CIGARETTE SMOKING AND THE EFFECTS OF A PSYCHOSOCIAL STRESSOR

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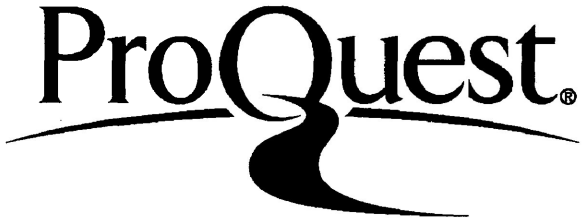

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This thesis is dedicated to my family who have faithfully supported me during my academic career.

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ABSTRACT

Sixty subjects were assigned randomly, within sex groups, to one of four groups to explore further the occurrence of Nesbitt's Paradox. The Paradox is that even though nicotine is a stimulant, many smokers report that they smoke to relax. The subjects consisted of 20 males and 40 females while the four groups consisted of no pre experiment smoking/no experiment smoking, no pre experiment smoking/experiment smoking, pre experiment smoking/no experiment smoking and pre experiment smoking/experiment smoking. The major dependent variables were changes in heart rate, perceived level of arousal, performance on a digit-letter task after subjects had been told that they would soon be engaging in social comparison, and responses to two sets of rating scales. Smoking was found to increase HR and this was especially so for subjects who had not smoked prior to the experiment. Smoking during the experiment was also found to affect increases in performance known to be associated with impending social comparison. No evidence was obtained to support the occurrence of Nesbitt's Paradox. However, it was pointed out that this was probably due to the inadequacy of the self-report measure used in the present study.

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According to Lewin (1931), smoking tobacco was introduced to western civilization by Christopher Columbus. After its introduction, smoking spread rapidly across Europe and other forms of tobacco usage emerged. For example, snuffing and chewing tobacco became popular methods of using this drug. From its inception into the European culture during the time of Columbus, the fact that using tobacco can become a habit has been problematic. Webster (1977) defines habit as an acquired mode of behaviour that has become nearly or completely automatic.

Jones, Shainberg and Byer (1970) consider tobacco usage to be one of drug habituation as opposed to drug addiction. They go on to report that drug habituation is a condition resulting from the repeated consumption of a drug. Its characteristics are:

1. a desire (but not a compulsion) to continue taking the drug for the sense of improved well-being or effect it produces
2. little or no tendency to increase the dose
3. some degree of psychic dependence on the effect of the drug, but absence of physical dependence and hence of abstinence syndrome
4. detrimental effects, if any, primarily on the individual. (p. 8)

Over the centuries, heavy penalties and punitive action have been taken against tobacco users. Jarvik (1970) reports that Pope Urban VIII excommunicated people who smoked or snuffed tobacco in the churches of Spain. He also reports that: the death penalty was enforced against those who smoked in Luneburg, Germany; James I imposed a high tobacco tax in England; smoking was prohibited because it violated the laws of the Koran in Turkey; and Persian and Russian tobacco users were faced with torture and death. In spite of these heavy punitive actions, the

tobacco habit flourished and expanded to the overwhelming extent to which it is evident today. The effects of smoking tobacco had, in earlier times, been controversial. It was questioned whether tobacco was harmful or beneficial to the health of a person. The contemporary literature indicates that smoking cigarettes is harmful to health (Dankenbring, 1970; Jones, Shainberg, Byer, 1970). The concern today is that people continue to smoke in spite of the well-known undesirable consequences of cigarette smoking.

Cigarette smoking appears to be a multidetermined behaviour associated with a combination of physiological, cognitive, and situational determinants. One aspect of the habit that has received attention is the presence of nicotine in tobacco smoke. Jarvik (1970) hypothesizes that nicotine is the reinforcing agent in smoking behaviour. To thoroughly examine the pharmacological properties of nicotine is beyond the scope of this thesis yet some background is necessary. Goodman and Gilman (1975) report that nicotine was first identified after extraction from the leaves of tobacco, Nicotiana tabacum, in 1828. In its liquid form, nicotine is one of the few natural liquid alkaloids. It is one of the most toxic of all drugs, acting at a rate comparable to cyanide. Nicotine markedly stimulates the Central Nervous System (CNS) resulting in tremors and eventually convulsions if the dose is high enough. It has been noted that stimulation of the CNS is followed by depression, and death results from failure of respiration due to both central paralysis and peripheral blockade of muscles or respiration (Goodman and Gilman, 1975). However, as Jarvik (1970) points out, the doses required to produce traumatic effects are much higher than those involved in smoking. Goodman and Gilman report that:

> Approximately 80 to 90% of nicotine is altered in the body, mainly in the liver but also in the kidney and lung.....Nicotine, together with its detoxication products, is eliminated completely and rapidly by the kidney. The rate of urinary excretion of nicotine is dependent upon the pH of the urine; when the urine is alkaline, only one fourth as much nicotine is excreted as when the urine is acid. (p. 568)

One of the most notable effects of nicotine is reflected by changes in the cardiovascular system. Goodman and Gilman (1975) state that:

> In general, the cardiovascular responses to nicotine are due to stimulation of sympathetic ganglia and the adrenal medulla, together with the discharge of catecholamines from sympathetic nerve endings and chromaffin tissues of various organs (Gebber, 1969). Also contributing to the sympathominetic response to nicotine is the activation of chemoreceptors of the aortic and carotid bodies, which reflexly results in vasoconstriction, tachycardia, and elevated blood pressure. In addition, there is evidence that nicotine increases coronary blood flow as a consequence of the increased cardiac work, elevated blood pressure, and increased cardiac output that it produces. (p. 568)

Jarvik (1970) notes that ". . . the predominant effect of nicotine is sympathomimetic. It consists of an increase of pulse rate, blood pressure, and peripheral vasoconstriction, and increase in free fatty acids; a mobilization of blood sugar, and in short, the effects that might be expected from an increase in the level of catecholamines in the blood" (p. 162). Central to this thesis is the observation that nicotine absorbed from tobacco smoking results in an increase in sympathetic arousal.

The pharmacological effects of nicotine have been experimentally investigated by Schachter (1977). Using habitual smokers of at least 20 cigarettes per day, Schachter found that long-term heavy smokers appear to regulate nicotine intake. After manipulating the nicotine content in cigarettes, he showed that smokers consistently smoke more low than high nicotine content cigarettes. To investigate these

findings further, Schachter and his coworkers examined the effects of urinary pH on cigarette smoking since it had already been established that the excretion of unmetabolized nicotine is dependent on the acidity of the urine (Goodman and Gilman, 1975). Using 14 habitual smokers, Schachter, Kozlowski and Silverstein (1977) found that cigarette consumption significantly increased when the acidity of the urine was chemically increased by Vitamin C and Acidulin. Silverstein, Kozlowski and Schachter (1977) further investigated the possible relationship between urinary pH and smoking behaviour. Since pH is a measure of the alkaline content of the urine, the lower the pH, the higher the acidity. They concluded from their study that going to a party leads to increased acidity of the urine and increased smoking. Urinary acidity also increased in nonsmokers. Investigations have also shown that experimentally induced stress and academic stress both acidify urine and lead to increased smoking (Schachter, Silverstein, Kozlowski, Herman and Liebling (1977). Schachter, Silverstein and Perlick (1977) summarize these investigations by stating that:

> The speculation that the effects of some of the psychological determinants of smoking rate are mediated by the effects of these events on urinary pH is supported by the following facts: (a) Experimentally acidifying the urine leads to an increase in smoking. (b) Party going acidifies urine and increases smoking. (c) The effects of party going and stress on acidity hold for nonsmokers as well as smokers - an indication that these acidifying effects are not due to smoking. (p. 31)

Schachter (1977) therefore suggests that heavy smokers regulate nicotine intake. The heavy smoker, defined by Schachter (1977) as someone who smokes 20 or more cigarettes per day, adjusts his smoking rate and consumption depending on the amount of nicotine in his system. This internal type of mechanism works to keep the nicotine at a uniform level.

However, the series of studies noted above are not conclusive in that urinary pH is affected by many variables. As Schachter, Kozlowski and Silverstein (1977) note, "Unless urinary pH has been stabilized, it is highly variable, fluctuating rapidly with diet, time of day, exercise, and as our own studies have demonstrated, with such conditions as stress and intense social activity" (p. 25). Other authors (Ashton and Watson, 1970; Jarvik, Glick and Nakamura, 1970) have suggested as Schachter has, that the heavy smoker regulates nicotine intake but to what extent is inconclusive.

There is evidence that personality characteristics may influence smoking behaviour. Jones, Shainberg and Byer (1970) report that no "smoker personality" has been identified, but certain personality characteristics common among smokers have been suggested. Smith (1970) summarized relevant literature which dealt with the relationship between smoking and personality. He reports that twenty-two of twenty-five analyses showed smokers to be significantly more extraverted (using personality profiles) than nonsmokers. Also, twenty-seven of thirty-two analyses showed smokers to be significantly more antisocial than nonsmokers. As Smith (1970) reports, "As with the studies of extraversion, the data linking smoking and antisocial tendencies come from studies varying widely regarding instruments used and populations studied" (p. 58). The relationship between smoking and other personality characteristics is not as convincing. For example, Smith (1970) in the same review article suggests that smokers are more externally oriented than non-smokers, that smokers are more impulsive than nonsmokers, that smokers have stronger oral needs than nonsmokers, and that smokers have poorer mental health than nonsmokers (Smith, 1970). However, as noted above,

these last distinctions between smoking and nonsmoking personalities are only suggestions. The task of differentiating personality characteristics between smokers and nonsmokers is an enormous task and probably to no avail due to the complexity of smoking behaviour. So far, nothing of substance as to the mechanisms of smoking behaviour have been offered by personality investigations.

Russell (1971) has proposed different smoking classifications based on the psychosocial, sensory, and pharmacological rewards of smoking. The psychosocial smoker smokes purely for the psychosocial rewards. Smoking behaviour usually is peculiar to social situations only and there may be very little nicotine intake. The indulgent smoker smokes for the pleasure involved, such as after meals, but smoking is not completely regular. Pleasure may be gained from oral rewards (oral-indulgent), sensorimotor rewards (sensorimotor-indulgent), or a mixture of these rewards (mixed-indulgent). Tranquillization smoking is reinforced by the sedative or calming effects of nicotine and the occupation of the hands to relieve anxiety and tension. Emotional states determine the frequency of smoking for the tranquillization smoker. The stimulation smoker utilizes the stimulant effects of nicotine to maintain performance and combat fatigue in situations such as long distance driving. In this category, the frequency of smoking is determined by specific situations. Finally, Russell describes the addictive smoker who experiences withdrawal symptoms whenever he has gone 20-30 minutes without smoking. According to Russell, these symptoms include depression, tension, irritability, restlessness, intense craving and difficulty in concentration. In this last classification, smoking frequency is only minutely affected by changing external situations. Russell notes that some problems in

classification are inevitable since, for example, some smokers obtain very little nicotine while others obtain a substantial amount. He also reports that the classifications he describes are not mutually exclusive in that a smoker may smoke for tranquillization as well as indulgent rewards.

