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TASTE RESPONSES IN SONS OF MALE ALCOHOLICS

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Abstract — The aim of the present study was to compare taste responses (intensity and pleasantness/unpleasantness) to sweet, bitter, sour, and salty solutions in sons of male alcoholics (SOMAs) and control subjects with no family history of alcoholism. In addition, responses to Coca-Cola flavour were evaluated in both groups. Unpleasantness of salty solutions was significantly enhanced and intensity of sour solutions tended to be higher in the SOMAs. There were no other differences between the groups. Thus, contrary to previous suggestions, genetically determined vulnerability to alcohol dependence may not be associated with altered responses to sweet substances. The present findings would rather suggest that increased aversive responses to salt taste may predict future development of alcohol dependence.

INTRODUCTION

It has been repeatedly reported that rodents with high preference for sweet solutions consume more ethanol (alcohol) than those with a low sweet preference (Gosnell and Krahn, 1992; Sinclair *et al*., 1992; Stewart *et al*., 1994; Bachmanov *et al*., 1996; Koros *et al*., 1998). The above correlation has been reported for both genetically selected alcohol-preferring and outbred strains of rats (for review, see Kampov-Polevoy *et al*., 1999). Therefore, it has been suggested that the same gene(s) may regulate sweets and alcohol preference (Stewart *et al*., 1994; Kampov-Polevoy *et al*., 1999).

In line with the above, it has been shown that more than 60% of male alcoholics preferred a high concentration sucrose solution (0.83 M), compared with 16–21% of non-alcoholic controls (Kampov-Polevoy *et al*., 1997, 1998). However, it should be kept in mind that qualitatively different parameters have been assessed in the animal (sucrose or saccharin consumption) and human studies (hedonic responses to sweet solution). Moreover, both inherited and environmental factors might have contributed to the results of Kampov-Polevoy *et al*. For example, it is possible that long-term consumption of alcoholic beverages alters sweet taste preference in alcohol addicts. Notably, this explanation does not apply to several animal studies in which rats selected for differential ethanol preference differed in their consumption of sweet solutions. These animals had never had alcohol before the test of sweet preference. Studies on non-alcoholic individuals being at risk for development of alcoholism could explain whether altered responses to sweet taste reported by Kampov-Polevoy *et al*. were genetically determined or were a consequence of alcohol dependence.

Human studies have repeatedly demonstrated that development of alcoholism is, at least in part, influenced by genetic factors (Goodwin *et al*., 1973; Cloninger *et al*., 1981; Steinhausen, 1995; Reich *et al*., 1998). It has been shown that sons of male alcoholic (SOMAs) are three to nine times more likely to become alcohol addicts than are the subjects with no family history of alcoholism (Cloninger *et al*., 1981; Goodwin, 1985). Moreover, clear-cut differences have been found between SOMAs and sons of non-alcoholic fathers in several biochemical, pharmacological and behavioural paradigms (Moss *et al*., 1986; Schuckit *et al*., 1987, 1988, 1996; Finn and Pihl, 1987; Peterson *et al*., 1992; Pollock, 1992; Steinhausen, 1995).

The purpose of the present study was to examine intensity and pleasantness ratings of sweet (sucrose), bitter (quinine), sour (citric acid), and salty (sodium chloride) solutions in SOMAs and subjects without family history of alcoholism. In addition, we aimed to assess taste responses to a soft drink which would be familiar to our subjects and contain high amounts of sucrose. For this reason, responses to the flavour of classic Coca-Cola were examined in both populations. Coca-Cola was rated as highly sweet and pleasant in our preliminary experiments (P. Bienkowski *et al*., unpublished).

METHODS

Subjects

Twenty SOMAs were recruited through outpatient clinics of the Department of Prevention and Treatment of Addictions, Institute of Psychiatry and Neurology, Warsaw, Poland. Their alcoholic fathers met DSM-IV criteria (American Psychiatric Association, 1994) for alcohol dependence and were free of any other Axis I psychiatric disorder.

