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This is to certify that the thesis prepared under my supervision by

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Is approved by me as fulfilling this part of the requirements for the

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Abstract

Cigarette smoking is a pervasive phenomenon which is a critical component in many people's daily lives. Traditional unicomponent cessation programs have been relatively unsuccessful. Multicomponent smoking cessation programs are currently being implemented, based on the rationale that the more kinds of treatment a smoker receives, the more successful he/she will be at achieving abstinence. Reviews of the literature do not lend clear support to this hypothesis.

The present research has two facets. The first study involved a statistical analysis of 51 multicomponent smoking cessation programs, to determine the effects of study variables on abstinence rates. None of the variables had significant effects on abstinence, although there was a relationship between mean abstinence and both the number of years subjects had smoked prior to treatment, and the selection of participants for each study. Much of the lack of significance may be attributable to the fact that studies did not consistently report study variables. Therefore, the analyses were done on data for only portions of the entire data set.

The second study involved the self-monitoring of smoking behavior by regular smokers to determine individual smoking patterns. This study served as a pilot study to analyse smoking patterns over the aggregate, and to determine the existence of possible subtypes of smokers. Spectral analysis of the smoking data confirmed the hypothesis that there are cyclic patterns of smoking for each individual smoker. It was also shown that there are differences between the weekday and weekend smoking cycle. The basis was laid for the analysis of smoking rituals on a large scale at the point that data from a large number of smokers is compiled.
Multi-component Smoking Cessation Programs
and Individual Differences in Smokers

Cigarette smoking is a pervasive phenomenon which is a critical component in many people's daily lives. In addition, it has important implications for the economic structure of individual families as well as for industry and the work force as a whole. 346,000 smoking-related deaths occur each year. Serious economic loss may be encountered by families when a family member suffers from a smoking-related illness. The work force also suffers from the loss of experienced workers because new employees must be hired and trained. The primary impetus for research on smoking behavior was the realization of a possible causal relationship between cigarette smoking and various physical maladies. Data which linked smoking to diseases such as lung cancer first began to appear in the 1920's and 1930's (Hoffman, 1939; Lombard & Doering, 1928). Confirmation of the association of smoking to lung cancer resulted from the epidemiological studies of the 1950's (Doll & Hill, 1952, 1956; Hammond & Horn, 1953, 1958; Wynder & Graham, 1950, 1951). The recent death statistics published by the Surgeon General (1979, 1981) only add to the need for more careful and properly controlled research on the phenomenon of smoking, its physiological effects, and most specifically, smoking prevention and cessation programs.

Reduction of the appeal of tobacco use by young people is the most obvious way to deal with the harmful consequences of smoking. Until
such prevention techniques are achieved, however, emphasis must also be placed on finding effective cessation programs whose effects are long-term. However, current research and data on smoking cessation programs indicate that, unfortunately, there is no magic treatment. Problems are encountered at many levels in attempts to modify smoking behavior. It is difficult to understand why, in consideration of the available evidence linking smoking to serious illness, (American Cancer Society, 1963; National Clearinghouse for Smoking and Health, 1967a, 1968a, 1967b, 1966b), the majority of smokers do not quit smoking. Straits (1965) delineates four subgroups of nonquitters: the uninformed, the unbelieving, the unmotivated, and the unable. The latter group is of ultimate concern to researchers designing cessation approaches. However, researchers are faced with many methodological difficulties. Although some research design problems may be attributable to lack of careful consideration in study development, inappropriate or unattainable goals may limit the effectiveness of treatment design (Bernstein, 1969).

Major changes in treatment design have occurred over the years. Early smoking cessation programs simply implemented one form of treatment on a group of smokers and calculated abstinence rates, with little concern for subjects' past smoking history, motivation, or long-term abstinence, (Ross, 1967; Bachman, 1964; Thompson, & Wilson, 1966). The focus was only on one aspect of the smoking ritual or on one factor presumed to be maintaining the smoking behavior. The temporary effectiveness of unicomponent programs served as a catalyst to employ
then in combination so as to not only suppress smoking behavior, but to also reinforce the alternatives (Kanisberg, 1976). However, attempts to attend to all variables related to smoking have not yielded substantially better success rates (Kanisberg, Note 1; Shapley Note 2). It has been suggested that multicomponent programs, which implement several cessation strategies simultaneously, would be relatively more successful than the traditional unicomponent treatments because they give the smoker a wider variety of treatment (Delahunt & Curran, 1976). This "more is better" philosophy does not appear to apply to smoking cessation (Emmons, Note 3). Dansher (1977) found that the combination of rapid smoking and self-control training yielded lowest abstinence rates when compared to combinations of rapid smoking, normal smoking, and filler discussion (mean abstinence was 57.1% at treatment termination, and 21.4% at the 13-week follow-up). Lando (1976) manipulated smoking experience (rapid smoking vs. slow-smoking), and subsequent treatment conditions (contingency management vs. follow-up vs. no follow-up). At the six-month follow-up, data failed to show a treatment effect. Elliott & Denney (1978) implemented a treatment package consisting of eight components: rapid smoking, relaxation, covert sensitization, systematic desensitization, self-reward and punishment, cognitive restructuring, behavior rehearsal, and emotional role-playing. In addition, subjects were assigned to either a specific booster condition (refresher lectures, mild encouragement, and supplemental rapid smoking trials), a non-specific booster condition (no rapid smoking trials), or a no-booster condition. The post-treatment
abstinence rate was 66%, which diminished to only 45% by the sixth-month follow-up. The booster session had no significant effect on cigarette consumption. In contrast to the "more is better" viewpoint, Lando (Note 4) hypothesized that an inverted U-shaped curve is applicable — that there is some middle range of number of components in cessation programs which effectively deals with the factors maintaining the smoking behavior, but which does not create stimulus overload for the smoker. Some programs virtually inundate the smoker with cessation techniques, and this may interfere with his/her ability to effectively implement any of the cessation devices. More research into cessation programs and their development is necessary before the rejection or acceptance of any programs can be made.

