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Recommended Citation

J Stud Alcohol. 1988 Nov; 49(6): 491-509. The Swedish studies of the adopted children of alcoholics. Littrell, J. Available at: www.jsad.com/jsad/link/49/491 Also available at: http://digitalarchive.gsu.edu/ssw_facpub/27/

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The Swedish Studies of the Adopted Children of Alcoholics

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ABSTRACT. The authors of the widely cited studies analyzing the Swedish adoption records of the children of alcoholics have advanced the notion that there are three distinct paths for the inheritance of alcoholism. One path results in moderate alcoholism in men and a form of somatization but no alcoholism in women. A second path results in severe and mild alcoholism in men and alcoholism in women. The third path results in a particular variety of alcohol abuse in men and a particular variety of somatization in women. This article analyzes the

authors' claims. It is argued that the data were improperly analyzed for the conclusions reached and alternative parsimonious explanations for the results are offered. Although the Swedish studies do not offer support for three distinct paths of inheritance of alcoholism, they do support the inheritability of alcoholism and suggest that alcoholism may be linked with somatization in women. Unfortunately, reasonable questions can be raised about the generalizability of the data base. (*J. Stud. Alcohol* 49: 491-499, 1988)

THERE HAS BEEN little that is revolutionary in the thinking concerning the inheritance of alcoholism, with the exception of the conclusions reached in a set of studies by Cloninger, Bohman, Sigvardsson and von Knorring (cited in the appropriate contexts in this article). The authors report a number of adoption studies analyzing an extensive data base collected from the records of Swedish adoptees. They have reached the conclusion that there are three separate types of inheritance for alcoholism. Their thinking is based on detailed differences in family histories for some sets of alcoholics. The details are used in the development of a rather complex picture of genetic history for alcoholism that is not easy to follow critically. Because these authors have had many works published and their conclusions are frequently cited (e.g., Cloninger et al., 1985; Petrakis, 1985; Schuckit et al., 1985; Thacker et al., 1984), it is important that their theorizing should receive detailed scrutiny. In this article an attempt is made to present the findings and conclusions of Cloninger and his colleagues in as clear and succinct a manner as possible, along with a careful analysis and evaluation that include comparisons with alternative explanations for the data.

The Data

In Sweden, citizens are registered with the Tem-

perance Board for occurrences of alcohol-related impropriety. Records of medical treatment, hospitalizations and criminal misconduct are also available from the public record. Utilizing these records, it is possible to determine the criminal, drinking, health and mental health status of individuals. Cloninger and associates used these public records to establish disability in their subjects and in the relatives of their subjects.

The Use of Discriminant Analysis

Most of the statistical analyses reported in the Swedish studies were discriminant analyses. The task in a discriminant analysis is to create a new predictor variable that will maximize the discrimination among the groups. A single new predictor variable (called a canonical variate) is created by summing several predictor variables each of which has first been appropriately weighted. The weights are chosen to increase the probability that the statistic being tested for significance will be significant. The statistic, Wilks's lambda, is generated through matrix algebra calculations. Unlike a *F* or a *T* statistic for which larger values are associated with smaller *p* values, smaller Wilks's lambdas are associated with smaller *p* values. Hence, the weights are chosen to minimize the Wilks's lambda.

In performing a discriminant analysis, predictor variables are added to the linear combination of variables in a sequential fashion. The first variable selected for inclusion is the variable with the largest

association with group membership. Successive variables are added if they add incremental predictive utility. The authors frequently relied upon SPSS (Nie et al., 1975) default values as their criteria. Each newly considered predictor variable is included in the further analyses if (1) it is not highly redundant with other variables already entered (tolerance = .001, a very liberal criterion of inclusion) and (2) the F value for change in Wilks's lambda is at least 1, $p = .50$, again a very liberal criterion of inclusion. The selection procedure ensures that each variable that adds any increment of predictive utility receives a weight in the discriminant function. Thus, the authors have taken care not to exclude variables that offer a predictive contribution.

Each time a variable is added the weights for all variables are recalculated. The procedure for producing a discriminant function reassesses individual weights in terms of commonly shared predictive value, permitting highly predictive variables to sometimes have relatively low weights in the function (i.e., variables that are individually highly predictive but correlate highly with other predictor variables can have lower weights).

Sometimes more than one Wilks's lambda is yielded from a discriminant analysis. Matrix algebra problems can have more than one solution. Each solution signifies a composite dimension along which group differences can be found. Finding more than one solution suggests there are additional dimensions along which group differences occur.