Male subjects (n = 22) without a history of alcoholism in a first- or second-degree relative served as a control group. Families of the control subjects were carefully screened for possible alcoholism indicators, i.e. reports that any first- or second-degree relative had ever been alcoholic, received help for a drinking problem, attended an Alcoholics Anonymous meeting, been hospitalized for a drinking problem, been

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arrested because of drunken behaviour, etc. (Selzer *et al*., 1975; Chassin *et al*., 1992). In each case, both parents were contacted and interviewed in order to verify family history of alcohol-related problems. The control subjects were recruited through all institutions involved in the study from families of staff members.

The subjects in both groups were Caucasians, aged 10 to 23 years (for details, see Table 1), non-alcoholic and non-smoking, in good medical health, and had no history of an Axis I psychiatric disorder. Special care was taken to eliminate individuals with disorders known to alter gustatory or olfactory function (Naumann, 1993; Cullen and Leopold, 1999). Four candidates (2 controls, 2 SOMAs) were eliminated because of cigarette smoking and excessive alcohol consumption. One SOMA was excluded because of a history of craniofacial surgery.

The study was carried out in accordance with the Declaration of Helsinki of the World Medical Association. The protocol for the study was reviewed and approved by a local Ethics Committee. Each adult participant read and signed an informed consent form prior to the initiation of the study. If the subject was aged <18 years, he signed a short assent and a full informed consent was obtained from his parents. The subjects (or their parents) were paid ~US$24 for their participation.

Procedure

All experimental procedures were conducted between 9:00 and 13:00 in a quiet room. The subjects were asked to refrain from eating and drinking for at least 1 h prior to the session. Each participant was first familiarized with all procedures and scales. Then, increasing concentrations of sucrose (sweet; 1, 10, 30%, w/v; Krasnystaw Sugar-Refinery, Krasnystaw, Poland), quinine hydrochloride (bitter; 0.001, 0.002, 0.005% w/v; Polfa, Warsaw, Poland), citric acid (sour; 0.02, 0.04, 0.1% w.v.; Libella, Kotyn, Poland), and sodium chloride (salty; 0.18, 0.36, 0.9% w/v; Polfa, Lublin, Poland) were administered in a volume of 1 ml on the anterior tongue from single-use syringes. The sucrose solutions were selected on the basis of our previous experiments (Scinska *et al*., 2000). The highest sucrose concentration (30% = 0.88 M) administered in the present study was comparable with that (0.83 M) used by Kampov-Polevoy *et al*. (1997, 1998; see Introduction). The same volume of distilled water was used as a control stimulus. Accordingly, in the first part of the session each participant received and rated 13 different gustatory samples. The solutions were prepared with distilled water on the day of administration and stored at room temperature. The order of administration was counterbalanced across all subjects.

The subject was asked to thoroughly taste each sample and to rate intensity ('How intense is the taste?') and pleasantness ('How pleasant is the taste?') on 100-mm lines labelled at the ends for intensity 'not at all' and 'extremely' (scored 0 to 100) and for pleasantness 'extremely unpleasant' and 'extremely pleasant' (scored –50 to 50). The testing of each sample was separated by 60 s during which time the subjects filled response forms, rinsed their mouths with distilled water, and waited for the next sample. The subjects were instructed to spit out or swallow the solutions.

In the second part of the experimental session (starting 5 min after presentation of the last gustatory sample), the participant was required to drink slowly 100 ml of classic Coca-Cola. The same volume of distilled water served as a control stimulus. The order of sample administration (water–Cola or Cola–water) was counterbalanced across all subjects. Intensity and pleasantness of Coca-Cola and water flavour was rated on the 100-mm lines (see above).

Statistics

A two-way (Group × Tastant Concentration) ANOVA with repeated measures (Concentration) was used to analyse the data. The Newman–Keuls test was chosen for post hoc comparisons. Sucrose concentration rated as the most pleasant was identified for each participant. The subjects preferring 30% sucrose were designated as 'sweet likers' (Kampov-Polevoy *et al*., 1997, 1998). The Fisher exact probability test was used to compare proportions of sweet likers in both experimental groups. All statistical analyses were performed with the aid of the Statistica 5.0 software package.

RESULTS

Baseline characteristics of the subjects are presented in Table 1. There was no significant difference between the SOMAs and the control subjects in age, height or weight (all P values > 0.23; Student's t-test).

