Pharmacology Biochemistry & Behavior, Vol. 35, pp. 923–931. © Pergamon Press plc, 1990. Printed in the U.S.A. 0091-3057/90 $3.00 + .00

Social, Circadian, Nutritional, and Subjective Correlates of the Spontaneous Pattern of Moderate Alcohol Intake of Normal Humans

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Received 11 July 1989

DE CASTRO, J. M. *Social, circadian, nutritional, and subjective correlates of the spontaneous pattern of moderate alcohol intake of normal humans.* PHARMACOL BIOCHEM BEHAV **35**(4) 923–931, 1990.—The relationship of moderate alcohol intake to the subjective states of hunger, thirst, depression, and anxiety, to social facilitation, circadian rhythms, and the ingestion of other nutrients by humans spontaneously behaving in their natural environment was investigated. Ninety-six adults were paid to maintain 7-day diaries of everything they ingested, when and where they ingested it, the number of other people present, and their subjective states at the beginning and end of the meal. The data from the 64 subjects who reported alcohol intake were analyzed individually with univariate and multivariate regression techniques. Subjective states were not found to be associated with subsequent alcohol ingestion, but alcohol was found to be associated with a reduction in subsequent thirst and anxiety. The amount of alcohol ingested was found to be positively related to the amount of nonalcohol calories ingested, particularly carbohydrates, the hour of the day, and the number of other people present. These results suggest that moderate alcohol intake by normal humans in their natural environment is affected by a variety of influences, but is primarily related to the time of day and socio-cultural factors.

Circadian rhythms Hunger Thirst Elation Anxiety Social facilitation Carbohydrates Meal size

ALCOHOL is both a nutrient and a drug that has been widely used and abused throughout history. Although the factors associated with alcohol abuse have been intensively investigated, little is known about the factors that influence the moderate alcohol consumption of normal humans in their natural environments. Studies of this spontaneous behavior are needed to demonstrate the importance and generality of laboratory and questionnaire research findings. Alcohol abuse produces so many physiological and psychological changes that it is extremely difficult to separate primary influences from secondary changes. Therefore, it is important to study individuals who ingest only moderate levels of alcohol. Seeking an understanding of the factors influencing controlled drinking may provide insights into the nature of the defect responsible for uncontrolled drinking.

One of the reasons frequently cited in the literature as to why people drink is that alcohol reduces negative emotional states such as tension (8), stress (34), anxiety or depression (38). However, lab and survey studies have produced contradictory results (3,36). The present study attempted to investigate the linkage of alcohol ingestion to emotional state in the ongoing behavior of nonalcoholic individuals in their natural environments.

Another factor that could influence alcohol intake is that alcoholic drinks are both a source of energy and of liquid. Alcohol, then, may, in part, be ingested for its caloric or liquid content. In a previous investigation of the effect of alcohol ingestion on spontaneous food intake in humans, it was found that alcohol appeared to supplement rather than displace macronutrient supplied calories (22) and did not influence the ingestion of other nutrients. On the other hand, rats compensate for alcohol intake with a reduction in the intake of other nutrients (24). Therefore, the present investigation attempted to ascertain the role and relative importance of other nutrients and the subjective states of hunger and thirst in the control of spontaneous alcohol intake.

Environmental variables, particularly the social context, are thought to be important determinants of alcohol intake [see (32) for review]; most drinking tends to occur with other people (7,9). Observations of drinkers in bars have suggested that alcohol intake is socially facilitated; that is, the larger the group, the more each individual will drink [see (32) for review]. However, these observations are restricted to bar situations and involve only single observations of each individual. It is possible that heavy drinkers prefer group situations (35). Multiple observations of single individuals in different social situations are needed to clarify this issue. In the present study every instance of alcohol ingestion over a one-week period by each individual in all locations will be used to investigate the social facilitation of alcohol intake.

A final factor that may be influential in the control of alcohol ingestion are circadian rhythms. The intakes of both food and fluids in humans have been shown to follow circadian patterns (12). Since the spontaneous alcohol intake in both rats and mice follows a circadian pattern (1, 2, 33), it is reasonable to suspect that alcohol intake in man follows a similar pattern. Thus, in the present study, an attempt is made to relate the frequency and amount of drinking to the time of day.

The data needed to evaluate these possible influences on spontaneous alcohol ingestion are available in the data base collected during prior research projects (11–14, 16–19, 22) that is routinely added to with new data from ongoing research projects. These data were collected by asking adult humans to maintain a diary for seven consecutive days of everything they either ate or drank, the time of occurrence, self-rated hunger, thirst, anxiety, and elation, and the number of other people present. How social influences, circadian rhythms, and subjective state might affect alcohol ingestion was addressed by correlating the number of other people present, the hour of the day, and the subjective self-ratings with the amount of alcohol ingested with univariate and multivariate techniques.

METHOD

The details of the methods used have been published elsewhere (11, 12, 14, 21); therefore, they will only be briefly summarized here.

Subjects

Twenty-three male and 63 female subjects recruited from a newspaper ad and by word of mouth were paid $30 to participate. They also received a detailed nutritional analysis based on their food intake for the 7-day reporting period. Sixty-four of the subjects, who reported ingestion of alcohol during the recording period, were selected for the present analyses. They ingested, on average, 126 kcal/day (range 25–331) of alcohol. They averaged 32.9 years (range 21–54), 62.3 kg (range 45.5–93.2) and 1.68 m (range 1.53–1.94).

