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The Effects of Smoking Schedules on Cessation Outcome: Can We Improve on Common Methods of Gradual and Abrupt Nicotine Withdrawal?

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This study compared the efficacy of 2 traditional methods of smoking cessation, gradual reduction and "cold turkey," with a new approach involving variation in the intercigarette interval. One hundred twenty-eight participants quit smoking on a target date, after a 3-week period of (a) scheduled reduced smoking (progressive increase in the intercigarette interval), (b) nonscheduled reduced smoking (gradual reduction, no specific change in the intercigarette interval), (c) scheduled nonreduced smoking (fixed intercigarette interval, no reductions in frequency), or (c) nonscheduled nonreduced smoking (no change in intercigarette interval or smoking frequency). Participants also received cognitive-behavioral relapse prevention training. Abstinence at 1 year averaged 44%, 18%, 32%, and 22% for the 4 groups, respectively. Overall, the scheduled reduced group performed the best and the nonscheduled reduced group performed the worst. Both scheduled groups performed better than nonscheduled ones. Scheduled reduced smoking was associated with reduced tension, fatigue, urges to smoke, withdrawal symptoms, increased coping effort (ratio of coping behavior to urges), and self-efficacy, suggesting an improved adaptation to nonsmoking and reduced vulnerability to relapse.

There is little doubt that smoking cessation can substantially reduce deaths and disability caused by smoking-related diseases (U.S. Department of Health and Human Services [USDHHS], 1989). The most well-researched cessation programs have varied along three key dimensions: the extent of education and behavioral training provided to the smoker; the provision of nicotine replacement; and the type of procedure used to bring about initial cessation. These frst two factors have been the subject of several carefully controlled studies (e.g., Hall, Tunstall, Rugg, Jones & Benowitz, 1985; Killen, Maccoby, & Taylor, 1984), whereas research on the latter group has received comparably less attention (see Glasgow & Lichtenstein, 1987; Viswesvaran & Schmidt, 1992).

The most commonly used procedures for bringing about initial smoking cessation have involved traditional methods of gradual reduction in smoking frequency or abrupt withdrawal from cigarettes, with or without aversive techniques, such as rapid smoking. For example, among the largest group of former smokers, those who quit on their own, 88.4% and 25.7% report having used abrupt or gradual cessation methods, respectively, in at least one of their quit attempts (Fiore, Novotney, Pierce, Giovino, Hatziandreu, Newcomb, Surawicz, & Davis, 1990). Both methods have also been used in large-scale public health projects (e.g., Ockene, Benfari, Nuttall, Huriwitz, & Ockene, 1982).

Although these procedures have massive public appeal, their impact on the overall success of a treatment program has not been fully described. Flaxman (1978) noted that participants who gradually reduced smoked less at 6 months posttreatment than those who abruptly stopped smoking, but this early study suffered from severe methodological limitations, including small sample size, minimal participant instruction, absence of compliance and abstinence verification, and contamination of procedures by the use of rapid smoking. Gunther, Gritsch, and Meise (1992) found no difference in the 1-year abstinence rates produced by gradual versus abrupt cessation but abstinence rates were unusually high (>65%) and may have been biased by excluding participants from the 1-year analysis that were nonabstinent at the end of the 12-week treatment period. Comparisons of gradual and abrupt cessation have also been made in secondary analyses of studies evaluating self-help manuals (e.g., Lando, Pirie, McGovern, Pechacek, Swim, & Loken, 1991) and

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relapse prevention techniques (Emmons, Emont, Collins, & Weidner, 1988), but the results have been inconclusive because these studies were not designed from the outset to support a contrast of the two procedures.

A gradual reduction technique that has received substantial attention is brand fading, in which a smoker's exposure to nicotine is gradually reduced by systematically changing the brand of cigarette consumed. Typically, no specific changes in smoking frequency are recommended but a target cessation date is set for the end of the third or fourth week of fading. High 1-year abstinence rates (31%–41%) have been reported in some studies (Brown, Lichtenstein, McIntyre, Harrington-Kostur [Study 1], 1984; Foxx, Brown, & Kata, 1983; McGovern & Lando, 1991) but not in others (10%–27%; Brown et al., [Study 2], 1984; Lando & McGovern, 1985). Differences in baseline smoking rates, relapse prevention training, and perhaps most importantly, variability between the actual and anticipated amount of nicotine reduction associated with the brand change (McGovern & Lando, 1991) may account for these discrepancies.

An important aspect of both brand fading and other techniques that reduce the smoking frequency is that they allow the smoker to control the timing of cigarette consumption, which may lead to the elimination of only low-preference cigarettes. This strategy may pose a serious disadvantage for breaking well-established associations among smoking, environmental cues, and changes in affect that follow nicotine consumption in high-preference situations (see Pomerleau & Pomerleau, 1984; i.e., relinquishing a cigarette while watching TV but not when fatigued). In contrast, smoking on a specific schedule of time is noncontingent on changes in these factors and may actually facilitate their uncoupling. In an early study of this approach, Bernard & Efron (1972) instructed participants to smoke in response to audible cues delivered by a pocket timer and separated by either a fixed or progressively longer interval of time. Abstinence rates were not reported, but a significant decrease in mean cigarette consumption was observed for both treatment groups. In a more recent version of this technology, a hand-held computer was programmed to record baseline intercigarette intervals and to provide prompts for future smoking over progressively longer periods of time. A modest 18.5% 6-month cessation rate has been reported for this self-help device (Prue, Riley, Orlandi, & Jerome, 1990). Neither study provided an adequate test of efficacy of scheduled smoking, given their small sample size, poor measures of procedural compliance, and the absence of concomitant behavioral interventions.

These problems were partially addressed in our first study of scheduled reduced smoking, which showed that smoking in response to progressively longer intercigarette intervals was associated with a significantly higher 1-year cessation rate (41%) than a self-help control condition (6%; Cinciripini, Lapitsky, Wallfisch, Mace, Nezami, & Van Vunakis, 1994). The design of this initial study, however, did not include important control conditions such as scheduled smoking without gradual reduction, nonscheduled smoking with gradual reduction, or nonscheduled nonreduced smoking, nor did it provide for the assessment of other constructs and behaviors such as self-efficacy, affect, coping or withdrawal symptoms, which may have some bearing on treatment outcome. The present research provided an assessment of these psychological factors as well as a specific test of abstinence associated with each treatment condition.