Group means can be computed on the canonical variate (the linear combination suggested by the discriminant function). Significant Wilks's lambdas or canonical correlations are analogous to a significant omnibus F test. Obtaining significance indicates the groups in the analysis differ significantly on the discriminant function score. Where particular group differences occur (e.g., Does Group 1 differ from Group 2 and Group 3 or only Group 2?) cannot be inferred without pairwise tests of group differences. Pairwise significance tests can be used to determine which group or groups are distinguished from the others (i.e., which group means are statistically different on the canonical variate). Unfortunately, the authors do not report tests of differences between any two specific groups from among the three or four being compared in the different studies.

To determine the meaning of a group difference, one has to examine the weights (signs and magnitudes) of the variables appearing in the linear combination. A group that has a statistically higher group mean on the canonical variate is described by those variables receiving positive, large magnitude weightings and is not described by those variables receiving

negative, large magnitude weightings. The prototypic image suggested by the pattern of weights suggests where significant differences on variables contributing to the canonical variate might reside.

Discriminant analysis does not obviate univariate significance tests. If inferences are to be made as to whether group means differ significantly on each particular variable, univariate pairwise comparisons are necessary. Discriminant analysis is not appropriate to univariate questions. Some variables that are statistically associated with group membership may not be represented in the linear combination of weights. This is sometimes the case when two variables share variance in predicting group membership. The weighting of the first variable can preclude the weighting of the second variable, or at least seriously reduce the weight of the second variable. Conversely, variables unrelated to group membership may appear in the linear combination of variables. Such would be the case, for example, if there were a suppressor variable (i.e., a variable the presence of which changes the relationship between a univariate dependent variable and the independent variable, but is not itself related to the dependent variable, that is, group membership). Thus, variables that are not individually predictive of group membership could be represented as relevant predictors. The correlations among the set of investigated predictor variables are therefore relevant to what appears in the canonical variate. Were another overlapping set of variables included in a different discriminant analysis, new solutions might possibly be generated. A different picture of univariate differences among groups would be suggested.

Discriminant analysis provides a gross predictive tool for categorizing cases (predicting group membership). If the theoretical question is whether two groups differ on some particular variable, discriminant analysis is not an appropriate technique to address the question. The question is more properly addressed by pairwise comparison between the two groups, first on the entire set of potentially differentiating quantitative variables of interest, employing multivariate procedures to correct for alpha inflation. Assuming significance, one is then entitled to perform univariate comparisons. In this way, information about the relationships between specific predictor variables and the group membership can be ascertained.

Male Alcoholics

The 1981 study

A 1981 study reported by Cloninger et al. (1981) analyzed data for 862 male adoptees from the Swedish

data base. This study was unique in that the adoptees were categorized into one of four groups: no alcohol abuse; one registration with the Temperance Board (mild abuse); two to three registrations with the Temperance Board (moderate abuse); and four or more registrations with the Temperance Board plus hospitalization (severe abuse). Cloninger et al. performed a discriminant analysis. Their purpose was to identify those predictor variables among variables pertaining to biological parental background that would best differentiate the four groups. When the variables descriptive of the biological parents were fed into the analysis, three significant Wilks's lambdas were derived suggesting three dimensions along which meaningful differences among groups should be found. (The authors did not report the discriminant weights for the discriminating variables. They provided only a verbal summary.)

The first discriminant function differentiated the moderate alcoholics among the adoptees. The highly weighted variables included in the function differentiating the moderates from all other groups were (1) frequent registration of the biological father with the Temperance Board and hospitalization for drinking, (2) recurrent criminal convictions of the biological father, generally of a property crime nature, and (3) teenage onset of deviant behavior in the biological father. The second discriminant function distinguished the mild abusers from the others. Those predictors contributing to the differentiation were (1) maternal alcohol abuse, (2) recurrent paternal alcohol abuse not requiring treatment, (3) little paternal criminality, and (4) the relatively higher occupational status in the biological father. The third discriminant function separated the severe alcoholic adoptees from the rest. The severe alcohol abusers were distinguished by the lowest occupational status in the biological father. Like the mild abusers, the severe abusers more often had alcoholic mothers and untreated paternal alcohol abuse.