Procedure

The subjects were given a small (8 × 18 cm) pocket-sized diary and were instructed to record in as detailed a manner as possible every item that they either ate or drank, the time they ate it, the number of people eating with them, the amount they ate, and how the food was prepared. They also rated their subjective state at the beginning and again at the end of the meal on four 7-point Likert scales. They rated how hungry they were from very sated (1) to very hungry (7), how thirsty they were from very sated (1) to very thirsty (7), their degree of elation from very depressed (1) to very elated (7), and their degree of anxiety from very calm (1) to very anxious (7). The subjects recorded for a day and were contacted by the experimenter to review the information, correct any problems and answer any questions. They then recorded their intake in the diaries for seven consecutive days. After receiving the diaries, the experimenter reviewed them and contacted the subjects to clarify any ambiguities or missing data in the diary records. The subjects were later contacted by phone if any questions arose about their entries in the diaries.

Before recording their intake the subjects were asked to provide the names and phone numbers of two individuals who would probably be eating with them sometime during the recording period. After the completed diaries were submitted each of these individuals were contacted and asked to verify the subjects reported intake. Although some difficulty was encountered in remembering exactly what the subject ate, in no case was the subjects diary report contradicted in either the nature or the amount of the food or drink reported.

Data Analysis

A computer file was used of over 3000 food items, assigned code numbers. The first step in the data analysis was to convert the foods reported in the diaries into the appropriate computer codes indicating food types and amounts and was performed by an experienced registered dietitian who was unaware of the experimental hypotheses and did not interact directly with the subjects. The second step was the identification of meals and the summation of the compositions of the individual items composing the meal. In order for a reported intake to be classified as an individual meal it had to contain at least 50 kcal, or more stringently 100 or 200 kcal. It also had to be separated in time from the preceding and following ingestive behaviors by at least 15 minutes. More stringent definitions of 45 and 90 minutes were also employed. Five different definitions of a meal were used combining these minimum criteria, 15 min/50 kcal, 45 min/50 kcal, 45 min/100 kcal, 45 min/200 kcal, and 90 min/50 kcal.

Meals were characterized by their total caloric content, carbohydrate, fat, protein, and alcohol content, and the estimated premeal and postmeal stomach contents. Alcohol calories were kept separate and were not included in either total caloric intake or carbohydrate calories. Premeal and postmeal intervals were also calculated excluding the overnight fast. The caloric content of the stomach was estimated with a computer model in which the reported intake was estimated to empty from the stomach at a rate proportional to the square root of the caloric content of the stomach (5, 14, 20, 21, 26–28).

For each subject the number of people present, the hour of the day (military time), the premeal hunger, thirst, elation, and anxiety self-ratings, the premeal to postmeal change in these ratings, the estimated premeal stomach contents, and the duration of the premeal interval were correlated using Pearson Product Moment Correlations with the amount of alcohol ingested in the meal. These same variables were used as predictors of the alcohol content of the meal in a multiple linear regression (32). Group means and standard errors were then calculated using the meal characteristics, beta coefficients from the multiple regressions, and univariate and multivariate correlations that had been calculated for each subject individually. Analyses of the correlation coefficients were performed on r to z transformed coefficients (10). The mean correlations and coefficients were then compared to 0 with a t-test.

RESULTS

Analyses were performed on meals identified by five different definitions of a meal (see the Data Analysis section). There were no significant qualitative differences in the results obtained with different definitions. Although data are presented from all definitions, the descriptive and inferential statistics reported in the text are for the minimum 50 kcal, 45 min definition, which is presented as representative. The amounts ingested of food and alcohol and the relationships of meal intake to alcohol have been presented in a prior publication (22) and will not be repeated here.

Self-Ratings of Subjective State

The mean self-ratings obtained prior to and after meals which included alcohol and those that did not are presented in Fig. 1. The subjects rated themselves significantly less hungry prior to meals containing alcohol than meals without alcohol, $t(63)=2.43$, $p<0.05$, but did not significantly differ on the after meal ratings or on the pre- to postmeal change in the ratings. The thirst self-ratings did not significantly differ between alcohol- and nonalcohol-containing meals prior to the meals, but were significantly lower after alcohol-containing meals than meals without alcohol, $t(63)=2.48$, $p<0.05$, and had a significantly greater pre- to postmeal change, $t(63)=3.66$, $p<0.05$. Hence, alcohol intake with a meal

