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RAPID COMMUNICATION

TASTE RESPONSES IN ALCOHOL-DEPENDENT MEN

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Abstract — The aim of the present study was to compare taste responses to sweet, bitter, sour and salty solutions in male alcoholics and control subjects. The groups did not differ in terms of rated intensity or pleasantness of sucrose (1–30%), quinine (0.001–0.005%), citric acid (0.02–0.1%) and sodium chloride (0.18–0.9%) solutions. The proportion of sweet-likers was also similar in both groups.

INTRODUCTION

It has been repeatedly reported that rodents with a high preference for sweet solutions consume more ethanol (alcohol) than rats or mice with a low sweet preference (Sinclair *et al*., 1992; Bachmanov *et al*., 1996). 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). In line with the above, it has been shown that 46–65% of male alcoholics were 'sweet-likers', i.e. preferred high-concentration sucrose solution (0.83 M), compared with 12–21% of non-alcoholic controls (Kampov-Polevoy *et al*., 1997, 1998, 2001). Given the above, it has been suggested that the same gene(s) regulates sweets and alcohol preference and that altered responses to sweet taste could be a marker for alcoholism risk (Kampov-Polevoy *et al*., 1999).

However, it should be noted that both inherited and environmental factors might have contributed to the results of Kampov-Polevoy *et al*. (1997, 1998). For example, it is possible that long-term consumption of alcoholic beverages alters taste sensitivity in alcohol addicts (Smith, 1972; Maier *et al*., 1994). Thus, in the present study, we decided to compare taste responses in male alcoholics and individuals without alcohol-related problems. For this aim, all subjects rated intensity and pleasantness of sweet (sucrose), bitter (quinine), sour (citric acid) and salty (sodium chloride) solutions.

SUBJECTS AND METHODS

Subjects

Thirty abstinent male alcoholics were recruited from the Inpatient Clinics of the Department of Prevention and Treatment of Addictions. All alcoholics met DSM-IV criteria for alcohol dependence (American Psychiatric Association, 1994). The patients were excluded if they had an additional substance use disorder other than nicotine dependence. The mean (± SEM) duration of alcohol dependence was 14 ± 1.4 years (range: 2–27). The mean (± SEM) duration of last abstinence was 40 ± 7 days (range: 6–105). Since only a small proportion of alcoholics who were approached refused to take part (<10%) the group recruited for the study was representative of our in-patient population. Thirty-two male volunteers without a history of alcohol misuse/dependence and consuming ≤1 drink/day served as controls. The controls were recruited through all institutions involved in the study from families of staff members. The subjects in both groups were Caucasians, aged 21–63 years (see Table 1), in good medical health and had no history of an Axis I psychiatric disorder. Care was taken to eliminate individuals with disorders known to alter gustatory or olfactory function (Cullen and Leopold, 1999). An interview based on DSM-IV criteria was administered to each participant to assess paternal history of alcoholism. 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 participant read and signed an informed consent form prior to the initiation of the study.

Procedure

Taste tests were conducted between 14:00 and 17:00 in a quiet room. The participants were asked to refrain from eating, drinking and smoking for at least 1 h prior to the test session. The subjects were questioned regarding drinking coffee and tea, adding sugar to beverages and smoking cigarettes. The Fagerström Tolerance Questionnaire (FTQ) was used to assess nicotine dependence (Fagerström, 1978). Craving for sweets on the day of testing was rated on a 100-mm line (0 = 'not at all', 100 = 'very much').

Increasing concentrations of sucrose (1, 10, 30%, w/v; Krasnystaw Sugar Refinery, Krasnystaw, Poland), quinine hydrochloride (0.001, 0.002, 0.005%; Polfa, Warsaw, Poland), citric acid (0.02, 0.04, 0.1%; Libella, Kotyn, Poland), and sodium chloride (0.18, 0.36, 0.9%; Polfa, Lublin, Poland) were administered in a volume of 1 ml on the anterior tongue

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Table 1. Baseline characteristics of subjects

