Journal of Abnormal Psychology
1992, Vol. 101, No. 1, 174–183

0021-843X/92/$3.00

Empirical Modeling of an Alcohol Expectancy Memory Network Using Multidimensional Scaling

Bruce C. Rather, Mark S. Goldman, Laurie Roehrich, and Michael Brannick
University of South Florida

Risk-related antecedent variables can be linked to later alcohol consumption by memory processes, and alcohol expectancies may be one relevant memory content. To advance research in this area, it would be useful to apply current memory models such as semantic network theory to explain drinking decision processes. We used multidimensional scaling (MDS) to empirically model a preliminary alcohol expectancy semantic network, from which a theoretical account of drinking decision making was generated. Subanalyses (PREFMAP) showed how individuals with differing alcohol consumption histories may have had different association pathways within the expectancy network. These pathways may have, in turn influenced future drinking levels and behaviors while the person was under the influence of alcohol. All individuals associated positive/prosocial effects with drinking, but heavier drinkers indicated arousing effects as their highest probability associates, whereas light drinkers expected sedation. An important early step in this MDS modeling process is the determination of iso-meaning expectancy adjective groups, which correspond to theoretical network nodes.

Over the last two decades, alcohol use and alcoholism have been linked to a wide range of antecedent variables that fall mainly within two domains: (a) childhood (and adolescent) environment and (b) genetically influenced alcohol reactivity and temperament (see Cloninger, 1987; Donovan, Jessor, & Costa, 1988; Marlatt, Baer, Donovan, & Kivlahan, 1988; National Institute on Alcohol Abuse and Alcoholism, [NIAAA], 1990; Tarter, 1988; Zucker & Gomberg, 1986). The relative importance of these variables has been debated (see Peele, 1986; Searles, 1988), but most researchers now support multifactor models that incorporate both domains. Identification of relevant variables does not, however, automatically reveal mechanisms or processes by which antecedent characteristics influence later drinking patterns. Investigation of potential controlling mechanisms is therefore now a high priority.

Because of their potential for tying together a host of psychosocial and biological/genetic variables, and carrying forward the influence of these variables over extended time periods, memory processes have emerged as one possible common pathway for drinking decisions (Goldman, 1989; Goldman, Brown, & Christiansen, 1987; Goldman, Brown, Christiansen, & Smith, 1991; Jaffe, cited in Barnes, 1988; Stacy, Krank, & Marlatt, 1990; Stacy, Widaman, & Marlatt, 1990; Tiffany, 1990; Wise, 1988), with alcohol expectancies posited as one relevant memory content (Goldman, 1989; Goldman et al., 1987; Goldman et al., 1991; Stacy, Krank, & Marlatt, 1990). Studies using questionnaire-type instruments have demonstrated an extensive "nomothetic net" for alcohol expectancies. Expectancies have been (a) identified in all age and drinker groups, including alcoholics; (b) related to overall, situational, and laboratory consumption levels as well as to alcoholism risk status and treatment outcomes; (c) shown, using appropriate statistical designs, to mediate drinking; and (d) manipulated with consequent alteration in drinking levels (see recent reviews by Goldman et al., 1991; Marlatt et al., 1988; NIAAA, 1990).

To advance our understanding of the storage and operation of alcohol expectancies in memory, it would be useful to draw on cognitive models developed during the investigation of general memory processes (Goldman, 1989). Although a number of competing network and feature-comparison memory models are readily adaptable for this purpose, the dilemma of selecting among them for applications to clinical phenomena is lessened by very recent theorizing that proposes a cognitive architecture common to all these models. In proposing this convergence, Estes (1991) averred that memory "traces can be viewed as vectors or lists, as nodes in a network, or as points in a multidimensional space" (p. 12). To guide the present investigation of alcohol expectancies, we chose a semantic network model (Collins & Loftus, 1975) because network theory has been recommended as a useful general theory of cognitive representation from which more specific theories can be developed (Chang, 1986). In semantic network theory, concepts are assumed to be represented at a molecular level by nodes that are linked together on the basis of intrinsic meaning and learning history. In well-known versions of network theory (e.g., Collins & Loftus, 1975), higher order concepts are assembled from this molecular structure by activation spreading from node to related node when appropriate stimuli are encountered.

Portions of this research were supported by National Institute on Alcohol Abuse and Alcoholism Grants ROIAA05946, ROIAA06123, and ROIAA08333. Appreciation is expressed to Timothy Baker and three anonymous reviewers for helpful comments on a previous version of this article. We thank Sylvia Johnson for assistance in data collection.

Correspondence concerning this article should be addressed to Mark S. Goldman, Department of Psychology, University of South Florida, Tampa, Florida 33620.

Several characteristics of a semantic network model recommend its use for beginning the investigation of the structure of alcohol expectancies in memory. First, semantic network models are parsimonious. Various qualifying characteristics of expectancies (e.g., strength and positive and negative value) can be encoded directly into the network structure rather than requiring the postulation of multiple, independently measured constructs, as recommended by some expectancy/attitude theorists (Leigh, 1989). Second, these models are process oriented. Rather than simple mathematical prediction based on linear combinations of variables, network models emphasize the process by which behavioral outcomes are controlled. Third, integration of semantic networks with neural substrate may be possible. Although as yet highly speculative, similarities have been noted between network theory and certain basic operations of the nervous system (Barinaga, 1990). Fourth, semantic network models may be integrated with existing memory research. A wide range of theory and experimental paradigms from memory research can be applied to alcohol expectancy investigations. Finally, semantic network models are comprehensive. Emotional reactivity and motor programs can be directly incorporated into network models (Lang, 1985), as can depth of processing effects, encoding–specificity interactions (known previously in the psychopharmacology literature as state-dependent learning), prototypicality effects, "fuzzy" categories, and non-language-based nodes (e.g., imagery).

Although earlier work on alcohol expectancies using factor analytically derived questionnaires provides clues to network structure (see Goldman, 1989), the covariance patterns represented by factors can obscure more molecular expectancy elements, which are analogous to memory "nodes." Ideally, such nodes should reflect a single, unambiguous meaning (i.e., a distinctive concept that represents the coactivation of associated lexical items), so that relations between nodes can be clearly understood. Because network structure is understood to be hierarchical, factors mathematically derived from questionnaire responses may reveal only higher order aggregations of those elementary semantic units that frequently cooccur in everyday experience. Furthermore, at a mathematical level, factors are vectors in multidimensional space, and the visual display of these types of vectors does not assist with our understanding of relationships among expectancy elements.

For these reasons, memory researchers have used category generation techniques from which concept nodes can be inferred (Battig & Montague, 1969), followed by multidimensional scaling (MDS; Kruskal & Wish, 1978; Takane, Young, & de Leeuw, 1977) to display a visual analogue of the network structure for that category. MDS is a statistical procedure that transforms perceived similarities among objects, words, or stimuli into locations on a dimensional map. (For example, MDS of a matrix of air distances between major U.S. cities would produce as output a reasonably accurate map of the United States.) That these techniques have validity as representations of semantic networks is supported by the concordance of MDS findings with a number of other experimental paradigms in memory research. For example, distances among category elements in MDS solutions are predictive of reaction times to categorical judgments (Rips, Shoben, & Smith, 1973; Shoben, 1976) and of interitem proximity in free recall (Caramazza, Hersh, & Torgerson, 1976). Solutions produced by MDS have also successfully guided the development of lists of items that are better recalled than control (nonorganized) lists (Cooke, Durso, & Schvaneveldt, 1986).