Cloninger et al. performed a second discriminant analysis to differentiate the four groups of adoptees, this time employing environmental variables to separate the groups. This analysis resulted in only one significant discriminant function. The authors did report the discriminant function group means, although tests of group mean differences were not reported. According to the authors, the mild (+.19) and severe (+.38) alcoholics were distinguished from all other adoptees (moderate [-.19] alcoholics and normals [+ .04]). The variables weighted in the discriminant function were (1) having been reared by the biological parent for more than 6 months, (2) age at final adoptive placement, (3) extent of post-natal hospital care, and (4) low occupational status

of the adoptive home (the severe alcoholics came from the lowest occupational status homes).

Summary of the authors' conclusions

Cloninger et al. interpreted their findings as supportive of two separate forms of genetic inheritance. The common form of inheritance (the majority of alcoholics in the sample fell into this category) results in mild or severe alcoholism in men, and alcoholism, undistinguished as to severity, in women. The common form of genetic liability can be moderated by environmental factors (i.e., it would be most likely to emerge under propitious environmental conditions). This common form is characterized by alcoholism in the mother and mild alcohol abuse in the father. The second genetic type, the less common form of inheritance, results in moderate alcoholism in men only. This genetic liability is distinguished by severe alcoholism and criminal activity in the father only. Environmental factors seem not to moderate the expression of this inheritance. Later in the article, the authors coined the term "milieu-limited" to refer to the common form and "male-limited" to refer to the less common form.

The results of discriminant analysis do not provide adequate support for the authors' conclusions. Univariate tests of significance should have been provided on those critical variables that are purported to distinguish the alcoholic types. Univariate significance tests demonstrating that the moderate alcoholic group mean did differ from the severe and mild group means and that the severe and mild group means did not differ from each other on the variable of paternal hospitalization for alcoholism should have been presented. Additional univariate tests should have been carried out for all of the critical distinguishing features (maternal alcoholism, paternal frequency of registration with the Temperance Board, etc.) suggested to differentiate the separate inheritance patterns. Without substantiated group differences, the basis for the theorizing of separate inheritance patterns is left unsupported.

The 1982 study

A revision of the authors' conclusions regarding the environmental influences on the male-limited type of inheritance was reported in a 1982 study (Bohman et al., 1982). In the 1982 report, two additional discriminant analyses on the environmental variables were performed. In one analysis, the category of criminal adoptee without alcohol abuse was added to the normal, mild alcoholism, moderate alcoholism and severe alcoholism categories. In the second analysis, criminals and moderate alcoholics were lumped

together. Significant environmental predictors were then identified for the criminals and the moderate alcoholic groups distinguishing them from the severe and mild alcoholic groups. (The characteristic variables were [1] having spent less time in the hospital after birth, [2] having spent less time with biological mother before adoption, and [3] having had more foster care placements.) In an analysis using discriminant weights to predict type of alcoholism in the adoptees (a kind of check on the utility of the discriminant functions), the environmental variables enhanced the prediction of moderate abuse (Cloninger et al., 1982). Apparently, prediction of moderate alcoholism is improved by combining environmental variables with biological variables in an additive model.

An alternative interpretation of the 1981 study

The conclusions of the authors may be correct despite the questionable nature of their statistical evidence. However, the counterintuitive nature of their conclusions (mild and severe alcoholics being jointly different from moderate alcoholics), and their invoking an entirely new theory (two separate inheritance pathways), would be expected to be accompanied by the strongest evidence. As indicated in the previous sections, their statistical analyses were inadequate for the task. Yet, the 1981 study and its interpretations have been widely referenced. It is therefore important to examine an alternative interpretation of the 1981 study.

One intriguing finding that has implication for an alternative explanation is that whereas the average maternal alcoholism in the moderate group was lower than in the control group, the severe and mild groups had relatively high rates of maternal alcoholism. Further, the extended postnatal hospitalization, which is highest in the severe alcoholic group, suggests that the mother might have been drinking during the pregnancy. Perhaps mothers and fathers contribute the same type of genetic protoplasm to their offspring. Having a mother who drinks during pregnancy, however, might constitute a congenital aggravation of genetic predisposition resulting in extreme alcoholism. (This line of reasoning is consistent with the rat studies that demonstrate that exposure to alcohol during gestation or lactation results in enhanced alcohol preference, impaired learning and hyperactivity [Randall and Lester, 1975]). Thus, intrauterine environment as well as genes could account for the findings in the severe alcoholic group. In the mild alcoholism group, the mothers were more frequently alcoholic, although the postnatal stay was close to that of the control group suggesting that the

mothers were not drinking through pregnancy. Perhaps the mild or no alcoholism in the father and the alcoholism in the mother contribute a genetic diathesis, although not an extreme one since the degree of affliction in the parents was not extreme. One might, therefore, expect the mild alcoholism that was found in the offspring without the exacerbation due to drinking during pregnancy. If one accepts the latter interpretation of the 1981 data, no separate genetic inheritance is implied by the findings. Variation in severity of alcoholism is attributable to intrauterine environment.