Just to what degree smoking is determined by nicotine regulation, personality characteristics associated with smoking or situational factors has not yet been established. It is apparent that people smoke for many different reasons. However, whatever the reasons for smoking may be, there appears to be one situational event or commonality among smokers; that is a stressor situation. Hans Selye (1973a) in introducing the book, Smoking Behavior: Motives and Incentives, mentioned various situations in which people smoke ". . . as a means of diversion. They do so instinctively, as it were, whenever one organ system or another is under excessive and unbalanced stress in proportion to the rest of the body" (p. 2). Selye goes on to quote various different authors in the context of the same book:

> Eysenck who states that 'different people smoke for different reasons, some to arouse and others to quiet themselves, under stress'. Hutchinson and Emley state that the intake of nicotine 'produces a differential reduction in the tendencies toward aggressiveness, hostility, and irritability.' Heimstra states, 'the data from these studies strongly suggest that smoking will modify mood states, or, more specifically, will tend to reduce fluctuation or change in mood'. Thomas writes, 'it therefore seems not unreasonable to conclude that adolescents who are outgoing and desire to obtain social acceptance are often aware of anxiety and anger in situations of stress, and that cigarette smoking, particularly heavy cigarette smoking, stems in large part from the inner need to cope with their negative affect'. Ryan states, 'we have noticed that under stress conditions in our laboratory, highly anxious subjects tend to smoke more than nonanxious subjects, with the interval between their puffs reflecting the state of tension they are experiencing'. (pp.2-3)

Selye (1973a) summarizes the above-mentioned quotes by stating:

> All of these passages allude to smoking as a response occurring in the context of a stressed state of a stressor situation. Perhaps no one explanatory model will suffice to account for all smoking behaviour, but whatever the ultimate explanation of explanations, we can certainly say at this point in time that the smoker finds smoking a gratifying experience. (p.3)

Selye's (1973a) quote refers to smoking in response to an environmental stimulus, specifically a stressor. A stressor is anything that causes stress. Stress is being used in Selye's (1976) sense of the word to refer to the nonspecific response of a person to any demand. Selye (1973b) states that all stressors make some increased demand on the organism to respond in an adaptive manner. It should be noted that Selye's definition of a stressful situation includes situations perceived as both unpleasant and pleasant.

This leads to an interesting aspect of smoking behaviour, as mentioned previously; i.e., smoking in response to an environmental stressor. A review of the literature indicates a large number of people report that they smoke for a feeling of relaxation (Ikard, Green & Horn, 1968; Meyer, Friedman & Lazarfeld, 1973). Schachter (1973) states that, "If you ask smokers why they smoke, overwhelmingly they respond in sedational terms" (p. 147). However, as Schachter points out, this is somewhat of a paradox in view of the fact that smoking causes an increase in sympathetic arousal reflected by an increase in heart rate, blood pressure and catecholamine excretion (Ague, 1974; Andersson & Post, 1974; Elliott & Thysell, 1968; Frankenhaeuser, Myrsten, Wazuk, Neri, Post, 1968; Frankenhaeuser, Myrsten, Post, 1970; Nesbitt, 1973). Schachter (1973) states that, "In short, smoking a cigarette leads to a set of physiological consequences, peripheral and

central, that we customarily associate with states of arousal or activation or emotionality" (p. 147). In other words, smoking a cigarette increases arousal in a manner similar to an environmental stressor yet smoking is perceived as relaxing. Tonic heart rate (heart rate measured over at least a 30 second period) is commonly used to measure changes in sympathetic arousal (e.g. Blix, Stromme, Ursin, 1975; Evans, 1972; Schachter, 1973; Weybrew, 1967) and also as a physiological measure of the effects of cigarette smoking (e.g. Agué, 1974, Elliott & Thysell, 1968; Frankenhaeuser et al., 1968, 1970). Hereafter, in the present thesis, the word arousal will refer to sympathetic arousal.

Nesbitt (1973) experimentally tested the apparent contradiction that even though cigarette smoking leads to an increase in arousal, smokers find it relaxing. Using habitual smokers and nonsmokers in 3 conditions--unlit, low nicotine, and high nicotine content cigarettes, Nesbitt established three thresholds of electric shock. Subjects had to indicate: first when they first felt the shock (the absolute threshold), secondly, when it first felt painful (the pain threshold), and thirdly, when it was too painful for them to bear any more (the endurance threshold) (p. 139). Nesbitt found that in the smoking condition, habitual smokers could endure more intense shocks than nonsmokers, thus having a greater endurance threshold, while in the no smoking condition, they endured less intense shocks than nonsmokers.

Both nonsmokers and smokers smoked in the smoking condition. He concludes that, "Smokers behave less emotionally (in enduring more shocks) in the cigarette condition" (p. 143). Nesbitt's conclusion was based on the assumption that a high level of anxiety (one form of emotionality) resulted in having a lower endurance threshold, i.e., the

inability of nonsmokers to endure as intense shocks as smokers in the smoking condition. The results of this experiment have been referred to as Nesbitt's Paradox (Schachter, 1973). The paradox is that even though smoking increased arousal, as indicated by increased heart rate, the fact that smokers were willing to endure more intense shocks suggests that smoking was sedational for the smokers.

The interpretation of results suggested by Nesbitt is open to question. Whether shock or fear of shock is a valid and dependable measure of emotional response such as anxiety (Schachter, 1973) or whether it is correct to infer that cigarette smoking was perceived as "calming" by the smokers because they endured more intense shocks, is not entirely acceptable. The fact remains that differences in endurance thresholds may be partially accounted for due to the design of the experiment. For example, in the smoking condition, nonsmokers who smoked reported that they felt more uncomfortable and dizzier and therefore may have affected results due to the unnatural effects of smoking. Also, in the nonsmoking condition, it was unnatural for the smokers to abstain from smoking, again possibly influencing their ability to endure shocks.

Nevertheless, the literature does offer explanations of Nesbitt's Paradox. One explanation is basically a "cognitive attribution interpretation" based on Schachter's (1964) two-component theory of emotion. Schachter notes that when exposed to an environmental stressor, the stress producing stimulus has a resulting effect of increased arousal. However, since smoking a cigarette also leads to an increase in arousal, when exposed to a stress producing stimulus, a person smoking a cigarette may subconsciously attribute their increase in arousal to the cigarette

and not the stressor. In this way, smokers can perceive smoking as relaxing. Recall that stress is the nonspecific response to any demand. Anything that causes stress is referred to as a stressor. In Nesbitt's experiment, Schachter (1973) suggests that subjects, at a subconscious level, cognitively attributed their high arousal level to the cigarette, a chemical stressor, and not to the environmental stressor, the shock or fear of shock. In this sense, Schachter proposes that people perceived smoking as relaxing, in spite of the fact that smoking caused an increase in arousal.

Since, other than the first cigarette of the day, cigarette smoking causes an increase in heart rate of approximately 5 beats per minute (bpm) (Elliott & Thysell, 1968), it seems unlikely that a person could detect this slight increase in arousal. Further, it also seems unlikely that this 5 bpm increase, when included with the arousal caused by an environmental stressor, would be subconsciously noticed, let alone subconsciously distinguished from the arousal caused by the environmental stressor. Therefore, Schachter's (1973) explanation of Nesbitt's Paradox is not totally convincing.

An alternative explanation of Nesbitt's Paradox in terms of pharmacological properties of cigarette smoking has been proposed by Vogel, Broverman and Klaiber (1977). EEG recordings of "driving" responses to photic stimulation of habitual smokers and nonsmokers were taken before and after both groups had smoked a cigarette. "Driving" responses to photic stimulation refers to the tendency of EEG rhythms to mimic the frequency of a bright flashing light. Since "driving" responses appear to reflect the balance between adrenergic (sympathetic) and cholenergic (parasympathetic) nervous systems, analyses of results indicated that

before smoking, smokers tend to have a central autonomic balance less in favour of adrenergic functioning than do nonsmokers. However, smoking increased adrenergic functioning reflected by lowered "driving" responses. Vogel, Broverman and Klaiber (1977) report that, "A deficit in central adrenergic functioning . . . was postulated by Schildkraut (1965) to be the basis of mental depression whose symptoms include fatigue, apathy, reduced motor activity, tension, anxiety, and agitation. Mental depression is often reduced by therapeutic measures that alleviate the deficit in central adrenergic functioning (Schildkraut, 1965, p. 42). They suggest that smoking may alleviate an adverse psychologic state associated with a central adrenergic insufficiency. However, this interpretation is based on the supposition that EEG "driving" responses reflect a balance between the adrenergic and cholinergic systems which, to the author's knowledge, has not been empirically proven. Vogel et al.'s (1977) speculation should be further explored before too much can be made of it.

The present study was designed to determine if, in fact, Nesbitt's Paradox exists. As mentioned previously, Nesbitt's measure of emotionality is questionable since there was no direct cognitive measure of subjects' feelings. This investigation was a conceptual replication of Nesbitt's work and examined the possibility of the existence of Nesbitt's Paradox in relation to the effects of a psychosocial stressor, i.e., a social environmental stressor. The psychosocial stressor used was impending social comparison which has been shown to be stressful (Evans, 1974, 1975).

One of the independent variables in the present experiment was whether subjects did not smoke or did smoke before the experiment.

Elliott and Thysell (1968) have shown that the first cigarette of the day increased tonic heart rate 20 bpm on the average, whereas on the day of the study, if subjects had smoked as usual before the experiment, smoking a cigarette only increased heart rate 5 bpm. These recordings were taken after five minutes of smoking. Since heart rate is significantly affected depending on whether or not it is the first cigarette of the day, the manipulation was designed to investigate these effects.

The second independent variable in the present experiment was whether subjects did not smoke or did smoke during a five minute relaxation period right after the introduction of the psychosocial stressor, i.e., impending social comparison.

The dependent measures in this study were changes in heart rate, perceived level of arousal, performance on a relatively simple task and responses to two rating scales each containing five statements. Following the logic of Nesbitt's Paradox, it was hypothesized that at the end of the relaxation period, after the introduction of impending social comparison, the two groups who smoked at that time during the experiment would perceive themselves to have been more relaxed and less anxious, in spite of the fact that they would have had the greater increase in arousal caused by smoking. This was anticipated because smoking increases arousal yet at the same time is reported to be relaxing.

METHOD

Subjects and Design

The subjects were 40 female and 24 male volunteers. They ranged in age from 17 to 27. All subjects reported that they smoked between 15 and 25 cigarettes per day for at least the last year. The majority of subjects were first year psychology students who were given one mark towards their final grade for their participation in the experiment. The rest of the subjects were secretaries and high school students who were given the equivalent of one package of cigarettes for their participation.

One of the independent variables in the present study was whether subjects did not smoke or smoked before the experiment. This meant that after subjects got up in the morning as usual, half smoked as they usually did before the experiment while the other half refrained from smoking before the experiment. During the experiment, the other independent variable was whether subjects did not smoke or smoked one cigarette during a relaxation period after they had been given seven trials of the digit-letter task. Four male subjects in the no pre experiment condition reported that they had smoked a cigarette prior to the experiment so their data were discarded. The resulting four groups had ten female and five male subjects in each of the following conditions:

1. no smoking during day/no smoking during second relaxation period (NSD/NSR)
2. no smoking during day/smoking during second relaxation period (NSD/SR)
3. smoking during day/no smoking during second relaxation period (SD/NSR)
4. smoking during day/smoking during second relaxation period (SD/SR).

It should be noted that some people smoke three or four cigarettes before

breakfast while others do not smoke until perhaps after coffee break. To control for these different smoking patterns and to increase the effectiveness of the no smoking/smoking before the experiment manipulation, the experiment was never conducted before 1:00 p.m.