Many studies have evaluated smoking cessation. Suggested treatments range from rapid smoking (Best, Owen, & Trentadue, 1978; Sachs, 1980), to subliminal stimulation (Glover, 1977), to self-control, (Fisher, et al. Note 5; Blittner, Goldberg, & Merbaum, 1978), to restricted environmental stimulation treatment (REST) (Best & Suedfeld, Note 6), to multicomponent packages, (Lando, 1976; Lando & McCullough, 1978).

There is evidence that the most relapse occurs during the first three to four months following treatment (Lichtenstein & Keutzer, 1973; Schmahl, Lichtenstein, & Harris, 1972). This is certainly supported by the literature on multicomponent strategies.

Abstinence rates, though often as high as 100% initially, drop
substantially by three months (Bernstein, 1969; Schwartz, 1969). The guidelines of the National Interagency Council on Smoking and Health (1974), specify that smoking cessation research programs institute follow-up periods through at least one year. Many studies (Paxton, 1981; Kantorowitz & Bussat, Note 7; Lando & McCullough, 1978; Blittner, Goldberg, & Merbaum, 1978; Delahunty & Curran, 1976; Danaher, 1977) do not include follow-up of abstinence data beyond six months. Judging from initial abstinence figures, one would think that most treatment programs are generally very effective. However, the long-term abstinence rates, particularly at six and twelve months, indicate that there needs to be much improvement in the long-term effectiveness of smoking cessation programs (Bernstein, 1969).

The effects of relapse have long-term implications for the smoker. One must consider that breaking the smoking habit requires a considerable amount of determination and conviction on the part of the smoker. Recidivism is often viewed as a personal failure (Marlatt & Gordon, 1980). Most studies categorize any relapse as failure and the National Interagency Council on Smoking and Health Guidelines (1974) also recommend that relapse be classified as failure. This seems necessary from a statistical perspective, but the effect of the stigmatization of failure on the smoker may be profound. If a first attempt at cessation is unsuccessful, the smoker's expectations for future success can be reduced, thus producing a circular network of events which limits any possibility
of success in future cessation attempts. Since the present focus of concern is on helping the smoker deal with his life-shortening habit, it seems vital to give primary consideration to the effect of the classification of failure.

The ethics involved in instigating treatment programs on all smokers who respond to advertisements, particularly when this aforementioned circular network is considered, is questionable. The marginal treatment success previously discussed is indicative of the fact that not all smokers can do well in any one particular cessation program.

One question that needs to be addressed is which people do remain abstinent, and with what types of intervention. Unfortunately the research in this area still seems to concentrate on identifying a group of smokers who are willing to participate in cessation research, giving them a particular treatment, or in the case of multi-component strategies, a series of treatments, and determining abstinence rates. Based on the relative ineffectiveness of this strategy, it is necessary to look for another approach to the abstinence problem.

Marlatt & Gordon (1980) suggest that, rather than asking how to make treatment more effective, the question of what conditions precipitate treatment failure must be examined. The rationale underlying this strategy is to identify the principles associated with recidivism, which apply regardless of the particular behavior involved.
The subtype hypothesis predicts that there are particular sub-sets of behaviors associated with the smoking habit. People smoke for many different reasons, which vary almost as much as the individual smokers themselves do. Self-report studies provide some support for the idea that there are subtypes of smokers. Some smokers feel they smoke more when exposed to temporary stress (McArthur, et al., 1958). Other smokers report that they smoke most when they are calm and relaxed. Sanford (1967) asserts that it is essential to actually confirm or disconfirm the idea of subtypes. Self-report measures are helpful, but they alone cannot be used as the basis of proving the subtype hypothesis.

Russell (1979) has defined two groups of smokers which are amenable to the subtype theory. "Trough-maintainers" are those smokers who regulate cigarette consumption to keep stable amounts of nicotine in their body, with accumulations showing smaller peaks relative to the overall nicotine level. After these individuals become addicted, smoking becomes a device to avoid the withdrawal effects accompanied by dropping levels of nicotine in the body. "Peak-seekers" smoke for the effects of sharp blood nicotine peaks following each cigarette. These smokers are maximizing the effect of each cigarette by longer interims between cigarettes. Because of the sharp changes in the nicotine level of their blood, "peak-seekers" are able to experience a stimulating effect from each cigarette, in comparison to the "trough-maintainers", whose smoking pattern allows them to maintain a fairly constant level of nicotine.
in their system.

