Public Health Briefs

A Color-Matching Technique for Monitoring Tar/Nicotine Yields to Smokers

LYNN T. KOZLOWSKI, PHD, WILLIAM S. RICKERT, PHD, MARILYN A. POPE, BSC, AND JACK C. ROBINSON, PHD

Abstract: We describe a technique that enables individuals to detect the number of puffs taken on a filter cigarette by comparing the "color" of the spent filter to a color scale that simulates the appearance of filters exposed to low-, standard-, or high-yield smoking-machine regimens. Average ratings of filters by 11 subjects correlated almost perfectly with the number of standard puffs to which the filters had been exposed. (*Am J Public Health* 1982; 72:597–599.)

Standard tar and nicotine assays are meant to encourage the reduced intake of toxic smoke products.[1] Unfortunately, smokers who want to reduce their tar and nicotine intake are as handicapped as drivers who want to reduce fuel consumption, but whose cars have no speedometers or odometers. Intake depends more on smoking behavior than on single-point estimates of yields to an idealized average smoker.[2,3] To deal with this problem, it has been proposed that the intensity of filter tar stains could be used by smokers as a monitoring device.[4] In this paper we show that individuals can detect with high resolution the number of puffs taken on a filter cigarette (and hence their tar yield) by comparing the color of spent filters to a color scale.

Methods

The color-matching scale was made by comparing the filter stains of machine-smoked cigarettes with color papers from the Pantone by Letraset Color-Matching System. Three cigarettes from a freshly-opened pack of a best-selling Canadian filter brand were smoked to a 30mm butt length on each of three settings: low, a 2 second 25cc puff per 120 seconds; standard, a 2 second 35cc puff per 60 seconds; high, a 2.5 second 45cc puff per 20 seconds. Nicotine yields were 0.26, 0.83, and 1.63mg, respectively. (Within a given brand, tar yields have been shown to correlate .94 with nicotine yields.)[5] Rothman King Size cigarettes with cellulose acetate filters were used (official yield: 0.9mg nicotine, 16mg tar, in about 10 puffs). The smoking-machine was a Heinr. Borgwaldt RM 4/CS.

Two individuals agreed independently on the optimal, although not perfect, color matches: low = a pale yellow (Pantone 127U),* standard = a greenish brown (Pantone 117U),* high = a brown (Pantone 139U).* The low, standard, and high colors were mounted at points designated as 2, 5 and 8 on a 0 to 10 scale (see Figure 1).

On smoking machines it is easy to vary puff-rate, but difficult to produce on demand a specific number of whole puffs, evenly distributed throughout the cigarette. To supply the filters for rating, cigarettes were smoked by means of a hand-operated 50cc syringe, providing stain intensities resulting from 5 to 16 puffs. A pilot study had shown that satisfactory filters could be made by the cruder procedure of having a smoker take the puffs. The lighting puff was not counted. One large survey has found that smokers take an average of 10 puffs (S.D. = 4) per cigarette.[6]

In all, 12 cigarettes were smoked within an hour by a practiced operator who took 2 second 35cc puffs with the syringe. Care was taken to distribute puffs through the length of the cigarettes. The brand smoked delivers roughly 0.09mg nicotine and 1.6mg tar per puff, including the lighting puff in the calculation; so the difference between 5 and 16 puffs was about 18mg tar and 1mg nicotine. These per-puff estimates

Address reprint requests to Lynn T. Kozlowski, PhD, Clinical Institute, Addiction Research Foundation, 33 Russell Street, Toronto, Ontario, Canada M5S 2S1. Ms. Pope is also at the Foundation. Drs. Rickert and Robinson are with Labstat Inc., Kitchener, Ontario N2C 1L3. This paper, submitted to the Journal October 16, 1981, was revised and accepted for publication December 17, 1981.

*These papers are readily purchasable in North American artist supply stores.

