To the Graduate Council:

I am submitting herewith a dissertation written by Robert Fisher entitled "Unobtrusive Observations of Cigarette Smoking." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

William S. Verplanck, Major Professor

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The Graduate School

UNOBTRUSIVE OBSERVATIONS OF CIGARETTE SMOKING

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Robert Fisher

June 1984

ACKNOWLEDGMENTS

It is a truism that no one's endeavors stand alone. I would like to acknowledge the assistance of the dissertation committee members, Drs. Kathleen A. Lawler and John C. Malone, Jr., of the Psychology Department, and Dr. John E. Nolt of the Philosophy Department. I would also like to acknowledge the help of Don Broach of the Computing Center in putting the raw data into computer analyzable form.

A special acknowledgment goes to the dissertation committee chairman, Dr. William S. Verplanck, whose unflinching insistence on observing and recording phenomena as they naturally occur as being essential to the scientific enterprise is, I hope, reflected herein.

This dissertation and the work preparatory to it would not have been possible without the continuous support and encouragement of my family which helped smooth out an often bumpy journey.

ABSTRACT

The results of laboratory studies of cigarette smoking are of questionable value if the experimental smoking patterns are not like those of "real world" smoking. For instance, the amount of tar, nicotine and hazardous gases collected by a smoking machine may not reflect the amount smokers are actually exposed to unless the machine is programmed to smoke as do people in ordinary, day-to-day situations. Whether or not this is the case for any given laboratory study is not readily apparent due to a shortage of information on naturally occurring smoking patterns. As a step to remedy this problem, a naturalistic observational study was carried out to collect normative data on the smoking patterns of cigarette smokers in everyday settings.

Over a one year period, 200 smokers, in two cafeterias, a university student center, two restaurant lounges, and at a baseball park, were observed smoking one cigarette each, from light-up to extinguishing. The observations were unobtrusive, that is, the smokers were unaware they were being observed. The microphone on a microcassette recorder was tapped once for the onset of each puff, inhale and exhale, and for the offset of each exhale. The recordings were later timed with stopwatches to give a continuous running record of the various elements of the entire smoking episode. Records were also kept of the brand of the cigarette, of the sex and estimated age and weight of the smoker, and a number of other smoker and situational variables.

The normative data are presented by way of a table of descriptive statistics and a visual display of the distribution of scores for each

of eight smoking parameters: Number of puffs; mean durations for puffs, inhales, exhales, combined puff-inhale-exhales, and intervals between puffs; and total puff-inhale-exhale and episode durations. The data suggest that a number of laboratory studies have used smoking patterns which are at variance with how a majority of people actually smoke. This includes the smoking machine settings used to measure the Federal Trade Commission published tar and nicotine deliveries of commercially available cigarettes. The normative data presented in this study can be of help to laboratory investigators who want to improve the external validity of their studies by using smoking patterns that better reflect those of "real world" smoking.

Also, a number of results are consistent with the hypothesis that nicotine plays an important role in smoking; 199 out of the 200 smokers inhaled the smoke from the cigarette, the inhale-exhale patterns were what would be expected of smoking-to-get-nicotine, many smokers compensated for falling short on one measure of smoke exposure by scoring higher on another, for most smokers there was a minimum level for several measures of smoke exposure, and smokers of cigarettes with low nicotine ratings smoked differently than smokers of cigarettes with high nicotine ratings.

And lastly, smokers were classified, in terms of how they smoked a single cigarette, into four groups: "Light" smokers (13%), most of whom appeared to be novices; "average" smokers (74%), who were very similar in smoking patterns; "heavy" smokers (9%), who scored slightly higher than the "average" smoker on one or more parameters; and "atypical" smokers (4%), who were extreme on one or more parameters.

PREFACE

> In our time the use of tobacco is growing greatly and conquers men with a certain secret pleasure, so that those who have once become accustomed thereto can later hardly be restrained therefrom.
>
> Francis Bacon
> Historia vitae et mortis

Health authorities have called cigarette smoking the nation's number one most preventable cause of premature disease and death and as such it has been the subject of extensive research over the past two or so decades. But cigarette smoking, and tobacco use in general, is not just a passing mid-20th century fad or the product of clever advertising ploys on the part of tobacco companies. Rather, tobacco has a long and colorful history and a reading of it gives a broader understanding and appreciation of the extent to which tobacco has become deeply ingrained in modern civilizations. This is the purpose of the first chapter, to show the degree to which tobacco played a central part in the lives of the New World natives, how quickly it spread worldwide after its discovery by the New World explorers, and its continued resistance to all attempts to eradicate its use.

The second chapter attempts to show that there is a good reason why tobacco has held sway over so many people for such a long time, and that is because tobacco, perhaps more than any other substance, reliably provides the user with a wide variety of benefits or payoffs. A case is made for tobacco's major alkaloid, nicotine, as a powerful psychopharmacological agent which is chiefly responsible for tobacco's charm.

The third chapter deals with the difficulties that most users of tobacco, especially cigarette smokers, encounter when they attempt abstinence, and how cigarette smoking is being viewed more and more as an addiction in every sense of the word. Because of the addictive nature of cigarette smoking and the lack of success of various quitting smoking programs, the recent trend has been toward trying to make cigarette smoking less hazardous, and the issues involved in this endeavor are presented in the fourth chapter.

These introductory chapters then provide a general background and set the stage for the research carried out and the results presented and discussed in the fifth through the seventh chapters.

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CHAPTER I

A BRIEF HISTORY OF TOBACCO

Fire has a natural fascination for us, as anyone who has sat before a fireplace or campfire knows. Fire's captivating effect may have its roots in the vital part it has played in day-to-day survival for a large part of human history. In 1981, paleontologists in Ethiopia found human-like skeletal remains dated at 3.5 million years old. Along with the bones were discovered fragments of charred clay, indicating that human ancestors may have used fire by this early date.

