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Self-Control in the Elimination of Cigarette Smoking: Case Histories Using a Changing Criterion Design

Jeffrey Leo Miller

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SELF-CONTROL IN THE ELIMINATION OF CIGARETTE SMOKING: CASE HISTORIES USING A CHANGING CRITERION DESIGN

by

Jeffrey Leo Miller

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
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I would like to thank Professors Neil Kent, Roger Ulrich and Malcolm Robertson for their advice on this thesis.

I would like to thank Dr. Hilary Karp for introducing me to this field of research and my subjects for their efforts and faith in the procedure.

This paper is respectfully dedicated to my parents in the hope that they too may quit smoking.

Jeffrey Leo Miller
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>ii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>METHOD</td>
<td>27</td>
</tr>
<tr>
<td>RESULTS</td>
<td>32</td>
</tr>
<tr>
<td>DISCUSSION</td>
<td>37</td>
</tr>
<tr>
<td>FIGURE LEGENDS</td>
<td>41</td>
</tr>
<tr>
<td>Figure 1</td>
<td>42</td>
</tr>
<tr>
<td>Figure 2</td>
<td>43</td>
</tr>
<tr>
<td>Figure 3</td>
<td>44</td>
</tr>
<tr>
<td>Figure 4</td>
<td>45</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>46</td>
</tr>
</tbody>
</table>
Cigarette smoking behaviors stand out as an enigma in operant research literature. Smoking would appear to be a nearly perfect target behavior for study and modification. Control of smoking behaviors could save natural resources and increase labor productivity. Decreases might be expected in cancer, emphysema and heart disease rates with their concomitant suffering and losses. Air pollution decreased even slightly would have a positive impact on those with respiratory ailments.

The habitual smoking of cigarettes seems to fit the operant control models admirably. Koenig and Masters (1965) enumerated the requirements of a behavior pattern suitable for investigation as:

(a) the behavior pattern is maladaptive and thus within the paradigm of neurotic behavior while providing motivation for the volunteering subjects to change their behaviors;

(b) the behavior is potentially observable and occurs in discriminable units; and

(c) the behavior occurs with fairly high frequency in the population at large.

Cigarette smoking is clearly maladaptive in regard to human health. It may also be a cause for stains and wrinkles in the skin, for interpersonal discord, burns and fires. Cigarettes are an unnecessary expense for people who have inadequate financial resources. The smoking of cigarettes is observable, discriminable in units and pervasive.
People who learn to control their cigarette smoking may expect better health, longer lives and some financial gains. They may also report a higher frequency of other self-control related behaviors. Dieting, exercise, assertion and skill acquisition could be accelerated.

With all of these potential positive events and despite the obvious negative aspects of smoking, the majority of studies in the field reveal a stereotypic group response. Almost any procedure, including several control procedures, yields an initial decrease in rate which disappears in time. These results graphed as rate over time resemble an elongated check mark and vary little with different therapies and populations.

Interpretation of these results may take a number of forms. In one respect we can see any decrease in smoking rate, even a short-lived one, as an improvement on the current situation. If in one of these studies has smoked 100 fewer cigarettes than normal as a result of his participation, some benefit has accrued. On the other hand, one might contend that the effort expended and lack of lasting results can only serve to decrease motivation to attempt future self-control programs.

The paradox in this area lies in the theoretical ease with which a discriminable, socially disdained habit could be eliminated versus the reality of collective failure to impact the smoking rate.
With only rare exceptions, operant smoking control studies have been as ineffective as psychodynamic approaches and even some placebos. Hundreds of researchers have led thousands of Ss through a maze of equipment and experimental designs with little change in smoking rates, measured by a ratio of smokers to nonsmokers, percent of base rate or number of cigarettes consumed.

This question of goals for smoking control studies reflects ambiguities in the technology which are core issues. The bulk of published smoking control research is supported by grants and the institutions funding this research expect results rather than knowledge. These contingencies of funding contribute to reporting results in terms of percent of base rate. The advantage of this system is that it reliably provides good graphic results. Even a minimal impact on the majority of Ss in the study will appear therapeutic when measured in this way. By accepting reduction over elimination as a goal, more success per dollar can be generated. A host of non-specific factors may serve to lower temporarily the rate of most Ss.

Some authors define a success as reducing to 12 cigarettes per day. This figure is considered "medically safe" as derived from the Surgeon General's Report on Smoking and Health (1964; Azrin & Powell 1968). This citation may be correct but the issues of continuing rate control and recidivism are ignored.

A few researchers have presented their data in terms of...
abstinence rates (Schmahl et al. 1972; Elliot & Tighe 1968; Lando 1976). These they consider the benchmark of success. The use of total elimination of smoking as a goal may be prompted by E's personal bias. Some authors see their role as moral entrepreneurs fighting the demon curse of tobacco, as in the Seventh Day Adventist's Five Day Plan to stop smoking (McFarland et al. 1964). A vague moralism is implied in article titles such as "The results of helping people fight cigarettes" (Schwartz & Dubitzky 1967) and "Modification of an overlearned, maladaptive response . . . ." (Pyke et al. 1966). Parallels, valid or not, may be drawn from alcoholism and drug addiction literature.