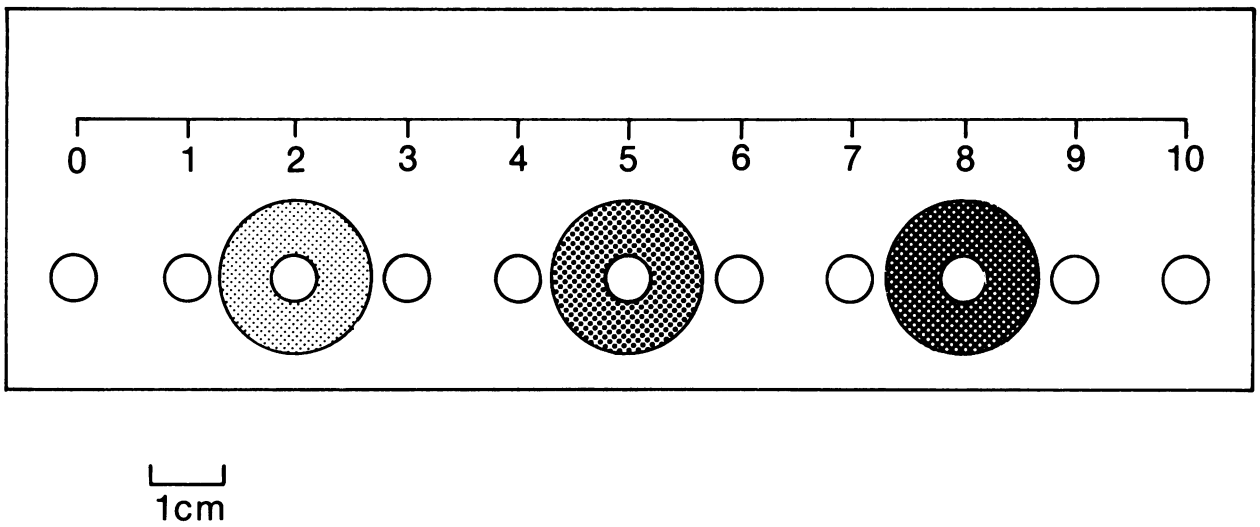

FIGURE 1—The Color-Matching Technique (CMT) Scale. (Pantone colored papers (127U, 117U, 139U) were mounted at locations 2, 5, and 8, respectively. Punch holes are indicated by the small circles.)

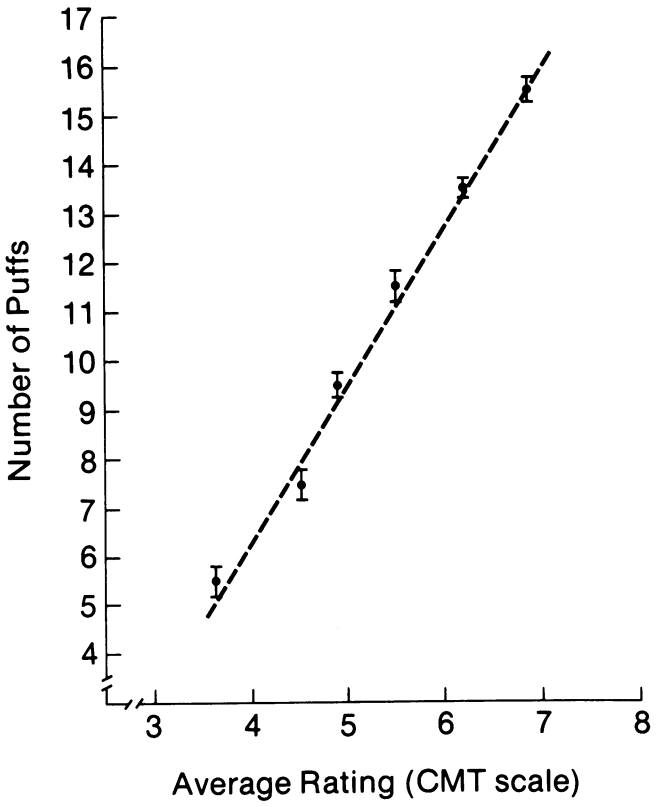

FIGURE 2—The Relationship between Number of Puffs Taken on a Cigarette and the Average Ratings (N = 11, ± SEM) of the Filter Stain on the Color-Matching Technique (CMT) Scale. (Color ratings were averaged for adjacent filters (i.e., $\bar{X}_1$ = (ratings for filters 5 + 6) ÷ 2, etc.). Linear regression, Puffs = 3.1 (Rating) − 6.0; r = .996; df = 4, $P < .01$. Correlations for the individual participants were .99, .98, .97, .96 (N = 4), .90, .83, .82 ($Ps < .05$, 2 tailed) and .73 ($P < .10$).