In addition to analyzing individual smoking patterns, it is important to examine factors associated with relapse. Marlatt and Gordon, (1980) suggest that there are common behavioral and cognitive components associated with relapse. Relapse, however, can be triggered by different factors for different types of smokers, (i.e. nicotine deprivation as opposed to stress). Therefore, although the relapse process can be common for all smokers, different groups of smokers will relapse under different conditions. Indeed, it seems reasonable that such components exist. We have all been guilty of using food or alcohol at some time to deal with a disappointment or to celebrate an accomplishment. However, food as a dependence mechanism has a different meaning for each individual. Some people cannot abstain from overeating when they encounter difficulties. For others, indulgence functions as a reward. This diversity in reliance also applies to smoking. There is no universal reason for the behavior, or for relapse. Definitions of common factors which precipitate relapse for different kinds of smokers would not only have tremendous implications for further research, but might also resolve the dilemma of why some smokers can quit and others cannot. An examination of common characteristics of those who have been successful is necessary to determine if, within those characteristics, there might be a key to the subtypes. It seems that members of a particular subtype would have some common feature which distinguishes them from other smokers.
Once it is determined if there are in fact subtypes, it will then be necessary to attempt to match members of the proposed subtypes to particular treatments.

The question of maintenance of smoking behavior is very complicated, as there is little substantiation for the proposal that one factor is consistently responsible for maintenance of all smoking behavior (Bernstein, 1969). It would be erroneous to infer that the subtype hypothesis predicts that each member of a subtype will have a smoking pattern nearly identical to that of every other member of that subtype. What the hypothesis does predict is that the smoking patterns will have similarities based on one main factor or group of factors. For example, one postulated subtype is composed of smokers whose cigarette use is governed by nicotine regulation, if not addiction. The smoking pattern of people in this category should be quite predictable, at the individual level. Nicotine-addicted smokers have relatively short interims between cigarettes in order to keep the nicotine level in their system fairly constant. Therefore, their cigarette consumption is consistent across time. Boredom may be another factor maintaining some smokers' habits. Some individuals may depend on cigarette smoking to relieve boredom in any of a number of situations. Because these smokers would have a higher consumption rate during periods of boredom, this pattern may not be as predictable based on the passage of time. However, investigation of the activity occurring at the time of cigarette consumption and the accompanying thoughts
and mood should be indicative of the correlation between boredom and smoking for members of that subtype.

At the point at which subtypes are determined, the focus must then be placed back on multicomponent treatment programs. If the factors maintaining smoking behavior for a particular subtype were known, cessation programs could be designed to deal specifically with those factors involved. The problem of information overload would thus be mitigated.

Several areas which need further research and scientific consideration have just been delineated. All of these areas merit attention if smoking behavior is to be fully understood and made amenable to permanent change. However, to focus on all of these areas simultaneously would obliterate the importance of each individual area. This paper has two focal points which are interrelated—the breakdown and analysis of the components of multicomponent treatment programs, and the determination of cyclic smoking patterns for general subtypes.

**Study I**

Before the determination of subtypes is made, however, important steps can be taken in the refinement of multicomponent programs so they will be amenable to use with subtype groups. It must be determined exactly what variables each study component attends to. An analysis of the component structure of multicomponent studies is vital to determine the areas dealt with by each individual component, and to assess the relation of the individual components to
Smoking Cessation

abstinence. The present study involves a statistical analysis of 51 multicomponent programs. The purpose is to explore research which attempts modification of smoking behavior via multicomponent cessation programs and to analyze their component structures. The collected data base from which the analysis took place included subject and experimenter data, as well as specific treatment plans and results, although many studies did not contain complete information. The analysis will yield information relating specific components, study design, duration, and other study variables to abstinence rates.

Method

Procedure. Fifty-one multicomponent smoking cessation studies were analyzed and charted according to their component structure, experimenter variables, subject variables, duration, and abstinence data (Appendix A). The information from each of these studies was coded and entered into a compute datafile. The Scientific Information Retrieval System (SIR) was utilized to allow retrievals from each of the four different record types of information collected.

Several statistical analyses were performed on the data. One-way analysis of variance measures were performed to determine the relationship of the various subject, study, and experimenter variables to abstinence rates.

Results

None of the variables examined reached statistical significance in relation to mean abstinence rate. Type of follow-up was the only
variable to approach significance ($p=.089$). However, Multiple Classification Analysis revealed a relationship between mean abstinence and both the number of years subjects had smoked prior to treatment ($r^2=.796$) and the inclusion of a method of selection to choose participants for each study ($r^2=.622$). These statistics illustrate the percent of the variance in mean abstinence accounted for by each of the individual independent variables. A three-way multiple regression analysis of these three variables indicates that approximately 86% ($r^2=.855$) of the total variance is accounted for by both the number of years smoked and the selection method.

The group mean abstinence was not found to be systematically related to the number of components used in individual treatment groups within each study (see Figure 1). The number of components was not strongly correlated to mean abstinence ($r^2=.167$). The highest abstinence was achieved by a group with four components.

Discussion

The results indicate that very few factors are distinctively related to abstinence rates. However, there are several problems in interpreting these findings. Variables are not consistently assessed across studies, such that some variables could only be analyzed for a
very small number of studies. Many vital pieces of information were excluded from several studies.

Guiding principles for the meta-analysis of literature have been outlined (Straw, 1982). Straw recommends the use of categorical variables. In the present study there was such a diversity of treatment methods (92 component types were recorded) and resultant abstinence rates that categorization would have been very difficult, and would have sacrificed vital information about treatment contents and their effectiveness.