The second reason for using abstinence as a success criterion involves another set of controlling contingencies. Es aware of the trend to recidivism in this field see controlled, low rate smoking as an exception rather than a rule. The best way to stop high rate smoking is to quit cigarette consumption altogether. Ongoing low rate smoking requires daily efforts.

A surprising result of one study suggests that the stated goals of a program can affect the outcome. Bernard and Efran (1972) used pocket-sized timers and reduction schedules to modify their Ss' smoking rates. Those in the Timer Elimination group lengthened their intercigarette intervals by advancing the timer to a maximum and then quitting. Timer Reduction Ss followed the same procedure with

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a terminal goal of 8 cigarettes, or half their base rate if it was less than 16 cigarettes per day. A control group followed the Timer Reduction schedule without timers. A follow up two months later showed the Timer Elimination and control groups at near base rates. The Timer Reduction group had four nonsmokers, three Ss at base rate and three at half base rate.

A self-reinforcement variable has been postulated to explain these results. Given a limit in controlling a behavior's frequency, we might anticipate some positive events associated with bettering this limit. Thus, studying for a longer period than contracted, or eating less than a daily caloric limit may be followed by a form of intrapersonal social reinforcement. These positive, albeit largely private, events might promote more extensive behavior change than is originally planned or anticipated. Another explanation may lie in the small sample size of ten subjects per group. This may have allowed a loading of the Timer Reduction group with Ss motivated to a different degree than other Ss. Motivation in this usage is an amorphous quality Ss bring to a program and which presumably is an establishing operation for the possible behavior change. Ss are said to be motivated to stop smoking if they volunteer for a research program and agree to accept the environmental changes it requires.

This essentially static view of motivation as a private class of events offers little room for change or hope for those who lack it.
Motivation may also be viewed as a combination of internal and external factors which varies relative to any particular behavior or class of behaviors. This approach to motivation allows for modification and this has occurred by a number of means. Ss may be given information on the hazards of smoking. They may be asked to fasten a picture of their family to each package of cigarettes. Attrition, one measure of motivation, may be largely eliminated by the judicious use of monetary deposits (Tighe & Elliot 1968; Winett 1973). This artificial manipulation of contingencies prior to or concurrent with the modification of the targeted response may prove a critical variable in transforming the balance of success and failure. As Goldiamond (1965:853) has stated, "If you want a specified behavior from yourself, set up the conditions which you know will control it."

Using negative events to manipulate motivation may eliminate failure, given a reliable delivery system, but the secondary effects of these aversive measures must be evaluated. Powell and Azrin (1968) demonstrated that effective levels of shock caused a decrease in the number of subjects along with a decrease in smoking rate.

To return to the requirements for research presented by Koenig and Masters (1965), a closer inspection reveals inherent difficulties with the field of smoking control. First, while cigarette smoking appears maladaptive in the abstract or to the nonsmoker, it does not in the specific instances of usage to the smoker. Lighting
a cigarette is the most expedient means to escape an aversive situation, i.e., high anxiety or low nicotine levels. Alternative responses are simply not as effective. Motivation to change is not a constant feature of the smoker's environment. This varies with stimulus cues, physiological feedback and external contingencies.

Second, the behaviors involved in smoking are not singular. To discuss smoking behavior as a discriminable, observable response is a simplification. The E must address the question of whether he seeks to control smoking or the use of tobacco. What role do cigars, pipes, snuff, chewing tobacco, marijuana and herbal smoking mixtures play in the design? Next, one must consider the question of units. The choice of the cigarette as the unit of response measurement has two complications. Cigarettes may vary in length from 70mm to 120mm. A hand-rolled cigarette may contain a widely varying amount of tobacco. Furthermore, are snuffed and re-lit cigarettes to be considered a separate unit? If not, what procedure will reconcile an observer's data with the Ss'? While cigarette smoking is potentially an observable response, it is not always so. Any S can easily manage surreptitious smoking.

The final condition, that the behavior(s) occurs with fairly high frequency in the population at large, poses no particular problems. In fact, one of the reasons smoking is so resistant to modification is this social sanction. With the advent of nonsmokers'
rights as a movement, this situation may change. The restrictions now imposed on smokers in restaurants, public conveyances and buildings bode well for the future of smoking control technology.

The operantly oriented studies cited herein as involving consequent control utilize either aversive techniques or contracting. While the loss of contracted money or possessions could be theoretically construed as an aversive event, the term "aversive technique" will be reserved for those studies using shock, satiation and smoke generators.

Koenig and Masters (1965) compared systematic desensitization, nondirective supportive counseling, and an aversive control procedure in which electric shock was presented randomly within the time required for five puffs of a cigarette. While there was a statistically nonsignificant decrease across modes, there were significant effects for some therapists across modes. A high correlation between negative ratings of the therapist and success was noted, as well as predicted, compared with actual success. All groups showed heavy recidivism at follow up.

Powell and Azrin (1968) demonstrated an unexpected theoretical advance in a program which otherwise might be considered a failure. The authors attempted to modify smoking rate using a cigarette case/shock apparatus. The device was modeled after an apparatus for postural control which presented an aversive tone to conseque
slouching (Azrin et al. 1968). While they were partially successful in smoking control, their design was more successful in reducing the number of Ss. Of 20 solicited Ss, only six agreed to wear the device. Three Ss later dropped out of the study and the other three apparently had professional or academic contingencies maintaining their participation. The maxim which may be developed from the study involves the correlation between effective measures in aversive paradigms and participation. As shock inevitability increased, volunteers decreased.

