

Determinants of Alcohol Abuse in a Psychiatric Population: A Two-Dimensional Model

John E. Overall

The University of Texas Medical School at Houston

A method for multidimensional scaling of group differences in categorical data patterns was used to investigate configural relationships among alcohol use and abuse groups. The analysis resulted in a model from which two primary etiologic concepts, plus a moderator, were derived. Exposure is the concept that summarizes demographic factors related to level of alcohol use. However, problem drinking differs from frequent drinking along a dimension in the demographic domain that is independent of the exposure dimension. Duration of frequent alcohol use is a concept that relates to age, duration, and chronicity variables. The relationship between resources and responsibilities appears to be a moderator in the dimension separating frequent and problem drinking. Low income and family responsibilities interact to make frequent alcohol use more likely to be perceived as a problem.

This study examines the application of a method of multidimensional scaling of categorical frequency patterns in the development of a conceptual model of demographic determinants of alcohol use and abuse in a psychiatric clinic population. Several demographic and sociocultural characteristics have been reported to relate individually to alcohol use and abuse in contemporary society (Cahalan, Cisin, & Crossley, 1969). A problem has been that the

variables have tended to be viewed either in isolation or in very small clusters (Winokur & Clayton, 1968). It was considered possible that a multivariate approach could shed light on the patterns of background variables that combine to define a population at risk. The aim of the analysis was to develop a model that could facilitate a parsimonious conceptualization of the major factors that distinguish populations having different potentials for alcohol use and abuse. Since there are more direct ways to predict from demographic variables whether given individuals currently abuse alcohol, that information was not included in this study.

The background variables that have been implicated in alcohol abuse are, for the most part, categorical descriptors of personal or population characteristics. Included are variables with several mutually exclusive categories, while other variables are dichotomous. Such nominal scale data pose serious problems for most methods of multivariate analysis. Nevertheless, factor analysis has been used with some degree of success to investigate individual differences in patterns of drinking behavior and related symptoms (Horn & Wanberg, 1969; Overall & Patrick, 1972). As is well known, factor analysis has the purpose of defining primary dimensions of difference among individuals within a heterogeneous sample. It is not a criterion-oriented method and, hence, is not most appropriate for studying

APPLIED PSYCHOLOGICAL MEASUREMENT
Vol. 6, No. 2, Spring 1982, pp. 213-218
© Copyright 1982 Applied Psychological Measurement Inc.
0146-6216/82/020213-06\$1.30

differences between samples from specified subpopulations, such as alcoholics and nonalcoholics.

To elucidate further the patterns of background variables that tend to distinguish problem drinkers from frequent drinkers, and frequent drinkers from moderate drinkers or abstainers, a multivariate methodology for analysis of categorical data was used (Overall & Woodward, 1977). The method is analogous to factor analysis (principal components) of a matrix of covariances among frequencies of occurrence of categorical variables within different criterion groups. Rather than distinguishing among different individuals within one heterogeneous population, the analysis has the aim of providing a scale model in which configural relationships among several groups are displayed. This study attempted to assess the interpretive value of this method of multidimensional scaling in relation to a problem for which a meaningful conceptual model is still lacking. The utility of the method in further alcohol research, and in epidemiologic investigations in general, is a question of concern.

Method

Subjects

As will be explained, the data that were analyzed came from a study that was not primarily designed as an "alcohol" project at the outset. The subjects were 750 consecutive new male and female patients seen in the Adult Psychiatry Clinic of the University of Texas Medical Branch in Galveston, Texas. The population is largely, although not entirely, lower socioeconomic. All individuals in the sample were referred by a private physician or agency for psychiatric evaluation.