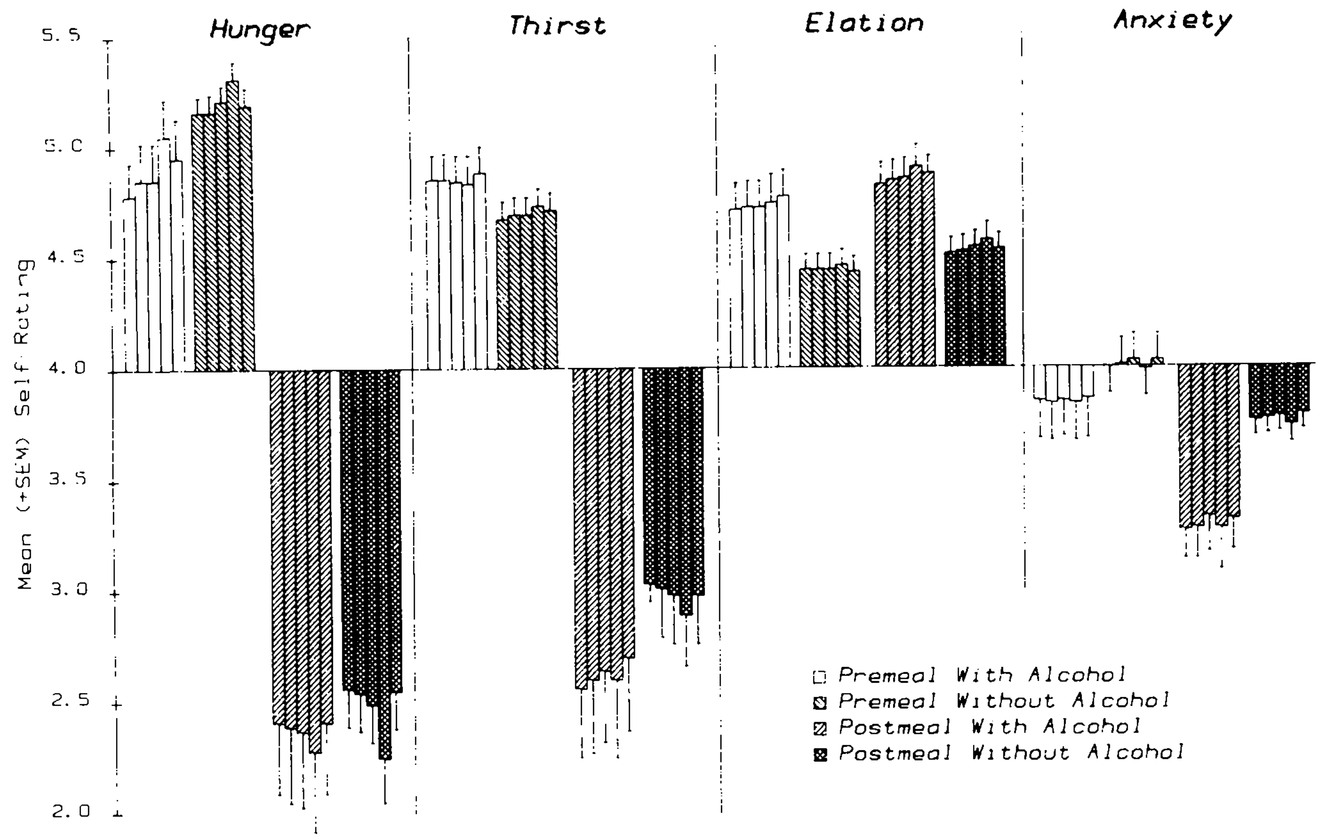

FIG. 1. Mean (± S.E.M.) self-ratings of the subject's subjective state of hunger (left), thirst (left middle), elation (right middle), and anxiety (bottom) prior to the meal (left 2 sets of 5 bars) and after the meal (right 2 sets of 5 bars), for meals eaten with accompanying alcohol (open and hatched up bars) and for meals eaten without alcohol (down and cross hatched bars). The sated-hungry scale was anchored with 2 = moderately sated, 3 = slightly sated, 4 = neutral, 5 = slightly hungry, 6 = moderately hungry. The thirst, elation, and anxiety scales were anchored similarly. The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcal size; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal.

is associated mainly with a greater reduction in subjective thirst and not hunger.

The mean self-ratings on the depression-elation scale indicated that the subjects were significantly more elated both prior to, $t(63) = 2.75$, $p < 0.05$, and after, $t(63) = 2.60$, $p < 0.05$, a meal containing alcohol than one without alcohol, but there are no significant differences in the amount of change in elation over the course of the meals. This result suggests that meals containing alcohol are eaten while in a relatively elated mood, but the alcohol ingestion itself does not produce or alter the elation. The ratings on the calm-anxious dimension, on the other hand, were not significantly different premeal, but were postmeal, $t(63) = 2.99$, $p < 0.05$, such that there was a significantly greater premeal to postmeal change toward calm with meals containing alcohol than those without, $t(63) = 2.90$, $p < 0.05$. The ingestion of alcohol, then, appears to have a significant calming effect.

The univariate correlations between the amount of alcohol ingested and the subjective self-ratings are presented in Fig. 2. The correlations suggest the same conclusions as the mean self-ratings. There is a slight but significant negative correlation between the amount of alcohol ingested and the premeal hunger self-ratings, $t(63) = 2.41$, $p < 0.05$, but not the premeal to postmeal change in the ratings. The correlations between the amount of alcohol and the thirst self-ratings, however, were not significant with the premeal ratings, but were significantly negatively correlated with the pre- to postmeal rating change, $t(63) = 3.52$, $p < 0.05$. These results suggest that alcohol intake has little effect on hunger, but tends to relieve thirst. The premeal elation self-rating was significantly positively correlated with the amount of alcohol, $t(63) = 3.55$, $p < 0.05$. Although equivalent in magnitude the pre- to postmeal change in elation-meal size correlations were not statistically reliable. The anxiety self-ratings premeal did not correlate with the amount of alcohol, but the pre- to postmeal change in the ratings had significant negative correlations with the amount of alcohol, $t(63) = 3.04$, $p < 0.05$. This, again, evidences the calming effect of alcohol.

In order to further investigate the effects of alcohol on changes in subjective states, multiple linear regressions were performed predicting changes in each of the self-ratings on the basis of the number of other people present, the amount of alcohol ingested, the meal size, and the hour of the day. The Beta coefficients from these regressions are presented in Fig. 3. Changes in self-rated hunger (top of the figure) were significantly predicted only by the amount of nonalcohol calories ingested, meal size. Alcohol calories did not make a significant contribution to the prediction. On the other hand, changes in the thirst self-ratings (top middle of the figure) were significantly predicted by both meal size and the amount of alcohol ingested. Hence, alcohol calories do not appear to satisfy hunger, but rather contribute to thirst reduction.