Parameter	Controls (n = 32)	Alcoholics (n = 30)	Statistics (P)
Age (years)[a]	41.3 ± 1.5[a]	43.6 ± 1.6	>0.05; *t*-test
Weight (kg)[a]	82.8 ± 1.9	79.6 ± 1.6	>0.05; *t*-test
Body mass index[a]	26.1 ± 0.6	25.8 ± 0.5	>0.05; *t*-test
Paternal history of alcoholism (%)[b]	25	47	>0.05; Fisher exact test
Presently employed (%)	100	60	<0.01; Fisher exact test
Education (years)[a]	13.3 ± 0.4	12.9 ± 0.5	>0.05; *t*-test
Smokers (%)	41	80	<0.05; Fisher exact test
Fagerström Tolerance Questionnaire score[a,c]	5.2 ± 0.4	5.7 ± 0.4	>0.05; *t*-test
Tea drinking (cups/day)[a]	2.3 ± 0.3	2.6 ± 0.5	>0.05; *t*-test
Coffee drinking (cups/day)[a]	1.8 ± 0.3	2.0 ± 0.4	>0.05; *t*-test
Adding sugar to beverages (spoonful/cup)[a]	1.4 ± 0.2	1.4 ± 0.2	>0.05; *t*-test

[a]Means ± SEM.
[b]Subjects with alcoholic fathers.
[c]Calculated only for smokers.

from single-use syringes. The same volume of distilled water was used as a control stimulus (Scinska *et al*., 2000, 2001). Accordingly, each participant received and rated 13 different gustatory samples. 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). The solutions were prepared with distilled water on the day of administration and stored at room temperature. The order of tastants administration was counterbalanced across the subjects.

The participants were asked to taste thoroughly each sample within the entire oral cavity and to rate intensity and pleasantness 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) (Scinska *et al*., 2001). The testing of each sample was separated by 60 s during which 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. Sucrose concentration rated as the most pleasant was identified for each participant. The subjects preferring 30% sucrose (0.88 M) were designated as sweet-likers (Kampov-Polevoy *et al*., 1997; Scinska *et al*., 2001). To accommodate the large number of comparisons, Bonferroni's correction was used in statistical analyses.

RESULTS AND DISCUSSION

Baseline characteristics of the subjects are presented in Table 1. There was no significant difference between the controls and alcoholics in terms of age, weight, body mass index, education, adding sugar to beverages, coffee and tea drinking. The alcoholics were more frequently unemployed. Although the percentage of cigarette smokers was higher in the group of alcohol-dependent men, a mean FTQ score was similar in the alcoholic and non-alcoholic smokers (Table 1). The proportion of subjects with alcoholic fathers tended to be higher in the group of alcoholics. However, the difference did not reach significance. Craving for sweets on the day of testing did not differ between the alcoholics (mean ± SEM: 22.7 ± 4.5) and controls (15.4 ± 4.3; $t = 1.18$, $P > 0.05$; Student's *t*-test).

A two-way analysis of variance (ANOVA) (Group × Concentration) revealed that intensity ratings of every tastant increased with concentration ($F > 53.59$, $P < 0.01$; Table 2). The analysis of responses to sucrose, quinine, citric acid and sodium chloride did not reveal any significant Group effect or Group × Concentration interaction ($F < 1.99$, $P > 0.05$).

Pleasantness ratings varied with concentration for sucrose, quinine and sodium chloride ($F > 5.95$, $P < 0.05$; Table 2). In the case of citric acid, pleasantness ratings did not change with concentration [$F(3,180) = 0.31$, $P > 0.05$]. The ANOVA did not indicate any significant Group effect or Group × Concentration interaction when hedonic responses to sucrose, quinine, citric acid and sodium chloride were analysed ($F < 2.28$, $P > 0.05$). A separate two-way ANOVA (Paternal history × Concentration) indicated that paternal history of alcoholism did not alter gustatory responses to any tastant ($F < 3.24$, $P > 0.05$). The proportion of sweet-likers among the subjects with a positive paternal history of alcoholism (64%) was comparable to that found in the group with no alcoholic fathers (55%; $P > 0.05$, Fisher exact test).

Sixty-three per cent of the alcoholics preferred the highest sucrose concentration compared with 53% of the control group. The proportion of sweet-likers did not differ between the groups ($P > 0.05$, Fisher exact test). Taste responses in the group of alcoholics did not correlate with abstinence duration ($P > 0.05$, Pearson product-moment correlation test).