Another paper presenting paradoxical results was published by Greene (1964). Using mildly retarded Ss and a sham "music appreciation" task, he superimposed white noise on classical music heard over earphones. The white noise, judged an aversive stimulus, was contingent upon cigarette puffs measured by a parabolic heat detector. An increase in smoking rate was recorded and later attributed, through a second control group, to the faint clicking of the relay apparatus. What had been designed as an aversive control study demonstrated the effects of stimulus cues in maintaining smoking behaviors.

A methodological innovation was introduced by Wilde (1964) in his study by using a stale smoke generator to consequtate the smoking of cigarettes in the laboratory. This technological approach was modified by several researchers to include stimulus panels and cool air for contrast (Franks, Fried & Ashem 1966). Lublin and Joslyn
(1968) combined the use of the smoke generator with an increased rate of smoking. Some inconsistencies in this study were corrected in a paper by Schmahl et al. (1972), who reported an impressive 53% quit rate at a six-month follow up.

A promising technique requiring no apparatus and which could be used in the smoker's natural environment was developed by Resnick (1968). His Ss were instructed to smoke to satiation, then quit. One group "chain smoked" two cigarettes whenever they wanted one. A second group smoked three cigarettes in a row every time they smoked and the control group smoked normally for a week before all groups quit. Significant rate decreases were reported for both treatment groups over the control group but not between the satiation groups.

Marston and McFall (1971) compared Resnick's triple satiation procedure with a reduction schedule employing time-of-day limits and two control conditions. As in the Resnick study there were no significant differences noted between treatment groups. There was also a marked degree of recidivism. The results of both of these studies have been scrutinized in a negative light (McFall & Hammen 1971; Lichtenstein 1971) but credit is due for the break into 24 hour apparatus-free field procedures.

A similar procedure was used by Keutzer (1968) and contrasted with other behavior modification techniques. Citing a negative
practice rationale developed from the early writings of Dunlap (1932) on habits and Yates (1958), triple rate satiation was augmented by a faster than normal controlled smoking rate. Ss were in an unventilated room taking one "drag" every 12 seconds. Upon completion of the third cigarette the Ss were removed to a ventilated, smoke-free room and instructed in noting the difference. A $20 deposit kept the S attrition level under 2%. Results were presented as percentage of base rate smoking. A significant difference for treatment over control groups was posted. No significant difference was found between negative practice and the other two procedures, covariant control and breath-holding.

The effects of an aversive smoke generating device versus a rapid smoking procedure, a combination of the two and an attention placebo were compared in a thorough study by Lichtenstein et al. (1973). Rapid smoking was defined as one drag every six seconds. Experimenter effects were investigated but no significant differences were seen. The apparatus was not significantly more effective than rapid smoking but both procedures, separately and combined, accounted for lower rates than the placebo group. Of the 40 Ss, 39 were abstinent at the end of treatment and 21 remained so at the six-month follow up.

A study by Lando (1976) compared two satiation procedures and also featured deposit return contingencies. Like Lichtenstein
et al., Lando chose to use abstinence as his success criterion. A rapid-smoking group had three three-minute sessions daily for six days in one week. They were to smoke at the rate of one puff every six seconds. A slow-smoking group followed the same procedure but with a rate of one puff every 30 seconds. Each group was further divided into contingency management (CM) and no contingency management (NCM) groups. The CM Ss received four additional supportive group sessions after the satiation sessions and were to receive a partial refund of their $50 deposit if they were abstinent at the two-month follow up. Rapid smoking proved no more effective than slow smoking, but the deposit contingency affected the abstinence rate significantly at the end of treatment and at the two-month follow up. No treatment effects could be claimed at the six-month follow up for any group.

The above studies share a concern for methodological precision which precludes out-of-lab procedures. To allow the treatment to be applied in the outside world requires either a blind faith in the veracity of self-report or extremely high reliability measures. The latter will be discussed in the stimulus control section of this paper. The question of effectiveness in laboratory-bound procedures was addressed by Yates (1970) in stimulus control terms. "The smoking sequence," he writes, "becomes attached to so many environmental stimuli that laboratory control of smoking is unlikely (however
successful) to maintain control over smoking behavior outside the laboratory." While partially contradicted by the excellent results achieved by Schmahl et al. and Lichtenstein et al., this offers some explanation for the recidivism that pervades other research.

In review, aversive techniques have shown effective smoking suppression within the laboratory but generalize to other environments poorly. At least one design (Greene 1964) actually increased the smoking rate of the Ss. A synopsis of designs reveals an evolution of increasing simplicity and application to a broader range of environments. Interest in electric shock has now dwindled to an historic one. The satiation literature shows a trend toward elimination of extraneous factors. Lichtenstein et al. (1973) proved the practical equivalence of their rapid-smoking procedure with the more expensive, cumbersome and limiting smoke-generating apparati. Lando (1976) then showed a lack of significance between the rapid-smoking procedures and a "slow smoking" satiation design. A comparison of each design with and without a contingency contracting stipulation touched upon another body of literature with the potential for more positive results.

The previously cited aversive techniques have proven to be less than optimal to obtain abstinence goals and are only moderately effective in sustaining a decreased rate of smoking. Another field of research was broached in the article, "Aversive Conditioning and
Contingency Management" (Lando 1976). This paper may be seen as the junction of two forms of consequent event manipulation, aversive control and behavior contracting.