With fire being used constantly to provide light, protection and warmth, to cook food, to bake bricks and pottery, and so forth, for so many years, humans have had ample opportunity to come in contact with fire's close associate, smoke. Countless occasions must have occurred where individuals, perhaps accidentally at first, got a whiff or two from whatever was burning. Sooner or later they doubtless noticed that the sniffing of or even inhaling some smoke was to their liking. This may have resulted from aromas in the smoke being associated with the cooking or curing of food, or from fragrant smoke of some woods or plants smouldering or burning. But on rare occasions such inhaling may have had psychoactive or "mind-altering" results, leading to the seeking out, preparing, and deliberate burning and inhaling of the smoke from these special materials.

Purposeful inhalation of smoke also may have played a part in religious rituals. "Smoke is inherently evocative of visions and mystery---a natural medium for the arts of tribal priests and medicine men" (Brooks,

1952, p. 20). By taking in smoke, shamans may have thought that they could capture part of the qualities of the spirits residing in the burning material. Inhalation of smoke could have shown bravery or mastery over the spirit world. Corti (1931) suggests that from very early times humans used fire and smoke for such religious-mystical purposes. Records show ancient Egyptians burning incense to their gods, a practice still seen in various contemporary religious ceremonies. The oracle prophetesses of Delphi inhaled smoke from burning laurel and barley-meal to produce trance states, a sign to onlookers that they were in communication with supernatural powers. Smoke may also have been used to treat sickness or injury; the early Greek natural historian Pliny recommended inhaling smoke from dried coltsfoot as a treatment for asthma.

At any rate, by the beginning of recorded history the deliberate inhalation of smoke from various sought-after materials was a well established, widespread human activity. It has remained so to this day.

Many different substances throughout human history have been set smouldering or aflame and the smoke inhaled. Three have distinguished themselves into a class all their own. Two of these, opium and marijuana, are native to the Old World and have histories predating written records. Tobacco, the third one and the focus of this dissertation, is usually considered native to the New World, although of the seventy-three species of tobacco's genus Nicotiana, two, N. fragrans and N. suaveolens are native to Australia, but they were not smoked there until after the arrival of Europeans (Robicsek, 1978). Fairholt (1859) lists a N. persica as being native to Persia. To further complicate matters, a short note in the Anthropological Journal of Canada (1978, 16, p. 10) reports

that fragments of tobacco and a tobacco parasite insect were found in the stomach of the 3212 year old mummy of Pharaoh Ramses II. These exceptions notwithstanding, most historians agree the Maya Indians of the highlands of Central America and southern Mexico were the first to use tobacco. The date of the earliest Mayan relief carvings depicting tobacco smoking has been deciphered as 432 A. D. (Spinden, 1950). These show theocrats or medicine men blowing smoke toward the sun in what is thought to be a plea to the gods for rain. There is abundant evidence that throughout their history the Mayas smoked and chewed tobacco. Tobacco was also the main ingredient in a liquid concoction that not only was drunk but was also used in enemas (Robicsek, 1978). The Mayas used tobacco extensively for social, religious and medicinal purposes, and it heavily influenced their folklore and art. It still is a central part of the day-to-day life of the Lacadones Indians, the only remaining direct descendants of the Maya.

Tobacco use spread to the Aztecs of Mexico and from there to the aboriginal natives of North America. The Mayas had used reeds and bamboo as cigarette-like devices, but as tobacco smoking went north these materials were no longer available and pipes of clay or stone were fashioned as a means of smoking. Many of these pipes found as far north as Ohio are ornamented with carvings or mouldings of birds and other animals found only in the tropics (Corti, 1931). And like their counterparts to the south, the North American Indians continued to use tobacco for social, religious and medicinal purposes (Dam, 1929). By the time Columbus arrived in the New World, tobacco was grown and used by Indians over most of North America, all of Central America, the northeastern areas of South America and throughout the Antilles.

According to entries in Columbus' diary, when he and his crew first landed in the New World they were approached by natives who brought them gifts of balls of cotton, spears, fruit and the dried leaves of a plant which had a remarkable odor (Corti, 1931). Back aboard ship the explorers ate the fruit, kept the other gifts, but threw away the dried leaves as worthless. Columbus did note that the leaves were presented with considerable ceremony. A few days later while sailing the islands, they encountered a lone native in a canoe. Since they thought he could be valuable as a pilot, they took him aboard. He carried with him some bread, a gourd filled with water and some of the same aromatic dried leaves. Columbus noted in another diary entry that the natives must value these leaves as again they were presented with ritualistic gestures. A few weeks later the explorers were to find out just how much these leaves were valued by the Indians.

In the first week of November, 1492, Columbus landed in Cuba and sent two sailors, Rodrigo de Jerez and Luis de Torres, inland to find the local chief or khan to ask him where the gold was. The natives apparently treated the two sailors as heavenly visitors and after a fortnight ashore they returned to the ships with tales of their hosts' extraordinary behavior. They found no gold but they did witness a spectacle that would soon come to play a significant role in world history. The natives carried rolled-up "firebrands" made of those same dried leaves with which they "perfumed" themselves by "swallowing" the smoke (Dickson, 1954). They would kindle the leaves at the glowing coals of the campfire and "In order to keep the leaves alight they repeatedly held them to their mouths, alternatively blowing on them and inhaling

the smoke, to the complete mystification of the Spaniards" (Corti, 1931, p. 39).

Such use of these leaves turned out not to be an isolated phenomenon, but a frequent, widespread custom of the New World natives. No other single practice or characteristic would capture as much attention of the Spaniards and subsequent explorers as the constant use of this "odoriferous herb." So widespread was the plant and its use that there existed over 600 names for it in as many native languages and dialects (Robicsek, 1978). The Spaniards standardized the name of the plant as tobacco (variously tobaco, tobago, tobak, tabak, etc.), not from an Indian name for the herb, but rather from a Guaraini name for a "Y" shaped tube that was often used to inhale the smoke (Fairholt, 1859). This technique involved inserting the two prongs of the tube into the nostrils, holding the single end over the burning leaves and then drawing in the smoke. The tube was also used to "snort" tobacco, which had been ground into a fine powder, into the nasal passages. (The island of Tobago was so named by Columbus because from a southerly approach it resembled this forked tube.)