We hypothesized that scheduled reduced smoking (increasing the intercigarette interval and reducing smoking frequency) would produce superior cessation rates and possibly result in fewer urges to smoke; fewer withdrawal symptoms; and more favorable changes in self-efficacy, mood, and coping behavior than smoking on a fixed schedule (scheduled nonreduced), gradually reducing (nonscheduled reduced), or abruptly quitting (nonscheduled nonreduced). Assessing this cluster of psychological factors (i.e., withdrawal, negative affect, coping, etc.) is particularly important because support for their contribution to relapse, although generally favorable (e.g., Bliss, Garvey, Heinold, & Hitchcock, 1989; Cohen & Lichtenstein, 1990; Killen, Fortmann, Newman, & Varady, 1991; Shiffman, 1982), has not been uniform (e.g., Hall, Havassy, & Waserman, 1990; Killen, Fortmann, Kraemer, Varady, & Newman, 1992). The specific contribution of the initial cessation method to favorable changes in affect has also been limited to one study of acute nicotine withdrawal (5 days) in which symptoms were rated as more severe after abrupt versus gradual cessation but no differences were observed on measures of tension, fatigue, and cravings (Hatsukami, Dahlgren, Zimmerman, & Hughes, 1988). Thus, the present study covers a longer period of time and includes measures of coping behavior, which has not yet been done.

Method

Participants

Participants were recruited from the Galveston–Houston community. Inclusion criteria were a 3-year smoking history; consumption of 15 cigarettes per day or more; and no current cessation treatment, psychiatric disorder, or uncontrolled systemic illness. Those with *SCL–90–R* (*Symptom Check List–90—Revised*; Derogatis, 1977) t scores > 65 were excluded.

Procedure

One hundred twenty-eight participants met all screening criteria and were randomly assigned to four groups: scheduled reduced (n = 32), nonscheduled reduced (n = 33), scheduled nonreduced (n = 31), and nonscheduled nonreduced (n = 32), balanced for sex and the smoker's screening level of cotinine (see Table 1). The cessation program consisted of four elements: (a) baseline, (b) cessation (pretarget date period), (c) relapse prevention (post-target date), and (d) follow-up. Participants met weekly for 2 hr, in groups of 7 to 11, through the first 9 weeks of the program (Phases 1–3). Brief cessation assessment sessions (20–30 min) were held at the 1-, 6-, and 12-month follow-up points of Phase 4. Sessions were conducted by two master's-level psychologists and were described in a treatment manual given to the participants in individual weekly modules (e.g., Cinciripini & Lapitsky, 1991).

Baseline Phase—Week 1

In this phase, participants self-monitored actual smoking and urges to smoke, noting the asociated time of day and environmental cues. They were told not to change their smoking behavior and, after completing at least 3 days of monitoring (2 weekdays and 1 weekend day), they returned to the clinic with a 3-week supply of cigarettes, based on their average level of daily consumption. These cigarettes were repackaged for subsequent weekly distribution, as appropriate for group assignment.

Table 1
Summary of Participant Characteristics at the Onset of Treatment

Variable	Group A	Group B	Group C	Group D
n	32	33	31	32
Sex (male/female)	14/18	14/19	13/18	13/19
M (and SD)				
FTC	.64 (.28)	.69 (.32)	.84 (.81)	.58 (.31)
FAGERT	6.06 (1.98)	6.09 (1.93)	6.32 (1.81)	5.87 (1.74)
Age	42.57 (11.06)	42.41 (9.03)	46.92 (11.15)	48.35 (12.75)
No. of years smoked	24.70 (10.33)	23.32 (8.86)	21.54 (10.32)	23.86 (11.15)
No. of previous cessation attempts	3.6 (1.17)	3.8 (1.22)	4.1 (1.44)	4.4 (1.32)
MCIGSWK1	22.19 (12.24)	23.21 (10.47)	24.97 (11.87)	28.48 (15.78)
COTININE1	425 (192)	471 (187)	478 (188)	475 (199)
CO1	21.21 (8.80)	19.58 (10.68)	16.44 (7.04)	21.53 (8.80)

Note. Groups A–D are participants in the scheduled reduced, nonscheduled reduced, scheduled nonreduced, and nonscheduled nonreduced smoking groups, respectively; FTC = mean nicotine rating of current brand; FAGERT = Fagerstrom dependency score (9 is highest); MCIGSWK1 = mean number of cigarettes consumed at baseline; COTININE1 = mean cotinine (nanograms per milliliter) of group at baseline; CO1 = mean carbon monoxide level (parts per million) of group at baseline.

Cessation Phase—Weeks 2–5 (Quit Week)

Scheduled reduced (Group A). These participants were instructed to smoke only at specific times of the day, and the intercigarette interval was progressively lengthened to accommodate planned reductions in smoking frequency. As in all scheduled groups, smoking was to take place only in the first 5 min of each interval; for all participants, "missed" cigarettes could not be accumulated for later use and were to be returned to the investigators. Software developed for this project was used to determine all smoking and reduction schedules as described later. During Weeks 2 and 3, the smoking intervals were set by dividing two thirds and one third of the participant's average baseline smoking rate, respectively, by the average number of hours in the participant's waking day (i.e., for a participant with a baseline average of 24 cigarettes per day over 16 hrs, 1 cigarette per hr would be permitted in Week 2 (2/3 × 24 = 16; 16/16 = 1.0) and 1 every 2 hrs in Week 3. In Week 4, the intervals were lengthened again, reducing consumption by one third of the rate for Week 2, every day, until the participant reached 2–4 cigarettes per day, which usually occurred within 1–2 days of the target date. The target date for all participants was the first day of Week 5 (i.e., participants had to be abstinent for the 24-hr period preceding the Week 5 meeting. Week 5 was referred to as the "quit week."

Nonscheduled reduced (Group B). For this group, the method involved the common practice of uncontrolled gradual reduction. Participants gradually reduced the number of cigarettes smoked per day using the same weekly reduction quota described for scheduled reduced (Group A) participants (i.e., two thirds of baseline in Week 1, one third in Week 2, etc.), but their intercigarette interval was allowed to be self-selected and no specific instructions were given on how to meet their daily quota.

Scheduled nonreduced (Group C). These participants were told to smoke at specific times of the day, as described for the scheduled reduced group (Group A), but an important difference was the absence of adjustment to the intercigarette interval or consumption frequency during the cessation phase. Scheduled nonreduced (Group C) participants smoked at their baseline rate, over a fixed intercigarette interval, that did not change during Weeks 2–5, (i.e., for a participant smoking an average of 30 cigarettes per day in a 15-hr span, the interval would be set for 1 cigarette every 30 min, until the target date, at which time they would be required to abruptly quit smoking.

Nonscheduled nonreduced (Group D). No manipulation of either the smoking frequency or intercigarette interval was carried out for this group (i.e., participants were not told to gradually reduce nor to smoke at specific times. Consumption during the cessation period was set at the baseline level, and the intercigarette interval was left to the participant's discretion. All participants were aware that they would be asked to abruptly quit smoking ("cold turkey") on the target date.

