

BRIEF COMMUNICATION

Preference Among Research Cigarettes With Varying Nicotine Yields¹

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Received 21 October 1986

BOREN, J. J., M. L. STITZER AND J. E. HENNINGFIELD. *Preference among research cigarettes with varying nicotine yields.* PHARMACOL BIOCHEM BEHAV 36(1) 191-193, 1990. —Cigarette smokers (N = 18), primarily women, chose, under double blind conditions, among three research cigarettes with nicotine yields of 0.17, 0.89 and 2.02 mg. Choices were made daily for 12 days following an initial 24-hour forced exposure to each cigarette type. Each subject developed a clear and stable preference for one cigarette type. Of 211 total choice opportunities analyzed, 46% were for the highest nicotine yield cigarette, 29% were for the medium yield, and 25% of the total dose selections were for the low yield cigarettes, suggesting a weak effect of dose. Across subjects, however, the preferences which developed were not significantly related to nicotine yield: low and medium yield cigarette were each preferred by 5 subjects; the remaining 8 subjects came to prefer the high yield cigarette. There was no consistent relationship between nicotine yield of the preferred experimental cigarette and that of the subjects' usual brand. In general, the cigarette choice data are consistent with the behavior of smokers in nonlaboratory settings who also tend to develop stable brand preferences. Specifically, within the range of cigarettes evaluated in this study, nicotine yield is not a strong determinant of cigarette type/brand preference.

Research cigarettes Cigarette preference Varying nicotine yields

CIGARETTE smokers typically buy and use one cigarette brand at a time and brand loyalties tend to remain stable for many years. Because nicotine is the primary pharmacological constituent that controls cigarette smoking (4), the nicotine yield or delivery of cigarette brands may be an important determinant of brand choice for individual smokers. The purpose of the present study was to determine if the nicotine delivery characteristics of cigarettes would influence smokers' selection of cigarettes when choices were made under double blind conditions. We assessed individual preferences to each of three research cigarette types which varied widely in nicotine yield, but not in delivery of other constituents.

METHOD

Subjects

Eighteen cigarette smokers, 17 female and one male, participated. All were employees of a large metropolitan hospital recruited through bulletin board advertisements and word of

mouth. Subjects provided written informed consent and were paid for their participation.

Cigarettes

The cigarettes which were supplied by the National Cancer Institute, differed in nicotine content but had similar levels of other tobacco constituents; they had similar taste and draw characteristics. The cigarettes delivered 0.17 mg nicotine (L), 0.89 mg nicotine (M) and 2.02 mg nicotine (H). Nicotine yield of these cigarettes had been varied by blending a partially denicotinized tobacco (used exclusively in the low yield cigarette) with different proportions of the same tobacco that had not been denicotinized. The cigarettes had the same paper and no filter, so the subjects could not manipulate the smoke concentration by blocking ventilation holes in a filter. Cigarette packs were labeled A, B and C: A was always the low yield (0.17 mg) cigarette, B the high yield (2.02 mg) and C the medium yield (0.89 mg). Neither subjects nor

¹This research was partially supported by USPHS grant CA 37736 from the National Cancer Institute.

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research staff were given information regarding the nicotine level associated with these letter codes.

Procedures

Subjects reported three times each day to a convenient site in the hospital: before work between 7:30 and 9:30 a.m., at lunchtime between 11:30 a.m. and 1:00 p.m. and after their workshift between 2:30 and 4:30 p.m. At each contact, subjects received a supply of research cigarettes for use until the next study contact, turned in cards on which they had recorded the time of day that each cigarette was smoked, turned in the butts of the cigarettes smoked, gave a breath sample for carbon monoxide (CO) analysis, and completed rating scales of the cigarette strength, harshness, and enjoyment.

The study began with an experimenter-determined exposure of each subject to each of the nicotine dose levels to be used in the study. During study days 1-3, subjects smoked each of the three cigarette types during a 24-hour period between two successive morning study contacts, with order of exposure counterbalanced across subjects.