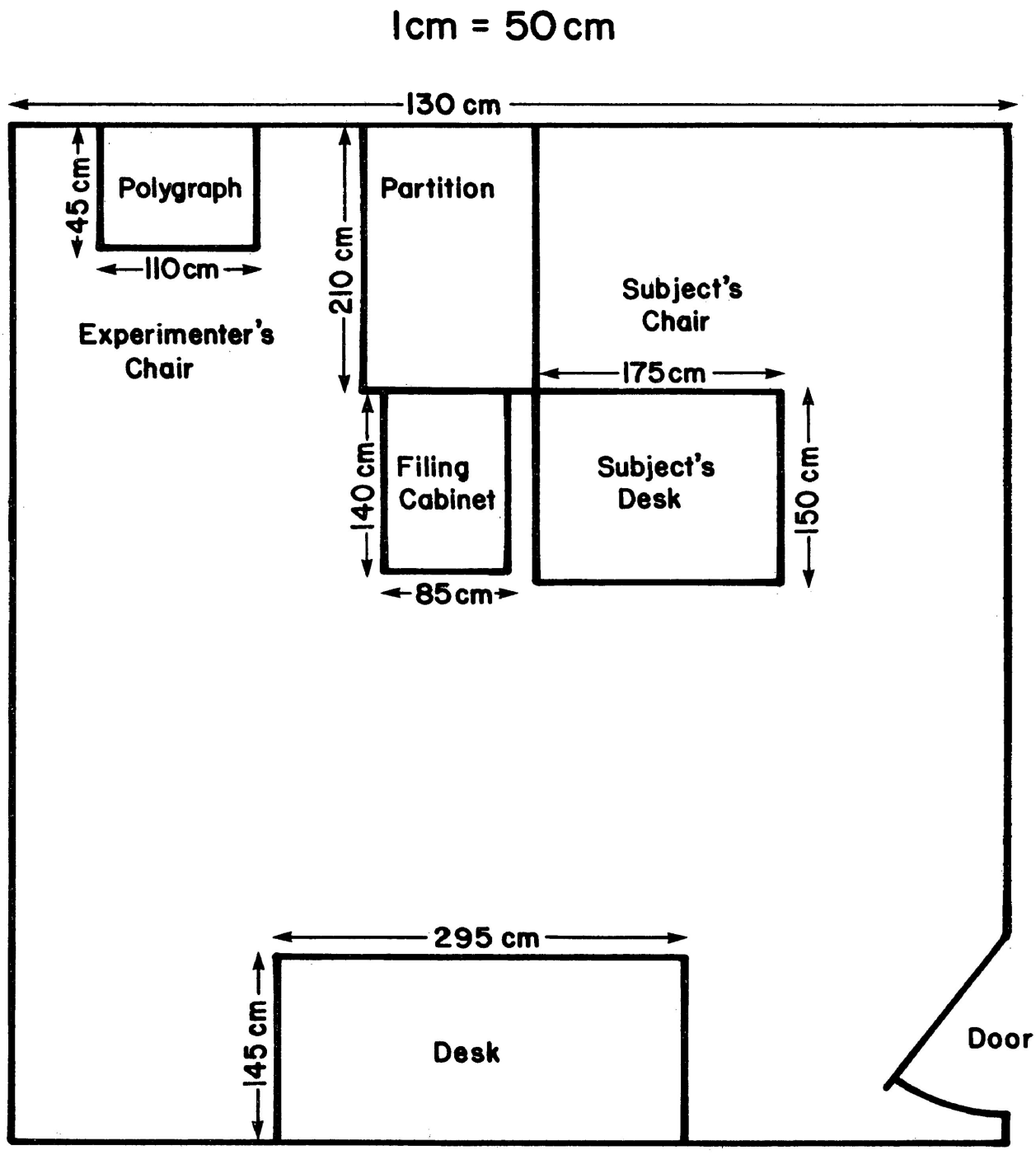
Apparatus

The experimental room was approximately 795 cm by 720 cm. A set of shelves approximated 210 cm by 130 cm separated the polygraph from the subject's desk. There were two desks in the room, one approximately 175 cm by 150 cm which the subject worked at and another situated at the end of the room approximately 295 cm by 145 cm where the subject's possessions and cigarettes were placed as soon as they entered the room. There was one chair at the subject's desk and another behind the shelves for the experimenter to sit on during the relaxation periods. Figure 1 illustrates the layout of the experimental room.

A digit-letter substitution task was used to measure performance. It is similar to the WAIS digit-symbol task (Wechsler, 1955) except that letters have to be matched with numbers instead of symbols. Eight different forms of the task were used, with a different arrangement of the letters for each form. (Appendix A contains an example copy of the digit-letter task).

Heart rate (HR) was inferred from changes in finger tip blood volume which was recorded continuously by a Gibson Model-M5P polygraph. A finger pick-up transducer FP-6 (plethysmograph) was attached to the index finger of the nonpreferred hand. Also, a buzzer was attached to the wall behind the subject. The experimenter used a remote control switch to operate the buzzer which was used to signal the subject to

FIGURE 1 GRAPHIC ILLUSTRATION OF EXPERIMENTAL ROOM



begin or terminate performance (PER) on the digit-letter task. Pushing the remote control switch also made a mark on the recording paper. This procedure made it possible to identify the beginning and end of trials on the HR record. The 60 second trial was measured with a stop watch.

To observe any change in perceived level of arousal (PLA) a magnitude estimation procedure patterned after the one used by Frankenhaeuser, Dunne, Bjurstrom and Lundberg (1974) was used. Verbal reports of PLA were recorded on a data sheet during the experiment (Appendix B contains a copy of the data sheet). A description of the PLA procedure will be given below.

Procedure

Each subject was tested in a separate session. After signing up for the experiment, subjects were contacted in advance by telephone and randomly assigned within sex groups to either no smoking during the day or smoking during the day, i.e., half of the subjects smoked as they usually did on the day of the experiment whereas the other half had to abstain from smoking, prior to the experiment, for the entire day. The subjects were informed in the initial contact only that the experiment was concerned with smoking. No other information regarding the purpose of the experiment or what aspect of smoking being investigated was discussed. However, all subjects were asked to bring their usual brand of cigarettes to the experiment.

It should be noted that standard nicotine content cigarettes, unlit cigarettes, menthylated cigarettes,or nicotine-free cigarettes were not included as a control measure due to the design of the experiment. For example, Goldfarb, Jarvik and Glick (1970) varied the nicotine

content in lettuce cigarettes. Subjects reported they could detect the difference in nicotine content and complained about the taste of the cigarettes. Jones, Shainberg and Byer (1970) report that nicotine-free tobacco or cigarettes made from other plant materials do not satisfy smokers. If the subjects in the present study smoked a distasteful cigarette or unusual cigarette, there was the possibility that the cognitive measures in the present study may have been influenced. Since cognitive factors are an important variable in the underlying logic of Nesbitt's paradox, subjects were asked to bring their own brand of cigarettes because they would probably find them more satisfying than any of the controls mentioned above.

After arriving for the experiment, all subjects were treated identically until the end of the seventh trial of the experiment. Once in the experimental room, the experimenter introduced himself and asked subjects their name. After asking the subject for his or her cigarettes, the experimenter placed the cigarette package on the table at the end of the room. The subject was asked to sit down at the table and the finger pick-up transducer was attached. From here on, HR was recorded continuously. The experimenter informed the subject that the study was investigating the effects of smoking but no specific details were mentioned. The subject was asked to relax while the experimenter explained the PLA procedure. The experimenter informed the subject that physiological arousal referred to how hard their body was working. They were also informed that physical factors such as running and psychological factors such as giving a talk can both increase physiological arousal and that they might notice an increase in physiological arousal by an increase in HR or sweating. After explaining the concept of physiological arousal,

the experimenter stated that PLA referred to an estimation of how high or low their physiological arousal was. Then the subjects were asked to assign the number 10 to their common every day level of arousal. They were told that they would have to estimate their level of arousal at critical points during the experiment in the following manner. If they thought they were half as aroused as usual, they were to say 5; if they thought they were 25% as aroused as usual, they were to say 2.5; if they thought they were twice as aroused as usual, they were to say 20; and so on. They were then asked example questions to ascertain if they understood the method of estimating their level of arousal and any questions that they had were answered. After the examiner was convinced that the subjects were familiar with estimating their PLA, the subjects were instructed to relax for the purpose of establishing a baseline HR. At the end of the five minute relaxation period, they were asked to estimate their level of arousal. Form 1 of the digit-letter task was then brought out. Instructions on how to perform the task were given, then the task was turned face down before the subjects to prevent mental rehearsal. The subjects were asked to begin the task the first time the buzzer sounded and to stop the second time it sounded. The experimenter then went to the polygraph and started the first trial. A trial consisted of inserting as many correct letters as possible under the numbers in a 60 second period. The subjects were asked to estimate their level of arousal after each trial. After the subjects had estimated their level of arousal at the end of trial 1, the digit-letter task was scored, the subjects were told how many correct responses they had made and any errors were pointed out. Task 2 was then introduced face down and the subject was instructed to complete it in the same

manner as trial 1, except that the letters were rearranged in a different sequence. After trial 2, the subjects were asked to estimate their level of arousal, the task was scored, any errors were pointed out, and the subjects were informed of their score. The same procedure was used for trials 3 to 7, with different letters associated with the digits for each task.

After trial 7, a psychosocial stressor, the opportunity to engage in social comparison, was introduced. All subjects were told that after the next trial, they would be able to compare their score with 20 other people - some practice students. An example chart was used for explanatory purposes. Subjects were informed that on the real chart they would be able to see the highest score and the lowest score, as well as how many students did better than they had and how many did worse. They were also told that the average score for the 20 comparison people would be given. The real chart was turned upside down in front of the subjects to emphasize the authenticity of the opportunity to engage in social comparison. Except for the pre experimental manipulation of no smoking/ smoking during the day of the experiment, all subjects were treated identically up to this point.

Subjects were now randomly assigned, within sex groups, to the second independent variable. Half of the subjects were instructed to relax for five minutes and have a cigarette. The experimenter picked up the subjects' cigarettes from the table, offered the subjects one and lit it for them. The other half of the subjects were told just to relax for five minutes before the last trial. After this second five minute relaxation period, the subjects in the smoking condition were asked to put out their cigarettes if they had not done so. All subjects were asked to estimate

their level of arousal at the end of the relaxation period. Then the experimenter removed the ash tray and cigarettes for the smoking group from the table and placed them on the other table. The eighth form of the digit-letter task was presented face down and the subjects were instructed to complete it the same way as the first seven. They were again reminded they would be engaging in social comparison at the end of the eighth trial. After the eighth trial was run, subjects were asked to estimate their level of arousal.