Cognitive-Behavioral Intervention—Weeks 2–5 (Quit Week)

Cognitive-behavioral training was implemented during each meeting and covered the following: adherence to smoking instructions; physiological and psychological effects of nicotine; deep breathing exercises; and acquiring behaviors incompatible with smoking, such as reviewing their reasons for quitting list, repeating certain coping phases ("the urge will pass"), or learning to otherwise change their environment in response to a smoking urge.

Relapse Prevention—Weeks 5–9 (Program End)

The meetings in Weeks 5–9 emphasized maintenance for those who quit and cessation for those who did not. Participants learned to anticipate and cope with high-risk situations for smoking by direct intervention (e.g., avoiding alcohol consumption, surrounding oneself with nonsmokers, or temporarily stepping outside of the room whenever a strong urge was present). New skills were also developed to manipulate affect, reduce tension, increase energy and pleasure, or avoid contact with aversive stimuli, using a variety of techniques including the following: time and contingency management, stress inoculation, assertion training, techniques to improve sleep and exercise habits, and scheduling of positive events.

Follow-Up

Participants returned at 1, 6 and 12 months posttreatment (Week 9). The sessions were not used to provide extensive therapeutic intervention but to assess abstinence, repeat the assessments described later, and to reiterate relapse prevention principles.

Assessments

Psychological assessment. Assessments were conducted weekly and at all follow-up visits. Participants completed the following scales: (a) Self-Efficacy (Condiotte & Lichtenstein, 1981), which measured confidence (on a scale ranging from 0 to 10) at resisting a smoking urge across 44 briefly described situations; (b) Hughes (Minnesota) With-

drawal Symptoms Checklist (Hughes & Hatsukami, 1986), which provided a total score using ratings from 0 to 3 of 17 symptoms of tobacco withdrawal (e.g., irritability, hunger, sleep disturbance, etc.); (c) the Coping Behavior Checklist for Smoking, which was developed for this study and consisted of a list of 28 strategies for coping with urges to smoke as described in the treatment sessions (i.e., "reading a reasons-for-quitting list," "walking," "saying 'this urge will pass,'" etc. The scale included several modified items from the original Ways of Coping Scale [Folkman & Lazarus, 1980], such as "I accepted understanding from someone," as well as negative coping items such as "I lectured or criticized myself," which reduced the total score. Participants noted how many times in the previous week they engaged in each of the coping behaviors [e.g., 0, 1–3, 4–6, or more than 6 times]); (d) The Tension and Fatigue subscales from the Profile of Mood States (McNair, Lorr, & Droppleman, 1981), which consists of nine and seven adjectives, respectively, rated on a scale (ranging from 0 to 4) of frequency of occurrence for the previous week; and (e) the eight-item Fagerstrom Tolerance Questionnaire (Fagerstrom, 1978), at baseline only.

Biochemical assessment. Expired carbon monoxide (CO) was determined at every contact using an Ecolyzer 2000 (National Drager, Inc.), calibrated weekly with a 100-ppm CO sample. A 2-ml saliva sample was also obtained and frozen at a −70°oF for later cotinine analysis using a radioimmunoassay (Langone & Van Vunakis, 1982). Cotinine was measured before group assignment, at Weeks 1, 5, 7, 9, and at the 1-, 6-, and 12-month follow-ups. All assessments were conducted at approximately the same time of day for each participant, within their treatment groups.

Deposit Contract System

Smokers placed a deposit of $110, which was returned weekly, in $10 increments contingent on attendance, compliance with smoking instructions, homework, and abstinence criteria (discussed later).

Assessment of Abstinence

Abstinence was assessed using the Smoking Status Questionnaire (SSQ), which was developed for this study, expired CO, and salivary cotinine.[1] On the SSQ, the participant noted whether they had smoked since the last meeting or follow-up, and if so, how much and under what conditions. Final outcome statistics were based on biochemically verified abstinence. At the quit week (Week 5), participants who refrained from smoking for the 24 hr preceding the meeting (target date) and who showed a CO of less than 6 ppm were classified as abstainers. At the program end (Week 9) and all follow-ups, participants were classified as abstainers if they reported no smoking or had smoked more than a puff in between assessments but on fewer than 5 days. In both cases, cotinine values less than 14 ng/ml were required to verify abstinence. This is within the lowest detectable level of the assay and below the threshold (26 ng/ml) observed for nonsmokers (Cummings & Richard, 1988). Those who exceeded these levels or were unavailable for assessment were counted as nonabstainers.

Distribution and Packaging of Cigarettes for Compliance

Cigarettes were repackaged to contain the exact number of cigarettes allotted for a participant on a particular day. Colored stickers (Avery Labels, Inc.) were placed on the filter of each cigarette. Participants were instructed to remove the "dots," before smoking and to place them in their book and note the time smoking took place. Paper inserts were also taped to the outside of each pack, displaying a pro-cessation graphic (for all groups), daily cigarette quota (for scheduled reduced [Group A] and nonscheduled reduced [Group B] participants), and the scheduled time of consumption (for scheduled reduced [Group A] and scheduled nonreduced [Group C] participants). The pack was resealed in heat-shrinkable plastic.

Results

Participant Statistics

A Treatment Group (A–D) × Sex multivariate analysis of variance (MANOVA) performed on age, Federal Trade Commission rating, Fagerstrom score, years smoked, previous cessation attempts, baseline cotinine, CO, and cigarette consumption revealed no significant differences. Chi-square analysis also showed no significant differences in the groups' sex ratio.

Compliance With Smoking Requirements

During the cessation period, scheduled reduced (Group A) and scheduled nonreduced (Group C) participants smoked all but two of their total daily cigarettes, within 5 min of a designated interval, 93% and 90% of the time, respectively. However, Groups A through D averaged 2, 3, 7, and 8 cigarettes less per day, respectively, than their assigned (baseline) amounts. Thus, compliance with the schedule was very good for both scheduled groups (Groups A and C), as was frequency compliance for both reduced groups (Groups A and B). However, nonreduced participants (Groups C and D) often smoked less than their baseline average.

Effects of Treatment on Tobacco Consumption

As recommended for a repeated measures design, separate MANOVAs were conducted on cigarettes and cotinine (Vasey & Thayer, 1987) using treatment group and sex as between-subjects factors and week (time) as the within factor. A significant MANOVA F (Wilks's lambda) for the Group × Week interaction of either variable was followed by planned contrasts of the groups at each assessment point using a least squares means procedure. In addition, planned contrasts were conducted within each group, comparing the baseline to each subsequent assessment. Only contrasts with a significant p value (<.01) are reported. This analytic approach (MANOVA and planned contrasts) was extended to all other dependent variables except abstinence, which is described later.