As Straw indicates, the use of statistical significance is the best method for testing hypotheses about groups of studies, but is also heavily dependent on sample size. Therefore, the assessment of a particular variable in only a few studies would substantially effect the outcome of the analysis.

Some studies include abstinence data only up to three months post-treatment. However, abstinence rates generally drop substantially after three months (Bernstein, 1969; Schwartz, 1969). Abstinence data of only up to three months following treatment are not representative of the full cycle of the smoker's fight against recidivism, and therefore inflate true success rates.

The mean base rate of smoking prior to treatment was rarely included in subject descriptions. This variable is important to assess the duration of the behavioral pattern which the treatment is attempting to manipulate. If, for example, a person has only been
Smoking for a few months, aversive procedures may be sufficient to disrupt their smoking pattern. However, it is much less likely that aversive procedures alone will be sufficient to induce long-term abstinence in a smoker of thirty or more years.

The selection of participants could potentially balance some of the potential inconsistencies in mean base rate. Only studies instituting treatment specifically on cardiovascular and pulmonary disease patients reported a selection process. Only two studies reported including all respondents as subjects. The remaining studies did not report use of a selection process. These studies either did not use a selection process, or did use one, but did not report it. Therefore, the relation of this variable to mean abstinence may be very misleading. The number of years smoked prior to treatment was more consistently reported.

In general, many variables assessed by this meta-analysis were not reported in the literature. Complete experimenter variables (sex, age, education, and number) were not reported in any of the studies. Experimenter sex was reported in only fifteen studies and experimenter age was reported in only nine studies.

The present meta-analysis of the available multicomponent smoking cessation literature does not yield favorable conclusions regarding the effectiveness of multicomponent treatment programs. As previously discussed, flaws in the literature may have contributed to this negative outcome. Researchers must begin to consistently report study
variables. When study variables are being consistently assessed, it will then be possible to do a meta-analysis which will include all variables present in all studies, and which will potentially yield more favorable results.

Study II

The importance of the determination of subtypes has been previously emphasized. This study is an attempt to explore directly the idea of subtypes via the self-monitoring of smoking behavior by regular smokers. It is necessary to determine when and how smokers use cigarettes before subtypes can be defined. Through extensive monitoring, it should be possible to see the consistencies and inconsistencies in individual smoking patterns, as well as in the aggregate.

Self-monitoring was chosen as the method for data collection because, as suggested by Russell (1979), the statements of smokers are the essential starting point in the investigation of the smoking behavior. Frederiksen, et al. (1975) found immediate self-recording of cigarettes smoked to be more accurate than daily or weekly recordings. An alternative method to the comprehensive monitoring of ever cigarette smoked over a specified period is time-sampling. Information which provides clues to the subtypes may not be discernible within an arbitrary time span, and determination of the cyclical pattern of the individual's ritual is vital. Subject cooperation might improve with time-sampling but
the subjects are also prone to forgetting the period of time which is to be monitored. Self-monitoring is also preferable to recall because the subject’s memory of their smoking may not be accurate and because bias may affect their reports. The rationale for the use of continual monitoring is to incorporate the recording process into the smoking ritual in a manner such that the cyclical pattern can be assessed.

The question of reactivity is inherently tied to the use of self-monitoring devices. McFall & Hammen (1980) suggest that reactivity may be tied to motivation. It was found that for smokers desiring to quit, self-monitoring did decrease smoking rates. However, this effect was not present for those individuals who did not wish to stop smoking. Similarly, motivational effects have been found in the self-monitoring of verbal participation (Komaki & Dore-Boyce, Note 8).

What is vital to make any differentiation of subtypes is the self-monitoring of the smoking ritual over an extended period of time. This would allow for the examination of the actual changes in smoking behavior as they occur throughout the day and during the week. The present study involves extensive self-monitoring of smoking behavior by smokers throughout their entire smoking ritual for a period of at least two weeks. This will allow the examination of the specific manner in which the smoker uses the cigarette. It is necessary to determine the cyclical cigarette
use rather than just the general usage pattern as determined by collection of smoking demographics.

As Russell (1979) emphasized, the statements of smokers should be the starting point in determining the motives underlying the dependence. This idea was incorporated in the construction of the present self-monitoring study. The subjects provided several items of information concerning each cigarette consumed. In addition to recording the time and location of where they smoked the cigarette, they also recorded activity involved in when they lit the cigarette, mood prior to the cigarette, thoughts following lighting the cigarette, intensity of craving for the cigarette, and enjoyment attained from each cigarette. The time the individual woke up in the morning and their mood at that time was also assessed. It is postulated that this information will help identify "trough-maintainers" and "peak-seekers", as discussed earlier.

Mahoney (Note 9) suggests that some subjects may be unsuitable for participation in self-monitoring. In the present study, this problem is diminished because the initiative was placed on the smoker to become a participant. To become involved in the study, the smoker had to call the investigator's office, and establish the initial contact. The aim was that only individuals who were willing to make a careful effort would participate. Another factor involved in the selection of self-monitoring as the method of data collection was the cost. The cost of the paper on which the self-monitoring
forms were printed and of the envelopes for return of the materials were essentially the only expenses involved. All self-monitoring packets were sent via campus mail, and subject participation was voluntary. Therefore, this was a very inexpensive research design to implement.