Contrary to the previous suggestions (Kampov-Polevoy *et al*., 1997, 1999, 2001), no differences were found in responses to sucrose solutions between controls and alcoholics. The percentage of sweet-likers as well as reported amounts of sugar added to beverages did not differ between the groups. Paternal history of alcoholism did not alter reactivity to sweet solutions in the present study. In general, our findings are in line with recent reports (Kranzler *et al*., 2001; Scinska *et al*., 2001; but see also Kampov-Polevoy *et al*., 2001) showing normal responses to sweets in children of alcoholics, i.e. in the population known to be at increased risk of developing alcohol dependence (Cloninger *et al*., 1981; Goodwin, 1985). The results of the present study may also support the findings of Agabio *et al*. (2000), who showed that selectively bred Sardinian alcohol-preferring (sP) and Sardinian alcohol-non-preferring (sNP) rats consume similar amounts of sweet solutions.

Table 2. Mean (± SEM) intensity and pleasantness ratings of sucrose, quinine, citric acid and sodium chloride solutions in male alcoholics and controls

	Intensity		Pleasantness	
Solution (%)	Controls	Alcoholics	Controls	Alcoholics
Water	8.7 ± 2.7	18.8 ± 4.3	–1.0 ± 1.8	–5.8 ± 2.3
Sucrose				
1	31.1 ± 3.2	27.9 ± 3.8	8.8 ± 2.2	–1.8 ± 2.6
10	68.5 ± 3.9	69.1 ± 3.4	21.9 ± 3.0	21.6 ± 3.6
30	81.7 ± 3.6	83.9 ± 2.5	21.8 ± 3.4	21.5 ± 4.3
Quinine				
0.001	23.8 ± 4.2	25.0 ± 4.6	–7.3 ± 3.0	–5.8 ± 2.7
0.002	33.3 ± 4.9	42.9 ± 6.0	–14.6 ± 3.2	–21.7 ± 3.6
0.005	63.7 ± 5.3	57.4 ± 6.1	–23.2 ± 3.9	–22.6 ± 3.7
Citric acid				
0.02	19.9 ± 3.2	20.7 ± 3.7	–1.9 ± 2.3	–3.6 ± 2.0
0.04	42.2 ± 3.6	33.8 ± 4.7	–2.5 ± 3.3	–3.5 ± 3.8
0.1	63.4 ± 3.6	54.0 ± 4.2	–7.6 ± 3.9	–1.7 ± 3.4
Sodium chloride				
0.18	15.0 ± 2.7	17.7 ± 3.3	–2.0 ± 1.7	–4.1 ± 2.7
0.36	43.6 ± 4.3	40.6 ± 3.1	–7.6 ± 2.7	–6.1 ± 3.9
0.9	62.0 ± 4.0	61.1 ± 4.7	–12.3 ± 3.2	–13.5 ± 4.5

However, it should be mentioned that there are some basic procedural differences between the present and previous studies on the relationship between sweet preference and alcohol dependence (Kampov-Polevoy *et al*., 1997, 2001). First, tastants other than sucrose have not been used in the previous studies. Although the order of the sample administration was randomized in our study, it is possible that the inclusion of other tastants altered gustatory responses to sweet solutions. Second, samples of distilled water were not administered by Kampov-Polevoy *et al*. These latter authors used five different sucrose solutions administered in a volume of 25 ml. Each solution was presented five times in random order. Thus, it seems that the subjects in the previous studies might have had a better reference point to evaluate pleasantness of different sucrose solutions.

Despite the above differences, the proportions of sweet-likers among the alcoholics in the present (63%) and previous studies (46–65%) were similar. In contrast, the percentage of sweet-likers among the controls in the present study (53%) was much higher than that (12–21%) reported by Kampov-Polevoy *et al*. (1997, 1998, 2001). Our results seem to be more comparable with data presented by Kranzler *et al*. (2001) who classified 75% of their non-alcoholic subjects (mean age: 26 years) as sweet-likers. Hedonic responses to sweets may decline with age (Cullen and Leopold, 1999). However, the non-alcoholic men recruited by Kampov-Polevoy *et al*. were even younger (mean age: 32.0 or 38.8 years) than those enrolled in the present study.

In a study on the relationship between alcohol dependence and reactivity to bitter solutions, Smith (1972) showed that alcohol addicts had higher taste threshold to quinine. The results of the present study seem not to support this latter finding. However, one should be aware that a completely different procedure (determination of threshold concentration) was used by Smith (1972). It is also possible that the alcoholics included in the present study do not represent the population of alcohol addicts. For example, men with more severe forms of alcohol dependence, e.g. with more antisocial features, are less likely to seek professional help and to enter in-patient treatment programmes. Given the well-known effects of alcohol on oral biology (Dutta *et al*., 1992; Maier *et al*., 1994), further studies with larger experimental groups will be necessary to evaluate fully the effects of chronic alcohol consumption on taste reactivity in humans.