The preceding alternative explanation does not require an entirely new theory, such as the Cloninger et al. suggestion of separate inheritance pathways. Yet, the above explanation is speculative. The 1981 study offered no test of differences between group means that would constitute a test of this alternative theory. The explanation relies on the apparent differences between the reported group means. However, an argument that the alternative explanation is correct is not being made here. Rather, the alternative explanation is offered in an attempt to demonstrate that there is at least one other explanation available that does not require invoking a completely new theory.

Studies on Female Adoptees

Female alcoholism

The Cloninger group has reported a number of investigations of alcoholism in female adoptees. The thrust of the authors' work has been to test the hypothesis suggested by the 1981 study: female alcoholics have biological backgrounds that are similar to the milieu-limited type background (the parental backgrounds of the male, mild alcoholics and male, severe alcoholics). The analyses performed to confirm the hypothesis are described in the following paragraphs.

An interesting preliminary analysis, reported in a study by Bohman et al. (1981), was the comparison of the incidence of alcoholism among those female adoptees having just an alcoholic mother, those having just an alcoholic father, those having both parents alcoholic, or those having neither parent alcoholic (referring to the biological parentage). Female alcoholism was 10.3% in the alcoholic mother group, 3.5% in the alcoholic father group, 9.8% in the both parents alcoholic group and 2.8% in the both parents nonalcoholic group. Only the mother's alcoholism increased the incidence of alcoholism in the female adoptee.

In the 1981 Bohman et al. article, a discriminant analysis distinguishing those female adoptees who

became adult alcohol abusers versus those female adoptees who were not adult alcohol abusers was reported. Those background variables identified by the discriminant analysis as descriptive of the female alcohol-abusing adoptee were (1) low SES given alcohol abuse in the biological mother, (2) property or fraud criminality in the biological mother, (3) little property crime although some jail time in the biological father, (4) alcohol registration in the father, (5) spending more time with the biological mother before adoption, (6) having had less postnatal hospital care, (7) being raised in a rural environment, and (8) having been raised by adoptive parents with low socioeconomic background.

Bohman et al. concluded from their study that the risk for female alcoholism is increased by maternal alcoholism. They claimed that the data support the conclusion that female alcoholics have fathers who have mild alcohol abuse, little history of property crimes and little treatment for alcoholism. Bohman et al. remarked that the characteristics descriptive of the biological paternal backgrounds of the female alcoholic are similar to those found in the fathers of the milieu-limited type alcoholics. It should be noted that specific tests of the similarity between the biological father of the female alcoholic and the biological father of the male mild and male severe alcoholic (milieu-limited inheritance) and of the dissimilarity between the biological father of the female alcoholic and the biological father of the male moderate alcoholic (male-limited inheritance) were never made. Such direct tests could be made by including male mild and male severe alcoholics, male moderate alcoholics and female alcoholics in the same analysis. Without such direct tests conclusions cannot be drawn.

The results from a 1982 analysis (Sigvardsson et al., 1982) are consistent with the 1981 Bohman et al. study's conclusions. In this analysis of the Swedish data base, the discriminant functions pertaining to biological background of male adoptees from the 1981 Cloninger et al. study and the 1982 Bohman et al. study were used. (The 1982 Bohman et al. study added the category of male nonalcoholic criminal to the categories of the 1981 study. Findings from the 1981 study were essentially replicated.) The authors in the 1982 Sigvardsson et al. study sought to determine how well the backgrounds found to be characteristic of types of male alcoholics would predict female alcoholism. Female adoptees were divided according to whether their biological background resembled that of male criminals, male mild alcoholics, male moderate alcoholics, male severe alcoholics, or male nonalcoholics. The incidence of female alcoholism was significantly elevated in the male mild alcoholism background group.