A number of MDS algorithms are available that are informative about different aspects of the relevant semantic network. In the present study, ALSCAL (Takane et al., 1977) was used with PREFMAP (preference mapping; Carroll, 1972) to display a model alcohol expectancy network; to clarify the operation of positive and negative expectancies in this network; and to show that individuals with different levels of drinking experience can hold a similar overall alcohol expectancy network, while differentially accessing this network in accord with their own drinking history. In operational terms, the ALSCAL algorithm locates alcohol expectancy nodes (subjective responses to alcohol use) in multidimensional space in accord with subjects' judgment of the frequency of occurrence of these responses in their own drinking experience. PREFMAP (a multiple regression procedure) then determines a vector (path) through this space that best represents the ordering of occurrence of each response for different subsets of drinkers.

To tailor these techniques for the study of expected alcohol effects (which are predominantly subjective), we incorporated a number of additions to preexisting methodology. First, any adjective taken from the general English language lexicon might have imprecise or extraneous meaning when used to describe the expected effects of alcohol (because of the applicability of most adjectives to a wide variety of circumstances, including those outside the realm of alcohol use). Hence, in the present study we used groups of adjectives refined in a reiterative process by multiple raters and statistical techniques (coefficient alpha), so that each adjective group represented a relatively pure specification of an expectancy semantic element (node). These "iso-meaning" elements were inherently content valid and were further evaluated for predictive validity against an alcohol-consumption criterion. Second, sufficient numbers of adjectives were collected and grouped to ensure relatively comprehensive coverage of the possible domain of alcohol expectancy nodes within the semantic space of most individuals.

Method

This research was conducted in two phases. In Phase 1, subjects chosen to represent a range of drinking histories generated an extensive list of adjectives that denote alcohol expectancies. In Phase 2, responses from a second subject group were used to refine this list, to create iso-meaning adjective groupings, and to demonstrate the concurrent validity of these groupings against an alcohol consumption criterion. Finally, the ALSCAL MDS algorithm was applied to a proximity matrix of the iso-meaning groups, followed by the PREFMAP procedure to assist in interpretation of the alcohol expectancy semantic space for a subset of subjects with varying customary drinking habits. For all analyses, a randomly determined, hold-out sample of subjects was used to cross-validate findings.

Phase 1

Subjects. A sample of 587 volunteer undergraduates (recruited by class announcements; approximately 80% participated in each class sampled) and 48 hospitalized (in a Veteran's Administration Medical

Center) alcoholic subjects was used for expectancy adjective generation. The undergraduates (64% female and 90% Caucasian) ranged from 17 to 58 years of age (M = 19.9) and from nondrinkers (4.5%) to moderate/heavy drinkers (27.4% consumed four to eight drinks and 4% consumed more than nine drinks per drinking episode). Approximately 15% of this sample had experienced three or more alcohol-related problems. The alcoholic subjects (all male) ranged from 30 to 65 years and met the Feighner et al. (1972) criteria for a diagnosis of alcoholism. This overall population well represents the full range of the adult drinking population, particularly in light of findings that college student groups are not a restricted subpopulation, but instead generally reflect the general population (Berkowitz & Perkins, 1988; Sher & Descutner, 1986). Although one recent study using a national sample suggested college students may be less representative of non-school populations (Crowley, 1991), the only group potentially underrepresented in this college sample from a relatively open-admission university may be individuals with severe Cloninger Type II alcoholism (Cloninger, 1987; Cloninger, Bohman, & Sigvardsson, 1981). Such individuals may be sufficiently affected by drinking and associated problems before they are of college age that they eliminate themselves from college entry (see Pihl, Peterson, & Finn, 1990). The inclusion of the male alcoholic subjects minimized the possibility that such individuals would be excluded.

Adjective generation. The domain of possible items relating to the construct of interest was identified by obtaining category norms for the concept "effects of alcohol." Subjects were asked to generate, within 30 s, as many adjectives as possible that would complete the phrase "alcohol makes one ______." A nonpersonal orientation was used for the prompt at this point so as to elicit the widest range of expectancies, including ones that subjects did not apply to themselves. The response frequencies for all words and phrases were tabulated and rank ordered. This process yielded 805 items consisting mostly of adjectives and virtually exhausting the English language lexicon of words of this type. Of the words on the alcoholic subjects' list, 83% overlapped with those on the students' list. The only unique word given by the alcoholic subjects more than two times was the word *unmanageable,* a word with special meaning taken from the first step of the Alcoholics Anonymous program. This overlap of the adjective pool suggests that the same information about the effects of alcohol is available to all late adolescent and adult drinkers.

This initial item pool was given to three judges, who independently eliminated items if they were curse words, phrases, a word that did not make sense with the prompt, or a nonword; in addition, they eliminated all words with a frequency less than 2, unless the word was a useful synonym of a high-frequency word or fit with previous alcohol expectancy findings (e.g., words related to cognitive enhancement were generally low in frequency but were important to consider). After the judges eliminated words on the basis of these criteria, they made a preliminary grouping of the words according to synonymous meaning (e.g., *happy, joyous,* and *cheerful*). Words that were very low in frequency were eliminated until five items were retained in each group. This process was intended to ensure that the final item pool would encompass every semantic category in the original item pool.

A compilation of the words from the three judges' lists resulted in 262 nonredundant words. The final list of 190 words contained 78% that were agreed on by two or more judges. The remaining words were selected after discussions between the judges and because they most accurately represented the categories. This process resulted in 38 five-item groups judged to have similar meaning.

Phase 2

Subjects. A separate subject sample consisting of 256 undergraduate students (again recruited through class announcements) participated in the next phase of this study. Twenty-four subjects were eliminated because they had never had a drink, were virtual abstainers, or were recovering from alcoholism. Such subjects represent an extreme category in which the relationship between expectancies and drinking behavior may be truncated (see Goldman et al., 1991). The remaining subjects (N = 232) were men (37.1%) and women (62.9%) ranging in age from 17 to 62 years old (M = 20.9). The majority of subjects were single (87.5%) and Caucasian (84.1%). The subjects ranged from light drinkers (9.5%) to heavy drinkers (e.g., 8.2% reported drinking three to four times per week or more).

To confirm that these college student subjects truly represented the full drinking continuum, including problem drinking, we administered the Short Michigan Alcoholism Screening Test (SMAST; Selzer, Vinokur, & van Rooijen, 1975). Strict scoring of the SMAST identified 39.7% as having potential alcohol problems or frank alcoholism. As in another recent study of the SMAST in college students (Martin, Liepman, & Young, 1990), this percentage appeared inflated by a substantial number of false positives.[1] We therefore reduced the SMAST to 8 unambiguous items (Cronbach's α = .70 and r = .88 with the 12-item SMAST) directly related to problem consequences of the subjects drinking (e.g., "Have you ever been arrested, even for a few hours, because of other drunken behavior?"). This more conservative scoring of unambiguous items revealed 11.8% who were experiencing some alcohol problem.