Method

Subjects. Volunteers were solicited via fliers posted in university buildings and advertisements in several newspapers. Any smokers who were not attempting to quit smoking were included in the sample. Subjects included both university employees and students, so that there was a wide distribution of both ages and occupations.

Procedure. Each respondent was informed exactly what the study entailed, and some minimal demographic information was collected (e.g. job address, home address). The study materials were sent to the participants via campus mail so as to maintain the lowest budget possible. Included in the instructions was a specified date on which the monitoring was to begin and end. The study materials included the self-monitoring booklet and questionnaires concerning general smoking behavior and demographics, such as length of time the subject had been smoking, the subject's age, occupation and marital status (Appendix B).

The self-monitoring booklet contained several self-monitoring sheets which were designed such that the smoker could record each
cigarette after it was lit, and answer several questions about that particular smoking event. The instructions included the specific manner in which the subjects were to fill out the self-monitoring sheets.

The subjects were instructed to return the questionnaires, in envelopes which were provided, at the conclusion of the 14-day monitoring period. The day before their monitoring period was to end, each individual received a phone call from the investigator reminding them to complete and return the materials the day following termination of the recording period. At this time, the subjects were thanked for their participation, any questions were answered, and comments and suggestions were elicited.

Results

Obtained Data. Spectral analysis was performed on the occurrences of sequential cigarettes smoked. The cigarette consumption over five 24-hour periods is represented in Figure 2. This subject smoked the first cigarette of the day at approximately 9:00 a.m. The ascending data points represent one day, and the sharp vertical descending lines represent the demarcation of 24-hour periods. The last two peaks represent weekend days.

The slope of these data points indicates that more cigarettes were
being smoked on the weekends than during the week. A steeper slope indicates that fewer cigarettes are being consumed. Inter-cigarette intervals (ICI) were calculated by computing the time span between sequential cigarettes (see Figure 3). A somewhat consistent pattern of consumption seems to be occurring. There is a fairly large interval between the second and third cigarettes (approximately 150 minutes), and a relatively short interval between the fourth and fifth cigarettes (approximately 71 minutes). A similar pattern occurs between the fifteenth, sixteenth, seventeenth, and eighteenth cigarettes, and again between the fifty-seventh, fifty-eighth, fifty-ninth, and sixtieth cigarettes.

Because spectral analysis requires equal time sampling, the data was transformed into equal time intervals. This procedure takes all ICIs beginning or ending within each time period and weights them based on their representation in the time period. The weighted intervals for Days 1 and 2 are represented in Figure 4. Spectral analysis requires that all data be stationary, or possess the same expected value of mean and variance independent of time.

To satisfy this stationarity requirement, the data were subjected to a 19-point moving average. The moving average filter removes
nonstationary components and smooths local fluctuations in the data, allowing the estimate of slow shifts in mean levels. Figure 4 is the representation of two series super-imposed on each other. The variance of the smoking process is decomposed into these distinct processes, which are the template and the residual series. The template series (see Figure 5) represents the slow-moving trends in the data. The residual series (see Figure 6) represents the faster-moving trends in the data that remain after the template series is removed.

Spectral analysis partitions the variance into rhythmic components of different periodicities. When smoking behavior demonstrates a sequential pattern of systematic increases or decreases in ICI, spectral analysis will identify a major component of the variance at a specific frequency in terms of power (see Figure 7). The dominant frequency is at .01 cycles per minute. This indicates that one complete smoking cycle for this subject is occurring every 100 minutes. Other spectral plots have indicated the existence of a 24-hour cycle for all subjects. Therefore, the 24-hour cycle is supplemented by individual cycles at varying periodicities.

Of all the subjects, one had one complete smoking cycle every
ninety minutes, two subjects had one cycle every 100 minutes, two subjects had one cycle every 110 minutes, and one had one cycle in 125 minutes. The smoking cycle periodicity, the average inter-cigarette interval for each subject, and the number of years the subject has smoked are represented in Table 1. It should be noted that subjects 5 and 6 did not complete the monitoring period.

Insert Table 1 about here.

All subjects have relatively similar cycle periodicities. However, it is of interest that the longer the subject has smoked, the shorter the ICI is.

**Idealized Data.** As previously discussed, two subtypes have been proposed in the literature (Russell, 1979). "Peak-seekers" are smokers who regulate their cigarette consumption to receive maximum effects from the nicotine. "Trough-maintainers" regulate their smoking to keep a constant level of nicotine in their system. After self-monitoring from a large number of subjects is analyzed via spectral analysis, it will be possible to verify the existence of these and other possible subtypes. Since the lack of available data in the present study made such verifications impossible, data was created to simulate the subtypes of "peak-seeker" and "trough-maintainer". This data was subject to spectral
analysis in the same manner as the obtained data to determine the cycles and patterns of idealized subtypes.

Insert Figure 8 about here

Figure 8 represents the sequential cigarettes smoked over a 24-hour period for a "peak-seeker". Several cigarettes are consumed in relatively short time period, with much longer intervals between smoking periods. This pattern illustrates the suggestion that "peak-seekers" smoke to maximize the stimulating effects of nicotine. The nicotine level in their system subsides during the long intervals (for example, between the tenth and eleventh cigarettes in Figure 8), and is reinstated during the smoking periods (for example, the first four cigarettes smoked in Figure 8). The spectral plot of this data indicates that although there is a definite cycle occurring every twenty-four hours, there is also a cycle occurring in approximately 100 minutes (see Figure 9).