The authors interpret this elevated female alcoholism result as support for the similarity between female alcoholics' biological backgrounds and the backgrounds of male mild alcoholics in terms of both maternal and paternal characteristics. The authors' interpretation extends beyond the limits of the analysis. Since a particular variable weighted in the discriminant function could have accounted for significant results, a conclusion that the composite backgrounds are equivalent is unwarranted. Both paternal and maternal alcoholism were variables in the discriminant function characterizing the mild alcoholic group. Whether one set of variables was more important than the other in accounting for the difference between groups cannot be determined from the analysis employed. This cross-fostering type analysis does not confirm similarity between backgrounds of female alcoholic adoptees and backgrounds of male severe and male mild alcoholic adoptees.

Again, confirmation of similarity between backgrounds of the female alcoholics and of the milieu-limited alcoholic men requires an analysis in which women and men are included and specific pairwise tests are made. In order to avoid predicting only the null hypothesis (the prediction for the backgrounds of female alcoholics and of milieu-limited alcoholic men), inclusion of male moderate alcoholics (male-limited background) in the analysis where a difference from female alcoholism background is predicted would be useful. Confirming a predicted pattern of both similarity and difference would suggest that a failure to reject the null hypothesis may reflect a true lack of difference between two groups.

Female somatization

In the next three studies in the literature, Cloninger, von Knorring, Bohman and Sigvardsson further examined data on female adoptees. Prior literature had suggested a possible link between somatization and alcoholism (Bohman et al., 1984). The authors build a case by advancing the notion that two different forms of hypochondriasis exist in women and each unique form is associated with a particular type of inheritance pattern of alcoholism. The details of each study will be reviewed so that the merit of the case can be evaluated.

The first study of the series (Sigvardsson et al., 1984) compared female adoptees with a matched control group of nonadoptees. The authors found that the adoptees were more likely to have used over 2 sick days per year than were the nonadoptees. The second study (Cloninger et al., 1984) examined the population of female adoptees, seeking to define further the group of female adoptees using more

than 2 days of sick leave per year. The authors performed a discriminant analysis on the female adoptees to differentiate the sick-leave users from a control group of sick-leave nonusers, feeding in variables descriptive of the type of sick-leave complaint. This analysis yielded a discriminant function which the authors then used to create a new predictor variable. For each subject, the authors calculated a score on the new predictor variable obtained from the discriminant function. The authors then evaluated the distribution of these new scores. Using a statistical analysis called admixture analysis, the authors demonstrated that the distribution was trimodal. That is, there was one mode capping the subset of scores for the sick-leave nonusers and two modes for the subset of scores for the sick-leave users. They used these three modes to designate three groups. Next, the authors performed a second discriminant analysis, feeding in 17 different variables descriptive of frequency of sick leave and type of complaint. The three distribution groups were to be differentiated on these 17 variables. This second discriminant analysis yielded descriptions of each of the two sick-leave-using populations. One population, referred to by the authors as diversiform somatizers, used relatively less sick leave but their excuses for sick-leave usage were diverse. The second group, referred to as high frequency somatizers, used the most sick leave of any group but requested sick leave for the same complaint. This latter group also had more psychiatric treatment and had the highest percentage of alcoholics and criminals (30%).

An alternative interpretation of the dual somatizer theory

The authors suggested that they had identified two groups of somatizers (i.e., persons who are malingerers, have a very low threshold for the perception of discomfort or who seem to worry about their health). The authors may be correct in their suggestion that there are two discrete pathological types of hypochondriasis, but another explanation is that the high frequency group is the group with legitimate illnesses. Recall that this group tended to request sick leave for a single complaint. (The authors made no attempt to cull from their sample those individuals whose complaints were not corroborated by a physician. In fact, all complaints had been diagnosed by a physician.) Given that the high frequency group was reported to contain as many as 30% alcoholics, veridical illness would not be a surprising finding. Consistent with alcoholism, the physical problems in the high frequency group were often gastrointestinal complaints and back pain.