Procedure. Each subject sequentially completed the following: (a) ratings of 190 alcohol expectancy words, (b) a SMAST (Selzer et al., 1975), and (c) the Demographic Data/Drinking History Questionnaire (Christiansen & Goldman, 1983). On the basis of recent literature that shows that self-report of drinking is often quite accurate when data are collected anonymously (Babor, Brown, & Del Boca, 1990; Sobell & Sobell, 1990), these reports were judged reasonably valid for the present purposes.

For each item in the 190-word list, subjects responded on a 7-point scale with *never* and *always* as end points to the statement "Drinking alcohol makes me ______." Subjects were instructed to "indicate how often you think that this effect happens or could happen to you after drinking several drinks of alcohol" and to "answer each item quickly according to your first impression."

Refinement of iso-meaning word groups. Our intent was to identify as nearly as possible alcohol expectancy semantic elements (equivalent to theoretical concept nodes). To minimize the impact of idiosyncratic meaning and ambiguity in single adjectives, we performed a multistage procedure that ensured that the grouping of items with highly overlapping meaning would effectively bracket, or encompass, the core semantic element. The first step in this reiterative process was the computation of Cronbach's coefficient alpha for the 38 five-item word groups created in the initial round of judging to statistically check consistency of meaning. Inspection by two judges of the groupings with lower alpha levels resulted in the immediate elimination of 4 groups with heterogeneous meaning. Furthermore, because the alpha and synonymous meaning of many semantic groups increased or remained nearly unchanged when one item (of the five) was eliminated, it was of obvious advantage to shorten the iso-meaning groups to four items. The alphas of the 34 remaining four-item groups ranged from .70 to .91, with a mean of .83. These groups were then presented to 27 new judges to be rated on a 6-point scale measuring the extent to which the words in each group meant essentially the same thing in relation to that person's experience with alcohol use. Thirty-two groups had mean

[1] Items such as "Does your wife, husband, a parent, or other near relative ever worry or complain about your drinking?" and "Do you ever feel guilty about your drinking?" could reasonably be answered positively by many college students without necessarily implying abusive drinking.

ratings affirming synonymous meaning. Of the groups rated not synonymous, one was retained because it was judged to be a critical expectancy concept (i.e., *escape, cope, content,* and *carefree*). Finally, therefore, 33 four-item iso-meaning groups (referred to henceforth by the word with the highest item–total correlation in that group) were retained for use.

Results

Validation of Iso-Meaning Groups

After the refinement of the iso-meaning word groups, it was necessary to ensure that these iso-meaning groups had construct validity as expectancies. An initial test was whether they could effectively match the capacity of previous expectancy scales to predict drinking (predictive validity is one part of a construct validation network). To this end, zero-order correlations and stepwise multiple regressions were computed, with reported alcohol consumption as the dependent variable.

Zero-order correlations between the sum of the subject's responses on the 7-point scale for each of the four words comprising each iso-meaning word group (total possible points = 28) and the quantity/frequency of alcohol consumption were computed. These correlations, as well as stepwise multiple regressions using these same scores, demonstrated concurrent validity at levels equivalent to or exceeding those achieved with any previous expectancy survey instrument (see Goldman et al., 1991). Twenty-seven groups were significantly ($p < .05$) positively correlated with drinking quantity/frequency (mean r = .34, range = .13 to .52) and one group had a significant negative correlation ($r = -.12$). The stepwise multiple regressions were performed using a random subsample (n = 156) representing two thirds of the full sample and were cross-validated on the remaining one third holdout sample (n = 76). (A larger percentage of subjects provides a more stable initial regression equation.) As can be seen from Table 1, the iso-meaning groups alone achieved an R of .68, which was considerably higher than the most important demographical/background variables (R = .45). The cumulative R was .70.[2] When these regression equations were used to predict drinking quantity/frequency in the holdout sample, the Rs closely approximated those achieved in the initial sample (see Table 1). Once again, the iso-meaning groups taken alone substantially outpredicted the demographical/background variables and added significant unique variance when demographical/background variables were entered first. In both initial and holdout samples, approximately 23% to 46% of the variance was accounted for by the iso-meaning expectancy groups alone. Thirty-one of the iso-meaning groups also significantly ($p < .05$) correlated with SMAST scores (mean r = .27, range = .14 to .44).

Table 1
Stepwise Multiple Regression Analyses Using the Iso-Meaning Groups to Predict Drinking Quantity/Frequency Scores

Predictor	R	Adjusted R^2	r cross-validation
Background variables			
White–other (−)	.35*		
Male–female (−)	.45*	.19	.40*
Iso-meaning groups			
Sociable	.44*		
Mean	.51*		
Sleepy (−)	.59*		
Pass out	.61*		
Unpredictable (−)	.65*		
Jolly	.67*		
Woozy (−)	.68*	.43	.48*
Background plus groups			
Sociable	.58*		
Sleepy (−)	.62*		
Pass out	.67*		
Undependable (−)	.68*		
Smart	.70*	.46	.54*

Note. In each group, Rs are cumulative. A minus sign in parentheses indicates negative beta weight. The regression equation was derived on a sample (n = 156) and cross-validated on another sample (n = 76).
* $p < .001$.

Multidimensional Scaling

Once statistical (coefficient alpha) and lexical judgment criteria had established a set of iso-meaning expectancy elements (corresponding to theoretical nodes in semantic network memory models), and these expectancy elements were shown to have concurrent validity that was equal or superior to that of previous instruments, it became possible to assemble these nodes in an empirically driven network structure using MDS. Such a structure would represent the first approximation of a working model of an alcohol expectancy cognitive network.

First, a 33 × 33 proximity matrix was constructed from the subjects' data by calculating the Euclidean distance between all possible pairs of iso-meaning expectancy groups. This "half-matrix" included zeros in the diagonal (the half-matrix above the diagonal was redundant with the portion below the diagonal). This one-mode, two-way data array was then submitted to the ALSCAL collection of algorithms (Takane et al., 1977; Young, Takane, & Lewyckyj, 1978) and analyzed by classical nonmetric MDS procedures (Kruskal, 1964). Optimal dimensionality of the data was determined using stress values, r^2, and interpretability. Stress values are a badness-of-fit measure (lower values indicate better fit); r^2 is, of course, a measure of the amount of variance accounted for. The r^2 and stress values for one-, two-, and three-dimensional solutions were .86, .95, and .98 and .22, .11, and .06, respectively. Although the three-dimensional solution resulted in a slight improvement in stress and r^2, the two-dimensional solution was retained because of its simplicity and ease of interpretation and because r^2 and stress tended to "elbow" at two dimensions.

