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THE EFFECTS OF SMOKING ON THE CFF THRESHOLD*

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This study was initiated as an essential preliminary to a more extensive project on nicotine and smoking. An earlier study by Eysenck et al. (1) had demonstrated a relationship between extraversion and smoking, and it was felt that this could be related to current work on the interaction of personality differences and drug effects (2). The connecting link can be found in the hypothesis put forward by Burn (3) concerning the effect of nicotine on the C.N.S. He points out that nicotine can readily liberate the stores of noradrenaline present in the hypothalamus, mid-brain and medulla. Thus nicotine has an effect similar to that of amphetamine, which acts as a C.N.S. stimulant.

However, before embarking on a large-scale study, it was necessary to observe the effects of smoking in a clearly defined situation, in which the action of a drug could be clearly delineated. For this reason, it was decided to look at the effect of smoking on the critical flicker fusion threshold. Landis (4) and Holland (5) have shown the CFF threshold to be sensitive to drug action. Also Larson, Finnegan and Haag (6) have found that in a group of habitual smokers, smoking a cigarette after a period of abstinence, produced an immediate increase in CFF. They also noted that this effect was a result of the action of nicotine, as it did not occur if the cigarettes contained less than 0.2% of nicotine.

Unfortunately, the above experiment was restricted to habitual smokers, and a further study by Garner, Carl and Grossman (7,8) using both smokers and

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of one cycle per second. The threshold was measured seven times on each occasion, but the first two readings were ignored. The CFF threshold was taken as the mean value of the last five readings.

Nine subjects were used, five smokers and four non-smokers. None of the non-smokers inhaled an appreciable amount of smoke, so it could be assumed that they absorbed an insignificant quantity of nicotine.

The smokers were tested 3 times each under the following conditions:- (a) abstaining for 12 hours, then smoking one cigarette; (b) smoking normally beforehand, then one cigarette; (c) no cigarette during the testing session. The non-smokers were tested under two conditions, smoking one cigarette in the test session, and without smoking.

Thresholds were determined three times, at five-minute intervals before smoking the cigarette, and four times at five-minute intervals after smoking. The cigarettes used were a standard brand of normal size, unfiltered cigarette. No attempt was made to make the subjects inhale more than they normally did.

Results.

In Table I the change in the mean level of the CFF threshold under the various conditions is shown. It is obvious that the only significant change in threshold is for the smokers, who have abstained from smoking before the test. This result is to be expected, as the non-smokers who did not inhale were not absorbing a sufficient quantity of nicotine to have any effect. A possible reason for the lack of effect in smokers, who had not abstained before the test, is that the amount of nicotine absorbed from one cigarette is quite small relative to the amount they will have absorbed by smoking before the test.

TABLE I

Mean Changes in CFF Threshold after Smoking

	Smoking (no smoking before)	Smoking (normal smoking before)	No Smoking
Smokers	+1.7	-0.02	-0.06
Non-smokers	-0.05		-0.02

Figs. I and II show the precise time-course of the experiment; it will be seen that the nicotine effect lasts for approximately 15 minutes.

The statistical significance of the changes was calculated by means of "t" tests. The effects of smoking in non-smokers were non-significant ($t = 0.2$). Effects on smokers not smoking beforehand were significant with $p < .02$ and $< .01$ respectively, as compared with (a) smoking normally beforehand, or (b) compared with the control condition, i.e. when they did not smoke during the experimental session. There were no significant or even suggestive differences between the two conditions where Ss smoked beforehand, but not in the experimental situation, and where Ss smoked beforehand and in the experimental situation. To achieve significance, it is required that abstinence prior to the test should be combined with smoking during the test.

Several conclusions can be drawn from these results. Firstly, the change in the CFF threshold is in the same direction as that found by Holland (5) for stimulant drugs (i.e. an increased flash rate), and is thus in line with predictions from Eysenck's (9) drug postulate.