Intensity and pleasantness ratings of gustatory stimuli

Intensity ratings of every tastant increased with concentration ($F > 57.50$, $P < 0.001$; Figs 1A–4A). The analysis of responses to sucrose, quinine, and sodium chloride did not reveal any significant Group effects or Group × Concentration interactions ($F < 1.65$, $P > 0.2$). The ANOVA indicated a significant Group × Concentration interaction [$F(3,120) = 2.79$, $P < 0.05$] when responses to citric acid were compared. The post hoc analysis indicated that 0.02% citric acid was rated as more intense by the SOMAs (Fig. 3A).

Pleasantness ratings varied with concentration for every tastant (all $F > 2.68$, $P < 0.05$; Figs 1B–4B). The ANOVA did not indicate any significant Group effects or Group × Concentration interactions when hedonic responses to sucrose, quinine, and citric acid were analysed ($F < 1.26$, $P > 0.2$). In contrast, a significant Group effect [$F(3,120) = 4.26$, $P < 0.05$] was found for hedonic ratings of the salty solutions. In comparison with the control subjects, the SOMAs rated the taste of 0.9% sodium chloride as more unpleasant ($P < 0.01$; Fig. 4B).

Sixty per cent of the SOMAs preferred the highest sucrose concentration compared with 73% of the control group. The proportion of 'sweet likers' did not differ between the groups ($P = 0.29$).

Table 1. Baseline characteristics of subjects

	Control group (n = 22)		Sons of male alcoholics (n = 20)	
	Mean	SEM	Mean	SEM
Age (years)	14	0.8	15.4	0.9
Height (cm)	163.4	2.4	163.9	3.7
Weight (kg)	57.8	3.0	54.7	3.3

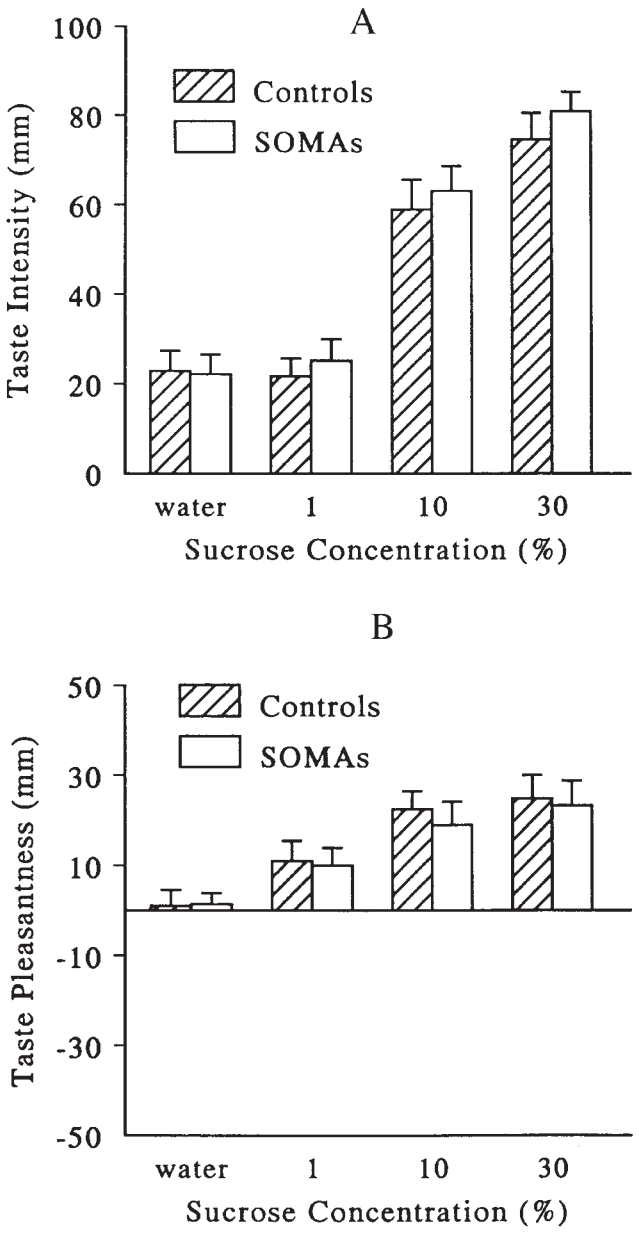

Fig. 1. Intensity (A) and pleasantness (B) ratings of sucrose taste in sons of male alcoholics (SOMAs) and control subjects. Values are means ± SEM (bars).