Significant overall effects were noted for the Week × Group interaction for cigarette consumption, $F(33, 325) = 3.53$, $p < .01$, and cotinine, $F(18, 325) = 1.45$; $p < .05$; and for the Week × Sex interaction, $F(11, 114) = 2.29$; $p < .01$, for cigarettes. Planned comparisons showed that cigarette consumption (see Figure 1) and cotinine fell significantly for all groups from the baseline through the quit week. However, both reduced groups (A and B) decreased cigarette consumption significantly more than both nonreduced groups (C and D), with the majority of their decrease taking place in the quit week. Consumption in the quit week averaged 4.5 (3.2), 7.4 (5.3), 11.9 (9.8), and 15.2,(10.1) cigarettes per day for Groups A through D, respectively. Similar results were obtained for quit week cotinine levels

[1]Although saliva thiocyanate was collected to verify abstinence periods of more than 3 days, laboratory technical problems experienced with the assay forced us to rely on cotinine measures to assess abstinence beyond 24 hrs.

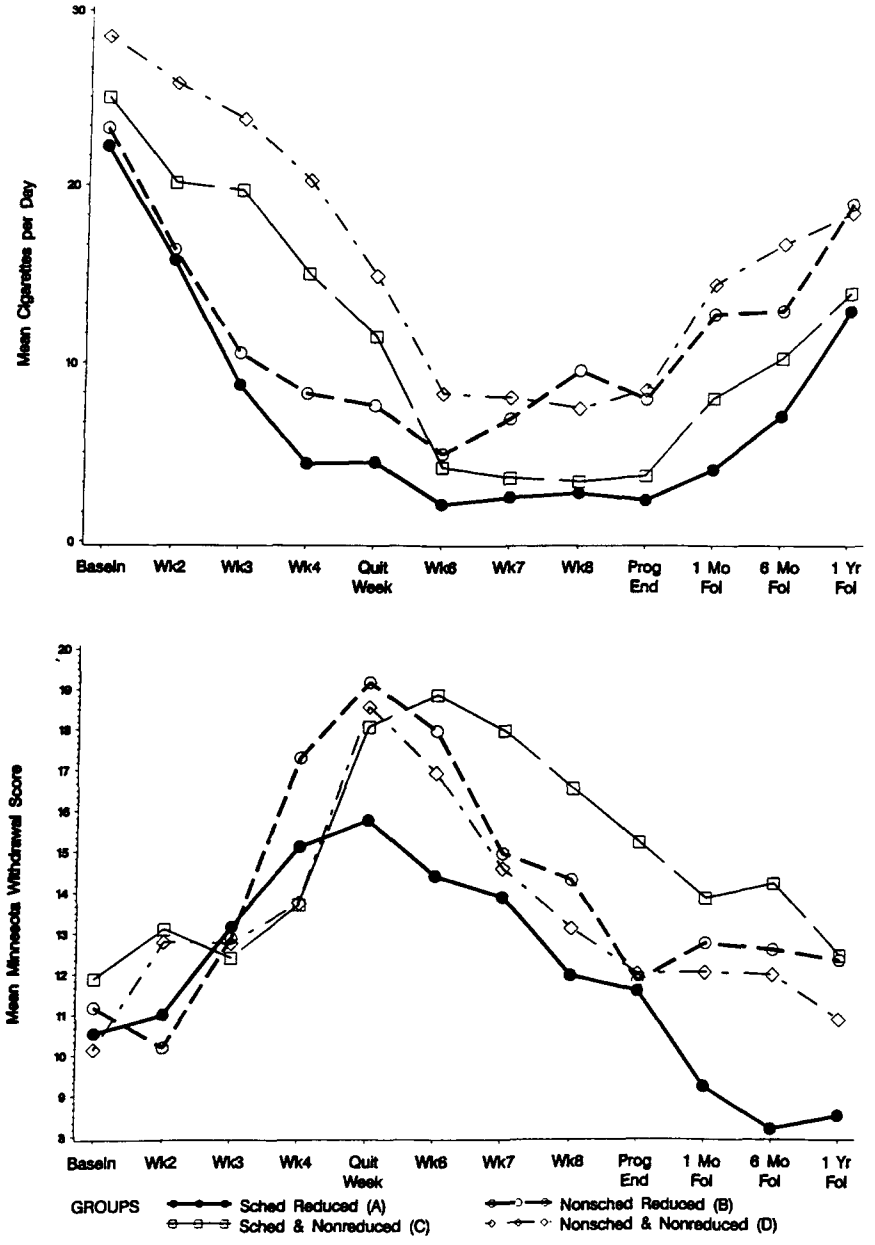

Figure 1. Mean number of cigarettes smoked and withdrawal scores for each group over time. Baseln = baseline; Wk = week; Prog End = end of program; 1 Mo Fol = 1-month follow-up; 6 Mo Fol = 6-month follow-up; 1 Yr Fol = 1-year follow-up; Sched = scheduled; Nonsched = nonscheduled.

(sample obtained on the target day). Mean cotinine and standard deviations were 74.1 (120), 138.9 (133.8), 178.77 (148.1), and 285.0 (209.9) ng/ml, for the four respective groups at the quit week. Thus, some reduction in nicotine exposure was noted for the nonreduced groups, which may be due to restrictions on smoking, an eagerness to quit, or both, but those who were specifically instructed to reduce (scheduled reduced, nonscheduled reduced [Groups A and B, respectively]), smoked significantly less than those who were not.

Only one significant contrast resulted from the Week × Sex interaction for cigarettes: male participants averaged 3 cigarettes less per day at the quit week than female participants. Perhaps female participants are less prepared to quit at the target date than male participants but the absence of any other effects that are due to gender, especially for long-term abstinence (discussed later), suggests that this finding is not particularly robust.

From the quit week through the 1-year follow-up, cigarettes consumed and cotinine concentration remained significantly below baseline for all groups; the scheduled reduced and scheduled nonreduced groups (Groups A and C, respectively), however, smoked consistently less than the nonscheduled reduced and nonscheduled nonreduced groups (Groups B and D, respectively). At 1 year, the scheduled reduced group (Group A)

showed the lowest level of cotinine in comparison to all other groups, who did not differ from each other. Respective 1-year cotinine values for scheduled reduced (Group A), nonscheduled reduced (Group B), scheduled nonreduced (Group C), and nonscheduled nonreduced (Group D) groups were 132.8 (50.57), 310.2 (201.4), 245.3 (190.6), and 289.6 (206) ng/ml. Thus, although scheduled reduced (Group A) participants may have smoked at a rate similar to nonscheduled reduced (Group C) participants, they experienced significantly less overall exposure to nicotine from the end of treatment through the follow-up period. Although the mean cotinine level for the scheduled reduced group (Group A) could have been biased by their higher rate of abstinence, separate analysis of nonabstainers revealed the same pattern as described earlier for the combination of both abstainers and nonabstainers.