The MDS two-dimensional configuration was then cross-validated by randomly dividing the total sample into two equal halves, subjecting each half to the MDS procedures, and correlating the stimulus dimensions of the subsamples and the total sample to determine the stability of the dimensions. Dimension 1 of the subsamples correlated highly with each other (r = .97, $p < .001$), and each subsample correlated highly with the stimulus configuration of the total sample (both rs = .99, both

[2] The *intoxication* iso-meaning group was left out of the multiple regression equation because of possible criterion contamination.

$ps < .001$). Dimension 2 of the subsamples also correlated highly ($r = .87$, $p < .001$), and again each subsample correlated highly with the stimulus configuration of the total sample ($r = .97$, $p < .001$, and $r = .96$, $p < .001$). Hence, the obtained stimulus dimensions were quite stable.

The cross-validated, two-dimensional solution can be seen in Figure 1. Although Dimension 1 was labeled social/positive versus antisocial/negative, and Dimension 2 was labeled arousing versus sedating, a primary objective of this analysis was the Euclidean relationship among expectancy semantic elements in addition to dimensionality. Recall that our intent was not to simplify or reduce variables (as does a dimensional emphasis, which is similar to an emphasis on factor structure), but to map expectancy nodes. Because the Euclidean distance between elements is a direct representation of the degree of association (in this case, the degree to which alcohol effects were judged to occur with the same frequency), elements close to one another in Figure 1 can be regarded as having high probability of joint activation (i.e., from a spreading activation viewpoint, either proximal elements would be activated together or activation would quickly reach one once the other has been activated). Elements farther apart are less likely to be coactivated. Hence, for the general population of drinkers the expectations of becoming jolly, sociable, verbal, energetic, and funny are likely to cooccur, whereas the associative strength of becoming dangerous or vulgar is much lower (these associates are seen as more remote) once any of the preceding positive expectancies has been activated.

PREFMAP

In order to better understand the association paths through the expectancy network that would most likely be taken by individual drinkers with differing levels of customary alcohol use, the PREFMAP procedure (Carroll, 1972; Chang & Carroll, 1972) was employed. For this analysis, it was desirable to have a gender-matched sample so that subgroups of drinkers with equal numbers of men and women could be assessed. Therefore, the computer was instructed to randomly sample women from the pool of 232 used in Phase 2 to match the total male sample from this pool ($n = 72$) on drinking quantity/frequency. This gender-balanced sample was then split into quartiles on the basis of drinking level ($n = 36$ in each), with equal numbers of men and women in each group. The medial drinker in the light-drinking quartile reported drinking one drink per occasion, three to four times a year, with no occasions of "drunkenness." In the heavy-drinking quartile, four to eight drinks were consumed on one or two occasions each week and drunkenness occurred once per week. PREFMAP found, via multiple regression of the mean ratings of the iso-meaning groups for each group of drinkers, an ideal vector in the given MDS stimulus space, such that the linear correlation between the expected effects of alcohol (i.e., the preference data) and the projections of the stimulus points on the fitted vectors was maximized. The resultant Rs ranged from .96 to .99. Note that these correlations are expected to be very high for adequate interpretation (Kruskal & Wish, 1978; Schiffman, Reynolds, & Young, 1981) because the observations (i.e., the stimulus coordinates) are not independent. These Rs indicate that the expected effects of alcohol could be successfully fitted to the coordinates of the configuration. (In other words, each stimulus point could be collapsed onto the regression vector by drawing a perpendicular from the vector to that stimulus point; the resultant sequence of stimulus nodes on each group's regression line would represent a rank order of the likelihood of occurrence of each alcohol effect for that group.)

In Figure 2, the PREFMAP preference vectors for each group are plotted on the original MDS solution. The iso-meaning groups that fall on the regression line closer to the arrowhead were endorsed more frequently. The vector angle indicates the emphasis that particular subject group placed on the overall MDS dimensions. These plots show that the PREFMAP vectors indicated that light drinkers most frequently expected effects such as *woozy, sociable, jolly, verbal,* and *sleepy,* whereas heavy drinkers expected the effects *sociable, jolly, verbal, funny, courageous,* and *energetic* most frequently. In sum, heavy drinkers more readily expected pharmacologically arousing effects than did light drinkers (who expected sedation), and the two middle-level drinking groups fell in between these extremes in their probability of expecting the different effects. All drinking groups expected social/positive effects with high probability, and no group immediately associated negative alcohol effects with drinking. In Table 2, the mean scores on each iso-meaning word group for each of the four drinking groups are presented along with results of one-way analyses of variance that compared these means across groups, Fisher's least significant difference tests, and rank ordering of the means. These mean ratings served as the raw data for the PREFMAP procedure. Table 2 highlights the differences among drinking groups as to the frequency of occurrence of each of the various expectancy elements.

To investigate possible gender differences, we performed the PREFMAP procedure using the mean scores on the iso-meaning word groups for men and women separately in each drinking group. There was more dispersion among the women's PREFMAP vectors than the men's, reflecting greater differences in expectancies between heavy- and light-drinking women than for their male counterparts.

Discussion

This research represents an initial effort to map the primary (molecular) level of alcohol expectancies in accord with a semantic network memory model. Key features are the reiterative process used to establish expectancy semantic nodes (adjective groups) and the empirical determination of the associative relationships among these nodes using MDS. Although further work is required before it can be established that the use of these expectancy nodes for prediction compares favorably with previous expectancy instruments, concurrent validation (and cross-validation) against a consumption criterion in the present study accounted for percentages of variance as high as, or higher than, those achieved in previous studies using similar subject samples (see Goldman et al., 1991).

Apart from simple prediction, however, collecting expectancies in this form allows us to apply some information-processing assumptions connected with a semantic network memory model. Such a model assumes that individuals gather indirect