Contingency management generally involves the relationship between money or goods and some class of behaviors. The exchange is defined in a contract, either formal or implied. The money or objects are usually the possessions of the Ss. In some cases the contracted contingencies can be social rather than material (Tooley & Pratt 1967). Recent restrictions of smoking rights in public areas and conveyances may also be seen as implied contracts. The smoker agrees to modify his behavior in exchange for social sanctions. By abiding with the established stimulus distinction of smoking and non-smoking areas he may avoid fines and disapproval while retaining the positive events he associates with appropriate smoking behaviors. The emission of nonsmoking behaviors is conversely reinforced by the maintenance of the environmental status quo and continued access to that environment.

The class of behaviors a S must emit in a contingency management design can be of several forms. The first is attendance at treatment sessions. Some researchers also require the Ss to turn in data on their smoking rate. A further stipulation might be that the data agree with records provided by observers. If cigarettes are only to be obtained through the facility conducting the study, the
number given each $S$ may serve as an additional reliability check.

The second category of behavior classes which may be required of a $S$ are goal related. In this instance, the $S$ might be asked to meet reduction quotas to receive a refund of his deposit or contracted goods. These quotas usually take the form of a unit reduction but they may also be based on time of response occurrence. Deposit contracts can continue beyond the treatment sessions, helping the $S$ stay off cigarettes. This arrangement may be planned for one treatment group (Lando 1976) or initiated by the $S$ on an individual basis (Tighe & Elliot 1968). Both Lando (1976) and Winett (1973) found significant reductions using contingent deposits in their first follow up. Both also noted serious relapses at the end of the contracted period. This suggested to Winett the need for longer, even indefinite length, contracts.

The material parameters of deposit contracts have yet to be studied extensively. The difficulty of balancing variables such as income and the value placed on the money or goods contracted presents problems. In comparing the deposits used in different studies, it would be wise to adjust the figures for the rate of inflation and the socioeconomic status of different $S$s. Thus the $20$ deposit used by Mees in 1966 is not far removed from the $50$ Lando asked of his $S$s in 1976. And while a $65$ deposit used in Elliot and Tighe's 1968 study may seem excessive, it should be remembered
that the Ss were members of the Dartmouth College community and were probably able to afford a larger loss through non-compliance. This study also required the Ss to pay cash at the beginning. No checks or promises were accepted.

The excellent results posted by Elliot and Tighe contrast sharply with non-contractual methods and even some studies from the same body of literature. Of 25 Ss, 21 were abstinent at the end of treatment and 10 remained so at the follow up.

The behaviors which constitute the class we label cigarette smoking occur in a sequence with clear antecedents. In smoking a cigarette, the following chain of behaviors must be emitted: reaching for the cigarette container and opening it if necessary, removing the cigarette, putting the cigarette between the lips, holding the cigarette with the lips, procuring a heat source, activating the heat source, placing the heat source in proximity to the end of the cigarette and inhaling through the cigarette. Eight or more discrete chained behaviors are necessary to light a cigarette. Smokers refer to this as a single event, lighting up. Indeed the fluency of the habituated smoker's movements blurs the distinctions between the events. Each behavior as it is emitted provides the stimulus for the next behavior.

Any variations in this sequence are usually minor. A smoker who is driving a car may activate the lighter before reaching for his cigarettes. A light may be offered before the cigarette is between the
lips. It has been suggested but not as yet documented that women who smoke tend to prepare their heat source before they place the cigarette between their lips. In any sequence, however, the critical item of the chain is the inhalation of air to light the cigarette. It is this specific behavior which is the micro-target of stimulus control approaches to smoking control technology.

The most obvious examples of stimulus control of smoking behaviors are those which increase rate. A cup of coffee, talking on a telephone or over drinks, an advertisement or the sound of a lighter are all examples of stimulus conditions conducive to smoking. Other stimulus conditions are usually associated with not smoking, theaters, and self-service filling stations, for example. It is interesting to note that in the latter case immediate and catastrophic consequence (immolation) may be associated with smoking, yet stimulus control is less than absolute and signs are posted as reminders.

Stimulus control measures in smoking research may involve keeping the S out of conducive stimulus conditions, in non-conducive conditions or a combination of these approaches. Some studies seek to establish different cues for smoking that are more amenable to modification.

Procedures useful in any attempt to decelerate smoking behaviors were cited by Harris and Rothberg (1972). These include: taping a list of your reasons to stop smoking to the top of your
cigarette packages, limiting your smoking to one room and then one chair, breaking up the smoking chain by putting your cigarette down for increasing breaks between puffs, and once you have quit, removing all cigarettes and ashtrays from your house.

The previously cited study by Greene (1964) demonstrates the power of subtle stimuli in modifying smoking rates. White noise introduced over classical music and contingent upon puffs from a cigarette was designed as a negative stimulus which would decrease rate. Instead, the clicking of the relay apparatus with each puff reinforced smoking. This fact was ascertained by the use of an additional control group who used the same apparatus but were isolated from the sound of the relays. The elicitation of smoking behavior by stimuli approaching subliminal thresholds can also be demonstrated by merely opening the top of a metal cigarette lighter in a room full of people who smoke and noting the chain of cigarette lighting that results.

