symptomatic of alcoholism.

Since the criminality in adoptees with alcohol abuse appeared to be primarily symptomatic of the alcoholism, another discriminant analysis was carried out subdividing the alcohol abusers according to severity (Table 6). The five groups of adoptees included N adoptees, C adoptees, and mild, moderate, and severe alcohol abusers, as defined in Table 4 and described in prior analyses of the inheritance of alcohol abuse.<sup>28</sup> Each of the five groups had a distinct profile of biologic parent characteristics: the complement of Wilk's  $\lambda$  was increased to .157 ( $P < .0001$ ). Four discriminant functions were derived as weighted sums of the variables listed in Table 6, and each was significant.

High values on the first function distinguished moderate alcoholics from the others; its canonical correlation, a measure of strength of discrimination, was .27 ( $P < .00001$ ). High values on the second function distinguished C adoptees from the others ( $r_2 = .19$ ,  $P < .0001$ ). High values of the third and fourth functions distinguished the mild and severe alcoholics, respectively, from the others ( $r_3 = .18$ ,  $P < .003$ ;  $r_4 = .16$ ,  $P < .04$ ).

The characteristics of the alcoholic subgroups have been discussed in detail elsewhere.<sup>28,29</sup> Briefly, note in Table 6 that the adoptees with a moderate number of registrations for alcohol abuse had fathers with severe alcoholism and criminality but phenotypically normal mothers. In contrast, both the mild and severe alcoholic adoptees had both parents with mild alcohol abuse and minimal criminality. The severe alcoholics had a congenital background similar to that of the mild alcoholics except that their biologic parents had lesser occupational skills. Once again, we observed that frequency of criminal registrations in the parents was correlated with the frequency of registration for their own alcohol abuse, but not with the frequency of alcohol abuse in their sons. Factors influencing frequency of registration for alcohol abuse are described elsewhere.<sup>28</sup> The congenital factors leading to petty criminality (C adoptees) appeared to be independent of the factors associated with criminality symptomatic of alcohol abuse.

#### Postnatal Environmental Heterogeneity

The postnatal experiences of the adoptees varied markedly, even though none of the adoptive parents had been registered for crime. We identified postnatal variables that distinguished the five groups of adoptees by discriminant analysis (Table 7). The occupational status of the adoptive father, but not his alcohol abuse, distinguished the adoptee groups. The rank order of the adoptive father's occupational status ratings for the five groups was similar to that of