Program Abstinence

Abstinence rates were based on verified nonsmoking at all panels (i.e., to be counted as an abstainer, a participant had to be abstinent at the current and all previous points of evaluation). Those with missing data or nonverifiable abstinence (see Method section) were counted as nonabstainers.[2] Program abstinence was evaluated using logistic regression analyses for categorical modeling (Bishop, Fienberg, & Holland, 1975) and chi-square comparisons with treatment group and sex included in the model (see Table 2). A series of planned contrasts (see text for chi-squares) were also conducted to compare both scheduled groups (Groups A and C) against both nonscheduled ones (Groups B and D).

As shown in Table 2, the percentage of smokers who achieved at least 24 hr abstinence at the quit week (target date, first day of Week 5), was high for all participants but did not significantly differ across treatment group (or sex). Thereafter, abstinence fell for all groups but the scheduled groups (scheduled reduced [Group A] and scheduled nonreduced [Group C]) consistently and significantly outperformed the nonscheduled groups (nonscheduled reduced [Group B] and nonscheduled nonreduced [Group D]), at the program end (Week 9), $\chi^2(1, N = 128) = 10.98$, $p < .001$; and at 1-month, $\chi^2(1, N = 128) = 11.05$, $p < .001$; 6-month, $\chi^2(1, N = 128) = 8.22$, $p < .01$; and 1-year follow-ups, $\chi^2(1, N = 128) = 4.81$, $p < .01$. In addition, significantly more Group A participants were abstinent, compared with those in all other groups at Week 9, $\chi^2(1, N = 128) = 8.57$–$2.99$, $p < .05$; and at the 1-month, $\chi^2(1, N = 128) = 10.56$–$3.10$, $p < .05$; 6-month, $\chi^2(1, N = 128) = 6.91$–$5.91$, $p < .01$ (vs. Groups B and D); and 1-year follow-ups, $\chi^2(1, N = 128) = 3.37$–$4.75$, $p < .05$ (vs. Groups B and D), although differences with the scheduled nonreduced (Group C) participants at 6 months and 1 year were marginal, $\chi^2(1, N = 128) = 2.68$–$1.65$, $p < .06$. The performance of the nonscheduled reduced (Group B) participants was also observed to be the poorest of all groups, from the program end through the follow-ups, although differences with the nonscheduled nonreduced (Group D) participants (4%) were not significant, $\chi^2(1, N = 128) = 1.88$, $p = .07$. The only interaction with sex was observed at Week 9, where the best performance (81%) was noted by male scheduled reduced (Group A) participants, $\chi^2(1, N = 128) = 5.78$ $p < .05$, although this pattern did not continue through the follow-up.

Hughes (Minnesota) Withdrawal Score

An initial univariate F showed no significant baseline differences for either group or sex. However, as shown in Figure 1, significant effects were noted for week, $F(11, 114) = 5.79$, $p < .01$, and the Week × Group interaction, $F(33, 332) = 1.33$, $p < .05$. Results of the planned comparisons revealed that from the quit week through the follow-ups (except Week 7), scheduled reduced (Group A) participants experienced significantly fewer withdrawal symptoms than the other groups, who did not significantly differ from each other. Relative to baseline, all groups experienced significantly more symptoms of withdrawal from Week 3 (2 weeks pretarget date) through Week 8 (4 weeks posttarget date), returning to baseline by the program end (5 weeks posttarget)and remaining there through the follow-ups.

Profile of Mood States: Tension and Fatigue

Preliminary analyses as described earlier revealed no significant group differences in either baseline level of tension or fatigue. However, significant effects for week, $F(11, 114) = 7.26$, $p < .001$, and the Week × Group interaction, $F(33, 332) = 2.63$, $p < .001$, were noted for the Tension scale and for the week effect, $F(11, 112) = 3.54$, $p < .001$, on the Fatigue scale (see Figure 2). Planned comparisons showed that the four groups did not significantly differ through Week 4. However, during the quit week (Week 5), scheduled reduced (Group A) participants reported the least amount of tension, whereas nonscheduled nonreduced (Group D) participants reported the most. Thereafter, tension scores fell for all groups, but those for scheduled reduced (Group A) participants remained significantly below the others from Week 8 (4 weeks posttarget) through the 6-month follow-up. The remaining groups did not differ.

Only the fatigue level of scheduled reduced (Group A) participants changed over time, averaging significantly below their own baseline, as well as the fatigue level of all other groups, from the quit week through the 1-year follow-up.

Urge Frequency Score

No significant group or sex differences were found in the analysis of baseline urge frequency ($p > .05$). However, significant effects were noted for week, $F(11, 114) = 12.70$, $p < .0001$; group, $F(3, 124) = 5.88$, $p < .001$; and the Week × Group interaction, $F(33, 332) = 1.54$, $p < .04$ (see Figure 3). From Week 2 (3 weeks before target) to Week 6 (1 week after the target), both the scheduled reduced (Group A) and nonscheduled reduced (Group B) participants reported significantly fewer urges than both the scheduled nonreduced (Group C) and nonscheduled nonreduced (Group D) participants, although neither pair

[2]However, an exception was made in computing the abstinence rates at the 12-month follow-up, as follows: 1 participant each from the scheduled reduced group and scheduled nonreduced group (Groups A and C, respectively); 2 from the nonscheduled reduced group and 3 from the nonscheduled nonreduced group (Groups B and D, respectively) were unavailable for the 6-month assessment and were counted as nonabstainers for that evaluation. These same participants were found to be abstinent at the 1-year follow-up point, as well as at the quit week, program end, and at the 1-month follow-up evaluation. Therefore, they were counted as abstainers at the 1-year point.

Table 2
Summary of Abstinence Rates

Abstinence at given week	% in Group A	% in Group B	% in Group C	% in Group D	χ^2	p
Quit week (Week 5)					2.441	>.05
Abstainers	88	79	81	72		
Nonabstainers	12	21	19	28		
Program end (Week 9)					13.04	<.01
Abstainers	72	30	52	34		
Nonabstainers	28	70	48	66		
1-month follow-up					13.66	<.01
Abstainers	63	21	42	25		
Nonabstainers	37	79	58	75		
6-month follow-up					9.48	<.001
Abstainers	41	12	29	13		
Nonabstainers	59	88	71	87		
1-year follow-up					7.3	<.05
Abstainers	44	18	32	22		
Nonabstainers	56	82	68	78		

Note. Abstinence rates are based on verifiable nonsmoking for all panels. Those with missing data or nonverifiable abstinence were counted as nonabstainers. Groups A–D are participants in the scheduled reduced, nonscheduled reduced, scheduled nonreduced, and nonscheduled nonreduced smoking groups, respectively.

differed from each other. Thereafter, scheduled reduced (Group A) participants reported significantly fewer urges than the other groups, who did not differ from each other.