This auditory cueing principle can be utilized to condition a discrete and controllable discriminative stimulus for smoking. Shapiro, Tursky, Schwartz and Shnidman (1971) used Bellboy paging devices or hand-set timers that buzzed on a fixed or random time schedule as exclusive smoking stimuli. An average of nine weeks was required of the 40 Ss to complete the reduction program. The terminal goal for these Ss was four cigarettes per day. The time

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intervals between signals were gradually lengthened and rate decreased. At program termination, a mean reduction of 75% was recorded. The six-month follow up found a 43% reduction from base rate. This compares to a 2% reduction reported by a control group waiting for programming.

Levinson, Shapiro, Schwartz and Tursky (1971) compared timers and response counters with and without group meetings, using cessation as their goal for Ss. This rationale was adopted from an earlier study (Schwartz & Dubitzky 1968) which claimed "even light smoking serves as a constant reminder of the pleasures of cigarettes, thereby making the habit all the more resistant to change."

The timers used were the same type "parking meter" two-hour devices Shapiro et al. (1971) employed. The 52 Ss deposited $15, contingent only upon completion of the program. All groups started the program at 32 cigarettes per day. Those Ss with timers set the dials for one-half hour intervals while counter group Ss kept track of their daily rates with a small golf stroke counter. Ss could slow the rate of reduction by remaining at one level rather than reducing the daily limit according to the reduction schedule. The group meeting Ss had sessions at the 12 cigarettes per day level and at the zero cigarettes per day level. Results indicated a combination of timers and group meetings was most successful in eliminating smoking.

Less than 50% of the Ss finished the program. A level of 12 cigar-
control have dealt with some form of self-monitoring. One drawback to operant measures for controlling cigarette smoking is the effort required of an observer to accurately chart data at all possible response occurrences. If it was possible to measure cigarette smoking rate by some biochemical means, cheating and failure-dropouts might be eliminated. Inevitably we return to the S as his own observer, with all of the concomitant problems and benefits.

Accuracy of data is a keystone of behavior change. Weaknesses at this level can precipitate the collapse of otherwise well-constructed studies. Most research since Pyke, Agnew and Kopperud (1966) has used some form of pencil and paper recording. In that study S recorded the frequency and situation of smoking responses on a daily basis. Harris and Rothberg (1972), McFall (1970), and McFall and Hammen (1971) all used similar data sheets but recorded different events. Harris and Rothberg (1972) asked S to record the time, place and reason to smoke. McFall had one group record instances of smoking and another record urges they declined. A third group surreptitiously monitored the first two. Levinson et al. (1971) used data postcards for all treatments but also had mechanical golf stroke counters for one group. Another group used the postcards and signaling devices as did the Ss in Bernard and Efran's (1972) study.

Some of the most sophisticated recording utilized is found in Azrin and Powell's (1968) behavioral engineering article. The study
used a cigarette case that featured an integral counter. Rather than the number of cigarettes smoked, the counter actually recorded the number of times the lid of the case automatically unlocked. The timer on one model of this case could only be adjusted by the E through disassembly. The other model's locked time could be advanced but not retarded by the S. Subjects could circumvent accuracy by leaving the case open after it unlocked, by removing more than one cigarette at a time or by smoking others' cigarettes. These options were partially controlled by the use of additional observers whose names Ss were to provide.

The preceding articles illustrate two additional stimulus control features employed in the present study. A manual self-monitoring provision, if properly placed in the smoking sequence, can serve to interrupt the chain of behaviors. If between the urge for a cigarette and the inhalation necessary to light the cigarette S has to record his behavior, attention is drawn to the act of smoking. To be maximally effective the self-monitoring procedure should precede lighting, be moderately difficult, remind S of his rate at that point and be highly visible for observers. This last provision serves as a social control for compliance and makes surreptitious smoking more difficult. The second feature, seen in the Azrin and Powell (1968) study, is the use of a cigarette case with smoking control specific stimulus properties. One of the most interesting facets of smoking phenomena
is the almost universal brand allegiance of smokers. A cigarette package is not so much a container as a badge of membership for the smoker. The behavior eliciting properties of a smoker's favorite brand's packaging can be cancelled by using a cigarette case. While the S is still subject to the eliciting factors of advertising and other smokers' packs, he carries a reminder of his commitment to a reduction program. The cigarette case may also carry the equipment necessary for self-monitoring. This improves the portability of the procedure and makes compliance easier.

Two studies stand prominent in the field of smoking control for their design innovations and success in achieving abstinence. The results of Elliot and Tighe's (1968) study were a welcome relief from the usual reports of recidivism. Demanding immediate and total abstinence from their Ss, 84% of the sample complied for the duration of the four-month study. At the follow up, 40% of the Ss were still abstinent. The authors attributed the first figure to the $65 cash deposit required of the Ss. This deposit was returned in stages to Ss who remained abstinent. Return dates were stretched with the first coming two days into the program, the second after two weeks, and so on. Forfeited money was divided among successful Ss.

The stated rationale for this study was twofold. First, the clients substituted a clear, immediate aversive event associated with smoking for the long term and poorly defined negative health and
financial contingencies. Second, the Ss continuously exercised the behaviors of nonsmoking in the natural environment.