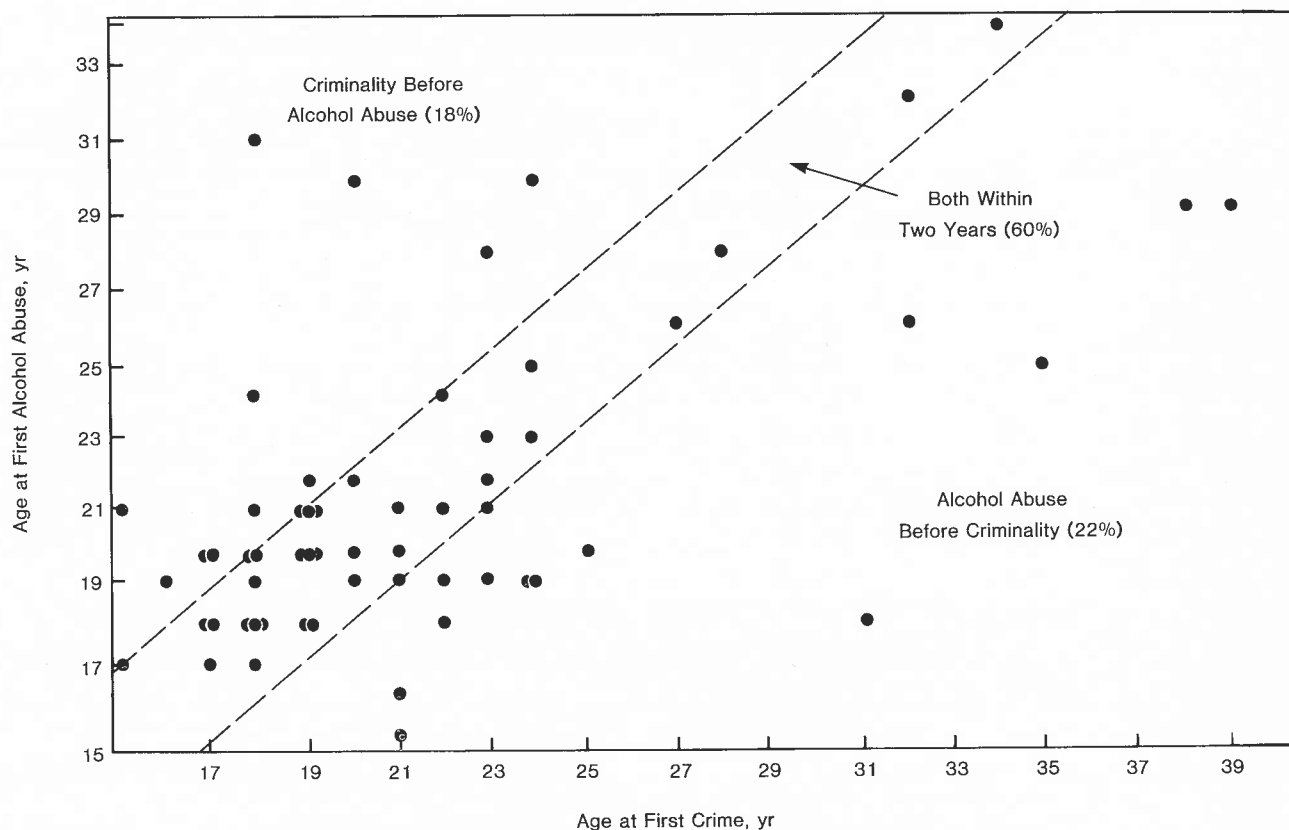


Fig 1.—Association between criminality and alcohol abuse in age at onset (adopted men with both types of registration,  $r = .61$ ,  $P < .000001$ ).

Table 4.—Frequency of Registration for Criminality and/or Alcohol Abuse in Adopted Men\*

Frequency of Criminality†	Ratio of Observed to Expected No. of Men, by Severity of Alcohol Abuse‡			
	None	Mild	Moderate	Severe
None	672:626†	50:56‡	20:32‡	17:45‡
Low	26:40‡	10:4†	5:2†	8:3†
Medium	11:26‡	2:2	6:1†	12:2†
High	2:19‡	2:2	5:1†	14:1†

\*Kendall's  $\tau_b$ , a measure of correlation for ordinal data, was .45 ( $P < .0001$ ) and  $\chi^2 = 286.7$  ( $P < .001$ ), showing strong positive association.

†Frequency of criminality was rated by subdividing those with one offense only (low), two or three offenses (medium), and four or more (high). Severity of alcohol abuse was rated in the same way, using number of Temperance Board registrations, but counting all with diagnosis of or treatment for alcoholism as severe and others with low or medium frequency as mild or moderate, respectively.

‡Greater numbers of observed cases are indicated by upward arrows and greater numbers of expected cases by downward arrows to aid inspection.

the biologic parents, suggesting that they exert an influence via a common intervening variable, such as the occupational status of the adoptee. Extent of hospital care and number of temporary placements were other distinguishing factors. The size of the adoptive hometown, age at placement, and extent of institutional care made no significant difference in group discrimination of male adoptees.

The complement of Wilk's  $\lambda$  was .062 ( $P < .007$ ). Low values on the first function distinguished the unaffected N adoptees from the other four groups ( $r_1 = 0.17$ ,  $P < .007$ ). High values on the second function tended to distinguish the mild and severe alcoholics from

the petty criminals and moderate alcoholics ( $r_2 = 0.15$ ,  $P < .10$ ).

Since only these two dimensions approached significance, we considered ways of combining the five subgroups.

Prior work had indicated that the postnatal experiences of mild and severe alcoholics differed in degree along a single dimension.<sup>28</sup> The postnatal variable means of the petty criminals and moderate alcoholics were similar (Table 7), so they were combined for further analysis. With the petty criminals and moderate alcoholics combined, two discriminant functions were significant (Fig 2).

The first function was largely defined by the occupational status of the adoptive father and distinguished affected (ie, criminal or alcoholic) from unaffected sons ( $r_1 = .16$ ,  $P < .001$ ). Criminal and alcoholic adoptees were offspring of adoptive fathers who were less skilled than fathers of unaffected sons. The second function seemed to reflect the overall stability of preadoptive care and ranks the affected individuals in the order of severe alcoholics (first), mild alcoholics (second), then moderate alcoholics or petty criminals (tied for third), as illustrated in Fig 2 ( $r_2 = .13$ ,  $P < .04$ ). This suggests that petty criminality and moderate alcoholism may share postnatal determinants.