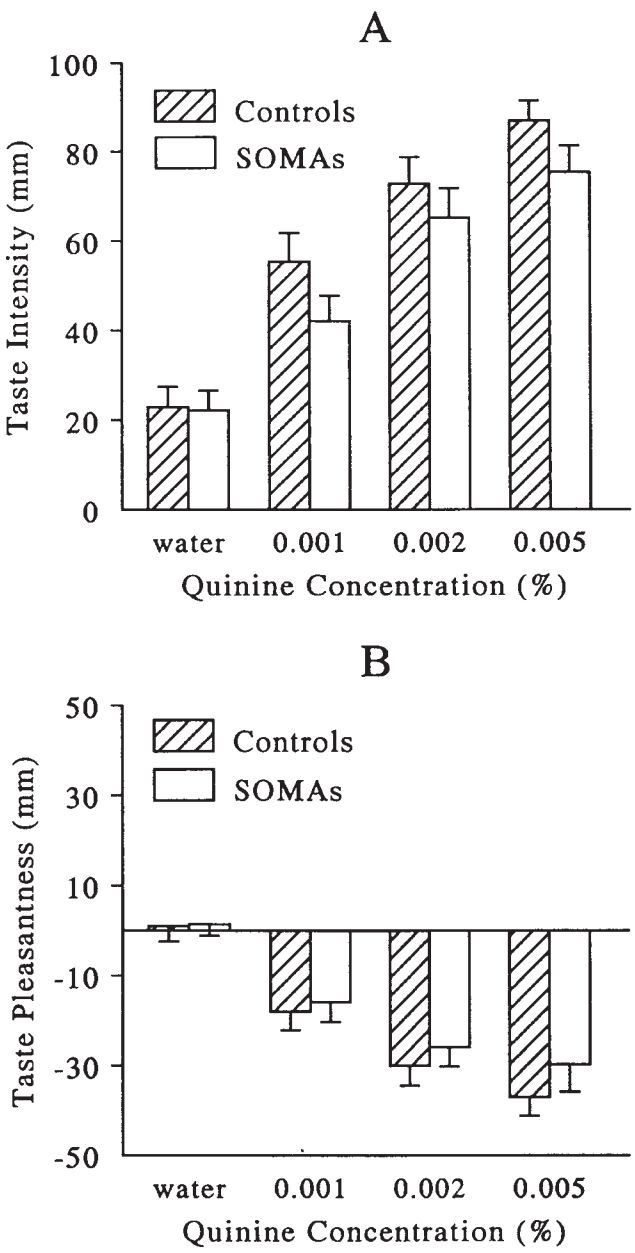

Fig. 2. Intensity (A) and pleasantness (B) ratings of quinine taste in sons of male alcoholics (SOMAs) and control subjects. Values are means ± SEM (bars).

Intensity and pleasantness ratings of Coca-Cola flavour

Coca-Cola was rated as more intense and pleasant than distilled water [intensity ratings: $F(1,40) = 62.99$, $P < 0.001$; pleasantness ratings: $F(1,40) = 68.27$, $P < 0.001$; Fig. 5]. However, the ANOVA did not show any significant Group effects or Group × Concentration interactions ($F < 1.95$, $P > 0.15$).

DISCUSSION

Contrary to the previous suggestions (see Introduction), no differences were found in responses to sucrose solutions between the SOMAs and control subjects. In line with the above finding, intensity and pleasantness ratings of Coca-Cola flavour did not differ between the groups. Thus, our results do not support previous findings in genetically selected alcohol-preferring rats (Sinclair *et al*., 1992; Stewart *et al*., 1994) and human alcoholics (Kampov-Polevoy *et al*., 1997, 1998). However, the results of the present study may support the more recent report of Agabio *et al*. (2000). These latter authors have shown that selectively bred Sardinian alcohol-preferring (sP) and Sardinian alcohol-non-preferring (sNP) rats consume similar amounts of saccharin solutions.