Amerigo Vespucci gave the Old World the first published account of tobacco use by the natives; Columbus' writings were not published until much later by his son. Vespucci wrote of natives on Magarita Island off the coast of Venezuela who chewed a green herb to relieve thirst, as the only source of fresh water there was dew collected from plant leaves (Dickson, 1954). Spaniards landing in Paraguay in 1503 also encountered natives who chewed tobacco; not only did they claim that tobacco allayed their hunger, thirst and fatigue, but by spitting tobacco juice into

their enemies' eyes, they gained considerable advantage in hand-to-hand combat (Fairholt, 1859). Thus within a few years of its discovery, tobacco use in all its modern forms had been observed.

The use of tobacco by the New World natives was not an idle or superficial pastime, but was intimately associated with many daily affairs, especially religious ones. Tobacco, along with maize, was considered a gift from the gods, and one that the gods themselves used. The Maya believed that thunder and lightning resulted from the gods striking flint stones together to light their tobacco and that shooting stars were butts being thrown away (Robicsek, 1978). The Indians used tobacco extensively in rituals and sacrifices involving life sustaining enterprises such as hunting, fishing and planting. It was also used as a bridge to the spirit world. An Indian priest approached by a tribe member for advice on a personal matter would throw some tobacco leaves on the fire and take in the smoke through the nose and mouth with a cane until he fell to the ground in a trance-like stupor. After remaining in such a condition, often for hours, the priest would awaken to report vivid dreams and visions and would answer his client's question accordingly (Arber, 1966). Tobacco had another important religious function; along with food and a war club, it was part of the burial accoutrements which were necessary for the arduous journey to sacred hunting grounds.

Tobacco was also used in more casual social interactions, especially if they involved guests or visitors (Lowie, 1920). One gets the impression that in this respect tobacco played a similar role to our contemporary use of alcohol as a "social lubricant." Reckoning time in

terms of pipes-full of tobacco attests to its extensive use in the daily lives of the New World natives (Fairholt, 1859).

The explorers were so taken with this intriguing habit that they soon followed suit and began smoking this "enchanted herb" themselves. Rodrigo de Jerez, one of the two Spaniards to first witness tobacco smoking, became a smoker himself. (When he returned to his home in Spain and his neighbors saw smoke issuing from his mouth and nose, they thought it was the devil's work. They reported him to the Inquisition and he subsequently was imprisoned for seven years.) Those who did take up the habit quickly learned a fundamental lesson about tobacco: Smoking had many pleasant effects, but with a catch---once they had smoked for awhile they were compelled to continue smoking (Breecher, 1972). A craving developed that could be satisfied by smoking, chewing or snuffing tobacco, but it was tobacco and no other substance that would appease the craving. Sailors began to carry not only tobacco but also tobacco seeds and they planted them along their journeys to assure a continuous supply on return trips. Within one hundred years of its discovery, tobacco was well established along trading routes around the world. Natives along these routes also learned of the "hook" in tobacco's charm. A failure of the local crop neared catastrophic proportions. Returning sailors were greeted with cries of "Tobacco, sir, strong tobacco," and "We die sir, if we have no tobacco" (Breecher, 1972, p. 210).

The discovery of the Tasaday people living in the Philippine rain forest in the 1960's illustrates the degree to which tobacco use rapidly spread worldwide. Despite initial claims for the unusually

primitive, cave dwelling, Stone Age life style of the Tasaday, little stir was created in anthropological circles until it was pointed out that they had had no contact with tobacco, which had been widely in use in the Philippines since its introduction there by Magellan and his crew in the very early 1500's. This meant that the Tasaday had not been in touch with other tribes for at least 450 years and teams of scientists were sent to study them. The Tasaday became recognized as among the most primitive, isolated peoples in the world (Nance, 1975).

Dutch herbalists brought in seeds and grew tobacco, N. rustica, in the early 1550's, but they incorrectly classified it as yellow henbane, Hyoscyamus luteus (Dickson, 1954), and the formal introduction of tobacco into Europe did not take place until 1560. Although Francisco Hernandez, physician to Philip II of Spain, had been sent to Mexico to study herbal medicines of the Indians and, along with other plants, had sent samples of tobacco to Philip, noting the natives' claim for its curative powers, the credit for introducing tobacco goes to Jean Nicot, French ambassador to the Portuguese court from 1559 to 1561. Nicot acquired tobacco seeds in Lisbon, grew some of the plants and sent leaves to various members of the French court with instructions on how to use it as a medicine. One important person to whom Nicot sent tobacco was the Queen Mother Catherine de' Medicis. He recommended it as a remedy for headaches, a chronic condition of her two sons, Francis II and Charles IX (Van Proosdij, 1960). It is reported that Nicot informed her that tobacco produced a quiet tranquility and submissiveness which, if used regularly, would make her subjects easier to govern (Larson, Haig & Silvette, 1961). Nicot wrote that he personally observed the

successful use of tobacco to cure a skin ulcer (noli me tangere), to heal a cook's severely cut thumb and to cure several cases of ringworm (Arber, 1966). Nicot spread word of these medicinal virtues and tobacco became known as the "Ambassador's Herb" (Corti, 1931). Nicot's central role in introducing tobacco into Europe is vouched for by the fact that the genus of the plant, Nicotiana, and its highly toxic alkaloid, nicotine, are both named in his honor.