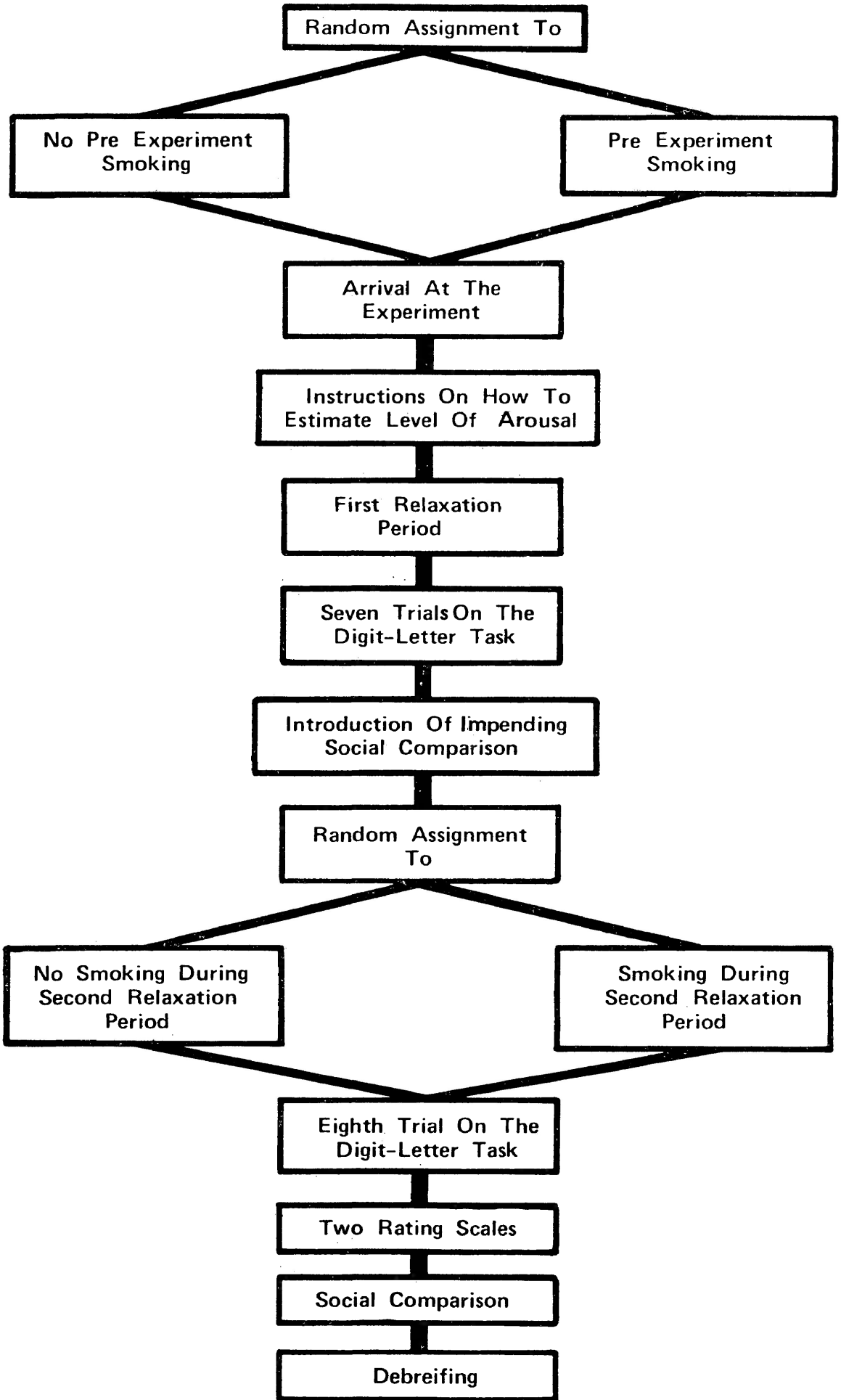
The plethysmograph was unhooked at the end of the eighth trial and the polygraph was shut off. The subjects were then asked to rate to what degree they were relaxed at five critical points in time. Another scale asked how anxious they were at the same five critical times. The presentation of these scales was counterbalanced. The five critical times were: generally during the day; generally during the experiment; during the first five minute relaxation period; during the second five minute relaxation period; during the last trial of the digit-letter task. The rating scale had four choices: 0 - not at all; 1 - to a slight degree; 2 - to a moderate degree; 3 - to a great degree. Copies of these rating scales are presented in Appendices C and D respectively.

After the subjects had completed the two rating scales, the eighth form of the digit-letter task was scored. The experimenter pointed out any errors and gave the subject their score. The real chart was turned over and subjects were allowed to compare their score to the scores of the other 20 people.

A debriefing session followed and the subjects' cigarettes were returned. The subjects were asked what they thought the experiment was about, if they had heard anything about the experiment, what were some

of their opinions about the experiment and what were some of their opinions about smoking. They were also asked to keep the details of the experiment confidential. For those subjects not in the introductory psychology pool, one dollar was given to them to buy a package of cigarettes. All subjects were thanked for their cooperation and participation. A schematic representation of the entire experimental procedure appears in Figure 2. Appendix E contains a complete set of instructions.

FIGURE 2 FLOW CHART OF EXPERIMENTAL PROCEDURE



RESULTS

Tonic HR and PLA scores were obtained for four times during the experiment: during the first relaxation period; during the 7th trial of the experiment; during the second relaxation period; during the 8th trial of the experiment. Tonic HR was calculated only for the last minute of both relaxation periods. Performance (PER) scores on the digit-letter task were recorded for the 7th and 8th trials of the experiment. The means and standard errors for these scores are presented in Table 1.

Prescores

The scores recorded before the second independent measure was introduced, not smoking or smoking during the second relaxation period, will be referred to as prescores. A t-test for independent samples performed on HR during the first relaxation period (resting HR) yielded a significant difference, t (58) = -2.87, p = .006. Those subjects who did not smoke before the experiment had a significantly lower resting HR ($\bar{X}$ = 74.20 bpm) than those subjects who smoked as usual before the experiment ($\bar{X}$ = 82.37 bpm). A t-test for independent samples performed on HR during the 7th trial of the experiment approached significance, t (58) = -1.77, p = .082. The subjects who did not smoke before the experiment still had a lower HR ($\bar{X}$ = 81.90 bpm) than those subjects who smoked before the experiment ($\bar{X}$ = 87.47 bpm) although this difference was not significant. Analyses of PLA during the first relaxation period, during the 7th trial of the experiment and PER for the 7th trial yielded no significant results. Appendix F contains a summary of these analyses.

TABLE 1

Means and Standard Errors of Raw Scores

Measure		GROUP NSD/NSR	NSD/SR	SD/NSR	SD/SR
HR During 1st Relaxation Period	$\bar{X}$	74.47	73.93	85.27	79.47
	SE	3.17	2.67	3.49	1.75
HR During 7th Trial of D-L Task	$\bar{X}$	84.53	79.27	92.07	82.87
	SE	3.10	2.78	3.85	2.22
HR During 2nd Relaxation Period	$\bar{X}$	72.93	97.40	82.40	86.53
	SE	2.65	3.25	2.78	1.98
HR During 8th Trial of D-L Task	$\bar{X}$	88.00	107.60	96.07	96.00
	SE	3.53	3.96	4.85	2.19
PLA During 1st Relaxation Period	$\bar{X}$	7.00	7.37	7.43	7.43
	SE	1.01	0.95	0.73	0.90
PLA During 7th Trial of D-L Task	$\bar{X}$	13.50	16.50	16.87	17.05
	SE	1.09	1.99	2.14	2.62
PLA During 2nd Relaxation Period	$\bar{X}$	8.50	12.53	9.67	9.87
	SE	1.05	3.33	0.85	1.15
PLA During 8th Trial of D-L Task	$\bar{X}$	15.07	17.60	15.87	16.23
	SE	1.66	2.68	1.37	1.67
Performance 7th Trial of D-L Task	$\bar{X}$	48.93	52.20	53.93	50.00
	SE	1.67	1.70	1.79	2.00
Performance 8th Trial of D-L Task	$\bar{X}$	53.47	53.60	59.20	52.73
	SE	1.81	2.15	2.33	1.63

Dependent Measures

The dependent variables in the present study were: HR change from the first relaxation period to the second relaxation period (resting ΔHR); HR change from the 7th to 8th trial of the experiment (performance ΔHR); PLA change from the first relaxation period to the second relaxation period (resting ΔPLA); PLA change from the 7th to 8th trial of the experiment (performance ΔPLA); PER change from the 7th to 8th trial of the experiment (ΔPER). The means and standard errors for these variables are presented in Table 2. The ten scores from the two rating scales, also dependent variables, will be discussed later.

It should be noted that all change scores were analyzed by a 2 x 2 factorial analysis of variance. The first factor no smoking/smoking during the day refers to the comparison of groups that did not and did smoke prior to the experiment. The second factor, no smoking/smoking during the second relaxation period refers to the comparison of groups that did not and did smoke during the second relaxation period. All of the analyses reported were also done taking out sex as another factor but nothing of significance was revealed so these analyses are not reported. All probabilities are reported correct to three decimal places as given by the Statistical Package for the Social Sciences (Nie, Hull, Jenkins, Steinbrenner, Bent, 1975).

Heart Rate Change Scores From the First to the Second Relaxation Period (Resting ΔHR)

Resting ΔHR was the dependent variable used to determine whether or not resting HR was influenced by the experimental manipulations. A 2 x 2 factorial analysis of variance with the two factors being no smoking/

TABLE 2

Means and Standard Errors of Change Scores

Measure		GROUP NSD/NSR	NSD/SR	SD/NSR	SD/SR
1. Resting ΔHR	$\bar{X}$	-1.53	23.47	-2.87	7.07
	SE	1.05	2.30	1.76	1.29
2. Performance ΔHR	$\bar{X}$	3.47	28.33	4.00	13.13
	SE	1.88	2.89	1.58	2.21
3. Resting ΔPLA	$\bar{X}$	1.50	5.17	2.23	2.43
	SE	0.51	2.81	0.60	1.19
4. Performance ΔPLA	$\bar{X}$	1.57	1.10	-1.00	-0.81
	SE	1.03	1.26	1.37	2.49
5. ΔPER	$\bar{X}$	4.53	1.40	5.27	2.73
	SE	0.89	0.83	0.92	1.00

1. Resting ΔHR = HR during the second relaxation period - HR during the first relaxation period.

2. Performance ΔHR = HR during the 8th trial - HR during the 7th trial.

3. Resting ΔPLA = PLA during the second relaxation period - PLA during the first relaxation period.

4. Performance ΔPLA = PLA during the 8th trial - PLA during the 7th trial.

5. ΔPER = PER during the 8th trial - PER during the 7th trial.