The choice procedure began on study day 4 and remained in effect through day 15. Each morning, subjects were given a supply of two different cigarettes, and were instructed to sample (i.e., smoke at least one of each) both cigarette types during their morning smoking. Subjects were exposed to each nicotine yield pair (i.e., H-L, H-M, L-M) four times in a counterbalanced order. At the lunchtime study contact, subjects chose one of the two morning exposure cigarettes to smoke during the early afternoon. At the late afternoon study contact, subjects chose the cigarette they would smoke until they reported back to the laboratory.

Data Analysis

Because the afternoon choice was always among all three cigarette types, these data were used to assess preferences. Percentage of opportunities on which each subject chose the low, medium, and high yield cigarettes were made at the afternoon study contact. Subjects were grouped according to the cigarette type they selected most frequently. A chi-square analysis was used to determine whether either the distribution of choices or of subjects by cigarette preference differed from that expected by chance. Data from lunch time pair-wise comparisons were not usefully grouped since the number of opportunities for each comparison differed somewhat across subjects. Therefore, the lunch time data were not used in final analyses; however, visual inspection of these data appeared to be consistent with afternoon three-way choice comparisons.

RESULTS

Table 1 shows data collected on the afternoon of experimenter-determined exposure days. Subjects smoked one additional cigarette on average under the low nicotine condition, $F(2,34) = 4.06$, $p < 0.03$, and had somewhat higher breath CO levels, $F(2,34) = 3.93$, $p < 0.03$. There were no systematic differences in weight of tobacco burned or subjective ratings of the 3 cigarette types.

Table 2 shows that most subjects quickly developed a preference for a single cigarette type and picked that type consistently throughout the study. As a group, the subjects scattered their choices among all three cigarette types although the high nicotine yield cigarette was selected most frequently. Out of 211 afternoon choice opportunities, 25% were for the low nicotine cigarette, 29% for the medium nicotine cigarette, and 46% for the high nicotine cigarette. The overall distribution of choices was significantly different from that expected by chance ($\chi^2 = 15.62$,

TABLE 1
INITIAL EXPERIMENTER-DETERMINED EXPOSURE

	Cigarette Type*			Significance
	L	M	H	
Smoking Measures				
Daytime Cigs (No.)	9.1 (0.97)	7.9 (1.0)	8.1 (0.92)	$p < 0.03$
Afternoon CO (ppm)	30.6 (3.3)	24.3 (2.1)	26.5 (2.5)	$p < 0.03$
Smoked Weight (g)	0.66 (0.02)	0.66 (0.03)	0.68 (0.03)	N.S.
Subjective Ratings‡				
Enjoyment	2.6 (0.19)	2.1 (0.21)	2.8 (0.17)	$p < 0.03$
Strength	3.3 (0.16)	3.4 (0.22)	3.3 (0.13)	N.S.
Harshness	3.3 (0.24)	3.7 (0.24)	3.5 (0.17)	N.S.

*L = 0.17 mg M = 0.89 mg H = 2.02 mg.

†Numbers within parentheses are s.e.m.'s

‡0 = least enjoyable, weakest, or mildest ever smoked.

10 = most enjoyable, strongest, or harshest ever smoked.

$p < 0.001$). Across subjects, however, the preferences which developed were not significantly related to nicotine yield: low and medium yield cigarette were each preferred by 5 subjects; the remaining 8 subjects came to prefer the high yield cigarette. Table 2 also shows that subjects' choice preferences bore no clear relationship to the nicotine yield of their usual cigarette brand.

DISCUSSION

Smokers selecting among three coded research cigarettes that differed in nicotine delivery quickly developed a preference for one of the three cigarette types. Subjects consistently chose to smoke their preferred cigarette type following the afternoon study contact even though they continued to sample the nonpreferred types each morning according to the experimenter-determined exposure sequence. Thus, choice performance was quite stable across time within individuals. These findings appear to be analogous to the behavior of smokers in their usual environmental settings who develop clear brand preferences that are stable over time.

The finding that the highest nicotine yield cigarette type was selected with the greatest frequency suggests that choices were determined to some extent by the yield. This observation is consistent with other data, both epidemiologic (3-5), and laboratory (2) indicating moderate preferences for higher nicotine yield cigarettes under a variety of conditions. However, yield was not a strong determinant of preference as indicated by the distribution of preferences across subjects. Furthermore, it appeared that cigarette preference did not appear to result from preexisting individual differences in preferred cigarette nicotine yield values because there was no consistent relationship between nicotine delivery ratings of subjects' usual brands and those of the cigarette types which they preferred in the present study.

