EFFECT OF SMOKING ON TASTE THRESHOLDS FOR PHENYL-THIO-CARBAMIDE (PTC)

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In the course of experiments on tasting ability the question arose as to whether a person's threshold was the true one if he had been recently smoking. Salmon and Blakeslee (1935) tested a large group for PTC threshold and recorded the type of smoking for each individual (heavy, moderate, none). These records show that the position of the subject's threshold on the PTC scale is not correlated with his smoking habits. That is, a heavy smoker is just as likely to have a low threshold as a high one and vice versa. The amount that an individual might vary from his resting threshold when he smoked again had not been tested. (Resting threshold is here used as the value obtained after nine or more hours of abstinence from tobacco.)

Such a series of tests was therefore undertaken to show the effect, if any, that tobacco has on the taste apparatus, and to determine how long a time must elapse between smoking and a return to the original threshold.

In a search of the literature for the effect of tobacco on the various senses it was found that the following reactions have been studied: visual acuity, skin pressure sense, eye accommodation, skin reaction to slight electric currents, taste preferences, and mental and physical efficiency. In addition a number of workers have analyzed smoke and the tobacco in its various forms, snuff, pipe cuts, and cigarettes, for the ingredient causing the reactions. Bogen (1936) after careful analyses reports that no single explanation applies to the problem of irritation by tobacco smoke. The innocent bystander receives the sidestream rich in ammonia and other alkaline substances quite irritating to the eye and nasal passages. The smoker who gets the main stream through the cigarette or pipe stem has a more acid material thereby receiving his nicotine (alkaloid) as salts which are less irritating. The smoker does get heat, pyridine, volatile acids, tarry and phenolic constituents, and the aldehydes, furfural and acrolein. These all lead to irritation of the membranes. .All workers are fairly well agreed that nicotine in whatever form absorbed is the principal toxic agent wherever the nervous system is involved.

Carefully controlled tests on mental and physical efficiency before and after smoking show a definite correlation between change in efficiency and smoking. Hull (1924) points out the following facts:

1. There is a large and uniform increase in the tremor of the hand lasting an hour and 23 minutes.
2. There is marked and uniform stimulation of the heart which is still present an hour and 40 minutes after smoking.
3. There is a minute increase in the speed of reading reaction time.
4. There is a gain in the rate of complex mental addition lasting an hour and 15 minutes but with no measurable effect on accuracy.
5. There is a high probability of loss in auditory memory and efficiency in rote learning, with recovery in an hour.

In a series of ten mental tests Bush (1914) reports a 10.5% decrease in efficiency after smoking.

Accommodation time, both near-to-far and far-to-near sight, has been studied over a period of years at Wellesley College. Homewood and Howe (1937) have shown that accommodation time is definitely decreased during the first 20 minutes after smoking, but increased from 40 to 60 minutes after. This agrees with Schrumpf-Pierron's (1927) statement that the effect of tobacco on the nervous system is first a stimulation and then a depression. They also found that the occasional smoker was stimulated more than the habitual one and depressed sooner and to a greater extent.

Wenusch and Schöller (1936) working on skin pressure found that sensitivity to both hair pressure and pendulum stroke was changed during smoking. They do not record any stimulating effect of smoking, only a depressant one.

From a survey of the literature on the changes in mental and physical states after smoking, and from a series of electrical tests on the finger before and after smoking, Mendenhall (1930) concludes that tobacco has the same effect as rest. If a person is tired and depressed, smoking will stimulate and bring him back to normal, if overexcited it will quiet him by its depressing action. If he is in a well-rested state it has no marked effect.

Sinnot and Rauth (1937) found the thresholds for sugar and salt high in smokers, but during a period of several days during which six smokers had abstained, their thresholds fell to the level of non-smokers. Laird (1939) tested the effect of the smoking habit on the preference for sweet or tart pineapple juice. He found no difference in the taste preferences of smokers and non-smokers among men, at any age, nor among women up to forty years. Among the women of fifty to sixty-eight years the non-smokers were like the other groups, but the smokers were predominantly in favor of the tart juice rather than the sweet. He did not test each individual before and after smoking, nor does he deal with threshold ability.

In testing the present group of subjects for the effect of smoking on tasting ability each person was his own control. Smokers were tested

only after nine or more hours of abstinence from tobacco. Of the 60 subjects, 32 were from the staff at Cold Spring Harbor and 28 were advanced students and staff at Wellesley College; 32 were habitual smokers and 28 non-smokers; 24 were men and 36 women. Concentrations of PTC were used from 1:5120 M up to 1:312.5 using a factor of two, such that each solution used in a test was twice as concentrated as that previously administered. (M in these numbers represents 1000.) In each test approximately 0.6 cc. was given by means of the straw method.