Although alcohol tends to be ingested under elated conditions, changes on the depression-elation dimension are not significantly related to alcohol ingestion (bottom middle of Fig. 3). Changes in

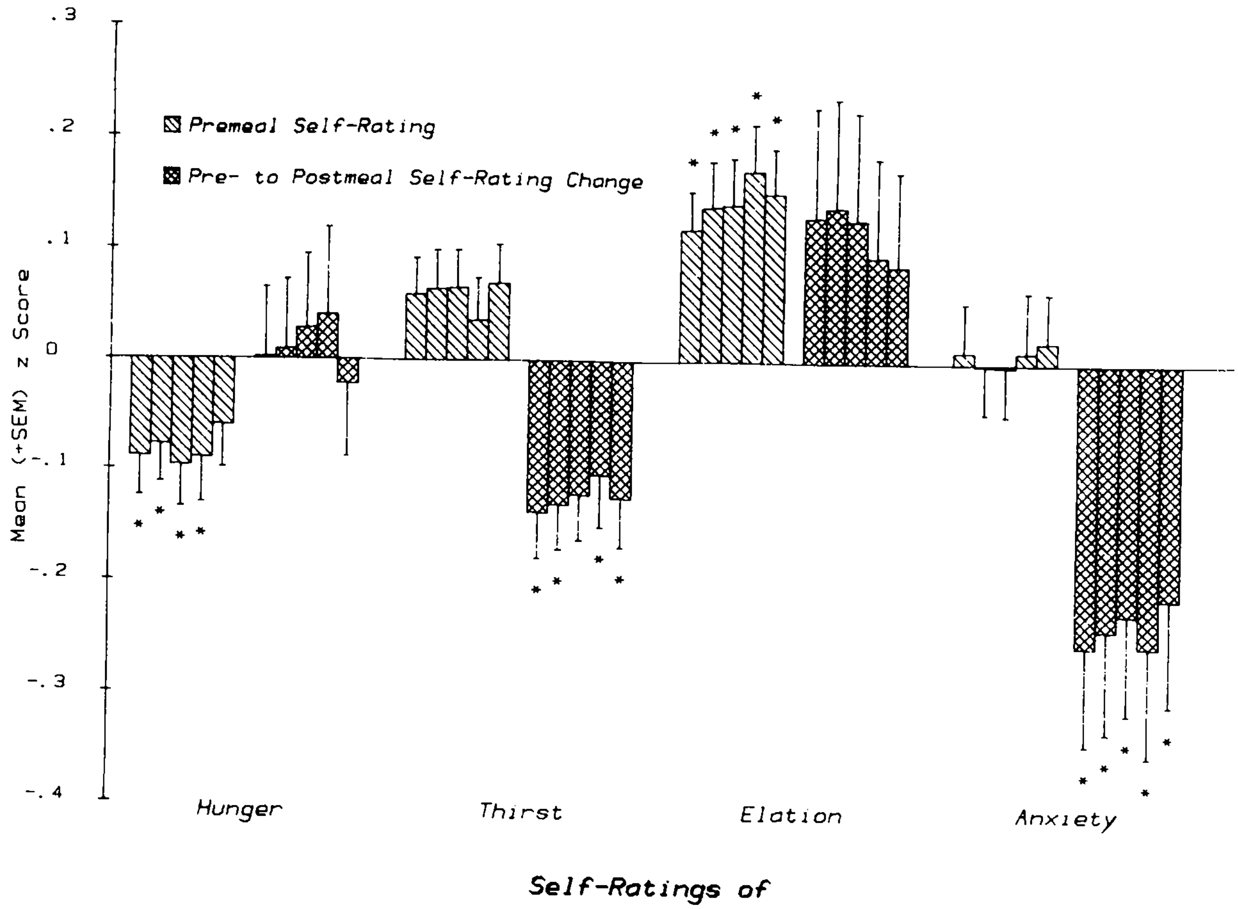

FIG. 2. Mean (±S.E.M.) z transformed correlations between the amount of alcohol ingested and the subjective self-ratings of hunger (left 2 sets of 5 bars), thirst (left middle 2 sets of 5 bars), elation (right middle 2 sets of 5 bars), and anxiety (right 2 sets of 5 bars), recorded prior to the meals (down hatched bars) or after the meals (cross-hatched bars). The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcal size; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal. Asterisks (*) indicate that the mean is significantly ($p<0.05$) different from zero as assessed with a t-test.

elation are associated with the amount of food ingested and the hour of the day. As is clear on the bottom of the figure, only the amount of alcohol ingested is significantly related to the change in anxiety. It would thus appear that the reduction in anxiety associated with alcohol ingestion that was apparent with the univariate correlations is a direct effect of alcohol ingestion and not due to a covariation with a third factor.

Meal Characteristics and Alcohol Intake

The univariate correlations between the amount of alcohol ingested and the conditions and characteristics of the meal are presented in Fig. 4. The amount of food energy ingested and the amount of carbohydrate, fat and protein in the meal are significantly positively correlated with the amount of alcohol accompanying the meal, $t(63)=4.60; 5.38; 3.41; 3.92, p<0.05$, respectively. Alcohol ingestion is also significantly positively correlated with the number of other people present, $t(63)=6.59$, $p<0.05$, the hour of the day, $t(63)=12.50$, $p<0.05$, the estimated premeal stomach content, $t(63)=2.49$, $p<0.05$, and the duration of the premeal interval, $t(63)=2.58$, $p<0.05$. Only the correlation with the stomach content would appear at all unusual. The amount in the stomach prior to a meal is negatively correlated with the amount of food energy ingested in the meal (14, 20, 21). Hence, the positive correlation with amount of alcohol ingested appears anomalous.

The univariate analyses do not separate those factors that are primarily and directly related to alcohol ingestion from those that act secondarily. For example, the anomolous positive relationship between the premeal stomach content and the amount of alcohol ingested might be due to a covariation with the time of day, wherein alcohol tends to be ingested late in the day while meals are initiated with relatively large amounts in the stomach (12). To better investigate the relative roles of these predictors of alcohol intake, multiple linear regressions were performed with amount of alcohol ingested as the dependent variable and various combinations of these predictors as independent variables. The Beta coefficients from three of these regressions are presented in Fig. 5.