Hernandez's and Nicot's claims for the therapeutic effects of tobacco caught the attention of the Western European medical fraternity. They had been eagerly awaiting news of any products from the New World which they could add to their pharmacopeias. The accounts of tobacco's healing powers quickly became even more exaggerated; the New World natives were apparently not without their European counterparts who believed tobacco had supernatural powers. By 1565, Nicolo Monardes, in his Historia Medicinal, listed a formidable array of diseases which he said yielded to tobacco's sway, among them all manner of pains, stiffness and swellings; it was claimed to "expel matter from the chest wonderfully," to be good for bad breath in children, to kill worms, to treat abscesses and toothaches, to be an antidote for poisons, and to cure and heal wounds (Dickson, 1954, p. 84).

In 1571 Matthias de l'Obel published the herbal Adversaria wherein he called tobacco sana sanctum Indorum---holy healing herb of the Indians. Tobacco achieved its greatest medical fame when the noted Dutch physician Everard, in his 1587 De herba panacea, said tobacco was the long awaited, long sought universal cure for most of the ills flesh is heir to (Corti, 1931).

Tobacco's heyday as a wonder drug was short-lived, however. By the turn of the 17th century its novelty had begun to wear off. Tobacco enjoyed a brief resurgence as a therapeutic agent during early 17th century outbreaks of the plague, when physicians were grasping for straws for a prevention or cure. By the middle of the 17th century tobacco fell into disfavor as a general medicinal agent, although it remained in pharmacopeias into the 20th century.

Events that transpired in England toward the end of the 16th century insured that tobacco would rise again in popularity, but this time in a very different fashion. Tobacco in 16th century Europe had only been used medicinally; after Nicot had completed his term as ambassador and returned to France, he published a dictionary of the French language in which the word for smoking did not appear. The recreational use of tobacco had so far been limited to sailors and seaports. The English, in contrast to the Europeans, adopted tobacco as a pleasurable pastime. Smoking tobacco was introduced by English sea captains returning from the Spanish Main, and the custom spread like wildfire throughout England. (The potato, a cousin of tobacco, was introduced about the same time but took over 100 years to become popular.) Smoking a pipe of tobacco soon became _de rigueur_ in fashion and high society.

Although not the first to smoke tobacco in England, Sir Walter Raleigh is credited with popularizing it there. He also started another time-honored custom; he smoked a bowl of tobacco on his way to the block to have his head chopped off. Some thought his smoking was scandalous but one commentator remarked that "It was well and properly done to settle his spirits" (Brooks, 1952, p. 70).

Tobacco was an enormous success in England. By 1614 there were over 7,000 shops selling tobacco and related paraphernalia (Fairholt, 1859). It joined with two other pastimes to form the "big three" most lucrative business establishments: The ale-house, the tobacco-house and the brothel.

Tobacco did not depend on low price or ready availability for its popularity. For much of the 17th century tobacco from the New World was extravagantly expensive. The purchaser would place coins on one side of the balance scale and this would be matched with tobacco; it was literally worth its weight in silver. This "ruinous cost" led antitobacconists to claim that many a young man's fortunes "ran out his nose"; "A man could hardly buy bread if he smoked a few pipes a day---and who could possibly smoke less than a few pipes?" (Brooks, 1952, p. 76).

What was an economic hardship to tobaccophiles in England was a boon to the settlers in the New World. Tobacco played a significant part in the early survival of the colonies. As a cash crop it was figured to be six to seven times more profitable than corn. Foreshadowing a post World War II phenomenon, tobacco itself was used as currency. Fines for various prohibited acts were paid for with tobacco. And since the early colonialists were predominantly male, in 1619 some entrepeneurs contracted to ship over potential wives from Europe, with the price to aspiring bridegrooms of 120 pounds of tobacco. The venture was so successful that it was repeated the following year (Billings, 1875).

The Thirty Years War (1618-1648) was largely responsible for the spread of tobacco smoking as a recreational pastime from England to Europe and to the Near and Middle East. The impact of war on tobacco's

spread and popularity would be repeated; the Napoleonic Campaigns would reverse the 17th century preference for snuffing tobacco back to smoking, the Crimean War would popularize the cigarette, and the two World Wars would make cigarette smoking one of the commonest characteristics of modern civilization (Corti, 1931; Sobel, 1978).

By the beginning of the 18th century, practically the whole world had surrendered to the use of tobacco. Progress in growing and curing techniques produced a variety of hybrids and various blends which were milder, more aromatic and more agreeable to the palates of the growing legions of smokers. Tobacco was not without its detractors, however. Religious groups were quick to condemn it. In 1575, smoking during services was formally forbidden by the Catholic Church in Mexico. In Europe, all manner of sins and degradations were blamed on the evil weed. Overzealous pamphleteers even ascribed Adam's fall from grace and the expulsion from the Garden of Eden to tobacco (Brooks, 1952). Over the years an incredible array of diseases were said to follow tobacco use; constipation, baldness, arsenic poisoning and various degenerative hereditary diseases are but a small sample (Lehman Brothers, 1955). Now tobacco was said to cause almost as many diseases as, a century before, it was believed to cure. This long history of "crying wolf" would make the acceptance of 20th century scientific evidence linking cigarette smoking with lung cancer and heart disease slow in coming about. Many smokers would think that this was yet another in a long list of attempts on the part of moralists to dissuade them from a harmless if not beneficial pleasure.

Government officials from many countries also placed sanctions against tobacco use, some of them quite brutal. In Russia, smoking was punishable by amputation of the nose (Fairholt, 1859). Another extreme example is that of Sultan Murad IV who decreed in 1668, in Constantinople, the death penality for smoking.

> Whenever the Sultan went on his travels or on a military expedition his halting places were always distinguished by a terrible increase in the number of executions. Even on the battlefield he was fond of suprising men in the act of smoking, when he would punish them by beheading, hanging, quartering or crushing their hands and feet and leaving them helpless between the lines. Nevertheless, in spite of all the horrors of this persecution and the insane cruelties inflicted by the Sultan, whose blood-lust seemed to increase with age, the passion for smoking still persisted. . . . Even the fear of death was of no avail to the passionate devotees of the habit (Corti, 1931, p. 39).