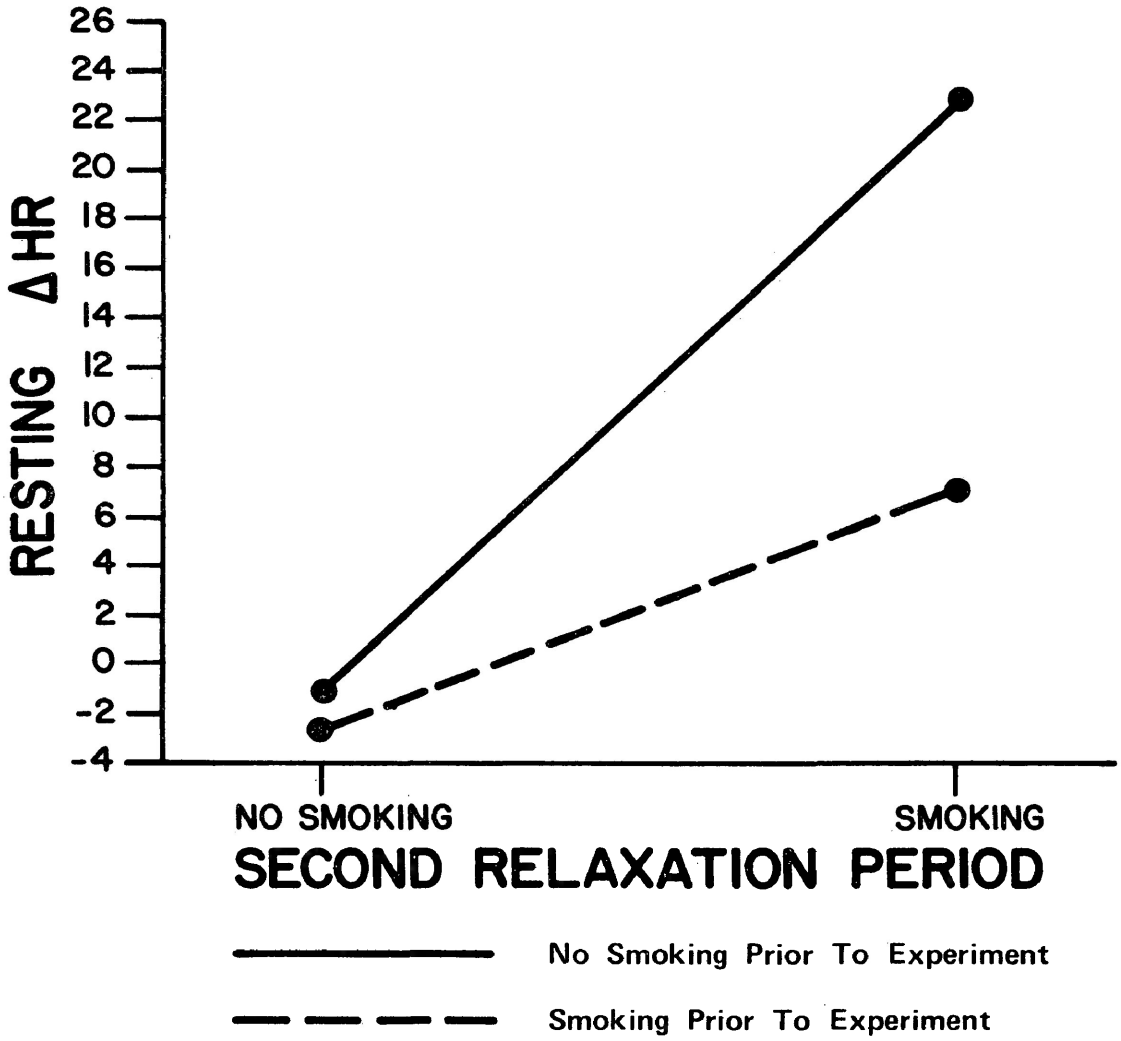
smoking during the day and no smoking/smoking during the second relaxation period was performed on resting ΔHR. The main effect of no smoking/smoking during the day was significant, F (1,56) = 28.17, p = .000. If the subjects did not smoke before the experiment, their heart rate increased more ($\Delta\bar{X}$ = 10.97 bpm) than if they had smoked as usual before the experiment ($\Delta\bar{X}$ = 2.1 bpm). The main effect of no smoking/smoking during the second relaxation period was also significant, F (1,56) = 109.33, p = .000. If the subjects did not smoke during the relaxation period, their HR decreased ($\Delta\bar{X}$ = -2.2 bpm) but if they smoked during the same period, HR increased ($\Delta\bar{X}$ = 15.27 bpm). There was also a significant interaction between the two factors, F (1,56) = 20.34, p = .000. The difference in ΔHR between those who did not and did smoke during the second relaxation period was greater for those who had not smoked during the day (difference = 25.00 bpm) than for those who had smoked during the day (difference = 9.94 bpm). Figure 3 illustrates the resting ΔHR interaction. Appendix G contains a summary of this analysis.

Heart Rate Change Scores from the Seventh to the Eighth Trial (Performance ΔHR)

Performance ΔHR was the dependent variable used to determine whether or not HR during the last trial of the digit-letter task was influenced by the experimental manipulations. A 2 x 2 factorial analysis of variance with the two factors being no smoking/smoking during the day and no smoking/smoking during the second relaxation period was performed on performance ΔHR. The main effect of no smoking/smoking during the day yielded significant results, F (1,56) = 11.37, p = .001. The no smoking group during the day had a significantly higher ΔHR ($\Delta\bar{X}$ = 15.90 bpm) than those who

FIGURE 3

No Smoking/Smoking Prior to Experiment With No Smoking/Smoking During Second Relaxation Period Interaction On Resting $\bar{\Delta}$HR



	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{\Delta X}$	- 1.53	23.47	- 2.87	7.07
SE	1.05	2.30	1.76	1.29

smoked during the day ($\Delta\bar{X}$ = 8.57 bpm). The main effect of no smoking/smoking during the relaxation period also yielded significant results, F (1,56) = 61.11, p = .000. Those subjects who did not smoke during the second relaxation period had a significantly lower ΔHR ($\Delta\bar{X}$ = 3.73 bpm) than those subjects who smoked during the same relaxation period ($\Delta\bar{X}$ = 20.73 bpm). The interaction of these two factors was also significant, F (1,56) = 13.09, p = .001. The difference in ΔHR between those who did and did not smoke during the second relaxation period was greater for those who had not smoked during the day (Difference = 24.86 bpm) than for those who had smoked during the day (Difference = 9.13 bpm). Figure 4 illustrates the performance ΔHR interaction. Appendix H contains a summary of this analysis.

Perceived Level of Arousal Change From the First to the Second Relaxation Period (Resting ΔPLA)

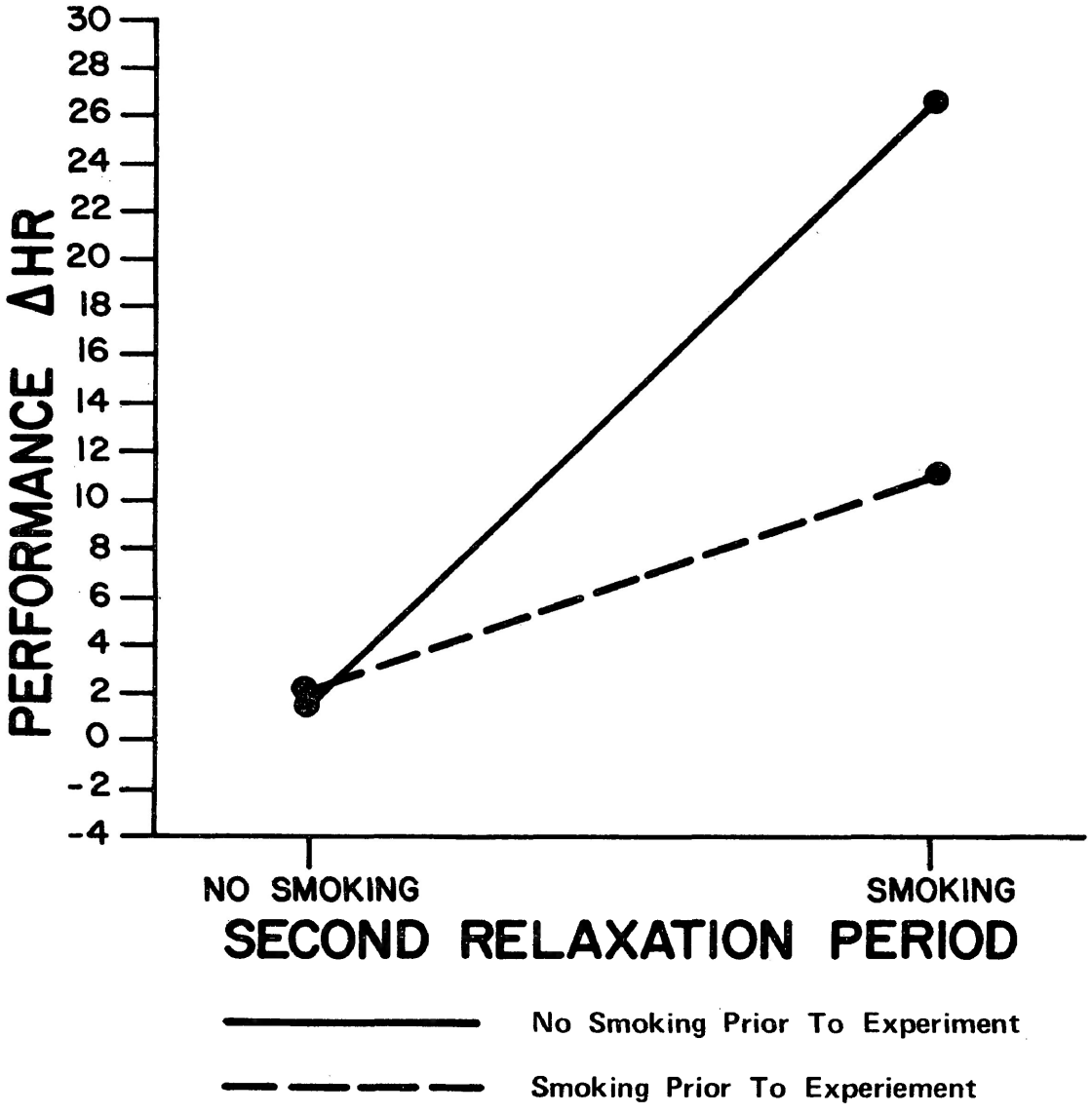
Resting ΔPLA was the dependent variable used to determine whether or not PLA scores between the first and second relaxation periods were influenced by the experimental manipulations. A 2 x 2 factorial analysis of variance with the two factors being no smoking/smoking during the day and no smoking/smoking during the second relaxation period was performed on resting ΔPLA. This analysis did not reveal any significant differences. Appendix I contains a summary of the analysis.

Perceived Level of Arousal Change From the Seventh to the Eighth Trial (Performance ΔPLA)

Performance ΔPLA was the dependent variable used to determine whether or not PLA scores between the 7th and 8th trials of the experiment were

FIGURE 4

No Smoking/Smoking Prior To Experiment With No Smoking/Smoking During Second Relaxation Period Interaction On PERFORMANCE ΔHR



	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\Delta \bar{X}$	3.47	28.33	4.00	13.13
SE	1.88	2.89	1.58	2.21

influenced by the experimental manipulations. A 2 x 2 factorial analysis of variance with the two factors being no smoking/smoking during the day and no smoking/smoking during the second relaxation period was performed on performance ΔPLA. This analysis also did not reveal any significant differences. Appendix J contains a summary of this analysis.

Performance Changes From the Seventh to the Eighth Trial (ΔPER)

The dependent variable used to determine whether performance was influenced by the experimental manipulations was ΔPER. A 2 x 2 factorial analysis of variance with the two factors being no smoking/smoking during the day and no smoking/smoking during the second relaxation period was performed on ΔPER. Only the main effect of no smoking/smoking during the second relaxation period was significant, F (1,56) = 9.64, p = .003. Performance improved more for the group who did not smoke during the relaxation period ($\Delta\overline{X}$ = 4.89 letters) than for the group who smoked during this period ($\Delta\overline{X}$ = 2.05 letters). Appendix K contains a summary of this analysis.

Rating Scales

The two rating scales were used to collect more information regarding the effects of smoking on cognition. It was hoped that these scales would provide some insight into why smokers perceive smoking as relaxing. Ten separate 2 x 2 factorial analysis of variance with the two factors being no smoking/smoking during the day and no smoking/smoking during the second relaxation period were performed on each of the scores from the rating scales.

Of all the possible significant effects in ten 2 x 2 factorial analyses of variance, only one of the interaction effects was significant. However, there was no logical explanation for this result. Appendix L contains a summary of these analyses.

DISCUSSION

Prescores

The analysis performed on resting HR revealed a difference between groups. Those subjects who did not smoke before the experiment had a lower resting HR ($\bar{X}$ = 74 bpm) than those who did smoke before the experiment ($\bar{X}$ = 82 bpm). This finding was expected and is consistent with previous findings. Elliott and Thysell (1968), using each subject as his or her own control, found similar differences. Habitual smokers who have not smoked during a particular day have a lower HR than those who have smoked during the day, due to the effects of smoking.

The analysis performed on the HR data collected during the 7th trial of the experiment only approached significance, indicating the initial difference in HR due to the effects of smoking were dissipating. Also, the effects of being in the experiment may have affected the no smoking during the day group more since they had abstained from smoking all day. However, the subjects who had not smoked prior to the experiment ($\bar{X}$ = 82 bpm) still had a lower HR than those who smoked before the experiment ($\bar{X}$ = 87 bpm).

Analyses of PLA during the first relaxation period and 7th trial yielded no significant differences, nor did the analysis of PER on the 7th trial. No differences were expected for these prescores.