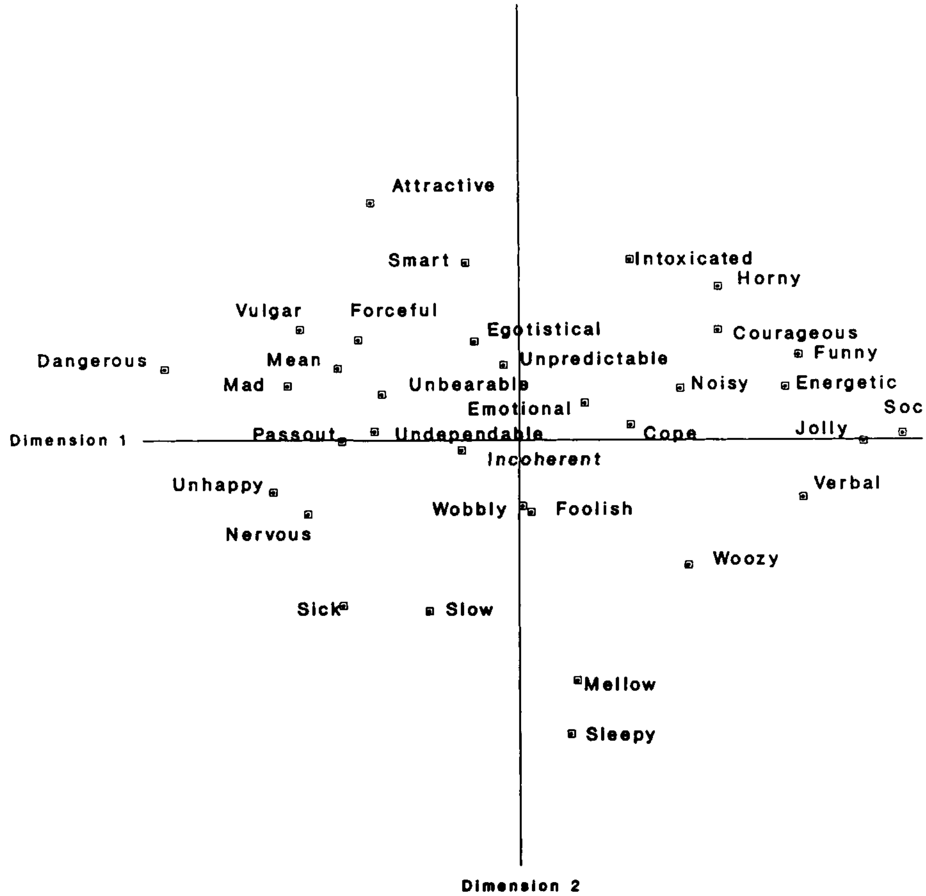

Figure 1. Multidimensional scaling of iso-meaning alcohol expectancy word groups.

information about alcohol usage and its effects in childhood and adolescence (perhaps differentially depending on family history of alcohol use) and direct information from their own early experience with alcohol consumption (again, differentially depending on individual differences in temperament and alcohol reactivity). This information is then stored in the semantic system in the form of expectancy elements (nodes) connected by a hypothetical network that allows aggregates of these elements to be jointly activated (by spreading activation) when alcohol stimuli are encountered.

The present MDS solution shows how, in a spreading activation model, coding of qualifying information about stored elements could take the form of proximity between elements. The strength (probability of activation) of an element is a function of how close that element is to other high-probability elements. Highly salient effects are those with the highest probability of activation and appear at, or in close proximity to, the entry point into the networks. The PREFMAP findings show how the entry point into the network may itself be determined by the particular drinking history of the individual (note in Figure 2 the different high-probability expectancies for each drinker group as determined by PREFMAP). It is also apparent from the present findings that the dimension that most distinguished lighter from heavier drinkers is arousal versus sedation. All drinkers expected positive/social effects (PREFMAP arrowheads point in this direction for all drinking groups), but heavy drinkers most anticipated becoming vital and active, whereas light drinkers most expected tranquility. Consistent with recent prediction studies (Brown, 1985; Christiansen, Smith, Roehling, & Goldman, 1989; Stacy et al., 1990), negative expectancy nodes appear in the present MDS findings much farther along the activation network and thus were much less likely to influence drinking behavior. In the present study we did not assess the expectancy network in relation to specific stimulus situations, but it is evident from other recent findings (see Levine & Goldman, 1989; Rather, Levine, & Goldman, 1990) that the entry point and pattern of network activation relate to the specific stimulus configuration as well. However, because individuals appear to encode drinking situations as a relatively finite number of prototypes or exemplars, the range of the expectancy patterns according to situation may also be limited (Levine & Goldman, 1989).

These MDS findings, and the underlying semantic network memory model, can be related to observable drinking behavior by borrowing from the work of Newell (1973), Lang (1985), and Bower and Cohen (1982). In these conceptualizations, in addition to outcome expectancies, memories of stimulus configurations previously encountered by individuals are stored as col-

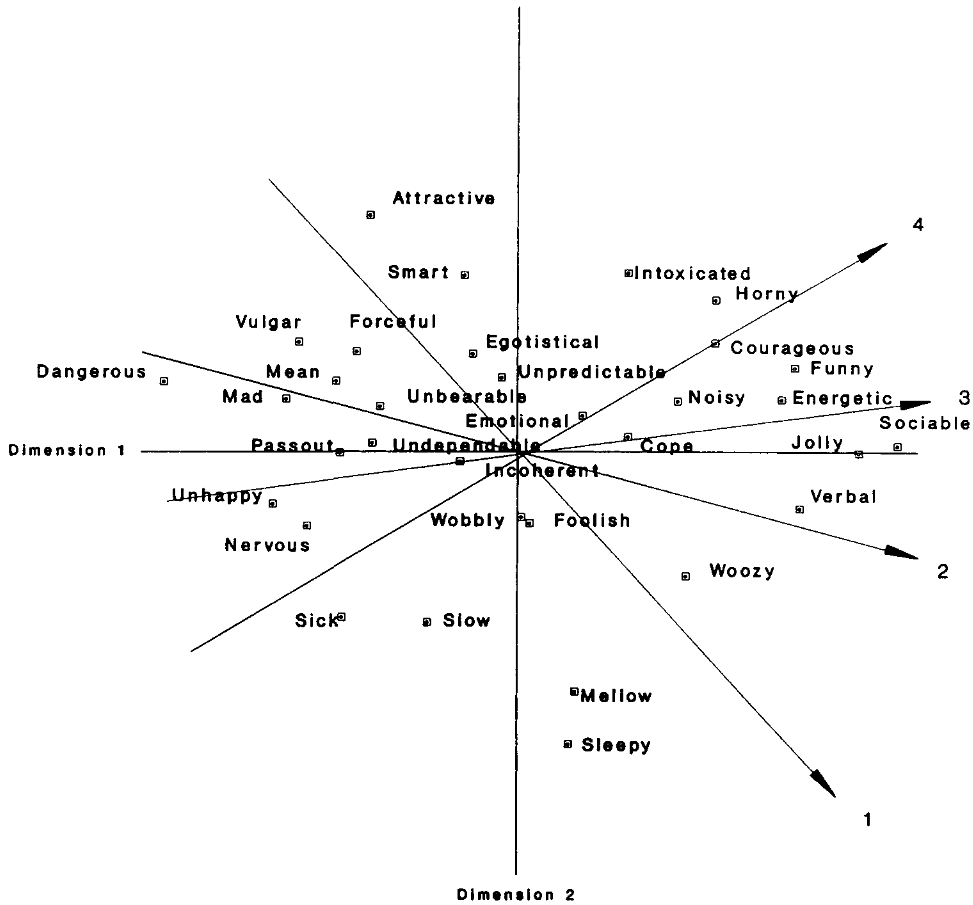

Figure 2. Multidimensional scaling of iso-meaning alcohol expectancy word groups with PREFMAP preference vectors of four drinking groups: 1 = light drinkers, 2 = light/moderate drinkers, 3 = moderate/heavy drinkers, 4 = heavy drinkers.

lections of nodes, as are memories of past emotions and motor patterns (schemata). These emotional and motor nodes are also linked to actual physiological/emotional activation and skeletal muscle patterns. When a newly encountered external stimulus configuration sufficiently matches a stored representation (prototype) of this pattern, activation spreads from this portion of the network to the expectancy nodes, and then to previously associated affective and motor portions of the network. (This activation can be presumed to spread similarly to activation in the visual system when cell groups respond to particular visual patterns.) With regard to drinking behavior, it is hypothesized that expectancies of arousal and sociability in heavy drinkers are connected to affective and action patterns that produce these same behaviors and further drinking (i.e., give a "go" signal). In contrast, light drinkers' expectancies of sedation lead to diminished activity (including drinking termination, a "no go" signal). See Lang (1985) for an excellent explication of such processes in relation to affective expression. The cross-linkages hypothesized in the network can also account for alcohol placebo effects (e.g., Marlatt & Rohsenow, 1980); if relevant expectancies can be activated by situational cues, other associated behavioral patterns can follow, even in the absence of ethanol.