Each new patient in this clinic setting is first interviewed by a medical student upon arrival in the clinic. The student completes a social and psychiatric history on a standard checklist form. One of the items on the form pertains to alcohol use in four categories: abstain, moderate, fre-

quent, and problem drinking. An individual was placed in the abstain category if he/she denied any use of alcoholic beverages. Problem drinking was understood to mean that, in the judgment of the interviewer, alcohol abuse was integrally involved in, or contributory to, the difficulties that brought the individual into the psychiatric treatment setting. The moderate and frequent categories were understood to represent different levels of alcohol use along an ordered continuum from abstain to frequent; but the exact dividing line between moderate and frequent was not explicitly defined, because it was implicitly assumed that those categories represented graded points along a continuum of increasing alcohol involvement. To the extent that the categories are distinguishable in terms of relevant history and demographic data, it can be accepted that the classification was made with reasonable reliability.

Analysis

This study was concerned with demographic similarities and differences among clinically defined groups that represent different levels of alcohol use and abuse. Recognizing that some background variables may distinguish certain alcohol groups, while other background variables may distinguish other of the alcohol groups, the number of independent dimensions of pattern variation was also of interest. A multidimensional scale model of configural relationships among the four groups (abstain, moderate, frequent, problem) was sought to provide answers to these questions and to provide a basis for conceptualizing the major demographic dimensions that separate the groups.

The categorical variables were first recorded as 0,1 dummy variates, with 1 entered as the score for the category to which an individual belonged and 0 otherwise. Each multicategory variable thus produced multiple 0,1 elements in the categorical data vector for each individual. A mean profile was calculated across the 0,1 dummy variates in each of the four groups. Note that the groups mean of the 0,1 scores for any

one of the dummy variates is also the proportion of the group falling in a single category of one of the original demographic variables. The within-groups variances of the 0,1 scores were also calculated and considered in the analysis. Weighting coefficients for the category variates are elements of the solution vectors for the matrix equation

$$(\mathbf{ZZ}' - \lambda_i \mathbf{E})\mathbf{a}_i = 0,$$

with restriction $\mathbf{a}_i' \mathbf{a}_i = 1$, where $\mathbf{Z}(p \times k)$ contains the means on p 0,1 category variates for k groups, and \mathbf{E} is a diagonal error matrix containing the pooled within-groups variances for the p 0,1 category variates. The solution can be obtained by putting the equation in standard principal components form

$$(\mathbf{E}^{-1/2} \mathbf{ZZ}' \mathbf{E}^{-1/2} - \lambda \mathbf{I})\mathbf{b}_i = 0,$$

where $\mathbf{b}_i = \mathbf{E}^{1/2} \mathbf{a}_i$, and thus $\mathbf{a}_i = \mathbf{E}^{-1/2} \mathbf{b}_i$. The \mathbf{b}_i are normalized vectors which are principal components of the matrix $\mathbf{E}^{-1/2} \mathbf{ZZ}' \mathbf{E}^{-1/2}$, and a_i is obtained by dividing each element in \mathbf{b}_i by the standard deviation of the 0,1 dummy variate with which it is associated. The vector \mathbf{a}_i contains the scoring weights to be applied to categories of the original nominal-scale data. When the weights are summed over all categories to which an individual belongs, the resulting composite variables are discriminant scores that tend to have maximum mean difference between groups relative to the variability within the groups.

The analysis was first accomplished to identify the number of dimensions of pattern variation required to distinguish among the four alcohol groups and to clarify the general configural relationships among the groups. It became apparent that two distinct types of pattern variation distinguished problem drinkers, frequent drinkers, and abstainers. Subsequent analyses attempted to refine the two primary contrast functions by first leaving out problem drinkers to define the abstain-to-frequent drinking dimension and then by contrasting problem drinkers with frequent drinkers alone. A multidimensional scale

model was constructed using the mean scale scores on the two discriminant functions as coordinate values to locate the groups in two-dimensional space. Interpretation of the common element in demographic characteristics most related to each dimension resulted in two constructs for a theory of the etiology of alcoholism. It is with the interpretive value of the multidimensional scaling method that this paper is concerned.

Results and Discussion

The initial analysis revealed that two independent dimensions of variation in patterns of background variables were adequate for description of differences among the four groups. Approximately 90% of the total variation in the group frequency patterns of the demographic variables was accounted for by the first two scale dimensions. This is not particularly surprising, since all differences among four groups can be represented in three dimensions.