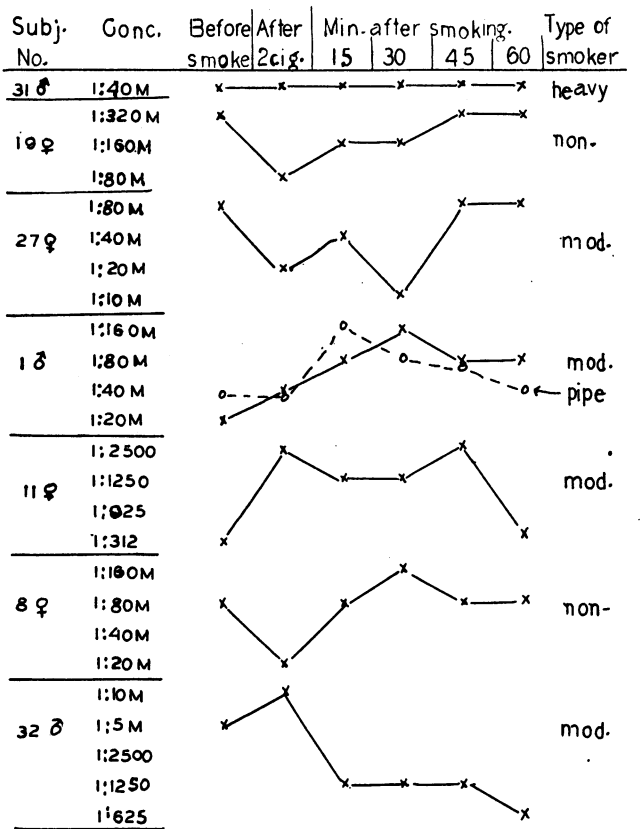

FIG. 1. ABILITY TO TASTE P.T.C. AFTER SMOKING.

Two types of experiments were performed. The procedure for the first series of tests was as follows:

1. The PTC threshold was determined.
2. The subject smoked two cigarettes of a standard brand in 10–15 minutes.
3. The PTC threshold was determined immediately after smoking and

at 15-minute intervals for one to two hours. (In several cases the tests ran still longer.) In the second series 10 individuals of the first series, both smokers and non-smokers, were tested as above except that the smoke was drawn through a dry flask for cooling and into the nose through a sterilized nose-piece keeping the mouth closed so that the smoke did not touch the taste buds.

A summary of the results of the first series may be found in table 1. Figure 1 shows typical PTC curves for each of the behavior groups.

TABLE 1

SUMMARY OF THE REACTIONS TOWARD PHENYL-THIO-CARBAMIDE AFTER SMOKING (SMOKE TAKEN IN THROUGH THE MOUTH)

CHANGE IN TASTING ABILITY	INDIV. IN GROUP	% OF TOTAL TESTED	NO. PTC GRADES INC.	NO. PTC GRADES DEC.	RETURN TO INITIAL LEVEL NO.	RETURN TO INITIAL LEVEL TIME	SMOKER YES	SMOKER NO	SEX ♂	SEX ♀
A. None	4	6.6	...	...	4	No change	2	2	1	3
B. Decreased only	32	53.3	...	1–5	22	30′–60′	15	17	12	21
					10	Over 60′				
C. Increased only	10	16.7	1–4	...	6	15′–60′	8	2	5	5
					4	Over 60′				
D. Decreased then increased	12	20.0	1–2	1–2	7	30′–60′	5	7	5	7
					5	Over 50′				
E. Increased then decreased	2	3.3	1	1–2	2	Over 60′	2	..	1	1
Totals	60	100			35	15′–60′	32	28	24	36
					21	Over 60′				

There were three types of reaction:

1. No change in tasting ability, group A (6.6%).
2. Decrease in tasting ability, groups B and D (73.3%): group B returned to initial level (53.3%); group D returned to initial level and then showed an increase (20%).
3. Increase in testing ability, groups C and E (20%): group C returned to initial level (16.7%); group E returned to initial level and then showed a decrease (3.3%).

These figures check very well with those of Mendenhall (1930) working on sensitivity to electric shock. He found that when tested before and after smoking (750 observations) 72.2% of the cases showed a depression while 28.3% showed a stimulation. In our work for taste 73.3% were depressed, 20% were stimulated and 6.6% showed no change.

Considering the time at which depression and stimulation occur the following summary may be made:

Time at which tasting ability is first lowered (groups B, D):

38 during smoking (10–15 minutes)
4 by 15 minutes after smoking
2 by 30 minutes after smoking

Time at which tasting ability is first increased (groups C, E):

8 during smoking
3 by 15 minutes after smoking
1 by 30 minutes after smoking

Time of greatest increase after an initial decrease (groups B, D):

5 by 15 minutes after smoking
10 by 30 minutes after smoking
16 by 45 minutes after smoking
10 by 60 minutes after smoking
3 not increased again by 60 minutes (one was still low at 105 min.)