The overlap of these findings and their associated theory with two other recent lines of research related to drug-reward systems is extensive and begs for further attention. First, the two major alcohol expectancy MDS dimensions found in this study (positive/social versus negative/antisocial and arousal versus sedation) are highly consistent with the dimensions of human affective response identified by Russell (1979, 1980) (pleasure versus displeasure and arousal versus sleepiness), suggesting that alcohol reactions involve the same psychophysiological systems that regulate all motivation/affect (Russell & Mehrabian, 1975). Hence, it appears that alcohol does not create new and unique affective responses, but instead interacts with, and is limited in effect by, existing regulatory mechanisms for emotional responding. Second, the implication of the present data that activation of the expectancy network may pass along a "go" versus "no go" signal to affective and action mechanisms is entirely consistent with a number of recent biopsychological theories that suggest that drug reinforcement is associated with activation of particular brain neurochemical systems that normally mediate appetitive (approach) behavior. Systems such as Wise's (1988; Wise & Bozarth, 1987) dopaminergic ventral tegmental/nucleus acumbens system; Panksepp's (1982) foraging/

Table 2
One-Way Analyses of Variance, Means, and Rank Orders of the Iso-Meaning Groups Across Drinking Groups

Iso-meaning group	Drinking group 1	2	3	4	$F(3, 140)$
Sociable	$20.8_{a,b}$ (2)	22.1_{c} (1)	22.8_{b} (1)	$24.6_{a,c}$ (1)	5.23**
Jolly	20.6_{a} (3)	21.3_{b} (2)	21.9 (2)	$23.8_{a,b}$ (2)	3.74*
Verbal	20.4_{a} (4)	20.5_{b} (3)	21.5_{c} (4)	$23.5_{a,b,c}$ (3)	4.24**
Funny	$19.1_{a,c}$ (7)	20.5_{b} (4)	21.4_{c} (3)	$23.1_{a,b}$ (4)	4.83**
Courageous	$17.7_{a,d}$ (12)	$20.2_{b,d}$ (6)	19.3_{c} (6)	$23.0_{a,b,c}$ (5)	7.92***
Energetic	20.1_{a} (5)	20.4_{b} (5)	20.8_{c} (6)	$22.9_{a,b,c}$ (6)	3.21*
Intoxicated	16.4_{a} (17)	17.0_{b} (14)	18.6_{c} (12)	$22.6_{a,b,c}$ (7)	11.34***
Horny	17.4_{a} (13)	19.6_{b} (7)	18.9_{c} (8)	$22.4_{a,b,c}$ (8)	6.35***
Noisy	18.8_{a} (8)	19.6_{b} (8)	18.7_{c} (11)	$22.3_{a,b,c}$ (9)	4.74**
Cope	17.3_{a} (15)	18.2_{b} (12)	18.8_{c} (10)	$20.8_{a,b,c}$ (10)	5.05**
Emotional	17.2_{a} (16)	18.1_{b} (13)	19.0 (7)	$20.7_{a,b}$ (11)	3.63*
Woozy	20.8 (1)	19.2 (9)	18.9 (9)	20.5 (12)	1.73
Unpredictable	16.1_{a} (21)	15.9_{b} (19)	16.6_{c} (17)	$19.9_{a,b,c}$ (13)	5.70***
Wobbly	17.3 (14)	16.8_{a} (15)	16.6_{b} (16)	$19.4_{a,b}$ (14)	2.67*
Foolish	18.3 (10)	16.2_{a} (18)	17.3 (14)	19.2_{a} (15)	3.01*
Egotistical	16.1_{a} (20)	16.3_{b} (16)	15.7_{c} (20)	$18.8_{a,b,c}$ (16)	2.87*
Mellow	18.5 (9)	18.6 (11)	16.9 (15)	18.3 (17)	1.54
Forceful	14.1_{a} (26)	14.2_{b} (25)	14.5_{c} (28)	$18.3_{a,b,c}$ (18)	6.22***
Incoherent	16.3 (18)	15.5_{a} (21)	15.9_{b} (19)	$18.0_{a,b}$ (19)	2.28
Unbearable	14.9_{a} (23)	14.0_{b} (26)	15.0_{c} (22)	$17.9_{a,b,c}$ (20)	4.79**
Mean	13.5_{a} (30)	13.9_{b} (27)	14.5_{c} (27)	$17.5_{a,b,c}$ (21)	5.32**
Vulgar	13.5_{a} (29)	13.4_{b} (31)	14.2_{c} (31)	$17.4_{a,b,c}$ (22)	5.09**
Undependable	15.8 (22)	14.4_{a} (24)	14.8_{b} (24)	$17.4_{a,b}$ (23)	2.77*
Smart	$14.2_{a,b}$ (25)	15.9 (20)	16.3_{b} (18)	17.4_{a} (24)	3.40*
Sleepy	$19.8_{a,b}$ (6)	18.7 (10)	17.3_{b} (13)	17.2_{a} (25)	2.48
Mad	12.8_{a} (31)	13.3_{b} (32)	14.4_{c} (30)	$17.0_{a,b,c}$ (26)	5.36**
Pass out	14.0_{a} (27)	13.5_{b} (30)	13.7_{c} (32)	$16.9_{a,b,c}$ (27)	5.59**
Attractive	$12.8_{a,b,c}$ (32)	15.4_{a} (22)	14.9_{b} (23)	16.4_{c} (28)	4.55**
Slow	17.8_{a} (11)	16.3 (17)	15.4_{a} (21)	16.2 (29)	1.72
Sick	16.1 (19)	15.0 (23)	14.8 (25)	16.1 (30)	0.75
Unhappy	13.8 (28)	13.7 (28)	14.6 (26)	14.8 (31)	0.54
Dangerous	12.3_{a} (33)	11.8_{b} (33)	12.2_{c} (33)	$15.4_{a,b,c}$ (32)	3.88**
Nervous	14.6 (24)	13.5 (29)	14.5 (29)	14.6 (33)	0.51

Note. 1 = light drinkers, 2 = light/moderate drinkers, 3 = moderate/heavy drinkers, 4 = heavy drinkers. The possible range of scores is from 7 to 28. The numbers in parentheses are the rank order of means of the iso-meaning word groups for each group of drinkers. These values are in descending order for the heavy drinkers. Means with a common subscript are significantly different from one another at $p < .05$ using Fisher's least significant difference test.
* $p < .05$. ** $p < .01$. *** $p < .001$.

expectancy system; Gray's (1982) behavioral activation system; or the incentive system of Stewart, deWit, and Eikelboom (1984) are all variants of a "go" motivational system. Baker, Morse, and Sherman (1987) have, in fact, applied very similar theorizing to explain drug "urges" in experienced drug users. These two areas of overlap indicate that expectancy is not a discrete area of theorizing, but intersects comfortably with other prevailing views and can be readily tied into a comprehensive explanation of alcohol and drug motivation.