The single S design reported in Weis and Hall (1970) and Hartmann and Hall (1976) demonstrated another form of fine avoidance which does not require a "cold turkey" cessation. Using a changing criterion design, the E/S decreased his daily smoking rate gradually. Smoking at or below the daily limit of cigarettes was not consequated. Cigarettes smoked in excess of the daily limit were subject to a response cost procedure (Weiner 1962) in which a dollar bill was to be torn into pieces. The S never exceeded his criterion and quit smoking during the six cigarette per day period. Data were presented graphically as rate over days with criteria superimposed.

The forte of the changing criterion design is that experimental control may be demonstrated for a single behavior and a single S without a counter-productive reversal. In the reversal design, Ss must revert to baseline phase contingencies at some point. This is non-therapeutic in many self-control areas. The multiple baseline design, while not requiring reversals, does necessitate more than one behavior, S, or situation to demonstrate experimental control (Hall 1971). The changing criterion design is best suited to studies using some form of step-wise change, such as shaping.

Hartmann and Hall (1976) describe the essential elements of the design as:
1) "The design requires initial baseline observations on the behavior."

2) "This baseline phase is followed by implementation of a treatment program in each of a series of treatment phases."

3) "Each treatment phase is associated with a step-wise change in the target behavior."

The design is particularly adaptable to smoking studies emphasizing gradual rate reduction. Each S's data can be presented individually and rate decrements are graphically visible. The criteria changes may be gradual, promoting S compliance while still maintaining a consistent rate decrease. The fact that this decrease is statistically visible and the data can be collected by the S adds to the motivational properties of the program.

In review, the stimulus control aspects of smoking control methodologies cover several areas. Some researchers have noted the power of certain environmental stimuli to evoke smoking behaviors. They have sought to limit S contact with these cues. Other studies emphasize contact with stimuli which are associated with non-smoking behaviors. Both approaches may be applied simultaneously or a new stimulus may be established as the only cue for smoking. Data collection in the smoking control literature generally features some form of self-monitoring. The technological sophistication of the method varies from oral reports to elaborate recording apparati. Reliability measures are not always used but are generally helpful.
The final papers cited displayed some interesting aspects. In the Elliot and Tighe (1968) study the data were self-reported but the Ss had their names and photos published in the small community's newspaper as a reliability measure. The data reported by Weis and Hall (1970) featured a similar closed academic environment which facilitated accuracy. The researcher also served as his own S which may be a confounding variable in determining the power of the response cost procedure for behavior control.
METHOD

Four case reports will be presented in this paper. Each S was a volunteer known by the E. All Ss used the same sort of apparatus and similar procedures to decelerate their smoking rate. The basic procedure will be explained in Case 1 and individual differences itemized in the other cases.

Each S carried a metal cigarette case measuring approximately 95mm x 70mm x 20mm. These cases contained up to 20 cigarettes, a short pencil and a 50mm x 90mm piece of graph paper ruled 10 squares per inch. Two folded one dollar bills were also carried in the case at all times. Graph paper was replaced when necessary and the data transferred to both the E's and S's master graphs.

An agreement was made with each S concerning the program procedure. This agreement contained the following provisions and definitions:

1) The client shall only smoke cigarettes from his own case and light them only after graphing each one.

2) The client agrees to inform all persons in his smoking environment that $1.00 rewards are available from the client for anyone asking about a cigarette not graphed before lighting. A reward may be claimed for a lit cigarette after it is graphed if the cigarette was lit before
graphing.

3) The client agrees to abide by a cigarette withdrawal schedule arranged by the client and the experimenter or to burn a one dollar bill for each unscheduled cigarette concurrent with smoking said cigarette.

4) A day is defined for the purposes of this study as beginning at 4:30 a.m. and ending 24 hours later.

5) A cigarette is defined as any unit of rolled tobacco which is burned. Relit cigarettes are to be graphed as a second unit if 5mm or more have burned.

6) Pipes and cigars may be smoked as long as a one dollar bill is burned concurrent with each cigar or bowl or portion thereof.

Further provisions allowed the renegotiation of the agreement with the written permission of both parties and established a weekly data reporting schedule. Additional clauses and changes from the agreement will be presented case by case.

Case 1

The S for the initial use of this procedure was the author. At the time of the intervention he was a 23-year-old graduate student employed as an agency counselor. The S had made one previous attempt to quit in his five years of smoking. The attempt lasted less
than one week. A previous attempt to reduce smoking using a fore-runner of the present procedure was partially successful for one month. In this case a day was defined as beginning at 6:00 a.m. and ending 24 hours later. No provisions were made for pipe or cigar smoking.

There was a 38-day baseline phase. Data were collected using the apparatus and fines for not graphing on time were possible but no limits were in effect. A daily mean rate of 13.4 cigarettes was recorded. The criteria phase began with a 15 cigarette per day limit. Each week the limit per day decreased by one unit. The intervention was scheduled to run 105 days.

Case 2

The second S in this study was a 33-year-old musician. He had quit smoking for one year at one time in his 15-year smoking history. The S's pre-intervention base rate estimate of 16 cigarettes per day was accepted in the interest of saving time. The initial intervention criterion was set at 17 cigarettes per day. Subject made a verbal agreement with the E identical to the one listed in this section. On the 81st day of the intervention the S defaulted on this agreement. No data were taken for the next 16 days. A written contract was signed on the 98th day of the intervention with an additional clause requiring weekly data reporting. Limits were reinstituted beginning with 12 cigarettes per day. The entire intervention ran for
182 days.