Insert Figures 9 and 10 about here

Examination of the sequential cigarettes smoked by a "trough-maintainer" reveals a more consistent pattern of consumption in comparison to the consumption pattern of a "peak-seeker" (see Figure 10).
Cigarettes are smoked at fairly short intervals in the morning until the nicotine level reaches the desired level. Cigarette consumption then tapers off, and fluctuates throughout the day to maintain the nicotine level. The spectral plot of this data would yield a much smoother curve than that obtained from the "peak-seeker" data.

**Discussion**

Spectral analysis of smoking data confirmed the hypothesis that there are cyclic patterns of smoking for individual smokers. It was also shown that there are differences between the weekday and weekend smoking cycles.

It is of great interest that the cycles of all subjects were very similar in duration. However, the small sample size requires cautious interpretation of these findings. The main factor which reduced the possibility of analyzing subtypes at the aggregate level was lack of subject cooperation in providing monitored information. The monitoring method used in this study proved too extensive and restricting. Several subjects commented that they found the form too complex and cumbersome. A less comprehensive method of monitoring should yield more cooperation. One alternative would be to ask subjects to record only the time and a broad category of activity engaged in at the time of cigarette consumption (e.g., work, play, other).

None of the actual subjects could be classified as either "peak-seekers" or "tough-maintainers" based on comparison of spectral plots. However, it is conceivable that there may be a group of
smokers which has some of the properties of both of these subtypes. It is also possible that this sample of subjects belong to other, as yet undefined, subtypes.

Smoking behavior is a cyclic phenomenon. The basis has been laid for the analysis of smoking rituals on a large scale. At the point that compilation of smoking data from a large number of smokers is possible, subtypes may be determined using the methods previously described.
Reference Notes


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### Table 1

Spectral Analysis Data

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<thead>
<tr>
<th>Subject Number</th>
<th>Smoking Cycle Periodicity</th>
<th>Average ICI</th>
<th>Years of Regular Smoking</th>
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<tbody>
<tr>
<td>1</td>
<td>125 minutes</td>
<td>37</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>100 minutes</td>
<td>96</td>
<td>3</td>
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<tr>
<td>3</td>
<td>110 minutes</td>
<td>47</td>
<td>6</td>
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<td>4</td>
<td>100 minutes</td>
<td>54</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>110 minutes</td>
<td>85</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>90 minutes</td>
<td>80</td>
<td>1</td>
</tr>
</tbody>
</table>
Figure Caption

Figure 1. The mean abstinence rate for treatment groups categorized by the number of treatment components in each group.
ARCSINE MEAN ABSTINENCE RATE

( )=Number of Studies

NUMBER OF COMPONENTS
Figure Caption

Figure 2. The sequential cigarettes smoked during each 24-hour period for five days.
Figure Caption

Figure 3. The smoking behavior illustrated in Figure 2 transformed to equal time intervals.
INTER-CIGARETTE INTERVAL (ICI)
Figure 4. The weighted inter-cigarette intervals for the first two days represented in Figure 2.
Sequential equidistant data points for days 1 and 2.
Figure Caption

Figure 5. The template series, which represents the slow-moving trends in the smoking pattern.
Smoking Cessation

43

TEMPLATE SERIES
Figure Caption

Figure 6. The residual series, which represents the fast-moving trends in the smoking pattern.
RESIDUAL SERIES
Figure Caption

Figure 7. The spectral plot of the smoking pattern graphed in Figure 2.
Figure Caption

Figure 8. The sequential cigarettes smoked during a 24-hour period for a "peak-seeker".
Sequential cigarettes for a "Peak-Seeker"
Figure Caption

Figure 9. The spectral plot of the smoking pattern for a "peak-seeker".
Smoking Cessation

SPECTRAL PLOT

FREQUENCY

POWER DENSITY

0  150  300  450  600  750  900  1050  1200  1350  1500  1650  1800
0 .0 .15 .30 .45 .60 .75 .90 .105 .120 .135 .150 .165 .180
0 .3 .6 .9 .12 .15 .18 .21 .24 .27 .30 .33 .36 .39 .42 .45 .48 .51
Figure Caption