The multiple regressions indicate that four of the predictors are only secondarily associated with alcohol intake. In particular, the premeal self-ratings of hunger (middle regression, far left) and elation (bottom regression, far left) which were significantly correlated with the amount of alcohol ingested do not significantly predict alcohol intake when entered into a multiple regression. Additionally, the estimated premeal stomach content and the duration of the premeal interval (middle regression) are not significant predictors in the multiple regressions. This suggests that these four factors have univariate correlations with alcohol

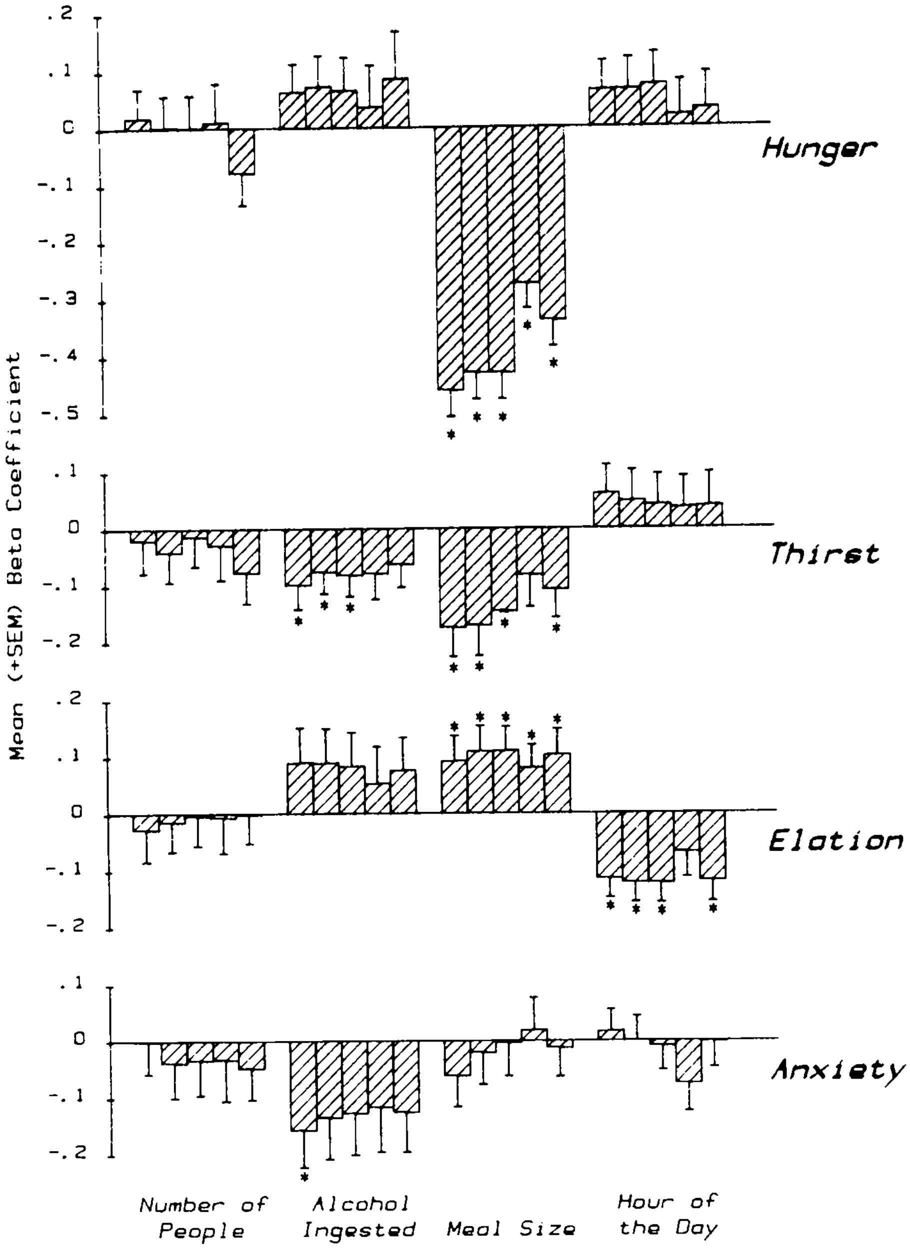

FIG. 3. Mean (±S.E.M.) beta coefficients from the multiple linear regression prediction of the pre- to postmeal change in the subjective self-ratings of hunger (top), thirst (upper middle), elation (bottom middle), and anxiety (bottom) on the basis of the number of other people present (left set of bars), the amount of alcohol ingested with the meal (left center set of bars), the amount of nonalcohol calories ingested (right center set of bars), and the hour of the day (right set of bars). The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcal size; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal. Asterisks (*) indicate that the mean is significantly ($p<0.05$) different from zero as assessed with a t-test.

because of secondary association with another factor, probably hour of the day.

The amount ingested in the meal is positively associated, in the multiple regressions with alcohol intake (bottom regression), $t(63)=2.58$, $p<0.05$. This effect appears to be due mainly to the carbohydrate content of the meal which is the only macronutrient with a significant predictor of alcohol intake, $t(63)=4.14$, $p<0.05$, when regressed together with fat and protein (top regression).

In all three regressions it is clear that the most significant predictors of the amount of alcohol ingested are the number of other people present and the hour of the day. These factors have strong positive Beta coefficients regardless of what other factors are regressed with them, $t(63)=3.87$; 9.09; for the top regression; 3.40; 5.64; for the middle regression; and 2.98; 8.61; for the bottom regression, $p<0.05$ for number of people and day hour respectively.