Because it has been recently suggested that expectancies should resolve after factor analysis into completely independent factors (scales; Leigh, 1989), it is important to note that current memory models suggest a measurement model with overlapping factors (scales). In this view, different subsets of expectancies from the larger network are activated differently in individuals with different alcohol consumption histories and in response to differing situations (including differences due to the situation in which the expectancies are assessed, e.g., laboratory and classroom), and even on different occasions of use. Therefore, any aggregation of nodes will show fuzzy rather than precise boundaries. Hence, the use of correlation-based procedures such as factor analysis will produce expectancy factors with both common and unique variance (see Goldman et al., 1991). This relationship obtains because some expectancy nodes will aggregate with more than one higher order factor or may shift major associative linkages in different situations. Such fuzzy boundaries for expectancy aggregates (e.g., factors) is consistent with current understanding of the formation of concepts (Smith & Medin, 1981) and with recently developed computer programs designed to improve machine decisions by mimicking human decision making ("fuzzy logic"; Gupta & Yamakawa, 1988; Zimmerman, 1987).

It is also important to recognize that, conceptualized as a memory network, expectancy operation is mostly automatic; that is, little conscious attention and decision making are required for control of alcohol consumption (for a similar analysis of drug "urges", see Tiffany, 1990). Therefore, although individuals may have some capacity to monitor their own decision processes, such monitoring is typically imperfect and can give erroneous explanations for the sources of behavior. This automaticity, however, does not rule out an individual's using top-down (conceptual) control of drinking decisions (e.g., when attempting to limit his or her drinking), but such control is not essential for ongoing control of drinking, particularly in experienced drinkers.

The network presented here should in no sense be regarded as definitive. Further sharpening of alcohol expectancy nodes should be accomplished in widely diverse subject groups, and a variety of other MDS approaches should be applied. The ultimate network should be an amalgam of results from divergent and convergent operations, used across divergent situations, from the general to the specific. Validation of MDS findings must also be extended to studies of retrieval latency and pattern of the kind already used in memory work (see Roediger, 1990). Moreover, this approach does not replace existing expectancy scales that have a strong validation network, but rather adds a new perspective to the investigation of expectancy operation.

References

Babor, T. F., Brown, J., & Del Boca, F. K. (1990). Validity of self-reports in applied research on addictive behaviors: Fact or fiction? *Behavioral Assessment, 12,* 5–31.

Baker, T. B., Morse, E., & Sherman, J. E. (1987). The motivation to use drugs: A psychobiological analysis of urges. In P. Clayton Rivers (Ed.), *Alcohol and addictive behavior: Nebraska Symposium on Motivation 1986* (pp. 257–323). Lincoln, NE: University of Nebraska Press.

Barinaga, M. (1990). The mind revealed? *Science, 249,* 856–858.

Barnes, D. M. (1988). The biological tangle of drug addiction. *Science, 241,* 415–417.

Battig, W. F., & Montague, W. E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monographs, 80*(3, Pt. 2).

Berkowitz, A., & Perkins, H. W. (1988). Personality characteristics of children of alcoholics. *Journal of Consulting and Clinical Psychology, 56,* 206–209.

Bower, G. H., & Cohen, P. R. (1982). Emotional influences in memory and thinking: Data and theory. In M. Clark & S. Fiske (Eds.), *Affect and cognition* (pp. 291–331). Hillsdale, NJ: Erlbaum.

Brown, S. A. (1985). Expectancies versus background in the prediction of college drinking patterns. *Journal of Consulting and Clinical Psychology, 53,* 123–130.

Caramazza, A., Hersh, H., & Torgerson, W. S. (1976). Subjective structures and operations in semantic memory. *Journal of Verbal Learning and Verbal Behavior, 15,* 103–117.

Carroll, J. D. (1972). Individual differences and multidimensional scaling. In R. N. Shepard, A. K. Romney, & S. B. Nerlove (Eds.), *Multidimensional scaling: Theory and applications in the behavioral sciences: Vol. 1. Theory* (pp. 105–155). New York: Seminar Press.

Chang, T. M. (1986). Semantic memory: Facts and models. *Psychological Bulletin, 99,* 199–220.

Chang, J. J., & Carroll, J. D. (1972). *How to use PREFMAP and PREFMAP2—Programs which relate preference data to multidimensional scaling solution.* Unpublished manuscript, Bell Laboratories, Murray Hill, NJ.

Christiansen, B. A., & Goldman, M. S. (1983). Alcohol-related expectancies versus demographic/background variables in the prediction of adolescent drinking. *Journal of Consulting and Clinical Psychology, 51,* 249–257.

Christiansen, B. A., Smith, G. T., Roehling, P. V., & Goldman, M. S. (1989). Using alcohol expectancies to predict adolescent drinking behavior at one year. *Journal of Consulting and Clinical Psychology, 57,* 93–99.

Cloninger, C. R. (1987). Neurogenic adaptive mechanisms in alcoholism. *Science, 236,* 410–416.

Cloninger, C. R., Bohman, M., & Sigvardsson, S. (1981). Inheritance of alcohol abuse: Cross-fostering analysis of adopted men. *Archives of General Psychiatry, 38,* 861–868.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82,* 407–428.

Cooke, N. M., Durso, F. T., & Schvaneveldt, R. W. (1986). Recall and measures of memory organization. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 538–549.

Crowley, J. E. (1991). Educational status and drinking patterns: How representative are college students? *Journal of Studies on Alcohol, 52,* 10–16.

Donovan, J. E., Jessor, R., & Costa, F. M. (1988). Syndrome of problem behavior in adolescence: A replication. *Journal of Consulting and Clinical Psychology, 56,* 762–765.

Estes, W. K. (1991). Cognitive architectures from the standpoint of an experimental psychologist. *Annual Review of Psychology, 42,* 1–28.

Feighner, J., Robins, E., Guze, S., Woodruff, R., Winokur, G., & Munoz, R. (1972). Diagnostic criteria for use in psychiatric research. *Archives of General Psychiatry, 26,* 57–63.

Goldman, M. S. (1989). Alcohol expectancies as cognitive-behavioral psychology: Theory and practice. In T. Loberg, W. R. Miller, P. E. Nathan, & G. A. Marlatt (Eds.), *Addictive behaviors: Prevention and early intervention* (pp. 11–30). Lisse, The Netherlands: Swets & Zeitlinger.