It is possible that nicotine yield-related preferences might have been stronger if subjects had been unable to modify the manner in which they smoked their cigarettes: modification of smoking topography can attenuate intended nicotine dose manipulations (1, 3, 4). Consistent with this hypothesis were the data from the experimenter-determined exposure days showing that subjects smoked somewhat more intensively when given the low nicotine

TABLE 2
AFTERNOON CIGARETTE PREFERENCES*

Subject	Usual Brand Nicotine Yield	Successive Choice Opportunities											
		1	2	3	4	5	6	7	8	9	10	11	12
CM	0.6	L	L	L	L	L	L	L	H	H	L	L	L
MW	0.8	H	H	L	L	H	L	L	L	L	L	H	L
DG	0.9	L	L	L	L	L	L	L	—	—	—	—	—
BA	1.0	H	L	L	L	L	L	L	L	L	L	L	L
EM	1.2	L	L	L	L	L	L	L	L	L	L	L	L
DF	0.6	M	M	M	M	M	M	M	M	M	M	M	M
KS	0.6	M	L	M	L	H	M	M	M	M	M	M	M
LC	1.1	M	M	M	M	M	M	M	M	M	M	M	M
ND	1.1	L	H	M	M	M	M	M	M	M	M	M	M
KK	1.5	M	M	M	M	M	M	M	M	M	M	M	M
SH	0.1	H	H	H	H	M	H	M	M	H	H	H	H
PS	0.4	M	H	H	H	H	H	H	H	H	H	H	H
OB	0.7	L	H	H	H	H	H	H	H	H	H	H	H
SS	0.8	M	L	H	H	H	H	H	H	H	H	H	H
DH	1.0	H	H	H	H	H	H	H	H	H	H	H	H
WM	1.0	H	H	H	H	H	H	H	H	H	H	H	H
LB	1.0	H	H	H	H	H	H	H	H	H	H	H	H
CJ	1.2	H	H	H	H	H	H	H	H	H	H	H	H

*L=0.17 mg; M=0.89 mg; H=2.02 mg.

yield types as compared to how they smoked when given the higher yield types. Such data are consistent with observations from other studies that smokers tend to adjust their behavior to compensate for weaker cigarettes by increasing the number of cigarettes smoked per day and the amount of smoke extracted per cigarette (3,4). Thus, cigarette brand preferences may bear little relation to cigarette nicotine yields, in part, because extracted nicotine may bear little relation to advertised yield ratings. This is also consistent with the finding that there is only a marginal direct

relationship between nicotine blood levels of smokers and the nicotine yield values of their cigarettes (1,4), particularly among cigarettes with nicotine yields above 0.1 mg, which constitute more than 95% of the U.S. market (3). Because nicotine yield ratings appear to have little influence on cigarette preference or nicotine intake, the slight decline in average nicotine delivery values of cigarettes in recent years (3-5) is probably not of significance with regard to the establishment or maintenance of nicotine dependence.

REFERENCES

1. Benowitz, N. L.; Hall, S. M.; Herning, R. I.; Jacob, P.; Jones, R. T.; Osman, A. Smokers of low-yield cigarettes do not consume less nicotine. *N. Engl. J. Med.* 309:139-142; 1983.
2. Henningfield, J. E.; Miyasato, K.; Jasinski, D. R. Abuse liability and pharmacodynamic characteristics of intravenous and inhaled nicotine. *J. Pharmacol. Exp. Ther.* 224:1-12; 1985.
3. U.S. Department of Health and Human Services. *The Health Consequences of Smoking. The Changing Cigarette: A Report of the Surgeon General.* Washington, DC: U.S. Government Printing Office; Publication No. DHHS (PHS) 81-50156; 1981.
4. U.S. Department of Health and Human Services. *The Health Consequences of Smoking: Nicotine Addiction. A Report of the Surgeon General.* Washington, DC: U.S. Government Printing Office; Publication No. DHHS (CDC) 88-8406; 1988.
5. U.S. Department of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General.* Washington, DC: U.S. Government Printing Office; Publication No. DHHS (CDC) 89-8411; 1989.