The 10 categorical background variables that contributed most to the definition of the two functions were identified by inspection of the category weighting coefficients (elements of the \mathbf{a}_i vectors) produced by the initial analysis. It can be noted parenthetically that a primary implication of this method of analysis is that it provides a quick and efficient way of screening larger collections of categorical variables for those few which discriminate best among several criterion groups. The 10 empirically identified discriminant variables were age, ethnicity, sex, duration of illness, course of illness, work level, marital status, number of children, religious attitude, and father's education.

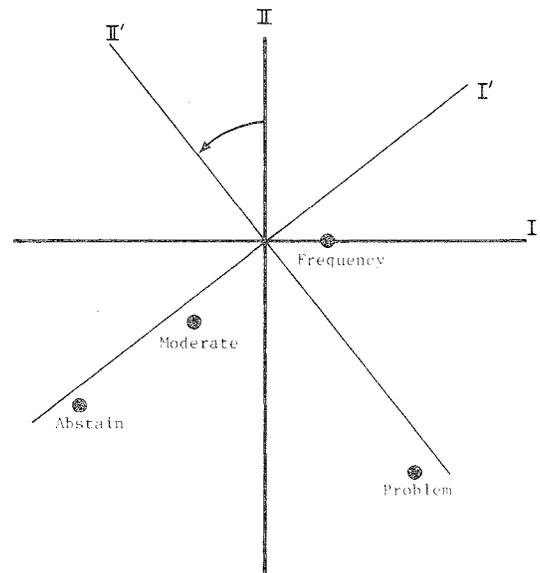
The 10 selected variables were entered into a second analysis of the same type to provide more refined definition of the primary functions separating the four alcohol groups. The analysis resulted in definition of two independent functions of the 10 background variates that accounted for 90% of the total discriminable differences among the four groups. The first discriminant

function provided almost equally spaced separation among the four groups in the order: abstain, moderate, frequent, and problem drinking. The first function was thus interpreted as representing the continuum of increasing levels of alcohol use. The second function separated the frequent group, at one extreme, from the problem group at the other extreme. Independent of mere level of alcohol consumption, the second function identifies the pattern of background characteristics that distinguish problem drinkers from other frequent users of alcohol.

The empirically derived scale values for the four groups on the two primary dimensions of difference in patterns of background characteristics were used to locate the groups in a two-dimensional model for the purpose of examining the configural relationships among them. The two-dimensional scale model is presented in Figure 1. It is apparent from this figure that the abstain, moderate, and frequent drinking groups differed from one another along a straight line in the multidimensional space and that problem drinkers differed from the other groups along a different dimension. Thus, in demographic characteristics, the model suggests that problem drinkers are qualitatively different from other alcohol groups. From an epidemiologic point of view, problem drinking occurs in the presence of combinations of background characteristics that are characteristic of frequent drinkers (axis I') but requires the presence of other background characteristics that are not equally present in the frequent user group.

The weighting coefficients assigned by the analysis to categories of the several background variables are of interest for understanding the nature of the discriminant dimensions. These weighting coefficients, which are presented in Table 1, are elements of the solution vectors a_i obtained from principal components analysis of the standardized product matrix $E^{-1/2}ZZ'E^{-1/2}$, as described in the Methods section. The scale values used to locate the alcohol groups in Figure 1 were obtained by applying these same weights to the category frequency vectors of ma-

Figure 1
Locations of Four Alcohol Behavior Groups
in Terms of Their Projections
on the Two Primary Scale Dimensions
with Rotation of Axes Indicating Distinction
Between Levels of Use and Alcohol Abuse



trix Z . Alternatively, the scale values for the four groups could be calculated by summing the category scale weights for categories in which each individual belonged and then by calculating the group means for the resulting composite scores.

Sex, work level, and religious attitude are the three variables that appear most important in defining the dimension of variation in levels of alcohol exposure. The subpopulation that tends to be most exposed to alcohol use is male, skilled (as opposed to unskilled or unemployed), and unconcerned or negative with regard to religion. The subpopulation that tends to be least exposed to alcohol is female, lower work level or housewife, and positive in religious attitude.