On a less severe note, James I of England earned a small niche in literature with his 1604 A counterblaste to tobacco. He discredited the claims for its sanative powers, comparing them to various false folk remedies, and classed "such a continuall use of taking this unsavorie smoke" as a "branch of the sinne of drunkennesse, which is the root of all sinnes" (Rait, 1900, p. 49). And in true counterblast style, he ends by calling tobacco smoking

> a custome loathsome to the eye, hatefull to the Nose, harmfull to the braine, dangerous to the lungs, and in the blacke stinking fume thereof neerest resembling the horrible Stygian smoke from the pit that is bottomlesse (Rait, 1900, p. 54).

In a more practical move to discourage tobacco use, James increased tariffs 4,000 percent, but this did not stem the tide. The result was a flourishing black market, the use of adulterants to increase bulk and weight, and an undiminished increase in the popularity of tobacco.

Corti (1931) aptly summarizes the situation at the turn of the 18th century:

> Within little more than a century after the introduction of tobacco in Europe, the cultivation of the plant and the habit of smoking, in spite of all obstacles and all attempts at prohibition, had spread over the whole world, and soon began to exercise so irresistible a sway over all men that neither emperors, kings, Popes, doctors nor savants could stand against it (p. 148).

For every detractor found in the literature on tobacco, dozens are there to sing its praises. Most speak glowingly of tobacco as a great creature comfort and of its ability to soothe and clarify the intellect, and, in general, to take away one's cares (Watkins, 1948; Bain, 1953). J. M. Barrie, in his My lady nicotine (1924), went so far as to say that the literary greatness of the Elizabethan period was due to the beginning influence of tobacco, and suggested that the "Elizabethan age might better be named the beginning of the smoking era" (p. 105).

If the Elizabethan age was the beginning of the smoking era, then the Industrial Revolution and the turn of the 20th century would be the beginning of the age of the cigarette. Although Hernandez had written of a cigarette-like device used by Central American natives, the pipe and later the cigar were the methods of smoking by Westerners from the 16th through the 19th centuries. Cigarettes were largely unknown until they were introduced into England by returning soldiers who had picked them up from Turkish troops during the Crimean War of 1853-1856. At first cigarette smoking was disdained, especially in the U. S., but since "they were easy to carry and so well fitted the modern need for a short, quickly begun and quickly ended smoke, the acceptance of the cigarette was inevitable" (Lehman Brothers, 1955, p. 25).

Several factors combined to make cigarette smoking, in the span of a few decades, become the preferred method of an overwhelming majority of tobacco users (Breecher, 1972; Sobel, 1978). The cigarette was indeed convenient to carry and smoke in an increasingly mobile, fast paced world. The advent of flue curing produced a much milder, more easily inhaled smoke. Wrapping paper was improved so that it contributed less harshness to the smoke. The introduction of burley tobacco gave manufacturers a leaf with superior absorbing qualities which allowed for more additives to give the cigarette consistent burning characteristics and its smoke a smoother, better taste. The introduction of the automatic cigarette rolling machine in 1885 by the American tobacco entrepreneur Buck Duke drastically changed the economics of manufacturing and marketing. Instead of the extravagant expense of tobacco for the 17th century Englishman, the "ready-rolled" cigarette's cost put it within reach of most everyone.

The perfection of the modern safety match was another factor in favor of the cigarette. Matches had been available in the 18th and 19th centuries, but they were expensive, unreliable and unsafe. It was often a matter of a lucky strike whether the smoker set fire to their pipe or cigar or the furniture or themselves. These early matches had another hazard; they all contained poisonous substances. Swallowing matchheads was one way people of this period committed suicide.

So the pre-20th century smoker was limited in the number of times per day he could light up. Smoking was an activity that required planning and proper setting. With the introduction of the cigarette and the safety match this all changed. The number of times a smoker could

easily and quickly light up became limited only to tobacco supply and personal preference. The stage was set for the 30, 40 or more cigarettes per day habit.

By 1910, cigarettes in the U. S. were making serious inroads into the traditional cigar, pipe and chewing plug markets, and they began to take on the wrath of these manufacturers as well as of prohibitionist-inspired anticigarette leagues. Cigarettes were said to be drugged with opium and morphine, the paper laced with arsenic and white lead, the tobacco derived from cigar butts picked from gutters and the cigarettes rolled by Chinese lepers. It was claimed that their use would send the smoker to the insane asylum or to suicide (Brooks, 1952). But these campaigns of condemnation were ineffective in dissuading converts to this newest tobacco vogue and in fact may have been another factor in the growth of the cigarette's popularity. Breecher (1972), among others, argues that official disapproval of a drug only serves to enhance its romantic image through the "lure of the forbidden fruit." During the years of these intense anticigarette efforts, roughly 1910 to 1930, cigarette production in the U. S. rose from 4.2 to 80.0 billion (U. S. DHEW, 1973), hardly a testimonial to the success of the cigarette prohibitionists.

The two 20th century World Wars were major factors in the growth of cigarette smoking. Tobacco already had a history of use during war, but in the form of pipes or cigars, it did not lend itself to ready use, especially during combat. One of James I's major criticisms in the Counterblaste was that having to stop and go through all the motions to smoke would interfere with the soldier's effectiveness in

battle. But as the British had discovered during the Crimean War, the convenience of the cigarette overcame this liability. During the years of World War I, 1914 to 1918, per capita consumption in the U. S. in pounds of tobacco rose from .5 to 1.8 (Schumann, 1977). The War Department made cigarettes part of the soldier's rations. One magazine editor wrote that we should be eternally thankful that "We had tobacco in sufficient abundance to those who went 'across' to make it one of the mightiest factors for magnificient morale in the history of armed conflict" (Literary Digest, 1919, 60, p. 20). When General John Pershing was asked what Americans could do to help his boys, he replied "You ask me what we need to win this war. I answer tobacco, as much as bullets" (Sobel, 1978, p. 84).