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REFERENCES

Agabio, R., Carai, M. A. M., Lobina, C., Pani, M., Reali, R., Bourov, I., Gessa, G. L. and Colombo, G. (2000) Dissociation of ethanol and saccharin preference in sP and sNP rats. *Alcoholism: Clinical and Experimental Research* **24**, 24–29.

American Psychiatric Association (1994) *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn. American Psychiatric Association Press, Washington, DC.

Bachmanov, A. A., Reed, D. R., Tordoff, M. G., Price, R. A. and Beauchamp, G. K. (1996) Intake of ethanol, sodium chloride, sucrose, citric acid, and quinine hydrochloride solutions by mice: a genetic analysis. *Behavior Genetics* **26**, 563–573.

Cloninger, C. R., Bohman, M. and Sigvardsson, S. (1981) Inheritance of alcohol abuse. *Archives of General Psychiatry* **38**, 861–868.

Cullen, M. M. and Leopold, D.A. (1999) Disorders of smell and taste. *Medical Clinics of North America* **83**, 57–74.

Dutta, S. K., Orestes, M., Vengulekur, S. and Kwo, P. (1992) Ethanol and human saliva: effect of chronic alcoholism on flow rate, composition and epidermal growth factor. *American Journal of Gastroenterology* **87**, 350–354.

Fagerström, K. O. (1978) Measuring degree of physical dependence to tobacco smoking with reference to individualization of treatment. *Addictive Behaviors* **2**, 235–241.

Goodwin, D. W. (1985) Alcoholism and genetics: the sins of the fathers. *Archives of General Psychiatry* **42**, 937–947.

Kampov-Polevoy, A. B., Garbutt, J. C. and Janowsky, D. S. (1997) Evidence of preference for a high-concentration sucrose solution in alcoholic men. *American Journal of Psychiatry* **154**, 269–270.

Kampov-Polevoy, A. B., Garbutt, J. C., Davis, C. E. and Janowsky, D. S. (1998) Preference for higher sugar concentrations and Tridimensional Personality Questionnaire scores in alcoholic and non-alcoholic men. *Alcoholism: Clinical and Experimental Research* **22**, 610–614.

Kampov-Polevoy, A. B., Garbutt, J. C. and Janowsky, D. S. (1999) Association between preference for sweets and excessive alcohol intake: a review of animal and human studies. *Alcohol and Alcoholism* **34**, 386–395.

Kampov-Polevoy, A. B., Tsoi, M. V., Zvartau, E. E., Neznanov, N. G. and Khalitov, E. (2001) Association between preference for sweets and excessive alcohol intake: a review of animal and human studies. *Alcohol and Alcoholism* **36**, 165–170.

Kranzler, H. R., Sandström, K. A. and Van Kirk, J. (2001) Sweet taste preference as a risk factor for alcohol dependence. *American Journal of Psychiatry* **158**, 813–815.

Maier, H., Weidauer, H., Zöller, J., Seitz, H. K., Flentje, M., Mall, G. and Born, I. A. (1994) Effect of chronic alcohol consumption on the morphology of the oral mucosa. *Alcoholism: Clinical and Experimental Research* **18**, 387–391.

Scinska, A., Koros, E., Habrat, B., Kukwa, A., Kostowski, W. and Bienkowski, P. (2000) Bitter and sweet components of ethanol taste in humans. *Drug and Alcohol Dependence* **60**, 199–206.

Scinska, A., Bogucka-Bonikowska, A., Koros, E., Polanowska, E., Habrat, B., Kukwa, A., Kostowski, W. and Bienkowski, P. (2001) Taste responses in sons of male alcoholics. *Alcohol and Alcoholism* **36**, 79–84.

Sinclair, J. D., Kampov-Polevoy, A. B., Stewart, E. and Li, T.-K. (1992) Taste preferences in rat lines selected for high and low ethanol consumption. *Alcohol* **9**, 155–160.

Smith, S. E. (1972) Taste thresholds in drug addicts and alcoholics. *British Journal of Addiction* **67**, 317–321.