Heart Rate Change From the First to the Second Relaxation Period (Resting ΔHR)

The experimental manipulation of no smoking/smoking during the day significantly influenced resting ΔHR. The no smoking before the experi-

ment group had a mean increase in HR of 11 bpm while the smoking before the experiment group only had a mean increase of 2 bpm. The other experiment manipulation of no smoking/smoking during the second relaxation period, just prior to the 8th trial of the experiment, also significantly influenced resting ΔHR. Those subjects who did not smoke during the second relaxation period had a mean decrease in HR of 2 bpm while the group that smoked at the same time had a mean increase of 15 bpm. The interaction of the two factors was also significant. As already reported, smoking a cigarette during the second relaxation period significantly increased HR but this effect was greater for the subjects who had not smoked prior to the experiment. To exemplify, the subjects in the NSD/SR group, who smoked their first cigarette of the day in the experiment, had a mean resting ΔHR of 24 bpm. The subjects in the SD/SR group who smoked as usual before the experiment and then also smoked in the experiment, recorded a resting ΔHR of 7 bpm. Other researchers have reported similar results. For example, Elliott and Thysell (1968) report a mean increase in HR of 20 bpm for the first cigarette of the day while subjects who smoked as usual before the experiment only recorded a mean increase in HR of 5 bpm. In another study, Frankenhaeuser et al. (1968) measuring hand steadiness, skin temperature, HR and blood pressure found that the largest effects of smoking a cigarette on HR was produced by the first cigarette of the day. They took recordings up to six cigarettes and found that after the first cigarette, subsequent cigarettes produced progressively smaller changes in HR. The major changes in HR in the present study can be mostly accounted for by the NSD/SR group. Thus, the results of Elliott and Thysell's (1968) and Frankenhaeuser et al.'s (1968) study as well as those from the present study indicate that

smoking increases HR, but the strongest effects are produced by the initial cigarette of the day.

Heart Rate Change From the Seventh to the Eighth Trial (Performance ΔHR)

For performance ΔHR, both of the main effects of no smoking/smoking before the experiment and no smoking/smoking during the second relaxation period were significant, as was the interaction of these two effects. Again, as demonstrated in the resting ΔHR data, the NSD/SR group had the largest ΔHR ($\bar{X}$ = 28 bpm). The results of performance ΔHR parallel those found for resting ΔHR. Elliott and Thysell (1968) report that the peak effects of smoking on HR occur five minutes after the first inhalation. Trial 8 of the experiment in the present study was performed approximately 7 minutes after the initial inhalation. Therefore, the same interpretations, given for the significant effects on HR found for resting ΔHR, are most probably valid for the significant effects reported for performance ΔHR, since all groups were exposed to the psychosocial stressor. That is, the first cigarette of the day increases HR significantly more than subsequent cigarettes.

Perceived Level of Arousal Change From the First to the Second Relaxation Period (Resting ΔPLA) and the Seventh to the Eighth Trial (Performance ΔPLA)

Data from the PLA measure failed to support the hypothesis that abstaining from smoking would be anxiety producing or that smoking would be perceived as relaxing. Nesbitt (1973) inferred whether subjects were relaxed or anxious from the amount of shock each subject was willing to endure. For the present study, it was though that the PLA procedure may be a good self-

report measure of anxiety and/or relaxation since it has been shown to be an effective measure of alcohol intoxication (Frankenhaeuser et al., 1974). However, this did not prove to be the case. In another study, Fish (1978) using the same self-report measure also failed to find it a useful measure. Fish found significant physiological and behavioural changes in response to various psychosocial stressors. At the same time, he failed to find any significant differences in PLA. Thus it appears as if the PLA measure is not a good self-report measure, possibly due to several reasons. It could be that the measure itself is too blunt an instrument for the HR changes recorded in the present thesis. Also, the possibility exists that the actual changes in HR are so minimal as not to be perceived by the subjects. Whatever the reason, it appears that even though Nesbitt's Paradox was not demonstrated, a different type of self-report measure should be used before the existence of Nesbitt's Paradox is dismissed.

Performance Changes From the Seventh to the Eighth Trial (ΔPER)

The group that did not smoke during the second relaxation period had a higher ΔPER ($\Delta\bar{X}$ = 5 letters) than the group that smoked during the second relaxation period ($\Delta\bar{X}$ = 2 letters). It has been shown previously (Evans, 1974, 1975; Fish, 1978) that a psychosocial stressor can result in an increase in performance on the digit-letter task but the significant difference in ΔPER between those who did not and did smoke during the second relaxation period was not anticipated.

A review of the literature indicates that smoking has differential effects on performance. Heimstra, Bancroft and DeKoch (1967) investigated the effects of smoking on a 6 hour simulated driving task. Tracking and

reaction time measures as well as two vigilance measures were the dependent variables. There were three groups of subjects: smokers, deprived smokers, and nonsmokers. Both smokers and deprived smokers were people who reported that they smoked at least one pack of cigarettes per day. The deprived smoking group performed poorer in comparison to the smoking group and the nonsmoking group on all four dependent variables and these differences were significant for two of the four variables. No significant differences were found between the smoking group and nonsmoking group. This study indicates that over a lengthy period of time, for habitual smokers, smoking was not detrimental to performance while abstaining from smoking was.

Frankenhaeuser, Myrsten, Post and Johansson (1971) tested visual reaction time with subjects who habitually smoked 5 to 15 cigarettes per day. Each subject took part in three sessions; an introductory session whereby the experiment was explained; a control session of 80 minutes where simple reaction time was recorded without smoking; and an experimental session where the subjects smoked three cigarettes at 20 minute intervals during the 80 minute session. Half of the subjects took part in the experimental session first while the other half took part in the control session first. Reaction time deteriorated significantly during the control session but not during the experimental session. In Frankenhaeuser et al.'s (1971) study, smoking was not detrimental to performance.

Myrsten, Post, Frankenhaeuser and Johansson (1972) investigated the effects of cigarette smoking on simple and choice reaction times. As in Frankenhaeuser et al.'s study, all subjects, who were habitual smokers of 10 to 15 cigarettes per day, attended three sessions. The

initial session involved an introduction to the study. There was one nonsmoking session where two 25 minute blocks of simple reaction time and two 25 minute blocks of choice reaction time were recorded. There was also one smoking session where a cigarette was smoked before each of these same four experimental blocks. For half of the subjects, the no smoking session was performed first and for the other half, the smoking session was performed first. For simple reaction time, performance significantly decreased in the nonsmoking condition but remained the same in the smoking condition. For choice reaction time, there were no significant differences associated with smoking or not smoking. Thus, in this study, smoking was not detrimental to simple reaction time but had no effect on choice reaction time.

Cotton, Thomas and Stewart (1971) investigated simple reaction time in habitual smokers who reported that they smoked 10 to 30 cigarettes per day. All subjects were tested on two separate occasions. Sessions were randomized to eliminate any training effects. In a smoking condition, 20 simple reaction times were taken as soon as subjects commenced the experiment, then they smoked one cigarette. Twenty more trials were given immediately after the cigarette, and then again 5, 15, 25, 40 and 55 minutes after smoking the cigarette. The control condition was carried out exactly in the same manner, the only difference being there was no smoking after the first 20 trials. Compared with reaction times taken before smoking, reaction times were significantly slower immediately and five minutes after smoking the cigarette. No differences were found for reaction times taken 15 and 25 minutes after smoking. However, reaction times were significantly faster 40 and 55 minutes after smoking. In the control condition, no significant differences were found among the

different testing times. Although Cotton et al. offer no explanation, their study suggests that smoking facilitated performance, in the form of simple reaction time, over a period of time, yet smoking was detrimental to performance immediately and five minutes after smoking.

It appears from the literature presented that abstaining from smoking is detrimental to performance on a relatively simple task over a lengthy period of time. This is indicated by the fact that abstaining from smoking results in a deterioration of reaction time, over a lengthy period of time, compared to a smoking situation. Also, there are significantly more errors in a driving simulation task for deprived smokers compared to a smoking group. Alternatively, smoking appears to be detrimental to the performance of a simple task if the task is performed immediately after smoking. This is what appears to have happened to the present study. The group that smoked immediately before performing the 8th trial of the digit-letter task did not exhibit as large an increase in performance as the group who abstained from smoking immediately before the task.

Accepting this finding as valid leads one to think of the reasons why this phenomenon occurred. One possible reason may be due to the pharmacological effects of nicotine. A review of the literature indicates that nicotine has effects on muscular activity in both humans and animals. For example, Domino (1973) in reviewing the literature, suggested that nicotine stimulated Renshaw cell discharge. This would lead to an inhibition of motor anterior horn cells resulting in depression of muscular activity. Domino and Von Baumgarten (1969) have demonstrated that depression of the patellar reflex in man occurred about 30 seconds after the initial puff of a cigarette and reached asymptote levels at the end of smoking.

The depression remained until 30 to 120 seconds after smoking. In all but one case, recovery almost reached control levels after 25 minutes. In summarizing the work of Ginzel (1967), Ginzel, Eldred, Watanabe and Grover (1970) and Ginzel, Watanabe and Eldred (1970), Domino (1973) reports that low doses of nicotine produce a dramatic reduction of the patellar reflex in animals but the mechanisms involved are complex, involving both central and peripheral components. In other studies, Frankenhaeuser et al. (1968, 1970, 1971) have shown repeatedly that hand steadiness is consistently impaired by cigarette smoking. Heimstra et al. (1967) in reviewing the literature on smoking and psychomotor performance concluded that the typical initial effect of tobacco appears to be a decrease in the precision of finely coordinated movements and a decrease in overall motor efficiency. The literature indicates that smoking has an effect on the muscular system. In the present study, this possibility may be partially responsible for the difference in performance on the digit-letter task immediately after not smoking or smoking a cigarette.

Neurological changes produced by cigarette smoking may also be partially responsible for difference in performance increases. Ulett and Itil (1969) have shown that, compared to smoking values, 24 hour smoking deprivation led to an increase in EEG slow wave frequency with a return to original frequency after smoking was resumed. Philips (1971) concluded from EEG patterns of habitual smokers that nicotine absorbed in cigarette smoking acts as a stimulant or activator. Assuming that an inverted U relationship between cortical arousal and performance exists, as suggested by Greenfield and Sternbach (1972), it is possible that smoking cortically overaroused subjects leading to a smaller performance increase. However, it should be noted that these explanations

are only speculation.

It is also possible that during the relaxation period the subjects who smoked changed their cognitive set. They could have been wondering what the relationship was between smoking and the digit-letter task or just the idea of relaxing and having a cigarette may have influenced their motivation on the 8th trial. Possibly any activity, even totally unrelated to smoking, that resulted in a change of set could have influenced the results. It should also be noted that subjects assigned to the smoking during the second relaxation period group had to smoke a cigarette. Some subjects complained, stating that they preferred not to smoke. Thus, the fact that they had to smoke even if they did not want to may have affected the performance results. Consequently, the performance results should be replicated before too much is made of them.

Conclusion

In summary, the present study supports previous findings that smoking increases HR, with the largest increase produced by the first cigarette of the day. Also, the present investigation demonstrated that smoking immediately before performing a digit-letter task led to a significant difference in an increase in performance caused by impending social comparison, when compared to a group that did not smoke. No evidence was obtained to indicate whether or not Nesbitt's Paradox exists. Even considering the results of the present study, the reasoning behind Nesbitt's Paradox still appears intuitively plausible to the present author. In his opinion, the existence or nonexistence of Nesbitt's Paradox should be further explored in another experiment using a methodology similar to that in the present study, but with a different

and hopefully better self-report measure.