Thus it may be seen that the initial depression occurs during smoking or by 15 minutes after. For those who show no initial decrease, stimulation occurs for most individuals during smoking or in 15–30 minutes after. If there is an initial decrease the return to the original threshold or to a period of stimulation is for most subjects at 30–45 minutes after smoking.

The taste apparatus according to Ranson (1939) is composed of taste buds on the tongue from which two sets of special afferent visceral fibers pass to the tractus solitarius via the chorda tympani (of the seventh cranial nerve) and the glosso-pharyngeal nerve. These taste fibers connect with the anterior part of the nucleus of the tractus solitarius. Further connections are rather vague but certainly reflexes to the gustatory center and the motor nuclei for mastication and swallowing exist. A cerebral center is not definitely fixed but a spot near the anterior end of the temporal lobe is thought to have such function. There are at least three synapses then between the surface of the tongue and consciousness.

According to the work done on other sensory-motor arcs the expected curve for taste should show an initial level, a more sensitive period, and then a depression period. But we have here an added factor to complicate results, namely, the exposure of the sensory endings, the taste buds, to the various drugs resulting from the combustion. It may be that the depressant effect on the taste buds antedates or coincides with the stimulative effect on the nerve cells and thus we get several forms of curves for the first half hour depending on the comparative strength of the two factors. Some individuals keep to the same level at first with later depression, others have a sharp early depression followed by stimulation, while others are stimulated immediately and to a greater degree than the depression

of the taste buds. We felt that it might be enlightening so to conduct the smoking period that the taste buds would not be touched by the smoke. Of the 10 individuals so tested 3 showed no change in tasting ability for 30 minutes to an hour followed then by a depression. Six had an initial stimulation followed at 30 to 45 minutes by a depression. These persons had all shown initial depression when smoking by mouth. One subject (of group C) who showed only stimulation when smoking by mouth had the same type of reaction (stimulation only) when smoking by "nose." Figure 2 shows the mouth and "nose" curves for two of these subjects.

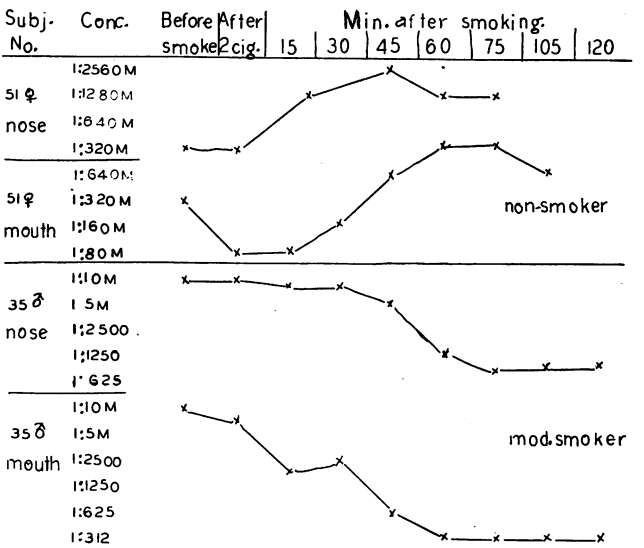

FIG. 2. EFFECT OF SMOKING BY NOSE.

It would seem then that the sharp depression noted for the larger number of subjects in series 1 may be due to the direct action of some product of combustion on the taste buds rather than to the effect of nicotine on the nerve cells.

We may therefore make the following conclusions:

1. There is a definite effect on the individual's ability to taste PTC after smoking, 73.3% of the subjects requiring stronger solutions in order to taste after smoking and 20% of them tasting weaker solutions.

2. The time which must elapse after smoking before the individual is a proper subject for tasting experiments varies with the individual. In the present series of tests only 58% had returned to the resting threshold within an hour, while some took several hours for recovery.

3. The initial effect of smoking in the larger number of cases is a direct dulling of the taste buds by some product of the combustion.

4. The true effect of nicotine on the nerve apparatus for taste appears to be the same as for other nerves tested—an initial stimulation with later depression.

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RESPIRATORY ENZYMES IN PARAMECIUM: 1. CYTOCHROME OXIDASE

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It has been generally stated, as the result of the work of a number of investigators,[1, 2, 3] that cyanide is without effect on the respiratory activity of Paramecium. The report of Kalmus[4] that respiration of Paramecium is depressed by cyanide has been largely disregarded because of serious defects in his experimental technique (cf. Howland and Bernstein[5]). Cyanide was likewise shown to be without effect on the respiration of a number of other ciliates,[6, 7, 8] and the conclusion was reached, as summarized by Lwoff,[8] that "Cette insensibilité à HCN et à CO n'est pas générale chez les Protozoaires, mais est jusqu'ici particulière aux Infusoires." The repeated failure to obtain depression of respiration in ciliates with cyanide and similar inhibitors led naturally to the belief that oxidations in these forms were mediated by a mechanism which was different from that of most aerobic cells.[9]