The second function, represented by the vertical axis in Figure 1, separates the problem drinkers at one extreme from the frequent drinkers at the other. The weighting coefficients for the second function in Table 1 reveal that age and duration or chronicity were the most

Table 1
 Category Scale Weights Derived from Multidimensional
 Scaling of Four Alcohol Usage Groups in Terms of
 Ten Selected Background Characteristics

Variable	Principal Components Coefficients	
	I	II
Age		
Less than 30	-.0148	.3042
30 to 49	.0680	-.1360
50 and over	-.0682	-.2093
Ethnicity		
Anglo American	.1209	-.1995
Black American	-.1221	.2518
Mexican American	-.0062	-.0624
Sex		
Male	.5379	.0235
Female	-.5342	-.0212
Duration of Illness		
Less than 1 year	-.1081	.3397
1 to 2 years	.0521	-.0464
More than 2 years	.0708	-.3066
Course of Illness		
Slow decline	.0204	-.3097
Recurrent episodes	.0460	.0674
First episode	-.0888	.3279
Work Level		
Never employed*	-.3546	-.1560
Unskilled	.0967	.1269
Skilled	.1508	-.0257
Marital Status		
Single	-.0368	.1645
Married	.0352	-.1817
Separated, divorced, widow(er)	-.0047	.0465
Children		
None	.0103	.1945
1 to 4	.0616	-.1111
5 or more	-.1006	-.0934
Religious Attitude		
Unconcerned	.3081	.0662
Moderate	-.2018	-.0306
Strong positive or fanatic	-.1854	-.0646
Father's Education		
Less than high school	-.0495	-.2747
High school graduate	.0824	.2211
Some college	-.0444	.1448

*Included with never employed are students and housewives.

salient variables in distinguishing between frequent and problem drinking. Contributing also to this function, but in lesser degree, were social class variables, including work level and father's education. Given that an individual belongs in a segment of the population that is exposed through frequent use of alcohol, classification as having a problem with alcohol is more likely for those whose fathers had low educational achievement and who themselves have a poor employment record. Finally, race enters as a moderator variable in that the negative weights given low social class indicators were nullified by a positive weight assigned to the Black ethnic category. Social class thus appears more relevant in the definition of problem drinking in the Anglo ethnic group. Marital status and presence of children also received some weight in defining the second function. Married individuals with children were more likely to be perceived as having an alcohol problem than are single individuals. With some interpretation, the variables entering into the discrimination between frequent and problem drinking might be separated into two groups. Age and age-related variables may be conceived as primary determinants of alcohol deterioration, while low social class and family responsibilities may enter into identification of alcohol abuse as constituting a problem.

References

- Bejerot, N. A theory of addiction as an artificially induced drive. *American Journal of Psychiatry*, 1972, 128, 842-846.
- Cahalan, D., Cisin, I. H., & Crossley, H. M. *American drinking practices: A national study of drinking behavior and attitudes*. New Haven: College and University Press, 1969.
- Horn, J. L., & Wanberg, K. W. Symptom patterns related to excess use of alcohol. *Quarterly Journal of Studies on Alcohol*, 1969, 30, 35-58.
- Jellinek, E. M. *Disease concept of alcoholism*. New Haven: Hillhouse Press, 1960.
- Overall, J. E., & Patrick, J. H. Unitary alcoholism factor and its personality correlates. *Journal of Abnormal Psychology*, 1972, 79, 303-309.
- Overall, J. E., & Woodward, J. A. Discriminant analysis with categorical data. *Applied Psychological Measurement*, 1977, 3, 371-384.
- Winokur, G., & Clayton, P. J. Family history studies. IV. Comparison of male and female alcoholics. *Quarterly Journal of Studies on Alcohol*, 1968, 29, 885-891.

Acknowledgments

This work was supported in part by Grant DHEW-1-R01-MH32457 from the Psychopharmacology Research Branch of the National Institute of Mental Health.

Author's Address

Send requests for reprints or further information to John Overall, Department of Psychiatry and Behavioral Sciences, University of Texas Medical School, P.O. Box 20708, Houston TX 77025.