We considered the possibility that the effect of the postnatal risk factors might be due to nonrandom adoptive placement. To test the extent to which congenital and postnatal risk factors were correlated, as might occur if there was any relevant matching of biologic and adoptive parents, we combined both the biologic and adoptive variables identified in Tables 6 and 7 in a single discriminant analysis to distinguish the five groups of adoptees. All the postnatal predictors were retained except the number of temporary placements. Similarly, all the congenital predictors were retained except teenage onset of crime in the biologic father. The discrimination between groups was reduced by only 8% because of the correlation between congenital and postnatal factors. The complement of Wilk's  $\lambda$  was .202 in the combined analysis instead of the .219 expected as the sum of the congenital (.157) and the postnatal (.062) contributions if these sets of variables were uncorrelated. This indicated that the extent of nonrandom placement was minor.



Table 5.—Biologic Parent Variables Distinguishing Four Groups of Adopted Sons

Biologic Parent Variables*	Variable Means of Each Group of Adopted Men†			
	Neither (n=672)	Criminality Only (n=39)	Alcohol Abuse Only (n=101)	Both (n=50)
Type of paternal crimes				
Violent crimes (0,1)	0.11↓	0.05↓↓	0.19↑↑	0.12↑
Fraud (0,1)	0.12↓	0.18↑	0.19↑↑	0.06↓↓
No. of paternal crimes				
Additive effect (n)	0.71↓↓	1.15↑	1.34↑↑	0.92↓
High repetitivity (n <sup>2</sup> )	4.34↓↓	6.64↓	9.61↑↑	9.24↑
Severity and onset of paternal crimes				
Moderate jail terms (0,1)	0.09↓	0.18↑↑	0.09↓↓	0.16↑
Severe jail terms (0,1)	0.07↓	0.08↑	0.14↑↑	0.06↓↓
Months in jail (n)	2.91↓↓	4.38↑	5.77↑↑	3.10↓
Teenage onset (0,1)	0.06↑	0.05↓	0.12↑↑	0.02↓↓
Alcohol abuse in father				
Recurrent abuse (0,1)	0.18↓↓	0.18↓	0.35↑↑	0.24↑
Registration (n)	1.88↓	1.62↓↓	2.38↑↑	2.06↑
Teenage onset (0,1)	0.01↓↓	0.10↑↑	0.03↑	0.02↓
Occupational status				
Rating in father (1-5)	3.77↓↓	3.79↓	4.22↑↑	4.10↑
Rating in mother if alcohol abuse present ([1-5]-[0,1])	0.13↓↓	0.13↓	0.30↑	0.30↑↑

\*The variables were found by discriminant analysis ( $P < .0001$ ). Coding of variables is indicated in parentheses after its label. Categorical (0,1) variable means indicate the proportion of men who have the factor. Interaction between maternal occupational status and alcohol abuse was scored as the product of the status rating (1 through 5) and either absence (value 0) or presence (value 1) of abuse.

†The rank order of the four groups from highest to lowest is indicated by upward and downward arrows to aid inspection.

Table 6.—Biologic Parent Variables Distinguishing Five Groups of Adopted Sons

Biologic Parent Variables*	Variable Means of Each Group of Adopted Men†				
	Neither (n=672)	Criminality Only (n=39)	Mild Alcohol Abuse (n=64)	Moderate Alcohol Abuse (n=36)	Severe Alcohol Abuse (n=51)
Type of paternal crimes					
Violent crimes (0,1)	0.11↓	0.05↓↓	0.11	0.36↑↑	0.10↓
Property crimes (0,1)	0.14↓	0.23↑	0.14↓↓	0.25↑↑	0.20
Fraud (0,1)	0.12↓	0.18↑	0.17	0.22↑↑	0.06↓↓
No. of paternal crimes					
Low repetitivity ([n] <sup>1/2</sup> )	0.38↓↓	0.59↑	0.44↓	0.99↑↑	0.39
No. if recurrent abuse (n[0,1])	0.39↓	0.56↑	0.55	2.03↑↑	0.25↓↓
Severity and onset of paternal crimes					
Moderate jail terms (0,1)	0.09↓	0.18↑↑	0.08↓↓	0.11	0.16↑
Teenage onset (0,1)	0.06	0.05↓	0.05↓↓	0.14↑↑	0.10↑
Alcohol abuse in father					
Recurrent abuse (0,1)	0.18↓↓	0.18↓	0.31↑	0.44↑↑	0.22
Hospitalization or treatment (0,1)	0.12↓	0.13	0.03↓↓	0.42↑↑	0.14↑
Registrations (n)	1.88↑	1.62	1.28↓↓	5.03↑↑	1.57↓
Teenage onset (0,1)	0.01↓	0.10↑↑	0.02	0.08↑	0.00↓↓
Occupational status					
Rating in father (1-5)	3.77↓↓	3.79↓	3.92	4.31↑	4.41↑↑
Rating in father if criminal ([1-5]-[0,1])	0.89↓↓	1.46↑	1.02↓	2.42↑↑	1.06
Rating in mothers if alcohol abuse present ([1-5]-[0,1])	0.13↓↓	0.13↓	0.39↑↑	0.14	0.29↑