It should be mentioned that there are some procedural differences between the present and the previous human studies.

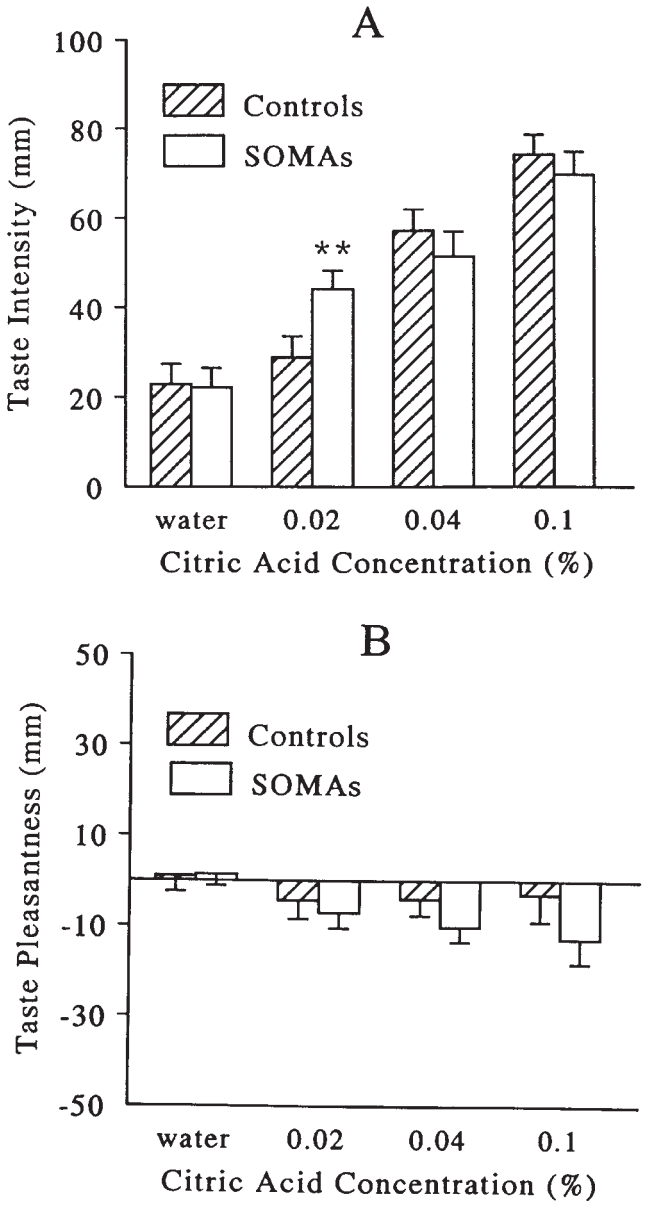

Fig. 3. Intensity (A) and pleasantness (B) ratings of citric acid taste in sons of male alcoholics (SOMAs) and control subjects. $^{**}P < 0.01$ vs taste responses of control subjects (Newman–Keuls test). Values are means ± SEM (bars).