Backgrounds of somatizers

The third study in the series (Bohman et al., 1984) related the two populations of sick-leave users to biological parental background. One analysis was a discriminant analysis distinguishing, on the basis of their biological backgrounds, three groups: 37 female high frequency somatizers adoptees, 157 female diversiform somatizers adoptees, and 665 female normal adoptees. The first discriminant function differentiated the normals from all of the sick-leave users. There was more alcoholism, criminality and low socioeconomic status in the biological background of the sick-leave users. The second function (for which the canonical correlation was not significant) differentiated the high frequency group from the diversiforms and normals. The biological fathers of the high frequency somatizer group had a teenage onset of criminality, frequent alcohol abuse registrations and recurrent alcohol abuse. These fathers had little alcoholism treatment and few property crime convictions. The discriminant analysis suggested that in the high frequency somatizing group the mothers were relatively less often alcoholic and the fathers were infrequently guilty of violent crime.¹

The authors speculated whether the cluster of variables in the discriminant function characterizing the high frequency somatizer women and the cluster characterizing the diversiform somatizer women overlapped with any cluster of variables characterizing the backgrounds of particular types of male alcoholics. They reported a second analysis addressing their speculation of overlap for which they used the discriminant functions identified in the male adoptee 1981 study that distinguished the milieu-limited type alcoholics and the male-limited type alcoholics. A score for each subject was computed on each of the functions. Then a determination was made concerning whether a female subject's background was most like the male mild alcoholism background, the male moderate alcoholism background, the male severe alcoholism background or male normal background. Further, the authors also included a background category for male criminality without alcoholism.

The authors found that there was a higher percentage of diversiform-type somatizers in the female groups with the male moderate alcoholism background or the male criminal background. Thus, the biological backgrounds of the male moderate alcoholics and the male criminals predicted female somatization. In their conclusion section, the authors maintained that diversiform somatizers have a male-limited type genetic background. The analysis yielded no significant results for the high frequency somatizers. None of the male backgrounds was associated

with high frequency somatization in women. Cloninger later related high frequency somatizers to a new, third type of paternal syndrome characterized by recurrent convictions for nonproperty, violent crimes and recurrent Temperance Board registrations. This third type of syndrome is referred to as the antisocial type of inheritance (Schuckit et al., 1985).

Summary of and Caveats for the Swedish Studies

The Swedish study authors proffer conclusions beyond the simple notion that alcoholism is inherited. They conclude that: (1) mothers who are alcoholic, and fathers who are recurrent alcohol abusers who are not treated for alcoholism and are not criminals, predispose to mild and severe alcoholism in sons, and alcoholism without regard to severity in daughters (the milieu-limited pattern); (2) normal mothers procreating with severely alcoholic, criminal fathers predispose to moderate alcoholism in sons and diversiform somatization in daughters (male-limited pattern); (3) fathers who commit violent crimes, who abuse alcohol as teenagers, but who are not treated for alcoholism predispose to high frequency somatizing in daughters. These hypotheses relate a type of alcoholic father to a particular type of alcoholism in the son. Interestingly, if the authors conclusions are accepted, the type of alcoholism in the father is not the type inherited by the son. *Viz.*, the father who recurrently abuses alcohol but is not hospitalized (the milieu father) produces a son who is frequently registered with the Temperance Board and is hospitalized (severe alcoholic adoptee). The father who is convicted of crimes and who is treated for alcoholism (the male-limited inheritance father who is severely alcoholic) sires a son who recurrently abuses alcohol but is not treated for alcoholism (moderate alcoholic adoptee).

The notions pertaining to the three separate inheritance patterns require further support. When specific characteristics are attributed great importance in defining the typology (*viz.*, frequency of alcohol registration in the biological father, frequency of treatment for alcoholism in the biological father, etc.), one would want evidence of significant differences between each typology group, making pairwise comparisons, on each predictor variable. Results of discriminant analyses do not yield evidence of group differences on specific predictor variables. Unfortunately, the authors frequently draw conclusions about the predictive value of specific variables without having made the appropriate tests.

The authors have implied that the background descriptors identified as characteristic of a particular group in one study are the same as the background descriptors identified as characteristic in a separate

study for a second group. (For example, female alcoholics are assumed to have biological parents similar to those of male severe or male mild alcoholics, but different from those of male moderate alcoholics.) To substantiate their claims, the authors have relied upon the use of discriminant functions (e.g., the discriminant function characterizing male moderate alcoholics) derived from one study to classify new subjects (e.g., female adoptees) in a second study. Despite substantiated predictability, this type of analysis yields little information about the contributions of specific variables. Since a large number of variables (e.g., maternal and paternal characteristics) were included in the linear combination of the discriminant function, it is unclear which variables were important in producing the significant results. The same variable may not have been responsible for the association in both studies.

The similarity (or difference) between two groups on background characteristics can be established directly. A test of similarity can be performed by entering all groups into the same statistical analysis. Group pairwise MANOVA followed by univariate analyses would provide specific information as to those particular variables that differed as a function of group membership.