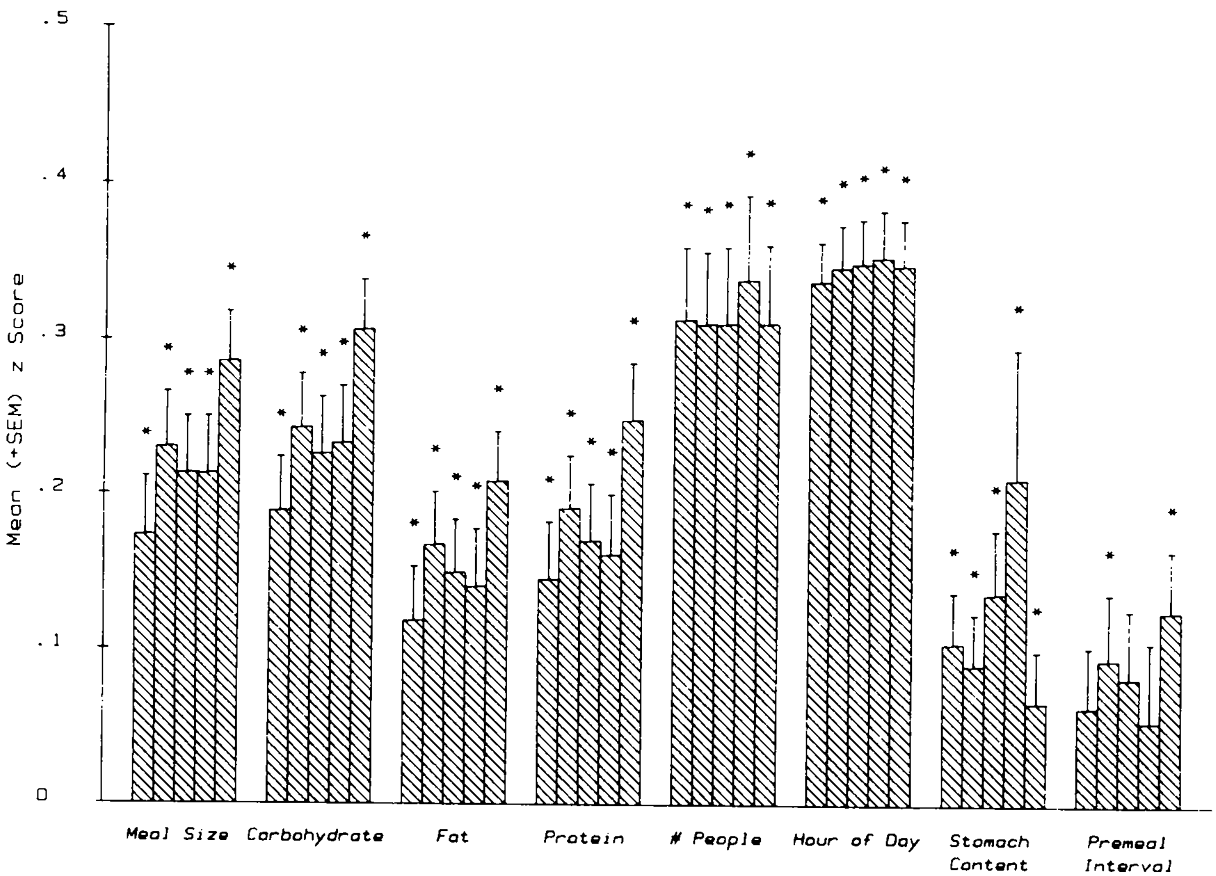

FIG. 4. Mean (±S.E.M.) z transformed correlations between the amount of alcohol ingested and the meal size (nonalcohol) calories, the amounts of the carbohydrate, fat, and protein in the meal, the number of other people present, the hour of the day, the estimated premeal caloric content of the stomach, and the duration of the premeal interval. The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcal size; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal. Asterisks (*) indicate that the mean is significantly ($p<0.05$) different from zero as assessed with a t-test.

DISCUSSION

Self-reports of intake, particularly recall procedures, have traditionally been thought to be inaccurate (30). However, this does not appear to be the case with the diary technique where subjects record at the same time that they eat or drink. It has been demonstrated to be both reliable and valid [(4, 25, 29, 37), see (14) for a review and discussion], even for alcoholics (23,39). In addition, the present study had characteristics which tend to enhance the veracity of the self-reports. The study was double blind, wherein neither the subjects nor the experimenter were aware that alcohol intake was of particular interest. The subjects' reward for accurate record keeping was a detailed analysis of their reported diets. The subjects expressed great interest in receiving such an analysis and were aware that it would only be as accurate as their records. Also, the subject's diary entries were verified by two people who ate with the subject. Thus, there is every reason to believe that the self-reports acquired in the present study are accurate.

The interpretation of the present findings has to be tempered because they result from correlative evidence. However, although correlation does not mean causation, it is a prerequisite for causation. Any causal factor should be correlated with the factor it influences. Thus, correlation can be used to test and potentially reject or support causal statements. In the present study the associations with alcohol intake are strictly correlative and no conclusive causal statements can or should be made. It is, however, perfectly legitimate to postulate and discuss a causal linkage since the correlative evidence supports such interpretations.

The analysis of the hunger and thirst self-ratings suggests that alcohol intake is associated with thirst and not hunger. Premeal to postmeal changes in self-rated thirst were larger for meals containing alcohol than for those without and were correlated directly and in a multiple regression with alcohol intake. None of these facts were true for the hunger self-ratings. In fact premeal hunger appears to be negatively related with alcohol intake. Thus, it would appear that alcohol intake is subjectively appreciated for its fluid content and not its energy content. This supports the conclusion that alcohol intake in humans is not involved in energy intake regulation (22). Additionally, the premeal thirst self-ratings were not significantly related to alcohol intake. This suggests that although the fluid content is subjectively appreciated, that alcohol intake is not elicited by thirst. This supports the view that fluid intake is not primarily determined by body fluid homeostasis in either humans (13) or rats (15).