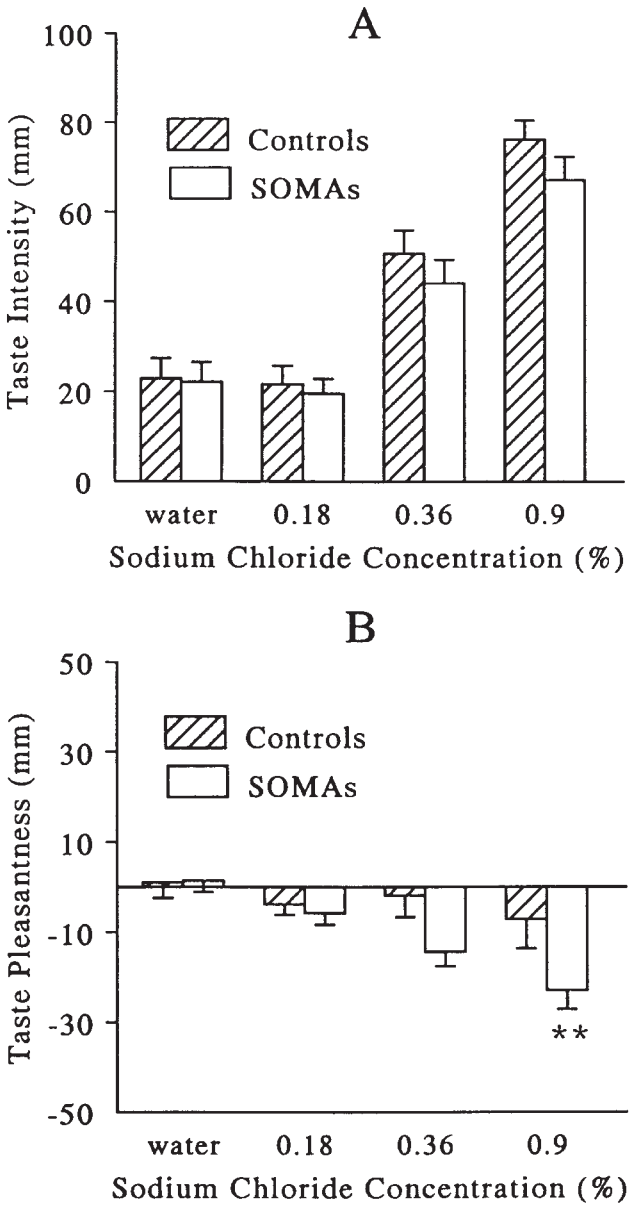

Fig. 4. Intensity (A) and pleasantness (B) ratings of sodium chloride taste in sons of male alcoholics (SOMAs) and control subjects. $^{**}P < 0.01$ vs taste responses of control subjects (Newman–Keuls test). Values are means ± SEM (bars).

First, Kampov-Polevoy *et al*. (1997, 1998) recruited alcohol-dependent men for their studies. Accordingly, the long-term history of alcohol intake (and/or any other factor associated with it) might have affected taste responses in those subjects. On the other hand, it can be suggested that only a proportion of the high-risk individuals recruited for the present study actually had a specific high-risk genotype (Pollock, 1992).

Second, it cannot be excluded that changes in reactivity to sweet tastants in SOMAs appear with age and/or as a consequence of environmental influences. It has been shown that humans reduce their preferred level of sweetness with age (Desor *et al*., 1975; Desor and Beauchamp, 1987). Recently, DeGraaf and Zandstra (1999) have reported that children (9–10 years) prefer higher sucrose concentrations than adolescents (14–16 years), and both children and adolescents prefer higher sucrose concentration than adults (20–25 years). It cannot be excluded that SOMAs do not show developmental changes in sweet preference. Future studies including older SOMAs might address the above hypothesis.

The alcohol-dependent men participating in the previous studies (Kampov-Polevoy *et al*., 1997, 1998) were older (mean age ~40 years) than the SOMAs recruited for the present experiment. In line with the above, the proportion of 'sweet likers' in our control group (73%) was substantially