Coping Behavior Checklist for Smoking—Total Score

Because this was the initial use of the instrument, measures of its reliability and sensitivity to detect changes in behavior were computed. Strong evidence of internal consistency was noted: Split half regression revealed R^2s of .89 and .86 and alphas of .97 and .95 from the baseline and quit weeks, respectively. The scale was also shown to be a sensitive measure of behavior change: Coping frequency significantly rose over time apparently in response to major treatment manipulations (see Figure 3) but not as a function of baseline scores. Baseline coping poorly predicted the quit week (R^2 = .15) and program end (R^2 = .18) response, which occurred after the schedule manipulations and relapse prevention, respectively. Thus, coping scores were reliable at a given point in time but were subject to change in response to the interventions.

No significant baseline differences in coping frequency were detected among the groups, but a significant main effect was noted for week, $F(11, 114) = 24.13$, $p < .0001$, indicating that all groups improved over time (see Figure 3).

Ratio of Coping to Urge Frequency

As a measure of coping "effort," the ratio of coping to urge frequency (C:U) was computed after standardization of both scores to a mean of 10 and a standard deviation of 2.5. No significant baseline differences were noted among the groups, although significant main effects were observed for week, $F(11, 114) = 13.09$, $p < .0001$, and the Session × Group interaction, $F(33, 332) = 1.52$, $p < .05$ (see Figure 4). Planned comparisons revealed no differences among the groups through Week 3 ($p > .05$); but from Week 4 (1 week pre-target date) through the 1-year follow-up, scheduled reduced (Group A) participants remained significantly above their baselines and showed a higher C:U ratio than any of the other groups. During the follow-up, scheduled nonreduced (Group C) participants also showed a C:U ratio above their baseline.

Self-Efficacy

A univariate F revealed no significant group or sex differences in initial levels of self-efficacy ($F < .1$). However, the results of the Group (A–D) × Week × Sex MANOVA and contrasts, revealed significant effects because of week, $F(11, 114) = 10.41$, $p < .001$, and the Week × Group interaction, $F(33, 332) = 2.03$, $p < .05$. Planned comparisons showed that from the quit week through the follow-ups, scheduled reduced (Group A) participants scored significantly higher, and nonscheduled reduced (Group B) participants scored significantly lower in self-efficacy than all other groups. The exception was at 1 month: The scores of scheduled reduced (Group A) and scheduled nonreduced (Group C) participants were equivalent, and those of nonscheduled reduced (Group B) and nonscheduled nonreduced (Group D) participants were equivalent.

Discussion

In summary, the best long-term abstinence was observed in treatment groups involving direct manipulation of the smokers' normal intercigarette interval (i.e., scheduled reduced [Group A] and scheduled nonreduced [Group C] smoking), as opposed to the more traditional approaches to cessation involving gradual reduction on one's own (nonscheduled reduced [Group B]) or quitting cold turkey (nonscheduled nonreduced [Group D]). These results sharply contrast with the high abstinence rates noted in population surveys of self-quitters, who reportedly prefer gradual and abrupt cessation methods (Fiore et al., 1990), or those of previous but less well-controlled studies (e.g., Flaxman,

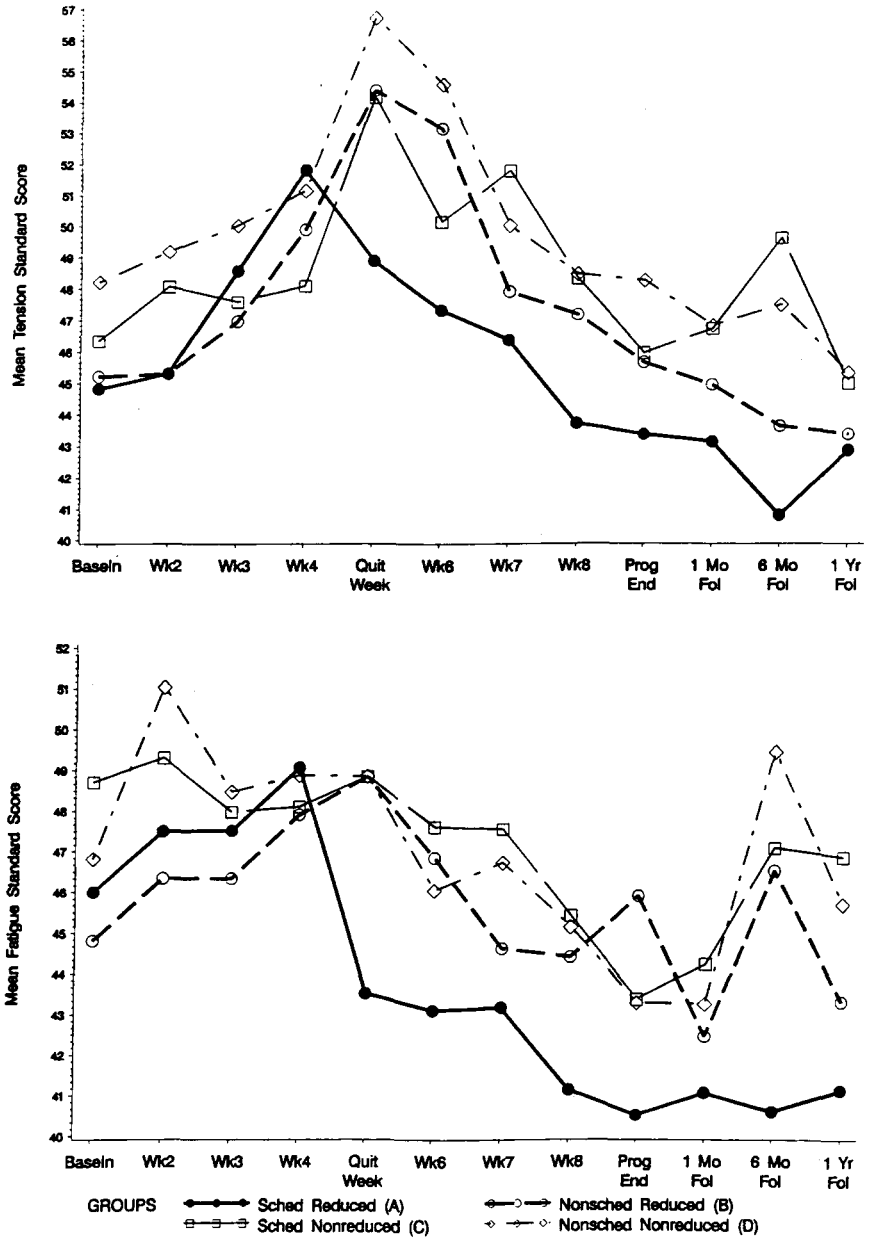

Figure 2. Mean standardized Tension and Fatigue scores from the Profile of Mood States. Baseln = baseline; Wk = week; Prog End = end of program; 1 Mo Fol = 1-month follow-up; 6 Mo Fol = 6-month follow-up; 1 Yr Fol = 1-year follow-up; Sched = scheduled; Nonsched = nonscheduled.