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LIST OF APPENDICES

Page

Appendix A

The Digit-Letter Task

0	1	2	3	4	5	6	7	8	9
L	V	T	A	E	N	W	X	H	K

3	5	1	0	6	6	2	0	6	9	9	2	9	7	5	9	5	3	2	0	5	7	7	3	4

9	6	9	8	2	6	6	2	2	4	2	4	0	1	5	9	6	7	4	9	0	7	5	8	9

0	5	0	1	4	9	0	9	6	6	3	3	6	7	4	6	9	0	9	6	3	3	4	8	8

2	1	9	9	8	0	8	5	2	8	2	6	3	7	2	9	2	9	2	3	6	5	0	2	6

5	6	6	7	0	0	0	2	2	1	5	0	1	9	3	9	9	5	9	1	6	2	3	7	7

7	1	3	0	1	3	5	7	4	2	8	3	6	3	6	7	3	0	5	8	8	7	2	2	9

5	8	7	4	8	3	1	4	4	6	8	0	2	3	7	3	1	2	5	2	9	6	3	6	7

8	6	2	3	0	4	8	2	9	6	3	8	3	5	2	2	3	8	1	6	6	4	0	9	4

Appendix B

Name: _____

	Heart Rate	Perceived Level of Arousal	Performance
First Relaxation Period			
D-L:1			
D-L:2			
D-L:3			
D-L:4			
D-L:5			
D-L:6			
D-L:7			
Second Relaxation Period			
D-L:8			

Appendix C

RATING SCALE

NAME: _____

Using the following scale (0-3) rate the degree to which you felt relaxed during the following times today. Please read all five statements before you answer any of them.

0 - not at all

1 - to a slight degree

2 - to a moderate degree

3 - to a great degree

	Generally during the course of the day
	Generally during the course of the experiment
	During the first five minute relaxation period
	During the second five minute relaxation period
	During the last trial on the digit-letter task

Appendix D

RATING SCALE

NAME: _____

Using the following scale (0-3) rate the degree to which you felt anxious during the following times today. Please read all five statements before you answer any of them.

0 - not at all

1 - to a slight degree

2 - to a moderate degree

3 - to a great degree

	Generally during the course of the day
	Generally during the course of the experiment
	During the first five minute relaxation period
	During the second five minute relaxation period
	During the last trial on the digit-letter task

Appendix E

INITIAL PROCEDURE

- (PUT SIGN ON DOOR, BRING THE SUBJECT IN, ASK THEIR NAME AND INTRODUCE YOURSELF. ASK THE SUBJECT FOR THE CIGARETTES AND MATCHES AND PLACE THEM ON THE TABLE. EXPLAIN THAT YOU ARE GOING TO KEEP A RECORD OF HIS/HER HR).
- (SIT THE SUBJECT DOWN AND GET THE HR RECORDING WORKING SATISFACTORILY, HAVING PUT THE PLETHYSMOGRAPH ON THE INDEX FINGER OF THE SUBJECT'S NON-PREFERRED HAND. EXPLAIN HOW THE PLETHYSMOGRAPH WORKS AND INFORM THE SUBJECT THAT IT MUST BE KEPT STILL IF IT IS TO FUNCTION PROPERLY).
- (READ THE FOLLOWING INSTRUCTIONS).

Now you will have to sit here for quite awhile and relax completely so that we can record your heart rate at resting level. Just relax and do not think about the experiment. There is nothing to worry about and I promise that you will not be hurt.

Once in awhile when you are relaxing, you should think about your level of physiological arousal. Your level of physiological arousal refers to how hard your body is working. If you ran quickly up a long flight of stairs your level of arousal would probably go up and maybe you would feel your heart beating faster than usual or you may have started to sweat. Often your level of arousal may go up even when you have not stressed yourself physically but just because of some psychological factor. For example, just before you had to give a talk to a large group of people, your level of arousal would probably be higher than usual. Again you may feel your heart beating faster than usual or you may have started to sweat. Right now, because being in this particular experiment is a new experience for you, your level of arousal is

probably higher than usual.

Every once in awhile, during this experiment, I am going to ask you to estimate your level of arousal. The first time I will ask you to estimate your level of arousal will be right after the relaxation period is finished. I will say . . . "Estimate your level of arousal at the end of the relaxation period". Then, what I will want you to do is to give me a number. To do this, you have to assign the number 10 to your usual-common-everyday level of arousal. Then, if at the end of the relaxation period you think you are only half as aroused as usual, you should say 5. If you think you are only 25 percent as aroused as usual, you should say 2.5. If you think you are twice as aroused as usual, you should say 20. Ok . . . let's try a few examples. If you think you are only one-tenth as aroused as usual, what should you say (1), if you think you are 35 percent more aroused than usual, what should you say (13.5), if you think you are three times as aroused as usual, what should you say (30), and so on . . . Ok. Whenever I ask you to estimate your level of arousal, you will have to give me a number to indicate how hard you think your body was working at a particular time. During the relaxation period, your main tasks are to relax as much as possible and to get your level of arousal as low as possible. Also, every once in awhile, you should think about and estimate your level of arousal. This will give you some practice at doing this task.

During the relaxation period, you will have to keep the plethysmograph as still as possible. You should move around as little as possible, and you will not be able to ask any questions. So, if you have any questions you should ask them now and you should make yourself as comfortable as possible so that you will be able to stay still during the

relaxation period. Any questions?

- (ENCOURAGE QUESTIONS AND HELP THE SUBJECT TO MAKE HIMSELF/HERSELF AS COMFORTABLE AS POSSIBLE).

- (GO BEHIND THE PARTITION AND ASK THE SUBJECT IF HE/SHE IS READY TO BEGIN THE RELAXATION PERIOD).

Are you ready for the relaxation period?

- (IF THE SUBJECT GIVES AN AFFIRMATIVE ANSWER, PRESS THE EVENT MARKER AND SAY)

"Ok, the relaxation period begins now".

- (REMAIN ABSOLUTELY QUIET AND STILL DURING THE SUBJECT'S RELAXATION PERIOD).

- (AFTER EXACTLY 5 MINUTES, PRESS THE EVENT MARKER AND SAY)

"Ok, the relaxation period is finished. Estimate your level of arousal at the end of the relaxation period."

- (RECORD SUBJECT'S RESPONSE).

- (BRING OUT TASK (1) FACE UP).

- (IF SUBJECT IS LEFT HANDED, SPECIAL PROCEDURE).

- (READ THE FOLLOWING INSTRUCTIONS).

This is a digit-letter substitution task. What you have to do is: Under each of these numbers (POINT) put the appropriate letter from above. You are to start here (POINT) and continue on. When you reach the end of a line, go on to the next line. You have to do digit-letter substitution tasks in sequential order. You cannot do all the 0s, then all the 1s, then all the 2s, etc. Ok? Get yourself into a comfortable position for doing the task and remember that you have to keep the plethysmograph as still as possible.

- (TURN TASK OVER, EXPLAIN TO SUBJECT).

- (HELP THE SUBJECT DISCOVER A GOOD COMFORTABLE POSITION FOR DOING THE TASK IN SUCH A WAY THAT HE/SHE IS ABLE TO DO THE TASK WHILE KEEPING THE PLETHYSMOGRAPH STILL).
- (PICK UP THE BUZZER AND READ THE FOLLOWING INSTRUCTIONS).

When we are ready to begin having you do a digit-letter substitution task, I will say . . . "Turn over the task" . . . and you should turn the task over with your free hand once again remembering to keep the plethysmograph still. Then I will say . . . "Ready?" . . . and when you are ready to begin doing the task you should say . . . "Yes". After you have said yes, I will say "OK!" and then I will buzz the buzzer like this (DEMONSTRATE). When I buzz the buzzer, begin doing the task as fast as possible. When time is up, I will buzz the buzzer again and you will have to stop <u>immediately</u>. Once again, remember that you have to keep the plethysmograph still even when you are doing digit-letter substitution tasks. Any questions?

Turn over the task.

Ready.

- (BUZZER).
- (RUN THE FIRST TRIAL).
- (BUZZER).
- (AS SOON AS THE FIRST TRIAL IS FINISHED SAY:)

Estimate your level of arousal while doing the task.

- (SCORE, POINT OUT ERRORS, GIVE SCORE).
- (BRING OUR TASK (2) AND PUT IT OUT FACE DOWN IN FRONT OF THE SUBJECT).
- (READ THE FOLLOWING INSTRUCTIONS).

Now you have to do another form of the task the same way you did the last one. Remember you are always to do digit-letter substitution tasks as fast as possible.

Turn over the task.

Ready.

- (BUZZER).

- (RUN THE SECOND TRIAL).

- (BUZZER).

- (AS SOON AS THE SECOND TRIAL IS FINISHED SAY:)

Estimate your level of arousal while doing the task.

- (SCORE, POINT OUT ERRORS, GIVE SCORE).

- (BRING OUT TASK (3) AND PUT IT FACE DOWN IN FRONT OF THE SUBJECT AND SAY:)

Now task (3).

Turn over the task.

Ready.

- (BUZZER).

- (RUN THE THIRD TRIAL).

- (BUZZER).

- (AS SOON AS THE THIRD TRIAL IS FINISHED SAY:)

Estimate your level of arousal while doing the task.

- (SCORE, POINT OUT ERRORS, GIVE SCORE).

- (BRING OUT TASK (4) AND PUT IT FACE DOWN IN FRONT OF THE SUBJECT AND SAY:)

Now task (4).

Turn over the task.

Ready.

- (BUZZER).

- (RUN THE FOURTH TRIAL).

- (BUZZER).

- (AS SOON AS THE FOURTH TRIAL IS FINISHED SAY:)

  Estimate your level of arousal while doing the task.

- (SCORE, POINT OUT ERRORS, GIVE SCORE).

- (BRING OUT TASK (5) AND PUT IT FACE DOWN IN FRONT OF THE SUBJECT AND SAY:)

  Now task (5).

  Turn over the task.

  Ready.

- (BUZZER).

- (RUN THE FIFTH TRIAL).

- (BUZZER).

- (AS SOON AS THE FIFTH TRIAL IS FINISHED SAY:)

  Estimate your level of arousal while doing the task.

- (SCORE, POINT OUT ERRORS, GIVE SCORE)

- (BRING OUT TASK (6) and PUT IT FACE DOWN IN FRONT OF THE SUBJECT AND SAY:)

  Now task (6).

  Turn over the task.

  Ready.

- (BUZZER).

- (RUN THE SIXTH TRIAL).

- (BUZZER)

- (AS SOON AS THE SIXTH TRIAL IS FINISHED SAY:)

  Estimate your level of arousal while doing the task.

- (SCORE, POINT OUT ERRORS, GIVE SCORE).

- (BRING OUT TASK (7) AND PUT IT FACE DOWN IN FRONT OF THE SUBJECT AND SAY:)

Now task (7).

Turn over the task.

Ready.

- (BUZZER).
- (RUN THE SEVENTH TRIAL).
- (BUZZER).
- (AS SOON AS THE SEVENTH TRIAL IS FINISHED SAY:)

Estimate your level of arousal while doing the task.

- (SCORE, POINT OUT ERRORS, GIVE SCORE).

SOCIAL COMPARISON

There is going to be a difference about the next trial. The difference will be that after the next trial is over, you will be given the opportunity to compare your score on that trial to the scores of 20 other people on their performance of the eighth form of the digit-letter substitution task. (PUT THE EXAMPLE CHART ON THE TABLE, FACE DOWN) You will be shown a chart on which 20 scores for the eighth trial will be rank ordered from the highest to the lowest score. (TURN EXAMPLE CHART OVER AND EXPLAIN). You will be able to find out exactly how well you did in comparison to how well the 20 people did after the same amount of practice as you have had. You will be able to find out how many people did better than you and how many did worse than you. You will also be able to see how well you did in comparison to the average score of the 20 people. OK. Your job is to do as well as you possibly can in comparison to these people.