World War II saw a big jump in cigarette consumption, from 5 to nearly 10 pounds of tobacco per capita during the years 1941 to 1945 (Schumann, 1977). During the war, President Roosevelt declared tobacco an essential crop and tobacco farmers were given the same draft deferments as wheat and corn farmers. When General MacArthur spoke to the employees of an aeronautical firm which had raised $10,000 for the war effort, he urged them to use it all to purchase cigarettes for his troops. The popular media image of the serviceman of this period showed a cigarette dangling recklessly from the corner of the mouth. Cigarette advertisers were quick to pick up on this; one ad showed a pilot, Camel between lips, with the caption "You want steady nerves when you're flying Uncle Sam's bombers across the ocean" (Sobel, 1978, p. 132). By the end of World War II, American produced cigarettes were universally prized, so much so that they were used for currency in

post-war Europe, 1945-1948, until new governments and monetary systems could be established.

All these factors, the improved tobaccos, modern production techniques, the safety match, the impact of the World Wars, plus the countless millions of dollars pumped into national advertising campaigns, resulted in a meteoric rise in cigarette smoking in the 20th century. In 1900, the number of cigarettes smoked per capita in the U. S. was 49. By 1963, the peak year for per capita consumption, the number had grown to 4,345, almost a 100-fold increase (U. S. DHEW, 1973). At this time nearly 60 percent of U. S. males, age 20 to 65, and nearly 40 percent of U. S. females, age 20 to 55, were regular cigarette smokers (Schumann, 1977). These astounding figures coupled with a growing body of scientific evidence implicating cigarette smoking as a major health hazard ushered in a new era of research to answer the question "Why smoke them?"

CHAPTER II

SMOKING

When the New World explorers observed the natives smoking tobacco, they were amazed. Why would anyone set fire to vegetable matter and ingest its smoke? This question is still being asked. One answer given over the centuries is that there is something peculiar or unusual about an individual that would draw him to smoking. This "something" often has been seen as a flaw or weakness of character. This was so when the early Christian missionaries saw the Indian medicine men smoke tobacco, become intoxicated or stupified, and tell of dreams and visions from the spirit world. The missionaries thought that the devil was at work and tobacco was associated with idolatry and demon worship. James I echoed this theme in the Counterblaste when he characterized tobacco smokers as those so decadent as to imitate the "Barbarous and beastly maner of the wilde, godlesse and slavish Indians, especially in so vile and stinking a custome" (Rait, 1900, p. 36). In his order to raise taxes on tobacco, he remarked that it was a "Drugge . . . excessively taken by a nomber of ryotous and disordered Persons of meane and base Condition" (Arber, 1966, p. 113).

There remained over the centuries a small but vocal antitobacco faction, but as tobacco's popularity grew and as the number of smokers, chewers and snuffers increased worldwide, the stigma associated with its use diminished. During the latter part of the 19th century, however, the emergence of the cigarette ushered in a new era of antitobacconist

activity. Although a few European artists and literati had smoked cigarettes in the early 1800's, probably more as an affectation than anything else, the cigarette was primarily the smoke of the poor and criminal elements of society (Sobel, 1978). Cigarettes of the time were usually made from scraps, leavings and inferior tobacco. In plays and novels of this period, cigarette smoking was often a device to identify the villians or heavies. Once again tobacco use, now in the form of cigarette smoking, was treated as the product of a deviant character.

The post-Crimean war era saw the acceptance and popularity of the cigarette with the more "proper" elements of society. The Turkish and Russian cigarettes, unlike their domestic counterparts, were carefully made with special paper, had cardboard mouthpieces, were packed in colorful boxes and gave off exotic aromas. For the returning soldiers, cigarette smoking became the badge of a gallant and courageous foreign war veteran.

Even though the cigarette's image had improved in England and Europe by the turn of the 20th century, this was not the case in the U. S. Lucy Gaston, the antitobacco league's answer to prohibition's Carry Nation, carried out a national campaign and was responsible for anti-cigarette legislation in many states. She said that as a teacher she noticed that most of her worst students were also cigarette smokers. Several studies in the early 1900's confirmed her claims by finding lower measures of scholarship for smokers as compared to nonsmokers (e. g., Holt, 1921; Powers, 1921). But what the Crimean War had done for cigarettes in England and Europe, World Wars I and II did in the

U. S. War heroes, matinee idols, famous sports figures and even physicians were smoking cigarettes and recommending them to the public.

The mounting scientific evidence in the 1950's and 1960's implicating cigarette smoking as a serious health hazard cast a new pall over the habit and provided additional incentive to find out why people smoked. Again it was thought that it was something about the individual that inclined them to take up smoking, but instead of being seen in moralistic terms, this "something" was now couched in the language of personality theory. Thousands of people were given every type of personality test known to psychology and the scores for cigarette smokers compared to those of nonsmokers. The search for the cigarette smoker personality was on. Hundreds of studies were published but initial results were for the most part inconclusive; there were studies that found no significant differences between scores for smokers and nonsmokers and those that did find differences were often contradicted by other studies finding opposite results. As the methods of research and analysis improved and a sufficient number of valid studies became available, a few personality test variables were found to be statistically associated with cigarette smoking.

In a 1970 review of published studies, Smith concluded that there were four variables which had recieved sufficient support to be considered reliably associated with cigarette smoking. That is, if the appropriate personality tests were given to a large number of smokers and nonsmokers, their scores as a group would slightly differ from each other. There would be, however, considerable overlap between smokers and nonsmokers on the personality test scores.