1978; Gunther et al., 1992). However, abstinence for scheduled reduced (Group A) and scheduled nonreduced (Group C) smoking, combined with relapse prevention procedures, compared favorably with results reported for nicotine replacement and psychological therapies (44%–50% [Hall et al., 1985; Killen et al., 1984]) and 16%–30% [Hughes, 1991; Viswesvaran & Schmidt, 1992]) and the average effect of behavioral procedures alone (22% [Glasgow & Lichtenstein, 1987]).[3] Although all participants experienced less exposure to nicotine after treatment than before, scheduled reduced (Group A) participants showed the least exposure at the 1-year follow-up, as well as the highest levels of abstinence and self-efficacy of all the groups. Nonscheduled reduced (Group B) participants, on the other hand, showed the opposite pattern.

What are some possible explanations for the treatment advantage afforded to scheduled reduced or scheduled nonre-

[3]It should also be noted that all panels abstinence criteria were applied in the present study, whereas these comparative studies used point prevalence estimates, which will almost always be higher; that is, 1-year point prevalence abstinence rates for the scheduled reduced (Group A), nonscheduled reduced (Group B), scheduled nonreduced (Group C), and nonscheduled nonreduced (Group D) participants were: 50%, 22%, 37%, and 23%, respectively.

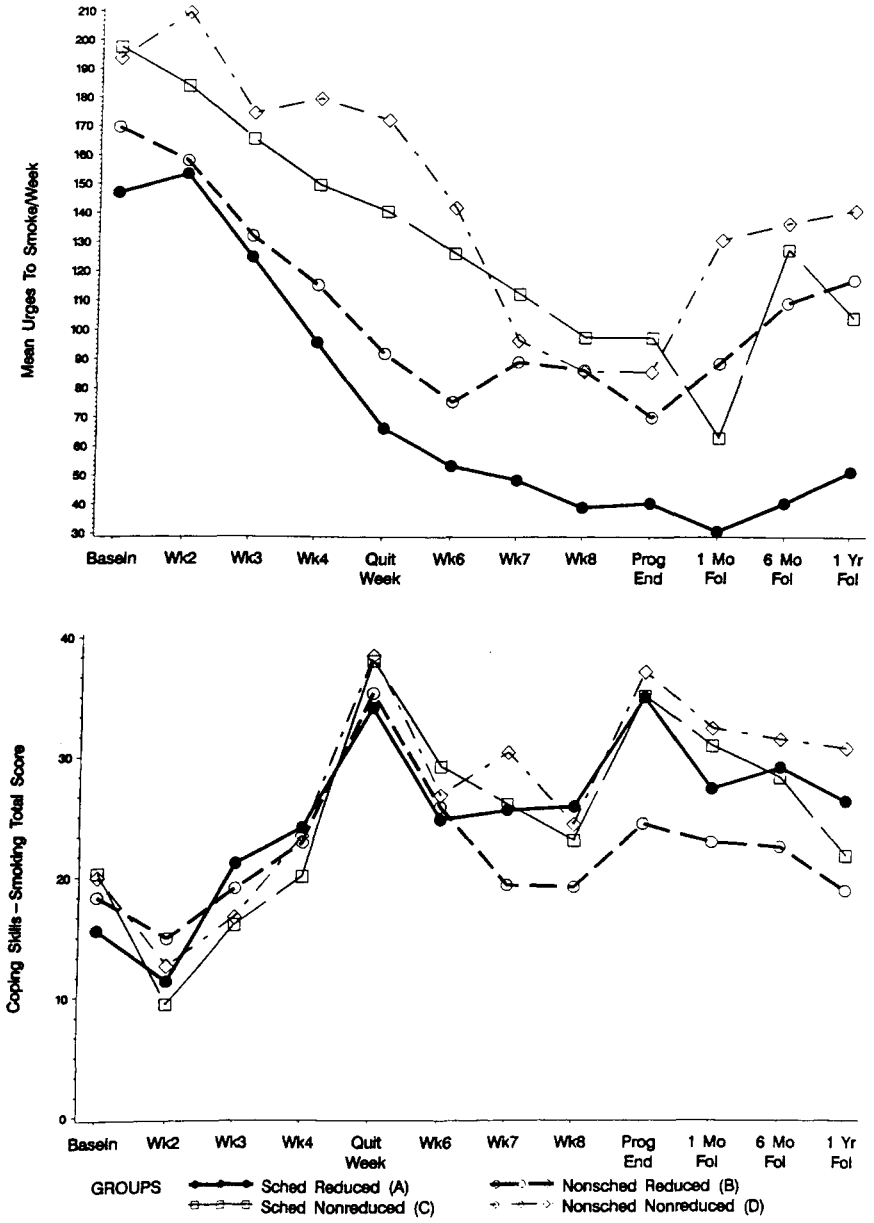

Figure 3. Mean frequency of urges to smoke and total coping skills (from the Coping Behavior Checklist for Smoking). Baseln = baseline; Wk = week; Prog End = end of program; 1 Mo Fol = 1-month follow-up; 6 Mo Fol = 6-month follow-up; 1 Yr Fol = 1-year follow-up; Sched = scheduled; Nonsched = nonscheduled.

duced smoking? Target date quit rates were the same for all groups and, hence, regression toward the mean would not explain the scheduled reduced (Group A) participants' lower vulnerability to relapse; neither would differences in exposure to behavioral training because relapse prevention was common to all groups. One explanation, that is generally supported by the data, is that scheduled and reduced smoking produced a more favorable profile among factors previously associated with poor long-term abstinence, namely, negative affect (Baer & Lichtenstein, 1988; Cohen & Lichtenstein, 1990; Shiffman, 1982), poor or infrequent coping responses in high-risk situations (Bliss et al., 1989; Curry & Marlatt, 1985; Shiffman, 1982), high levels of nicotine withdrawal, and urges to smoke (Killen et al., 1991). Changes in these parameters form the background physiological and psychological conditions under which coping skills are learned and manipulating nicotine administration through the scheduled reduced (Group A) approach seemed to influence this learning environment in a unique and positive way.