Goldman, M. S., Brown, S. A., & Christiansen, B. A. (1987). Expectancy theory: Thinking about drinking. In H. T. Blane & K. E. Leonard (Eds.), *Psychological theories of drinking and alcoholism* (pp. 181–226). New York: Guilford Press.

Goldman, M. S., Brown, S. A., Christiansen, B. A., & Smith, G. T. (1991). Alcoholism etiology and memory: Broadening the scope of alcohol expectancy research. *Psychological Bulletin, 110,* 137–146.

Gray, J. A. (1982). *The neuropsychology of anxiety: An inquiry into the functions of the septo-hippocampal system.* New York: Oxford University Press.

Gupta, M. M., & Yamakawa, T. (Eds.). (1988). *Fuzzy logic in knowledge-based systems, decision, and control.* Amsterdam: Elsevier.

Kruskal, J. B. (1964). Nonmetric multidimensional scaling: A numerical method. *Psychometric, 29,* 115–129.

Kruskal, J. B., & Wish, M. (1978). *Multidimensional scaling* (Sage University Paper series on quantitative applications in the social sciences, #07-011). Beverly Hills, CA: Sage.

Lang, P. J. (1985). The cognitive psychophysiology of emotion: Fear and anxiety. In A. H. Tuma & J. D. Maser (Eds.), *Anxiety and anxiety disorders* (pp. 131–170). Hillsdale, NJ: Erlbaum.

Leigh, B. (1989). In search of the seven dwarves: Issues of measurement and meaning in alcohol expectancy research. *Psychological Bulletin, 105,* 361–373.

Levine, B., & Goldman, M. S. (1989, August). *Situational variation in alcohol expectancies.* Paper presented at the annual meeting of the American Psychological Association, New Orleans, LA.

Marlatt, G. A., Baer, J. S., Donovan, D. M., & Kivlahan, D. R. (1988). Addictive behaviors: Etiology and treatment. *Annual Review of Psychology, 38,* 575–630.

Marlatt, G. A., & Rohsenow, D. J. (1980). Cognitive processes in alcohol use: Expectancy and the balanced placebo design. In N. K. Mello (Ed.), *Advances in substance abuse: Behavioral and biological research* (pp. 159–199). Greenwich, CT: JAI Press.

Martin, C. S., Liepman, M. R., & Young, C. M. (1990). The Michigan

Alcoholism Screening Test: False positives in a college student sample. *Alcoholism: Clinical and Experimental Research, 14,* 853–855.

National Institute on Alcohol Abuse and Alcoholism. (1990). *Seventh special report to the U.S. Congress on alcohol and health.* Washington, DC: U.S. Government Printing Office.

Newell, A. (1973). Production systems: Models of control structures. In W. G. Chase (Ed.), *Visual information processing* (pp. 463–526). New York: Academic Press.

Panksepp, J. (1982). Toward a general psychobiological theory of emotions. *Behavioral Brain Science, 5,* 407–467.

Peele, S. (1986). The implications and limitations of genetic models of alcoholism and other addictions. *Journal of Studies on Alcohol, 47,* 63–73.

Pihl, R. O., Peterson, J., & Finn, P. (1990). Inherited predisposition to alcoholism: Characteristics of sons of male alcoholics. *Journal of Abnormal Psychology, 99,* 291–301.

Rather, B. C., Levine, B., & Goldman, M. S. (1990, August). *Multidimensional scaling for measuring alcohol expectancies.* Paper presented at the annual meeting of the American Psychological Association, Boston, MA.

Rips, L. J., Shoben, E. J., & Smith, E. E. (1973). Semantic distance and the verification of semantic relations. *Journal of Verbal Learning and Verbal Behavior, 12,* 1–20.

Roediger, H. L. (1990). Implicit memory: Retention without remembering. *American Psychologist, 45,* 1043–1056.

Russell, J. A. (1979). Affective space is bipolar. *Journal of Personality and Social Psychology, 37,* 345–356.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39,* 1161–1178.

Russell, J. A., & Mehrabian, A. (1975). The mediating role of emotions in alcohol use. *Journal of Studies on Alcohol, 36,* 1508–1536.

Schiffman, S. S., Reynolds, M. L., & Young, F. W. (1981). *Introduction to multidimensional scaling.* New York: Academic Press.

Searles, J. S. (1988). The role of genetics in the pathogenesis of alcoholism. *Journal of Abnormal Psychology, 97,* 153–167.

Selzer, M. L., Vinokur, A., & van Rooijen, L. (1975). A self-administered short Michigan Alcoholism Screening Test (SMAST). *Journal of Studies on Alcohol, 36,* 117–126.

Sher, K. J., & Descutner, C. (1986). Reports of paternal alcoholism: Reliability across siblings. *Addictive Behaviors, 11,* 25–30.

Shoben, E. J. (1976). The verification of semantic relations in a same-different paradigm: An asymmetry in semantic memory. *Journal of Verbal Learning and Verbal Behavior, 15,* 365–379.

Sobell, L. C., & Sobell, M. B. (1990). Self-report issues in alcohol abuse: State of the art and future directions. *Behavioral Assessment, 12,* 77–90.

Smith, E. E., & Medin, D. L. (1981). *Categories and concepts.* Cambridge, MA: Harvard University Press.

Stacy, A. W., Krank, M., & Marlatt, G. A. (1990). *Expectancy effects on alcohol use: A critical and integrative review.* Unpublished manuscript.

Stacy, A. W., Widaman, K. E., & Marlatt, G. A. (1990). Expectancy models of alcohol use. *Journal of Personality and Social Psychology, 58,* 918–928.

Stewart, J., de Wit, H., & Eikelboom, R. (1984). Role of unconditioned and conditioned effects in the self-administration of opiates and stimulants. *Psychological Review, 91,* 251–268.

Takane, Y., Young, F. W., & de Leeuw, J. (1977). Nonmetric individual differences multidimensional scaling: An alternating least squares method with optimal scaling features. *Psychometrika, 42,* 7–67.

Tarter, R. E. (1988). Are there inherited behavioral traits that predispose to substance abuse? *Journal of Consulting and Clinical Psychology, 56,* 189–196.

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and non-automatic processes. *Psychological Review, 97,* 147–168.

Wise, R. A. (1988). The neurobiology of craving: Implications for the understanding and treatment of addiction. *Journal of Abnormal Psychology, 97,* 118–132.

Wise, R. A., & Bozarth, M. A. (1987). A psychomotor stimulant theory of addiction. *Psychological Review, 94,* 469–492.

Young, F. W., Takane, Y., & Lewyckyj, R. (1978). ALSCAL: A nonmetric multidimensional scaling program with several differences options. *Behavioral Research and Instrumentation, 10,* 451–453.

Zimmerman, H. J. (1987). *Fuzzy sets, decision-making, and expert systems.* Norwell, MA: Kluwer Academic.

Zucker, R. A., & Gomberg, E. S. L. (1986). Etiology of alcoholism reconsidered: The case for a biopsychosocial process. *American Psychologist, 41,* 783–793.

Received October 29, 1990
Revision received April 22, 1991
Accepted May 8, 1991 ■