The variable with the strongest, most consistent association with cigarette smoking is extraversion. Smith (1970) counted 22 out of 25 studies finding a statistically significant relationship between extraversion and smoking. Subsequent studies have continued to support this association between being a cigarette smoker and scoring higher on measures of extraversion (Cherry & Kiernan, 1976; Coan, 1973; Reynolds & Nichols, 1976).

Extraversion, as a measured personality variable, is frequently interpreted in terms of the work of H. J. Eysenck, according to whom the extraversion-introversion dimension is comprised of four major traits: Sociability, liveliness, impulsiveness and jocularity. The extravert typically craves excitement, is willing to take risks, is sociable, likes parties, is carefree, easygoing, etc. Eysenck (1973) has incorporated the extravert-smoker association into his biological approach to personality. In this scheme, extraverts have a chronically underactive cerebral cortex and so seek to augment cortical activity via some external source of stimulation. Introverts, on the other hand, have a high level of cortical activity and do not need external sources of stimulation. Extraverts who try cigarettes would find a source of stimulation from the neocortical activation demonstrated in the EEG properties of smoking tobacco. They would then be more likely to continue smoking than the introvert who might find the additional stimulation excessive.

The smoking-extraversion association can be approached from a more socially oriented perspective. To the extent that people who score high on extraversion measures are more active socially, then the higher

the probability they would encounter people who smoke, as compared to introverts who are more to themselves and get less exposure to other people. And since one of the best predictors of who will take up smoking is the number of peer-friends who smoke, a given population of extraverts would more likely be influenced toward smoking than would an equal sized population of introverts. People who spend a lot of time in social interactions might also be more likely to adopt some practice which gives them "something to do with their hands" or which has displacement activity properties; and cigarette smoking does this nicely.

A second personality variable which is associated with cigarette smoking is neuroticism, a label subsuming such dimensions as nervousness, anxiety, psychosomatic disorders, emotionality and other such terms relating to the broad category of mental health or psychological adjustment (Matarazzo & Saslow, 1960). By the time of Smith's (1970) review, just over half of the 50 studies tallied showed a positive relationship between neuroticism scores and cigarette smoking. In that same year, Jacobs, Knapp, Rosenthal and Haskell (1970) published results of a study showing that heavy cigarette smokers as a group tended to show greater disturbances in their personal and emotional lives than did former, light or nonsmokers.

There may be a gender difference for the neuroticism-smoking association; Eysenck (1973) found no relationship between smoking and neuroticism in a large sample of adult males, and Clausen (1968) found a positive relationship for females but not for males. The sex difference could stem from a greater reluctance on the part of males to give self-reports that could be interpreted as neurotic.

The positive relationship between cigarette smoking and neuroticism has continued to show up in a number of studies using a variety of measures. These include inventories of life crises (Lindenthal, Myers & Pepper, 1972); habits of nervous tension (Thomas, 1973); and measures of overall psychological adjustment (Reynolds & Nichols, 1976). In a longitudinal study conducted in Great Britain, Cherry and Kiernan (1976) found that the personality scores at 16 years of age for 2,753 people were related at follow-up with cigarette smoking in their young adult years. Those scoring high on neuroticism were more likely to be smokers with deep inhalers having the highest scores.

Several interpretations present themselves for the observed, although small relationship between neuroticism and smoking. Throughout its history tobacco has been praised for its ability to calm the nerves, soothe the spirit and take away one's cares, effects which in modern psychopharmacological terms would be typical of a mild sedative or tranquilizer. For some, then, smoking might be a case of self-medication, and these people would have personality test scores similar to groups of people taking sedative or tranquilizing drugs. The possibility that nicotine could be responsible for the calming effect of cigarette smoking will be discussed later in this chapter.

Russell (1971) has proposed an additional interpretation; an addicted or dependent smoker might experience frequent acute withdrawal symptoms such as irritability or restlessness, and this could result in a greater self-perceived and subsequently reported neuroticism. Also, the steadily mounting evidence linking cigarette smoking with several life-threatening diseases could make those smokers who are unwilling

or unable to quit come to see themselves as and to give self-reports of behaving irrationally.

The third and fourth personality variables considered by Smith (1970) to be reliably associated with cigarette smoking are antisocial tendencies and external locus of control. The former is related to rebelliousness, belligerence, defiance, misconduct, disagreeableness and the like, and its association with smoking has been corroborated in more recent studies (Lebovits & Ostfeld, 1971; Nesbitt, 1972; Reynolds & Nichols, 1976). The latter variable relates to the degree that a person perceives their life as being under their own control and direction (internal locus of control) vs having their life determined by luck, fate or, in general, factors beyond their own control (external locus of control). Since Smith's review, three additional studies have supported the association between cigarette smoking and external locus of control (Berman, 1973; Hjelle & Clauser, 1970; Schwebel & Kaemmerer, 1977).

Cigarette smoking's association with antisocial tendencies and external locus of control has good face validity. In the case of antisocial tendencies, a majority of smokers take up the habit during adolescence, for many a time of rebelliousness against authorities, established values, codes of conduct, etc. Since cigarette smoking among minors faces social and legal sanctions, a cigarette dangling precariously from the corner of the mouth or a cigarette pack rolled up conspicuously in the sleeve of a T-shirt can be a badge of a rebel, a flaunting of what the straight adult world considers proper behavior. On the other hand, the "prosocial" adolescent is less likely to indulge

in behavior that is frowned on by straight adults, among these cigarette smoking.

The relationship between cigarette smoking and external locus of control may have two sources. In the first place, cigarette smoking may be more likely taken up by the sort of individual who generally seeks stimulation, pleasure, comfort, etc., from external sources. For example, cigarette smoking has long been associated with higher levels of intake of other drugs, especially coffee, alcohol and marijuana (U. S. DHEW, 1979). From this perspective, the smoking-external locus of control relationship may overlap with the smoking-extraversion association. And in the second place, cigarette smoking is notoriously difficult to quit. In the face of growing evidence that it is a serious health threat, those who try to quit and fail surely come to see themselves at the mercy of a situation beyond their control.