\*The variables were found by discriminant analysis ( $P < .0001$ ). Coding of variables is indicated in parentheses. Categorical (0,1) variable means indicate the proportion of men who have the specified factor.

†The rank order of the five groups from highest to lowest is indicated by upward and downward arrows to aid inspection.

### COMMENT

Our major conclusion is that different genetic and environmental antecedents influence the development of criminality depending on whether or not there is associated alcohol abuse. Consequently, it is crucial to distinguish antisocial personality disorders from criminality symptomatic of alcohol abuse in future clinical and etiologic studies.

In particular, criminality without alcohol abuse is characterized by petty property offenses whereas alcohol-related criminality is more often violent and highly repetitive.

We suggest that the best descriptive label for criminals without an alcoholic predisposition is "petty criminality" because of the type of crimes they usually commit. Also, such individuals have no specific protection against alcohol abuse so they may manifest sporadic alcohol abuse at least



Table 7.—Adoptive Home Environment and Preplacement Experience Variables Distinguishing Five Groups of Adopted Sons

Adoptive Placement Variables*	Variable Means of Each Adoptee Group†				
	Neither (n = 672)	Criminality Only (n = 39)	Mild Alcohol Abuse (n = 64)	Moderate Alcohol Abuse (n = 36)	Severe Alcohol Abuse (n = 51)
Occupational status of adoptive father					
Effect of high (unskilled) rating ( $r^2$ )	9.61↓↓	10.67	10.64↓	11.22↑	12.90↑↑
Effect of low (skilled) rating ( $[r]^{1/2}$ )	1.52↓	1.52	1.53↑	1.46↓↓	1.66↑↑
Contact with biologic mother					
Duration, days (n)	135.0↓↓	189.3↑↑	157.1	166.6↑	151.9↓
More than six months (0,1)	0.26↓↓	0.36↑	0.39↑↑	0.31↓	0.35
Extent of hospital care					
Duration, days ( $[n]^{1/2}$ )	0.73↑	0.38↓	0.46	0.33↓↓	1.39↑↑
No. of temporary placements					
Total No. (n)	1.75↓	1.87↑	1.59↓↓	1.97↑↑	1.84
More than two (0,1)	0.23↓	0.36↑↑	0.22↓↓	0.28↑	0.27

\*The variables were found by discriminant analysis ( $P < .007$ ). Coding of variables is indicated in parentheses. Categorical (0,1) variable means indicate the proportion of men who have the specified factor.

†The rank order of the five groups from highest to lowest is indicated by upward and downward arrows to aid inspection.

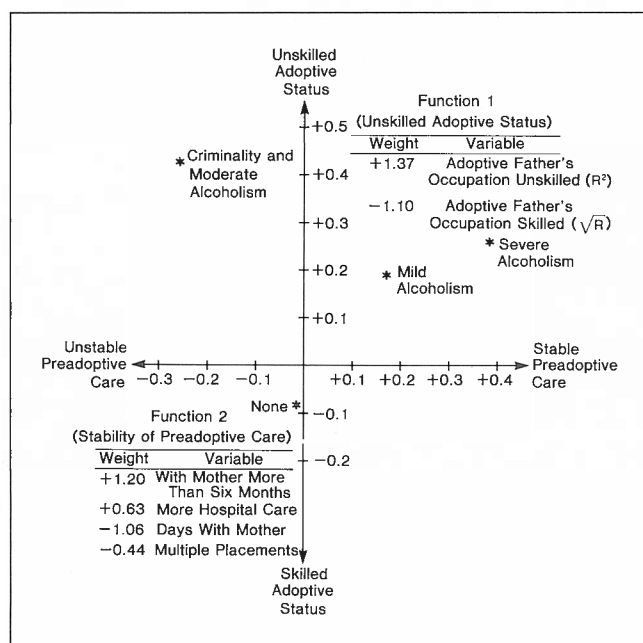


Fig 2.—Adoptee group means on two significant discriminant functions of their postnatal experience.

as often as people with neither criminal nor alcoholic predispositions. This is supported by the tendency of some fathers registered for teenage-onset alcohol abuse and petty property offenses to have an excess of petty criminal sons (Tables 2 and 5). Consequently, the term nonalcoholic crime is overly restrictive.