For example, scheduled reduced smokers (Group A) may have initially coped with smoking urges by simply delaying smoking until the next interval. The demands on their behavior were gradually increased as the intercigarette intervals became progressively longer and nicotine dose was reduced. Before the target date, the groups were similar on all dependent measures

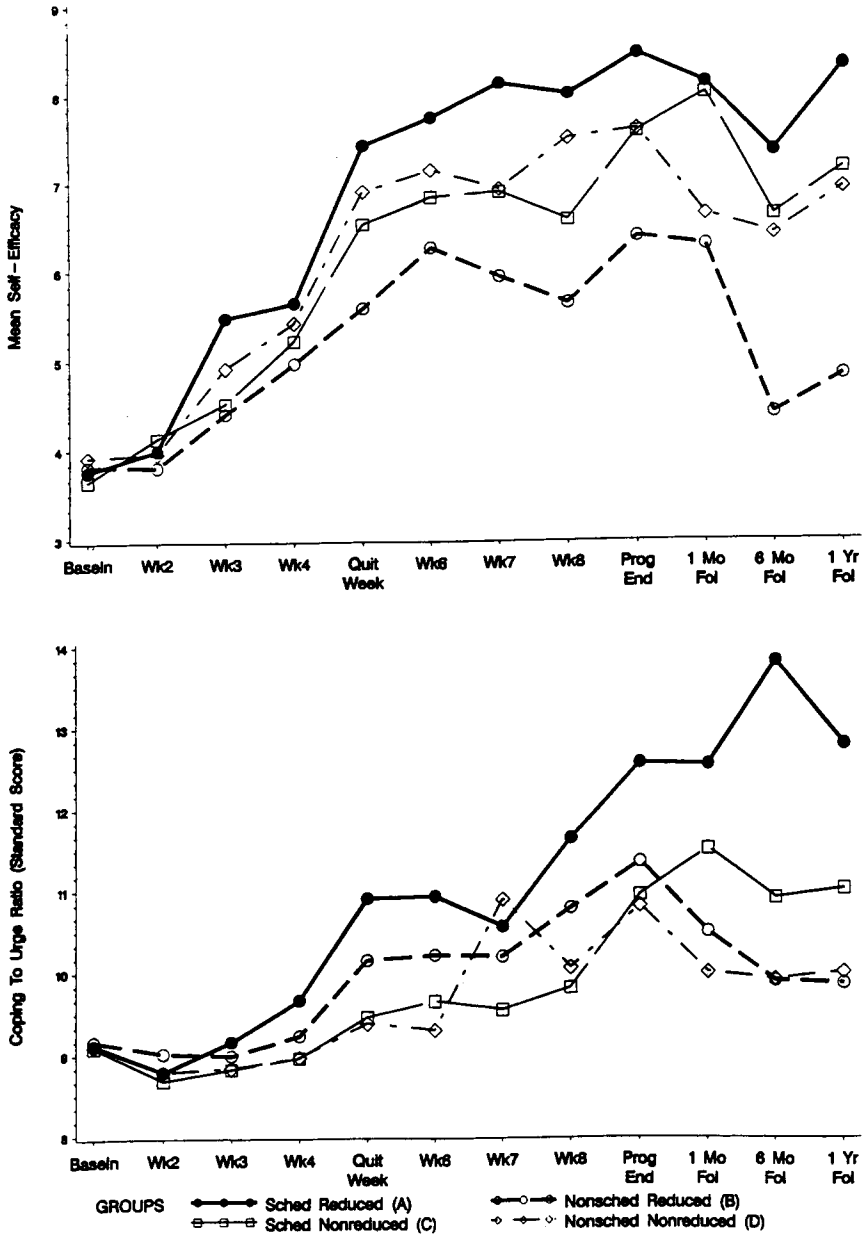

Figure 4. Mean total self-efficacy score and standardized coping to urge ratio (M = 10; SD = 2.5). Baseln = baseline; Wk = week; Prog End = end of program; 1 Mo Fol = 1-month follow-up; 6 Mo Fol = 6-month follow-up; 1 Yr Fol = 1-year follow-up; Sched = scheduled; Nonsched = nonscheduled.

but afterward scheduled reduced (Group A) participants experienced the lowest level of tension, fatigue, and withdrawal of all the groups. Although the frequency of their coping behavior did not generally exceed that of the others, their urges were generally lower and their coping effort, as measured by the C:U ratio, was significantly higher than the others long into the follow-up. This suggests that scheduled reduced (Group A) participants brought more coping strategies to bear on individual smoking urges than did those in the other groups, which could be a unique adaptation to the progressively longer time required between cigarettes. This group also showed fewer adverse reactions to nonsmoking long after the target date (i.e., lower levels of withdrawal, tension, and fatigue), suggesting that a proportionally higher level of coping responses to smoking urges may be instrumental to making a successful transition to nonsmoking. Indeed, refraining from smoking without undue distress may have also enhanced their self-efficacy and further reduced their vulnerability to future relapse.

Scheduled nonreduced (Group C) smokers were also required to delay smoking but there was no provision to systematically strengthen coping responses by increasing demands made upon their behavior (i.e., their intercigarette interval was fixed). In contrast to the scheduled reduced (Group A) participants, they showed a significantly higher level of withdrawal

symptoms, tension, and fatigue after the quit week, and a lower coping to urge ratio. Tension and fatigue levels eventually returned to baseline, and their coping frequency stablilized, but their responses seemed less effective at reducing the distress brought about by not smoking (i.e., withdrawal and urges remained higher than in the scheduled reduced group (Group C). This may also have contributed to their lower self-efficacy and abstinence performance.

The interpretation of the results for nonscheduled reduced (Group B) and nonscheduled nonreduced (Group D) participants suggests that they may never have learned to break the pattern of ad lib nicotine self-administration to which they had become accustomed. Interestingly, although the demands of their pre-cessation environment were quite different: nonscheduled reduced (Group B) participants were free to choose which of their cigarettes to eliminate over the precessation period, whereas no such conditions were placed on nonscheduled nonreduced smokers (Group D); the effects of these conditions on future coping effort may have been similar. For example, after the target date, nonscheduled reduced (Group B) participants showed a low coping frequency and an intermediate level of smoking urges. Nonscheduled nonreduced (Group D) smokers showed a higher posttreatment coping frequency but also experienced more urges to smoke. The net effect for both groups was poor coping effort as evidenced by their low C:U ratio, which appeared less efficacious than in either of the scheduled groups at reducing withdrawal, tension, and fatigue.

It is possible that the nonscheduled reduced (Group B) participants learned to savor cigarettes smoked at particular times, as they were free to reduce on their own. When future urges arose under these same conditions, these smokers may have been less prepared to cope and experienced a reduction in self-efficacy. Nonscheduled nonreduced (Group D) smokers, on the other hand, were not forced to ration their cigarettes, but this meant that little systematic exposure to nonsmoking conditions took place before the target date. Hence, they experienced a high level of urges when cessation was attempted. Thus, neither strategy seemed effective at breaking fundamental patterns of nicotine self-administration, because the timing of precessation cigarette consumption was under the control of the smoker. Breaking this pattern is the distinguishing mark of the scheduling methodology, and appears to result in sustained coping effort, effective management of affect, urges, withdrawal, and a reduced vulnerability to future relapse. However, future replications of these results are required to strengthen these conclusions and possibly to adapt the scheduling technology to wider scale public health usage.

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