Figure 10. The sequential cigarettes smoked during a 24-hour period for a "trough-maintainer".
Appendix A
<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>SUBJECT CHARACTERISTICS</th>
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<tr>
<td>Components</td>
<td>Race</td>
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<td></td>
<td>Age Range</td>
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<td>Physical Condition</td>
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<td>Occupation/Education</td>
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<td>Ss Goals</td>
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<tr>
<td></td>
<td>Other Treatments Tried</td>
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<td>Experience with Psychotherapy</td>
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<td></td>
<td>Length of time Ss has smoked</td>
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<td>Typical</td>
<td>Base Rate of Smoking</td>
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<tr>
<td></td>
<td>Recruiting Techniques</td>
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<tr>
<td>Long-Term Maintenance</td>
<td>Ss Restrictions</td>
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<tr>
<td></td>
<td>Method of Ss selection from Interested Parties</td>
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<tr>
<td>Experiment Design</td>
<td>Terms of Participation</td>
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<td>Smoking Cessation</td>
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<tr>
<td>Prediction</td>
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<td>Age</td>
<td>Others</td>
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<td>Education</td>
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<td>Number</td>
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<tr>
<td>Amount of contact with Ss</td>
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<tr>
<td>Others in contact with Ss</td>
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<tr>
<td>Significant</td>
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<td>others</td>
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<tr>
<td>Inventories prior to Tx</td>
<td></td>
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<tr>
<td>Inventories after Tx</td>
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<td>OUTCOME</td>
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<td>---------------------------------------------------------------------------</td>
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<tr>
<td>Analysis Performed on Data</td>
<td>% abstinence</td>
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<tr>
<td></td>
<td>% baseline</td>
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<td></td>
<td>long term abstinence (length of time)</td>
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<td></td>
<td>similarity to prediction</td>
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<td>definitions success failure</td>
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<td>&quot;Typc&quot; smoker most benefited</td>
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<td>Follow-up: when method</td>
<td>Confident intervals</td>
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<td></td>
<td>Mean changes in group posttest smoking rate follow up</td>
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<td></td>
<td>Possible limitations listed</td>
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</table>
Appendix B
Cigarette Use Study

Department of Psychology
University of Illinois

Name _______________________

Cigarette Brand _____________
Dear Participant:

Over the past years, a great deal of both public and research attention has been directed toward cigarette smoking. Widespread concern has been focused particularly on the health hazards of smoking. A multitude of "stop-smoking" programs have been developed, most of which claim some degree of success. Research into such programs, however, has found little evidence of success, particularly on a long-term basis. To improve what is currently known about cigarette smoking, we would like to take a somewhat different approach and examine actual cigarette use.

This investigation focuses on patterns of smoking behavior to learn about the ways in which people use cigarettes. Specifically, we would like to determine the different ways people actually use cigarettes, in addition to the way people perceive they use them. Our interest is to determine the "nuts and bolts" of cigarette use. Although we are not offering a treatment program, the names of cessation programs in the Champaign-Urbana area will be available upon request.

Your role in this research project is two-fold. First, we would like you to fill out the two enclosed questionnaires. Please fill them out at the same sitting. Second, we would like you to keep an accurate record of all the cigarettes you smoke over a two-week period, beginning on

Recording sheets are enclosed for this purpose. Instructions are included, explaining exactly how to fill out the form. Please put the forms and the questionnaires in the enclosed envelopes at the conclusion of the two-week period, and return by campus mail, no later than the day following the final day of recording.

If you are interested in the results of the study, please indicate this on the front of the booklet, and a copy of the results will be sent to you after the analyses are completed. Thank you very much for your cooperation.

Karen Emmons
Research Assistant

Douglas A. Bernstein, Ph.D.
Professor of Psychology
333-4731
**Questionnaire Instructions**

Please fill out the enclosed questionnaires. Fill them out as accurately as possible, and please answer all at one sitting, if possible. Return the questionnaires with the recording sheets at the end of the recording period.

**Recording Instructions**

Please record the following information for each cigarette after you light it. If you forget to record a cigarette, fill in as much information as you are positive about later, but skip any information about which you are unsure. Please indicate that you are recording the cigarette at a later time. If you smoke a cigarette different from your usual brand, please indicate the exact brand (e.g. Salem 100's, Marlboro Menthol, Marlboro King Size, Camel Lights, Kent Filters) on the recording sheet for that day. You may use as many sheets as needed for each day, but please start recording each day on a new sheet. A brief explanation for each question on the recording sheet follows:

**Time:** Record approximate time of light up.

**Location:** Record where you were when you lit the cigarette (e.g. at home, at work, in a bar, etc.).

**Intensity of Craving:** 1=no craving; 2=slight craving; 3=moderate craving; 4=strong craving; 5=intense craving.

**Activity When First Desired Cigarette:** Record what you were doing when you first thought you wanted a cigarette (e.g. reading, talking to a friend, watching TV, etc.).

**Activity When Lit This Cigarette:** Record what you were doing when actually lit the cigarette. This may be the same activity engaged in as when you first desired the cigarette (e.g. reading, talking to a friend, watching TV, eating/drinking, etc.).

**With Whom:** Record who you were with when you lit the cigarette, or if you were alone.

**Mood Prior to Light Up:** (e.g. nervous, angry, happy, etc.).

**Thoughts Following Light Up:** (e.g. "I feel good now", "I have a lot of work to do", etc.).

**Enjoyment from Cigarette:** 1=none; 2=little; 3=some; 4=great

-Please be certain to wrap a new sheet around your cigarette pack each morning. Please record each cigarette as soon after you light it as possible.
SMOKER'S QUESTIONNAIRE

Name ___________________________ Age ______ Sex _____ Race ____________

Address ___________________________ Phone Number _______________________

Marital Status ___________ Number of Children ______

1. What is your occupation?

2. Where are you employed?

3. How long have you been employed there?

4. Circle the number of years you have gone to school and/or any degrees you have obtained.
   0-8 9 10 11 12 13-15 Bachelor's Master's Ph.D.