No evidence was found in the present study to indicate that alcohol is used by normal individuals to relieve depression. In fact, alcohol tended to be ingested in a "slightly" elated subjective state that was higher than when food was ingested without alcohol. In addition, the degree of elation, not depression, was

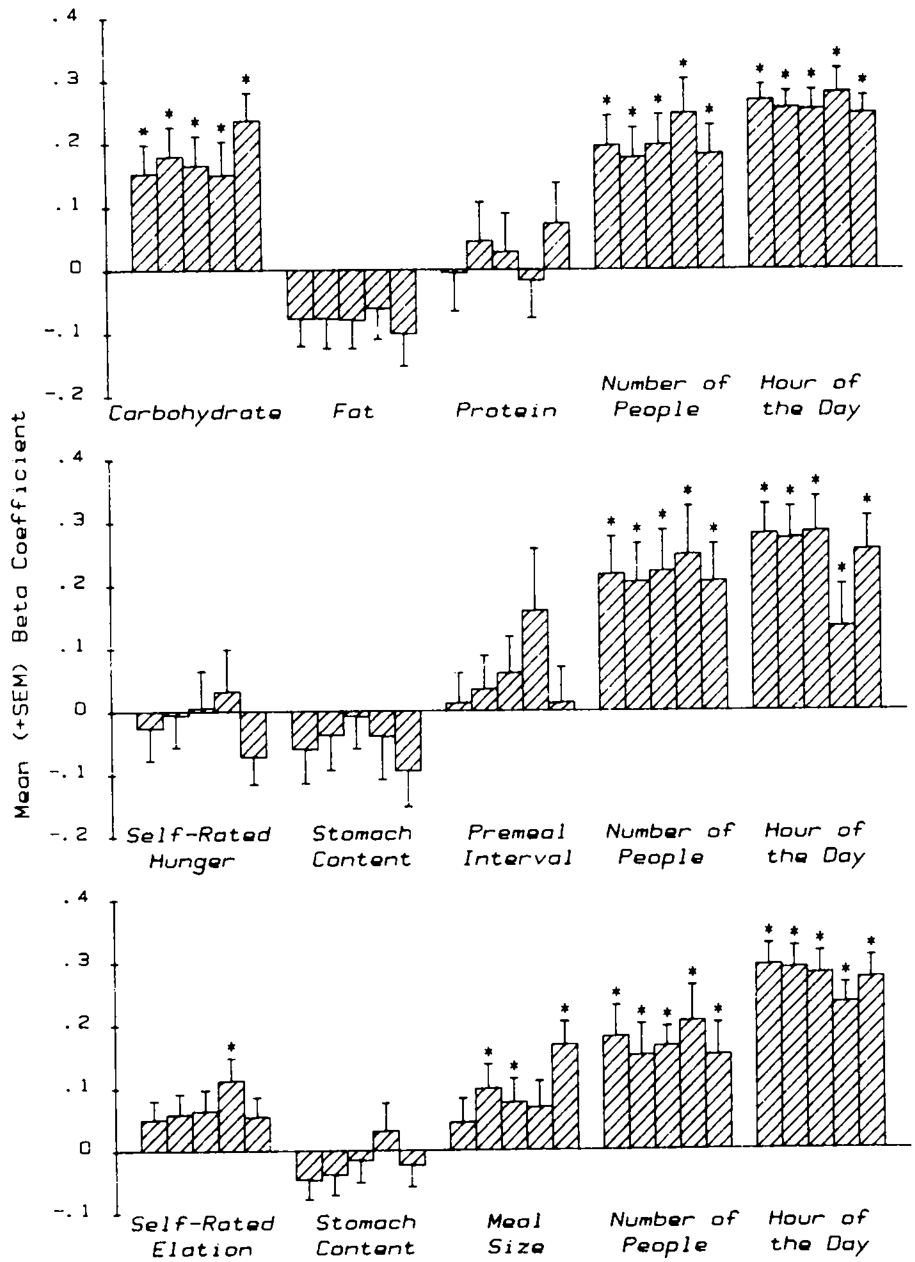

FIG. 5. Mean (±S.E.M.) beta coefficients from the multiple linear regression prediction of the amount of alcohol ingested. Three different sets of independent variables are used. In all three the number of people present (right center) and the hour of the day (far right) are used as independent variables. In the regressions represented at the top the amounts of carbohydrate, fat, and protein ingested are added as independent variables. In the middle, the premeal hunger self-ratings, the estimated premeal stomach content, and the duration of the premeal interval are added. On the bottom, the premeal elation self-ratings, the estimated premeal stomach content, and the meal size of nonalcohol calories are added as independent variables. The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcal size; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal. Asterisks (*) indicate that the mean is significantly ($p<0.05$) different from zero as assessed with a t-test.

related to the amount of alcohol ingested. However, the multiple regression analysis indicates that the relationship between elation and alcohol intake is a secondary effect that is due to a covariation with either the time of day or the number of other people present. Also, alcohol ingestion does not appear to significantly change the subjective state on the depression-elation dimension. The postmeal ratings are equivalent to the premeal ratings and the change is not significantly correlated with the amount of alcohol ingested. Thus, it would appear that spontaneous alcohol intake by normal individuals is not related to depression-elation and this mood state for these individuals is not a determinant of the choice to ingest an alcoholic beverage.