Also several important methodological indications can be drawn from this study regarding future work on the effects of nicotine. Cigarette smoking, as a technique for the administration of nicotine is not of much value, as the amount absorbed will be dependent on whether the subject is an inhaler or non-inhaler. Secondly, it is almost impossible to produce an adequate placebo cigarette. Consequently, it would seem advisable to administer the nicotine in the form of tablets to ensure that all subjects receive the same dose. Another point is that habitual smokers must be deprived of cigarettes for a number of hours before testing, or the effects of the nicotine will be nullified. Finally, it must be kept in mind that heavy smokers tend to develop a tolerance to nicotine, which may produce differential effects (10).

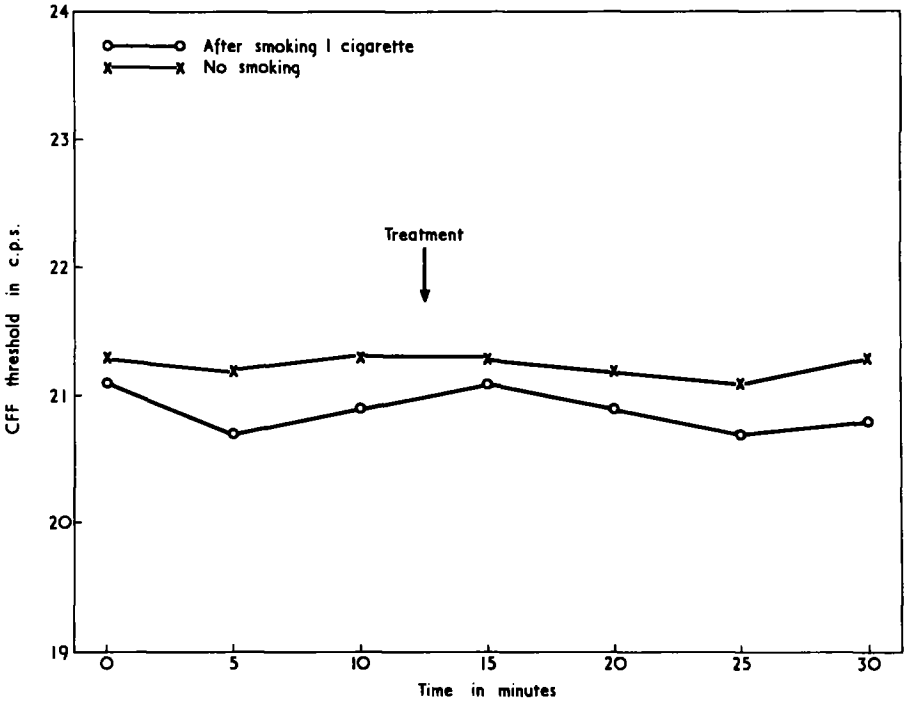

FIG. I. CFF thresholds for two groups of subjects.