5. What is your estimate of your physical condition?
   1 2 3 4
   poor fair good excelent

6. How many cigarettes do you smoke per day, to the nearest cigarette?

7. Approximately when do you smoke your first cigarette of the day, to the nearest half hour?

8. When you smoke cigarettes, how often do you inhale?
   1 2 3 4 5 6 7
   always sometimes never

9. How old were you when you first became a regular smoker?

10. What one reason best explains why you started smoking cigarettes?

   ___a. To see what it was like
   ___b. Because my friends smoked
   ___c. Because my parent(s) smoked
   ___d. To act or feel more like an adult
   ___e. Other (please specify) _____________________________________________
11. What one reason explains best why you smoke now?
   _a. My friends smoke
   _b. I enjoy it
   _c. It calms me
   _d. I feel like an adult
   _e. It gives me a lift
   _f. Other (please specify) ___________________________

12. For how many years of your life have you actively been a regular smoker?

13. How do you usually feel when you smoke cigarettes?
   _a. I feel happy, and I am having fun
   _b. I feel nervous, upset, or I am unhappy
   _c. I feel there is nothing else to do
   _d. I do not usually feel any particular way

14. Are you in any way concerned about the possible harmful effects of smoking on your health?
   _a. Not at all concerned
   _b. Only slightly concerned
   _c. Fairly concerned
   _d. Very concerned

15. Have you ever before seriously attempted to quit smoking? ______
   If yes,
   a. How many times? _____
   b. Date of last attempt? _____
   c. What was the longest period of time you were able to go without smoking? _____
   d. When you started smoking again, did you smoke more or less than before you quit? _____
   e. Describe the methods you used to try to quit smoking:
f. If you participated in a treatment program (e.g. Smokers, American Cancer Society Stop Smoking Program), how long was the treatment program to last? _______________

g. If you participated in a treatment program, how long did you participate in the program? _______________

h. On your most successful attempt, what happened to cause you to start smoking again? (if possible, describe the specific circumstances)

16. Are there any smokers who live with you in your immediate home environment? _____ If yes, please list (e.g. wife, son, roommate, etc.) and state whether they are heavy, moderate, or light smoker:

________________________________________

________________________________________

17. Are there any smokers in your immediate work environment with whom you have routine contact? _____ If yes, please list (e.g. boss, co-worker, etc.) and state whether they are heavy, moderate, or light smoker:

________________________________________

________________________________________

18. Which of the following best describes your feelings toward your cigarette smoking?

___a. I am satisfied and have no wish to quit

___b. I wish I had never started but I don't plan to quit now

___c. I want to quit, but I am not sure I can

___d. I definitely plan to quit

___e. I plan to cut down on the number of cigarettes I smoke
19. If you have an urge to smoke, but choose to ignore it, what do you do instead?

___a. chew gum
___b. eat
___c. drink
___d. nothing
___e. give yourself mental encouragement
___f. other (please specify) __________________________
WHY DO YOU SMOKE?

Here are some statements made by people to describe what they get out of smoking cigarettes. How often do you feel this way when smoking them?

Circle one number for each statement.

**Important:** Answer every question:

<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I smoke cigarettes in order to keep myself from slowing down.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Handling a cigarette is part of the enjoyment of smoking it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Smoking cigarettes is pleasant and relaxing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I light up a cigarette when I feel angry about something.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5. When I have run out of cigarettes I find it almost unbearable until I can get them.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I smoke cigarettes automatically without even being aware of it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7. I smoke cigarettes to stimulate me, to perk myself up.</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>8. Part of the enjoyment of smoking a cigarette comes from the steps I take to light up.</td>
<td></td>
<td></td>
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<tr>
<td>9. I find cigarettes pleasurable.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10. When I feel uncomfortable or upset about something, I light up a cigarette.</td>
<td>Always</td>
<td>Frequently</td>
<td>Occasionally</td>
<td>Seldom</td>
<td>Never</td>
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<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11. I am very much aware of the fact when I am not smoking a cigarette.</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. I light up a cigarette without realizing I still have one burning in the ashtray.</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
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</tbody>
</table>

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<thead>
<tr>
<th>13. I smoke cigarettes to give me a &quot;lift.&quot;</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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</table>

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<thead>
<tr>
<th>14. When I smoke a cigarette, part of the enjoyment is watching the smoke as I exhale it.</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15. I want a cigarette most when I am comfortable and relaxed.</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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</table>

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<thead>
<tr>
<th>16. When I feel &quot;blue&quot; or want to take my mind off cares and worries, I smoke cigarettes.</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
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<td>2</td>
<td>1</td>
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</tbody>
</table>

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<thead>
<tr>
<th>17. I get a real gnawing hunger for a cigarette when I haven't smoked for a while.</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
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<td>2</td>
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<thead>
<tr>
<th>18. I've found a cigarette in my mouth and didn't remember putting it there.</th>
<th>Always</th>
<th>Frequently</th>
<th>Occasionally</th>
<th>Seldom</th>
<th>Never</th>
</tr>
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<td>2</td>
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</tbody>
</table>
What time did you wake up this morning? 

What was your mood when you woke up?

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Intensity of craving</th>
<th>Activity when lit cigarette</th>
<th>With whom</th>
<th>Mood prior to light up</th>
<th>Thoughts following light up</th>
<th>Enjoyment from cigarette</th>
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Intensity of craving: 1=none; 2=light; 3=moderate; 4=strong; 5=intense

Enjoyment from cigarette: 1=none; 2=light; 3=moderate; 4=strong; 5=intense

(continued on other side)