The notion that there are three separate forms of inheritance is different from prior theorizing. Even if the authors were to provide confirming evidence of hypothesized group differences among the severe, mild and moderate types on univariate tests, there is a second issue. One would want to determine whether sample differences found in the Swedish data base can be replicated in another sample. Only 19% of severe alcohol abusers are registered with the Temperance Board (Kaij, 1970). Others, using DSM-III (American Psychiatric Association, 1980) criteria, have reported one-third false positives and one-third false negatives if Temperance Board registration is relied upon as the criterion for alcoholism (Hagnell et al., 1986). Cloninger et al. (1985) remark that only 29% of women and 58% of men who have health system diagnoses of alcoholism are registered with the Temperance Board. It is unclear how a sample derived by meeting Temperance Board criteria might differ from a sample categorized as alcoholic through satisfaction of some other criteria. A replication of the findings in an independent sample, with other criteria for alcoholism and degrees of alcoholic severity, should precede confidence in any conclusions.

An additional question regarding the type of alcoholism investigated in the Swedish studies can be raised. Given the degree of criminal activity associated with drinking found in the Swedish studies and the fact that the criteria for alcoholism in the 1981

Cloninger et al. study (Temperance Board registration) are themselves social problem criteria for alcoholism, the Swedish studies may have been investigating primary sociopathy/secondary alcoholism. Bohman et al. (1982) did address the issue of the relationship between criminal behavior and alcoholism. They adduced evidence suggesting that there is a form of criminality unassociated with alcoholism. According to Bohman et al., antisocial conduct after the onset of heavy drinking should be regarded as a symptom of the severity of alcoholism. Although Bohman's differentiation between nonalcoholic criminals and alcoholics displaying sociopathic acts may be a useful distinction, a second category of alcoholic may exist. There are many alcoholics presenting in middle-class clinics whose alcoholism is indeed severe if the criteria for severity are physical sequale, but who never exhibit antisocial behavior. Perhaps this latter type of individual is more appropriately viewed as a separate variety of alcoholic distinct from the alcoholic whose drinking creates social misconduct. (The distinction raised here overlaps with the primary/secondary distinction but is not the same as that suggested by Schuckit [1980], which assigns a critical role to temporal factors.) Given the ambiguity of the population under study, it is unclear whether conclusions from the studies should be reserved for alcoholics exhibiting antisocial conduct or can be generalized to alcoholic populations who do not violate social conduct norms except for those norms pertaining to amount imbibed.

In two articles focused on testing the genetic independence of alcoholism and criminality in male adoptees (Bohman, 1978; Bohman et al., 1982) and in the previously mentioned article exploring female alcoholism (Bohman et al., 1981), nonparametric tests of the contribution of an alcoholic mother or an alcoholic father to the risk for alcoholism in the adopted-out son and daughter were reported. These reports suggest the following conclusions. First, alcoholism in the father does increase the risk for alcoholism in the son. Second, alcoholism in the mother increases the risk in the daughter and son. The extent to which this increased risk from the mother reflects genetic factors or influence on gestational development is unknown. Further, whether susceptibility to this latter type of risk varies between the sexes is unknown.

The Swedish studies do support the general case of the inheritance of alcoholism. A third tentative speculation suggested by the discriminant function but not verified by substantiated significant group differences is: Paternal alcoholism predisposes adopted-out daughters to the increased use of sick leave, possibly because they have a lower threshold for

pain. This third speculation requires an additional caveat. It is known that alcoholic, antisocial men marry hysterical, high somatizing women (Guze et al., 1970; Woerner and Guze, 1968). Cloninger et al. did not measure or control for the possible confounding of high somatizing mothers mating with the alcoholic fathers. If there were such a confound, it is possible that diversiform somatizers inherited their condition via their mothers' hysteria and not their fathers' alcohol affliction.

Notes

1. The latter two findings pertaining to the limited maternal alcohol abuse and infrequency of paternal violent crime in high frequency somatizers are based upon the signs of the discriminant analysis weightings. One would reach the opposite conclusion if group means were examined and the discriminant analysis were ignored. (The authors rely on the group means and conclude that the fathers of high frequency somatizers are often violent criminals.) Discrepancies between the results of discriminant analysis and the direction of differences suggested by the group means can occur because discriminant analysis takes into account the intercorrelation among all the variables in the analysis.

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