are only approximate; tar yield in particular increases with each puff.[1] The spent filters were kept in a foil-lined, air-tight container to retard color changes caused by oxidation.

Eleven adults (6 males, 5 females), with no known defects of color vision, rated the filters within five hours of their preparation. They were asked to decide whether the filter looked "lighter, darker, or about the same color" as each of the colored discs (high to low, in turn), and then select the most appropriate scale number. Filters were presented in separately randomized orders to each subject without feedback.

Results

Averaged across the 11 subjects, the mean ratings of the filter stains increased as the number of puffs increased (r = .97; df = 10, $P < .01$; linear regression, puffs = 3.0 (rating) − 5.1). See Figure 2 for additional results.

Discussion

We found a serviceable interval scale, at least for this range of puffs; performance would likely improve if feedback, practice, and a wider range of more exact colors were provided. Chemical assays for residual nicotine in spent filters have been used to estimate mouth-level delivery of nicotine.[5] This color-matching technique (CMT) shares with these butt-nicotine assays the assumption of constant filter retention-efficiency: variations in puff velocity can alter retention-efficiency and cause error in estimates of actual yield.[5-7] In part, since retention-efficiencies vary from brand to brand, color scales will need to be established for each

brand. Also, we have noted that saliva affects filter appearance. If this is a problem, the cigarette could be broken and the tobacco end of the filter used for the matching task; however, this would prevent the puff-by-puff monitoring of tar/nicotine (T/N) intake.

Tobacco chemists who use weight-selected, humidity controlled cigarettes to produce numbers for T/N yields may be dissatisfied with the levels of precision and accuracy attainable with the CMT scale; yet it should be remembered that, to bio-behavioral researchers or individual smokers, the standard machine-smoked T/N yields are more precise and accurate than required.[2,4,8] In addition, these T/N numbers do not reflect the amount of smoke that the average smoker ingests from a given brand.[9]

Consultants to the United States Surgeon-General have advised that information be made available on the "maximum" tar and nicotine yield of a brand, along with "average" yield ratings.[10] The CMT scale could be combined with information on a range of yields possible from a brand and, at the same time, give smokers some means of gauging where they fall within that range. Since this scale is based on a printer's color-matching system, it could be practically applied as part of cigarette packaging, match-book covers, or supplementary pamphlets on T/N yields.

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ACKNOWLEDGMENTS

We thank R. C. Frecker for collaborating on the original development of using color-matching techniques for this purpose, and C.-P. Appel, J. Simpkins, and K. A. Wagner for advice.

Workshop on Heart Attack Prevention

The Laboratory of Physiological Hygiene at the University of Minnesota and the Minnesota Affiliate of the American Heart Association will present a Workshop on Heart Attack Prevention, June 2–4, 1982. The workshop will provide the knowledge, skills, and procedures needed by busy practitioners to help patients reduce their risk of cardiovascular disease. It will give practical guides to risk assessment and specific skills in treatment methods to minimize risk. Participants will learn how to modify blood lipid levels, blood pressure, smoking habits, weight, and physical activity levels in a step-care approach. One of the teaching methods will include a personal risk profile including serum cholesterol determination, blood pressure, smoking history, and other pertinent history data.

The workshop will be of particular interest to physicians, nurses, physician assistants, dietitians, and nutritionists. A limited number of "Team Registrations" are available.

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Registrar, Continuing Medical Education
University of Minnesota Medical School
420 Delaware Street, SE
Box 293 Mayo Bldg.
Minneapolis, MN 55455
612/373-8012