Case 3

The third S was a 43-year-old university instructor who had smoked heavily for 30 years. He had made no attempt to stop smoking before this program. An 18-day baseline phase revealed a mean daily rate of 42.4 cigarettes. The previously presented agreement was made verbally. An additional clause required the S's wife to make two reliability checks at times unknown to the S. The initial criterion was set at 44 cigarettes per day with weekly decreases of two units per day for 14 weeks.

On the 98th day of the intervention the weekly criteria decreases were set at one cigarette per day. At this time the S was offered a written version of the agreement to sign. The S kept the agreement for several days before stating that he was not ready to sign it. On the 114th day of the intervention S exceeded his limit by one cigarette and failed to consequate the act with the response cost procedure. Future criterion excesses were also not consequated. The S continued to keep data and use the apparatus through this period. On the 157th day of the intervention he stapled the case and cigarettes in a paper bag and quit smoking.
Case 4

The fourth S was a 31-year-old agency counselor and a smoker for 13 years. She expressed an interest in controlling her smoking and agreed to take data, but not to utilize the agreement. Although the S used criteria at one point, they served only as vague guidelines and had little effect on rate. The data are included in this study as an extended baseline and control condition. The data presented covers 250 days, and was recorded using the standard apparatus but without a fine system.
RESULTS

It has been said that quitting smoking is one of the easiest tasks there is. Every smoker quits each time he snuffs out a cigarette. The problem is staying abstinent. Two forms of results will be presented in each case, the graphic deceleration procedure and the length of abstinence measured in months from the quit date to the present. The E accepts the vehement denunciations of cigarette smoking offered by S1, S2, and S3 as high probability evidence for continuing abstinence.

The data presented is that judged accurate by the E. Lapses which could have been filled with anecdotal data are not graphed and will be discussed in the case.

Case 1

The baseline phase for S1 was 38 days long and is presented in Figure 1. Having obtained a mean daily base rate of 13.4 cigarettes, the first criterion was set at 15 cigarettes per day. Criteria are marked in the figure as broken horizontal lines. The dependent measure, cigarette units, are presented as a function of days.

Daily cigarette consumption decreased as limits decreased. Variance from the criteria was slight and never in excess of the limit. On the 15th day of the intervention a variance of seven units was recorded (six units smoked, 13 allowed).

Two fines were paid in the reliability procedure for failure to
graph a cigarette before lighting it. Both were immediately paid to the S's roommate. Inquiries were made daily by the S's work and school colleagues. Frequent questions from strangers on the nature of the apparatus and graphing procedure were also answered. This generated a great deal of social reinforcement and many new observers.

Cigarette smoking ceased entirely on the 94th day of the procedure. Cigar smoking, not covered in this form of the agreement, occurred sporadically in the final month of the intervention period. There has been no tobacco usage by this S from that date. Abstinence has continued for 17 months.

Case 2

S_2_ requested that intervention begin as soon as possible so no baseline phase was used. S_2_ reported a daily rate of 16 cigarettes, and the first criterion was set at 17 cigarettes per day. The initial reactive effects of self-monitoring are evident in the first week of the intervention. Following this, the data corresponds to the criteria well. Variances of seven units were recorded on the 36th, 37th and 46th days of the intervention. Two fines were paid in the reliability procedure. The data are presented in Figure 2.

Data closely matches the criteria from day 50 to day 81. On day 82 S discarded the apparatus and began ad lib smoking. He reported that until day 99 he was smoking "about a pack a day." On
day 99 an agreement to reestablish the procedure was signed and a criterion of 12 cigarettes per day for that week was set.

Cigarette consumption decreased with criteria changes until the 151st day when S2 stopped smoking. This was 24 days ahead of his scheduled quit date. The S has remained abstinent in the ten months that have elapsed since the cessation of smoking.

Case 3

The baseline phase for S3 was 18 days long. The daily rate proved highly variable, between 32 and 50 units. Subject had originally reported smoking three packs a day. A mean daily rate of 42.4 cigarettes was determined and the first weekly criterion was set at 44 cigarettes per day. Weekly criteria changes were initially set at two cigarettes per day decrements. Beginning with the 15th week the decreases were one daily cigarette per week.

In addition to the standard reliability procedure, the S's wife carried out two checks on data accuracy by comparing the data with cigarettes in the case. Accuracy was confirmed in both instances. These are marked on Figure 3 with checks.

Rate decreases with the criteria changes until day 114. On that day S3 smoked one cigarette over his limit and failed to use the response cost procedure. Criteria were met for several days and then exceeded on days 121, 122, 123 and 126-156. S3 did not consequences this over-criterion smoking but he continued to use the
apparatus and collect data. Rate climbed steadily through this period to a high of 28 cigarettes on day 153. On the 157th day of the intervention, §3 put his remaining cigarettes and the cigarette case in a paper bag, labeled the bag "John's Folly" and quit smoking after 30 years.

Nine months have elapsed since the cessation of smoking.

Case 4

§4 initially agreed to use the apparatus to obtain an extended baseline. She expressed interest in controlling her smoking and wanted to quit when her husband stopped smoking. When presented with the entire procedure and agreement, §4 declined to use it as it was designed. This data is presented as a control condition, using the apparatus and data collection method, but without the fines or criteria system.