Bohman's<sup>20</sup> earlier failure to detect the heritability of petty criminality illustrates the importance of rejecting unitary trait models of crime. Bohman implicitly assumed that predisposition to criminality was either all independent of alcoholism or all a consequence of alcoholism. Reexamination of Table 3 in his 1978 report<sup>20</sup> shows an excess of criminality alone in the sons of biologic fathers with criminality alone compared with the sons of other fathers (8.9% of 169 v 4.9% of 812,  $\chi^2 = 4.1$ ,  $P < .05$ ). However, no significant excess of criminality in the sons of fathers with criminality alone was detected because all tests were carried out for total criminality (ie, combining criminality

alone with both criminality and alcohol abuse). Nevertheless, his major conclusion, that most criminality is a consequence of alcohol abuse, is confirmed herein.

Most importantly, our data show that criminality that is heritable independent of a specific predisposition to alcoholism is characterized by commission of a small number of petty property offenses rather than repetitive aggressive acts. This confirms Crowe's<sup>15,16</sup> adoption study in Iowa, in which the adoptees were shown to have an excess of antisocial personality but not alcoholism. It is surprising that little comment has previously been made of the fact that the criminal records of his antisocial adoptees involved property offenses that were mostly misdemeanor theft.

In contrast, current diagnostic criteria for antisocial personality are based largely on longitudinal studies<sup>5</sup> in which the interaction of personality disorder, abuse of alcohol and other drugs, and low social status may be confounded. Both Robins' original criteria and current *DSM-III* criteria<sup>34</sup> include alcohol and substance abuse as diagnostic features of antisocial personality. Furthermore, alcohol abuse and low social status are associated with a greater number and severity of antisocial acts, including criminal recidivism.<sup>4,7</sup> Therefore, individuals at high risk for both criminality and substance abuse will be identified by criteria requiring severe, repetitive antisocial behavior. Current *DSM-III* criteria<sup>34</sup> for antisocial personality are even more restrictive than the Feighner et al<sup>35</sup> criteria used by Crowe<sup>15</sup> which did not include alcohol abuse as a diagnostic feature of antisocial personality. This suggests that heritable antisocial personality disorders are often less severe than those identified by *DSM-III* criteria. Further multivariate analyses of clinical data about separated family members are needed to develop criteria that are specific for more etiologically homogeneous clinical populations.

Another related observation should be made about criminal recidivism as a measure of severity of illness. In comparisons among all criminals, alcoholic criminals had more criminal offenses than did nonalcoholic criminals (Table 3). Also, the number of criminal convictions was correlated with the severity of alcohol abuse within alcoholic criminals (Table 4). Furthermore, the number of criminal convictions appeared to be correlated with the severity of predisposition to criminality within nonalcoholic criminals, according to data about sex differences in this population reported elsewhere in this issue (see p 1248). Thus, recidivism was a measure of severity of two geneti-

cally independent disorders. Also, severity of alcoholism, and hence severity of symptomatic crime, was largely determined by environmental, not genetic, factors in this population. Therefore, if recidivism is used as a measure of severity of predisposition to criminality, highly inconsistent results may be obtained in populations that differ in the proportion of alcoholics unless the population is stratified into alcoholic and nonalcoholic subgroups. Once the heterogeneity related to alcoholism is taken into account, recidivism appears to be a useful measure of severity.

The subclassification of alcohol abuse into two types appears to be relevant to our findings about petty criminality. As shown in Table 6, men with a moderate number of registrations for alcohol abuse had biologic fathers with a combination of alcoholism and criminality, but normal female relatives; this male-limited pattern has been denoted as type 2 alcoholism. In contrast, both mild and severe alcoholics had both parents with alcohol abuse and minimal criminality. They manifested alcohol abuse only when reared in particular postnatal environments; this milieu-limited pattern has been denoted as type 1 alcohol-

ism. This is discussed in detail elsewhere.<sup>28</sup> Here it is of particular interest that both the genetic and environmental antecedents of petty criminality were uncorrelated with those of the type 1 form of alcohol abuse. Petty criminality and type 2 alcoholism, however, seem to share postnatal environmental determinants, which would lead to familial association between petty criminality and type 2 alcoholism. This is particularly interesting since the biologic fathers of type 2 alcoholics were often alcoholic criminals. This possible overlap is further evaluated in the second report in this series.

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