No evidence was obtained to indicate that moderate alcohol intake is used by normal humans to relieve anxiety. The subjects self-ratings on the calm-anxious dimension were on average "neutral" at the time of alcohol ingestion and these ratings were not correlated with the amount of alcohol ingested. Thus, the subjects are not particularly anxious when they decide to drink and their degree of anxiety is unrelated to the amount they spontaneously drink. On the other hand, alcohol appears to have a considerable calming effect on the subjects. Self-ratings after alcohol ingestion average "slightly" calm and the amount of change is significantly correlated with the amount of alcohol ingested. Thus, the present results indicate that normal, spontaneous, moderate alcohol intake is not prompted by anxiety, but does have a calming effect on the drinker.

Although conflicting results have been reported on alcohol effects on anxiety, the differing results appear to be due to the social climate. In general, it has been found that when alcohol is ingested alone in laboratory settings negative emotional changes ensue, while, in comfortable settings, in groups, positive emotional changes occur [see (3) for review]. The fact that the subjects in the present experiment indicated greater than normal elation prior to alcohol ingestion and that the meals containing alcohol were ingested with more other people than meals without alcohol (17,22), suggests that in the present investigation alcohol was ingested in comfortable, pleasant, social conditions. According to the literature, this should result in a reduction in anxiety associated with alcohol ingestion, as was observed.

The present results suggest that the amount of alcohol consumed is related to the quantities of other nutrients that are also consumed. The amount of nonalcohol calories that are ingested is positively related to the amount of alcohol ingested. This association is not secondary to social facilitation or the time of day, as it is still present when the influence of all of these factors is combined in a multiple regression. Although there are direct relationships between each of the macronutrients and alcohol intake, when all three are combined in a multiple regression, only carbohydrate remains as a significant positive factor. Thus, it would appear that the intakes of alcohol and carbohydrate are somehow linked.

The reason for this relationship is not at all apparent in the present results. It is doubtful that carbohydrate intake is causing a facilitation of alcohol ingestion, since the amount of carbohydrate predicted to be present in the stomach at the time of alcohol ingestion is not related to the amount of alcohol drunk. Conversely, the amount of alcohol predicted to be in the stomach at the onset of the meal is not related to the amount of carbohydrate ingested. It may be that the relationship is due to a third factor, possibly setting or cultural factors, that promotes both alcohol and carbohydrate consumption. Further research will be needed to assess this possibility.

The present analyses reveal clear evidence of a social facilitation of alcohol intake. The amount of alcohol ingested at a meal was positively correlated with the number of other people present. Furthermore, this effect does not appear to be secondary to amount eaten in the meal or to the time of day. When all these factors were taken together in the multiple regression analyses, the number of other people present still had a strong positive relationship to the amount of alcohol ingested.

These results replicate and extend the prior studies of social facilitation of alcohol intake (32). In particular, in the present study, social facilitation was documented within subjects. That is, the correlation between the number of people present and the amount of alcohol ingested was calculated for each subject individually and was found to be on the average strong and positive. Hence, the results cannot be accounted for on the simple basis of heavy drinkers tending toward drinking in large groups (35). In addition, the present results document social facilitation of drinking in individuals who ingest only very modest amounts of alcohol and who do so in a variety of different environments. Thus, social facilitation of alcohol intake would appear to be a generalizable phenomenon.

The present findings demonstrate a clear relationship between the time of day and the amount of alcohol ingested. The hour of the day was positively correlated with alcohol intake directly and in the multiple regressions. Thus, the time of day effect is not a secondary consequence of meal size or social facilitation, but is an independent relationship with alcohol ingestion. Circadian rhythms of intake in humans produce an increase in intake over the course of the day (12) and, thus, produce a positive relationship between the clock hour and amount ingested. The relationship between alcohol intake and hour of the day, then, may indicate that alcohol intake in man also undergoes circadian variation.

The amount of alcohol spontaneously ingested by mice or rats undergoes a circadian rhythm (1, 2, 33). Also, the behavioral response to alcohol changes over the day in both rats (6) and man (30). Alcohol ingested early in the day, although producing equivalent blood alcohol levels, has a substantially larger behavioral effect than later in the day (30). Thus, the observed relationship between the hour of the day and the amount of alcohol ingested may be due to a circadian rhythmic process. On the other hand, there are strong socio-cultural influences which tend to restrict alcohol intake to later in the day and there tends to be a greater availability and accessability of alcohol later in the day. Thus, the present results document the relationship between time of day and alcohol intake, but do not indicate whether it represents a circadian rhythmic process, a cultural influence, or an alcohol availability effect. Further research is needed to clarify the reason for the relationship.

Finally, the present findings provide a glimpse at the relative importance of the influences on alcohol intake. The Beta, standardized, coefficients from the multiple regression analysis can be compared to judge the respective impact of each of the variables on the dependent measure, alcohol intake. Clearly, the most important influences on alcohol ingestion are the time of day and the number of people present while the meal size and amount of carbohydrate ingested are of lesser importance. The subjective state, premeal interval, stomach content, and fat and protein intakes have no significant influence. Thus, it would appear that moderate alcohol intake by normal humans in their natural environment is primarily influenced by socio-cultural factors, with physiological and psychological variable playing at best secondary roles.

ACKNOWLEDGEMENTS

The author would like to express his appreciation and acknowledge the substantial contributions of Ms. Dixie K. Elmore, Sara Orozco and Ms. Margaret Pedersen without whose assistance the work could not have been performed. This research was supported in part by Grant R01-DK39881-01A2 from the National Institute of Diabetes and Digestive and Kidney Diseases, from a grant from the Georgia State University Research Grant Program and from a Biological Research Support Grant whose support is gratefully acknowledged.

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