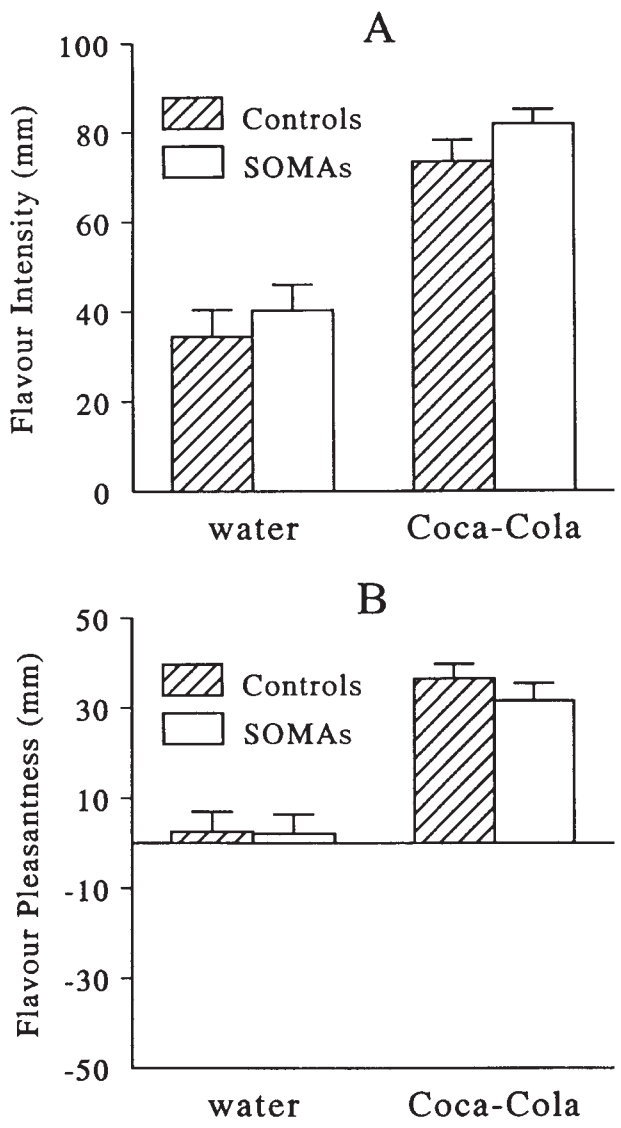

Fig. 5. Intensity (A) and pleasantness (B) ratings of distilled water and Coca-Cola flavour in sons of male alcoholics (SOMAs) and control subjects.
Values are means ± SEM (bars).

higher than that reported by Kampov-Polevoy *et al*. (16–21%). Notably, this high percentage of 'sweet likers' in our control population might prevent further increase of this proportion among the SOMAs.

Third, although the order of the gustatory sample administration was randomized in the present study, it is possible that the inclusion of other tastants altered responses to the sucrose solutions. Other tastants have not been used in the previous human studies. Similarly, samples of distilled water have not been administered by Kampov-Polevoy *et al*. (1997, 1998).

In comparison with the control group, the SOMAs rated the salty solutions as more unpleasant. In addition, intensity of the lowest citric acid concentration was increased in the SOMAs, although in this case the results of statistical analysis were less conclusive. As pleasantness and intensity ratings of the sucrose and quinine solutions did not differ between the groups, it seems rather unlikely that the above differences resulted from any cognitive deficits and/or personality characteristics found in SOMAs (Gabrielli and Mednick, 1983; Drejer *et al*., 1985; Finn and Pihl., 1987; Whipple *et al*., 1988; Knowles and Schroeder, 1990; Peterson *et al*., 1992).

Taste reactivity to salty solutions is typically correlated with salt appetite and consumption (Beauchamp *et al*., 1990; Stellar and Epstein, 1991). Thus, the present results support previous reports on the relationship between alcohol and salt consumption in the rat. It has been shown that, in a free-choice situation, genetically selected alcohol-preferring P rats consume less salty solutions than their alcohol-non-preferring NP counterparts (Stewart *et al*., 1994). Interestingly, another genetically selected line of salt-sensitive (SS) rats, bred to develop hypertension when fed a high-salt diet (Dahl *et al*., 1962), had lower salt preference and drank more alcohol than their salt-resistant SR counterparts (Grupp *et al*., 1986, 1991).

Considering the results of the present study, one should be aware that the SOMAs selected by our group may not represent the whole population of SOMAs. For example, our SOMAs might represent a subgroup in which those with highest risk for alcohol dependence were eliminated. In addition, it should also be mentioned that environmental factors might have contributed to the taste responses in the SOMAs recruited for the present study. For example, it is possible that the pattern of salt consumption (or any other dietary habit) is altered in families with alcoholic fathers. This hypothesis could be tested in future studies on dietary choices in alcohol-dependent individuals and their families.

In conclusion, the results of the present study suggest that taste responses to sweet and bitter solutions do not differ between SOMAs and subjects with no family history of alcoholism. On the other hand, it seems that responses to salt and to a lesser extent to sour taste may be associated with paternal history of alcohol dependence. Further studies with larger experimental groups are needed to clarify this.

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