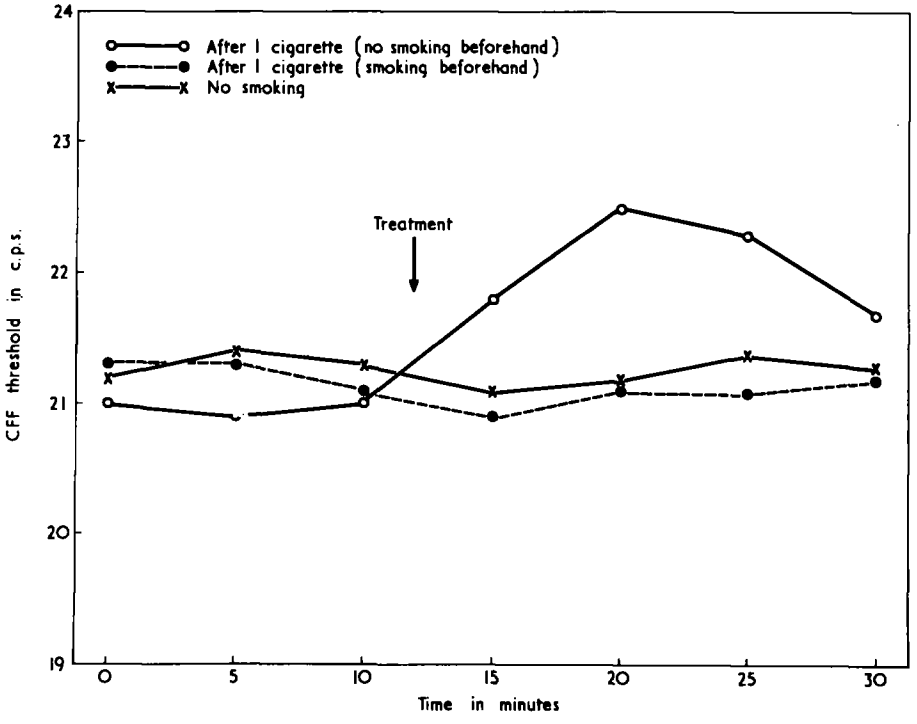

FIG. II. CFF thresholds under three conditions of treatment.

Experiment Two

This experiment was an extension of the previous study, but substituting for the smoking of one cigarette the oral administration of 0.1 mg. of nicotine, absorbed through the buccal membrane. The psychophysical procedures used were the same, and the optical system used was identical with that of Experiment One, except that the light source was a Feranti CL40 glow modulator tube, which emitted a blue light. The intensity of the light was lowered by means of neutral density filters, and was approximately twice the intensity of the light source in Experiment One. This increase in intensity would lead us to expect higher thresholds, and these were indeed obtained, as will be seen in Fig. III.

Three groups of 5 subjects each were tested under drug, placebo and no-drug conditions. None of the subjects had smoked before the test was carried out.

The results are shown in Fig. III, and it will be seen that they are similar to those from Experiment One, i.e. nicotine has the effect of elevating the CFF threshold. The changes in threshold due to nicotine are significant at the $p < 0.001$ level when comparing the drug and placebo groups, and at the $p < 0.01$

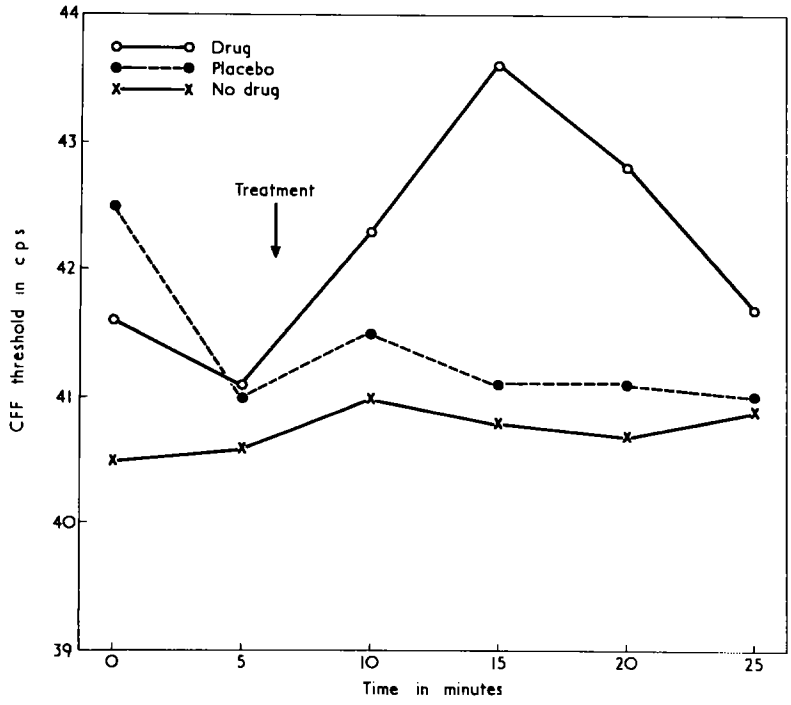

FIG. III. CFF thresholds under drug, placebo and no-drug conditions.

level when comparing the drug versus no-drug groups. The effect seems to be more pronounced in Experiment Two than in Experiment One, probably because nicotine can be absorbed in tablet form better than from smoking the cigarette.

Summary

CFF thresholds were determined in groups of smokers and non- smokers when nicotine was administered (a) through smoking a cigarette, (b) orally. It was found that the CFF threshold was raised after the administration of nicotine orally, and also after smoking one cigarette; however there was no change after smoking for non-smokers (presumably because they fail to inhale) or for smokers who had not abstained beforehand. The experiment supports the hypothesis that nicotine is a stimulant drug.

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