A mean daily rate of 20.34 cigarettes was computed from the first 100 days of free operant smoking. This may be seen in Figure 4. The daily rate varied from a high of 32 (day 41) to a low of 13 (day 80). Weekly averages were also determined and ranged from 26.3 cigarettes per day in week 1 to 18.6 cigarettes in week 11.

On day 101 § stated that she was establishing a criterion of 28 cigarettes per day and that this limit would decrease by one daily cigarette weekly. There were no contingencies attached to this "criterion." The mean daily rate for the previous week was 19
cigarettes. No smoking to criterion occurred until day 174, when
the limit was 18 cigarettes. Criteria were exceeded beginning on
day 193. On day 234 S reported she had quit smoking, but she was
seen smoking on day 238. S4 currently reports her smoking rate
at approximately 20 cigarettes per day. Data judged reliable are
presented in Figure 4.
DISCUSSION

Several dimensions for the evaluation of smoking control research were discussed in the introduction of this paper. A study may be analyzed in terms of its utilization of stimulus control and subsequent control, such as self-monitoring and contingency contracting. Research may be directed to two goals: the reduction of smoking rates or the elimination of smoking behaviors in the S.

Other relevant dimensions that could be examined include the cost, both minimal and potential, of the procedure; the portability of the apparatus, the simplicity of the design and the relative effectiveness of the method.

The present study may be seen as employing both stimulus and consequent control features in reducing smoking rates. The self-monitoring of smoking rate by the Ss was an important step in the program. By introducing the monitoring process before the emission of the monitored behavior, two purposes are served. Since the behavior is yet to occur, what is actually monitored is the process of deciding to light a cigarette. This focuses the S's attention on those antecedent events which contribute to the act of smoking. Secondly, the chain of behaviors we know as "smoking a cigarette" is broken by the act of graphing the unit. This in itself may have an inhibitory effect on smoking rate. A related phenomenon is the substitution of smoking control cues for smoking cues through the use
of the apparatus and procedure. The sight of the cigarette case, graph paper and dollar bills (potential fines), and noting the number of cigarettes already smoked may promote behaviors incompatible with or decelerative to cigarette smoking. It was the experience of the author while serving as S that urges for cigarettes decreased upon examining a graph that was almost full. Other Ss have corroborated this finding.

While the response cost procedure was an integral part of the design for this study, it played only a small part in practice. The power of the fine system lies in the potential for punishment. S1 and S2 each paid two fines for failing to graph a cigarette prior to lighting it but no fines for smoking more than the daily limit were implemented by any S. In the cases where Ss exceeded the criterion and the response cost procedure was not employed, rate increased for a period of time followed by a regain of self-control in the form of continuing the program or quitting altogether. It is interesting to note that both of these Ss quit smoking well in advance of their schedule. While the exact extent of the contribution this program made in S3's decision to quit is unclear, a comparison to the data for S4 and a comparison of the ad lib smoking rate over criterion with the baseline data suggests a strong treatment effect.

Future research with this model could explore several variables and their relation to smoking control. The length of time
required by this design might be shortened by using larger criteria changes or shorter intervals. \textit{S}3 demonstrated the feasibility of two unit changes in the first part of his intervention. Criteria changes could come as frequently as daily, abbreviating the intervention interval for a one pack per day smoker from 140 days to 20 days.

The use of program deposits presents the possibility of avoiding some of the difficulties encountered in this study. A comparison could be made between deposits contingent upon rate change and deposits returned as data is turned in. Cash could be compared with postdated checks, previously owned materials or social contingencies.

The type of fine employed by the design could be modified in several ways. The $1.00 fine in the reliability procedure worked well in the cases presented. It had the advantages of portability and effectiveness yet was not so severe that the \textit{S}s refused to use it. The use of others in the \textit{S}'s smoking environments as observers served both to increase data reliability and as a continuing source of social reinforcement for controlled smoking. The over-criterion fine of burning a $1.00 bill was simply not used. Reports from \textit{S}s suggest that exceeding the criterion usually occurred at night when the \textit{S} was alone. The thought of burning a dollar bill seemed distressing and pointless in that situation, even to \textit{S}s who commented on the response cost's parallel to excessive smoking when the

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procedure was first explained. The monetary value of the fine seems reasonable, but the method of consequation requires refinement. Mailing a dollar to the American Cancer Society may be a more feasible procedure. This would require carrying a stamped, addressed envelope and going to the mailbox. The response cost procedure should be carried out prior to the smoking for maximum effect. It is imperative that the $ not drop the program altogether at this point. For this reason a balance between a strong punishment and likelihood of implementation must be found.
FIGURE LEGENDS

Figure 1. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals. Criteria appear as broken horizontal lines . . . . . . . 42

Figure 2. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals. Criteria appear as broken horizontal lines . . . . . . . 43

Figure 3. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals. Criteria appear as broken horizontal lines . . . . . . . 44

Figure 4. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals . . . . . . . 45

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Figure 1. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals. Criteria appear as broken horizontal lines.
Figure 2. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals. Criteria appear as broken horizontal lines.
Figure 3. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals. Criteria appear as broken horizontal lines.
Figure 4. Cigarette units smoked as a function of days. Axes marked in ten-unit intervals.
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