NOW, AND ONLY NOW RANDOMLY ASSIGN

SUBJECTS TO NO SMOKING OR SMOKING

CONDITION

TURN TO THE APPROPRIATE SET OF INSTRUCTIONS

NO-SMOKING CONDITION

However, before you begin the next trial, you will be able to relax for five minutes. Make yourself as comfortable as possible so that you will be able to stay still during the relaxation period. Remember to keep the plethysmograph as still as possible. I will let you know when the relaxation period is over.

Are you ready for the relaxation period?

- (IF THE SUBJECT GIVES AN AFFIRMATIVE ANSWER SAY:)

OK, the relaxation period begins now.

- (PRESS THE EVENT MARKER, RECORD TIME, WAIT BEHIND PARTITION).
- (AFTER EXACTLY FIVE MINUTES IS UP, SAY:)

OK, the relaxation period is over. Estimate your level of arousal at the end of the relaxation period.

SMOKING CONDITION

However, before you begin the next trial, you will be able to relax for five minutes and have a cigarette. Make yourself as comfortable as possible so that you will be able to stay still during the relaxation period. Remember to keep the plethysmograph as still as possible. I will let you know when the relaxation period is over. (LIGHT CIGARETTE).

Are you ready for the relaxation period?

- (IF THE SUBJECT GIVES AN AFFIRMATIVE ANSWER, SAY:)

OK, the relaxation period begins now.

- (PRESS THE EVENT MARKER, RECORD TIME, WAIT BEHIND PARTITION).
- (AFTER EXACTLY FIVE MINUTES IS UP, SAY:)

Ok, the relaxation period is over.

- (IF SUBJECT HAS NOT DONE SO, ASK HIM/HER TO PUT OUT CIGARETTE).

Estimate your level of arousal at the end of the relaxation period.

- (REMOVE ASH TRAY).

Remember, you will be given the opportunity to compare your score on this trial to the scores of 20 other people. You will be able to find out exactly how well you did in comparison to how well the other 20 perople did after the same amount of practice as you have had. Your job is to do as well as you possibly can in comparison to these people. Here is the real chart (GET REAL CHART AND TURN UPSIDE DOWN ON SUBJECT'S TABLE). Real scores instead of just these dashes are on the other side of this chart and you will be able to look at them after this trial. OK.

Now trial 8.

Turn over the task.

Ready.

- (BUZZER).
- (RUN THE EIGHTH TRIAL).
- (BUZZER).

Estimate your level of arousal while doing the task.

- (SHUT OFF LIGHT - SWITCH TO STAND BY).
- (REMOVE PLETHYSMOGRAPH FROM SUBJECT'S FINGER).

Now, before we mark your task and compare your score to the other people's scores, I would like you to fill out a couple of rating scales.

- (SCORE, POINT OUT ERRORS, GIVE SCORE).
- (SHOW THE SUBJECT WHERE HE/SHE STOOD IN COMPARISON TO THE OTHER PEOPLE).

DEBRIEFING

- ask subject what he/she thought the experiment was about.
- ask subject if he/she had heard anything about the experiment.
- if in the no smoking during the day group, ask subject if he/she had a cigarette and stress the importance of experimenter knowing.
- ask subject some of his/her ideas about smoking.
- ask the subject if there is anything he/she wants to know about the experiment.
- ask the subject to keep the details of the experiment confidential.
- if not in introductory psychology pool, give subjects one dollar.

Appendix F

Heart Rate During the First Relaxation Period

Group	$\bar{X}$	SE	t	df	Probability
No Smoking During Day	74.200	2.034	-2.87	58	0.006
Smoking During Day	82.367	1.990			

Heart Rate During the Seventh Trial

Group	$\bar{X}$	SE	t	df	Probability
No Smoking During Day	81.900	2.103	-1.77	58	0.082
Smoking During Day	87.467	2.345			

Perceived Level of Arousal Scores for the First Relaxation Period

Group	$\bar{X}$	SE	t	df	Probability
No Smoking During Day	7.183	0.679	-0.28	58	0.779
Smoking During Day	7.433	0.570			

Appendix F continued

Perceived Level of Arousal Scores for the Seventh Trial

Group	$\bar{X}$	SE	t	df	Probability
No Smoking During Day	15.000	1.147	-0.97	58	0.336
Smoking During Day	16.957	1.660			

Performance Scores for the Seventh Trial

Group	$\bar{X}$	SE	t	df	Probability
No Smoking During Day	50.567	1.206	-0.77	58	0.445
Smoking During Day	51.967	1.366			

Appendix G

Heart Rate Change Scores From the First to the Second Relaxation Period (Resting ΔHR)

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	1179.267	1	1179.267	28.173	0.000
No Smoking/Smoking During Rest (R)	4576.266	1	4576.266	109.327	0.000
D x R	851.267	1	851.267	20.337	0.000
Error	2344.078	56	41.859		
Total	8950.875	59	151.710		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\Delta\overline{X}$	-1.53	23.47	-2.87	7.07
SE	1.05	2.30	1.76	1.29

Appendix H

Heart Rate Change Scores From the Seventh to the Eighth Trial (Performance ΔHR)

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	806.667	1	806.667	11.371	0.001
No Smoking/Smoking During Rest (R)	4334.996	1	4334.996	61.107	0.000
D x R	928.267	1	928.267	13.085	0.001
Error	3972.730	56	70.942		
Total	10042.660	59	170.215		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\Delta\bar{X}$	3.47	28.33	4.00	13.13
SE	1.88	2.89	1.58	2.21

Appendix I

Perceived Level of Arousal Change From the First to the Second Relaxation Period (Resting ΔPLA)

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	15.000	1	15.000	0.404	0.528
No Smoking/Smoking During Rest (R)	56.067	1	56.067	1.509	0.224
D x R	45.067	1	45.067	1.213	0.275
Error	2080.195	56	37.146		
Total	2196.329	59	37.226		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\Delta\overline{X}$	1.50	5.17	2.23	2.43
SE	0.51	2.81	0.60	1.19

Appendix J

Perceived Level of Arousal Change from the Seventh to the Eighth Trial (Performance ΔPLA)

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	75.264	1	75.264	1.876	0.176
No Smoking/Smoking During Rest (R)	0.294	1	0.294	0.007	0.932
D x R	1.601	1	1.601	0.040	0.842
Error	2246.146	56	40.110		
Total	2323.304	59	39.378		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\Delta\bar{X}$	1.57	1.10	-1.00	-0.81
SE	1.03	1.26	1.37	2.49

Appendix K

Performance Changes from the Seventh to the Eighth Trial (ΔPER)

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	16.017	1	16.017	1.283	0.262
No Smoking/Smoking During Rest (R)	120.417	1	120.417	9.644	0.003
D x R	1.350	1	1.350	0.108	0.744
Error	699.196	56	12.486		
Total	836.979	59	14.186		

	$\overline{NSD}$/NSR	NSD/SR	SD/NSR	SD/SR
$\Delta\overline{X}$	4.53	1.40	5.27	2.73
SE	0.89	0.83	0.92	1.00

Appendix La

Degree to Which Subjects Felt Anxious Generally During the Course of the Day

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.067	1	0.067	0.131	0.718
No Smoking/Smoking During Rest (R)	0.267	1	0.267	0.526	0.471
D x R	0.267	1	0.267	0.526	0.471
Error	28.400	56	0.507		
Total	29.000	59	0.492		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	0.67	0.93	0.87	0.87
SE	0.16	0.30	0.21	0.26

Appendix Lb

Degree to Which Subjects Felt Anxious Generally During the Course of the Experiment

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.067	1	0.067	0.078	0.781
No Smoking/Smoking During Rest (R)	0.267	1	0.267	0.313	0.578
D x R	0.267	1	0.267	0.313	0.578
Error	47.733	56	0.852		
Total	48.333	59	0.819		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	1.40	1.67	1.47	1.47
SE	0.21	0.16	0.17	0.19

Appendix Lc

Degree to Which Subjects Felt Anxious During the First Five Minute Relaxation Period

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.017	1	0.017	0.035	0.852
No Smoking/Smoking During Rest (R)	0.150	1	0.150	0.315	0.577
D x R	0.817	1	0.817	1.715	0.196
Error	26.666	56	0.476		
Total	27.650	59	0.469		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	1.00	1.33	1.20	1.07
SE	0.22	0.13	0.20	0.15

Appendix Ld

Degree to Which Subjects Felt Anxious During the Second Five Minute Relaxation Period

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.067	1	0.067	0.093	0.761
No Smoking/Smoking During Rest (R)	0.067	1	0.067	0.093	0.761
D x R	1.067	1	1.067	1.488	0.228
Error	40.133	56	0.717		
Total	41.333	59	0.701		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	1.20	1.53	1.40	1.20
SE	0.20	0.21	0.21	0.24

Appendix Le

Degree to Which Subjects Felt Anxious During the Last Trial of the Digit-Letter Task

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	2.017	1	2.017	2.265	0.138
No Smoking/Smoking During Rest (R)	0.150	1	0.150	0.168	0.683
D x R	0.817	1	0.817	0.917	0.342
Error	49.866	56	0.890		
Total	52.850	59	0.896		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	2.01	2.40	1.93	1.80
SE	0.27	0.19	0.23	0.28

Appendix Lf

Degree to Which Subjects Felt Relaxed Generally During the Course of the Day

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	1.350	1	1.350	1.469	0.231
No Smoking/Smoking During Rest (R)	0.817	1	0.817	0.889	0.350
D x R	0.017	1	0.017	0.018	0.893
Error	51.466	56	0.919		
Total	53.650	59	0.909		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	1.80	1.60	2.13	1.87
SE	0.28	0.25	0.19	0.26

Appendix Lg

Degree to Which Subjects Felt Relaxed Generally During the Course of the Experiment

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.417	1	0.417	0.936	0.338
No Smoking/Smoking During Rest (R)	0.150	1	0.150	0.337	0.564
D x R	1.350	1	1.350	3.032	0.087
Error	24.933	56	0.445		
Total	26.850	59	0.455		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	1.47	1.27	1.33	1.73
SE	0.21	0.12	0.16	0.18

Appendix Lh

Degree to Which Subjects Felt Relaxed During the First Five Minute Relaxation Period

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.017	1	0.017	0.029	0.866
No Smoking/Smoking During Rest (R)	0.417	1	0.417	0.720	0.400
D x R	2.817	1	2.817	4.868	0.031
Error	32.400	56	0.579		
Total	35.650	59	0.604		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	2.13	1.53	1.73	2.0
SE	0.19	0.17	0.25	0.17

Appendix Li

Degree to Which Subjects Felt Relaxed During the Second Five Minute Relaxation Period

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.067	1	0.067	0.085	0.771
No Smoking/Smoking During Rest (R)	0.067	1	0.067	0.085	0.771
D x R	0.067	1	0.067	0.085	0.771
Error	43.733	56	0.781		
Total	43.933	59	0.745		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	1.67	1.67	1.53	1.67
SE	0.23	0.21	0.24	0.23

Appendix Lj

Degree to Which Subjects Felt Relaxed During the Last Trial of the Digit-Letter Task

Source of Variability	SS	df	MS	F	Probability
No Smoking/Smoking During Day (D)	0.267	1	0.267	0.413	0.523
No Smoking/Smoking During Rest (R)	1.667	1	1.667	2.583	0.114
D x R	0.267	1	0.267	0.413	0.523
Error	36.133	56	0.645		
Total	38.333	59	0.650		

	NSD/NSR	NSD/SR	SD/NSR	SD/SR
$\bar{X}$	0.67	0.87	0.67	1.13
SE	0.21	0.24	0.19	0.19