A few other personality variables have occasionally been found to correlate with cigarette smoking, such as higher measures of "orality," measures of "Type A" personality (time-conscious, competitive, work oriented, etc.), and lower measures of "deference" and "order," but these have not been reported either often or consistently enough to be judged firmly established (U. S. DHEW, 1979).

These four personality variables are statistically significant in their association with smoking status but this should be tempered by the fact that the variable with the strongest association---extraversion---accounts for a maximum of three to five percent of the variation (U. S. DHEW, 1979), i. e., 95 to 97 percent of the variation between being a smoker or nonsmoker can not be accounted for on the basis of

extraversion scores. In the final analysis, the search for the cigarette smoker personality profile has been unsuccessful. No personality variable or group of variables has been found that will clearly identify smoker or nonsmoker. As Russell (1980) points out, although the use of many other drugs is often associated with social or psychological problems, this is not the case for cigarettes. This should not be suprising since, at the height of the personality test research, 69 and 42 percent of U. S. adult males and females, respectively, were either present or former smokers (U. S. DHEW, 1973). With this large a segment of the population involved, considerable overlap would be expected in such general measures as "personality" (Coan, 1973).

The history of tobacco use in all its forms is consistent with this outcome of the search for the cigarette smoker personality. Tobacco use has always been characterized by its adoption by so many people of diverse political, religious, cultural and social conditions. In the mid-19th century, Fairholt observed that "Three hundred years ago a few American savages only consumed tobacco and now it is consumed by all mankind, being the only commodity common to the comsumption of all races and all social conditions" (1859, p. 11). At a time when tobacco was being used by the wealthiest and most powerful people in Europe, Charles Darwin, during his exploration of South America on the H. M. S. Beagle, was writing of the eagerness for tobacco on the part of some of the poorest and most primitive people on earth. Tobacco use, especially in the form of cigarette smoking, has become so widespread and accepted that it is one of the distinguishing features of most modern civilizations and is popularly regarded as part of the normal standard

of living almost everywhere on the globe (Brooks, 1952). Since this is the case, perhaps it is not something about the individual but rather something about the product itself that will explain why "The habit has conquered the barriers of dissimilar culture patterns, antagonistic nationalities, and powerful social prejudices" (Lehman Brothers, 1955, p. 5).

Getting smoke into the mouth, nose, throat and especially the lungs is aversive and normally something to be avoided. For someone close to a campfire or pile of burning leaves, a sudden shift in wind direction will bring home this point. Under more extreme conditions it can be fatal; most deaths from fires result from smoke inhalation rather than from the flames per se. How odd it is then that some people will purposely inhale smoke, and at that many times per day, day in and day out without fail, often for most of their lives. Can we help but be intrigued at this remarkable behavior? And when those who "smoke" are our parents, teachers, friends, heroes and heroines, is it any wonder that that most human characteristic, imitation, comes into play and many of us become "smokers" ourselves? Research results echo this message: If our parents, siblings and friends smoke, we are much more likely to become smokers (e. g., Horn, Courts, Taylor & Solomon, 1959; Gorsuch & Butler, 1976; Reeder, 1977; Horn, 1979). With parents who both smoke, sons are twice and daughters three times as likely to become smokers as those of nonsmoking parents (Evans, Henderson, Hill & Raines, 1979). And the single best predictor of smoking onset is the number of "best friends" who smoke (Evans, et al., 1979; McCaul, Glasgow, Freeborn & Rump, 1982).

This general tendency toward curiosity, imitation and conformity is augmented by the fact that cigarette smoking can have symbolic meaning. One can make a statement about oneself by smoking. As just mentioned, cigarette smoking can be part of an antisocial, rebellious image. Cigarette smoking can also have a romantic, sexy image, such as with movie stars like Humphrey Bogart and Marlene Dietriech, who were practically synonymous with smoking. Cigarette advertisers have played heavily on this sex appeal theme with slogans like "so round, so firm, so fully packed" and with macho images like "come to Marlboro country" and "Camel---where a man belongs."

And last but certainly not least, cigarette smoking can be a sign of adulthood (e. g., Towns, 1912; MacKenzie, 1957). Many societies have rites of passage, often demanding endurance of pain and hardship as a symbolic leaving of childhood and adolescence behind. The successful initiate gets a badge, such as body markings or distinctive clothing or decorations which clearly mark the individual as an adult. This ritualization of a critical period in one's life has been diluted or lost in much of modern Western culture. Cigarette smoking makes a nice substitute; it is not for children or weaklings since the first few cigarettes can be an ordeal, producing coughing, headaches, dizziness, nausea and vomiting (e. g., Head, 1939). Being able to inhale cigarette smoke in public without these effects is a sign of one's toughness and sophistication, a sign that the individual has now entered the adult world (Russell, 1971).

All these factors, the inherent fascination with such an unusual behavior as inhaling smoke, the tendency to copy the behavior of role

models such as parents, conforming to group norms to win peer acceptance and approval, and the symbolic value of smoking as a emblem of rebellion, sex appeal and adulthood, make cigarette smoking a powerful attraction which has ensured a steady supply of new recruits into the ranks of cigarette smokers.

With evidence that has been accumulating over the years that smoking is a serious health threat, one might reasonably expect, however, that the number of new cigarette smokers would have dropped precipitously. This has not been the case. There has been a small decrease in the number of young males taking up the habit but this has been offset by an increase in the number of new female smokers. And the age of smoking onset has been declining (Evans, et al., 1979). Are these young people purposefully courting disease and early death? Apparently not. Apparently the majority are taking up smoking or continuing to smoke with the mistaken belief that, since it takes 20, 30 or more years for the ill effects of smoking to occur, they will quit smoking in "a year or two," and thereby avoid any health hazards (Pomerleau, 1979; Kozlowski, 1979). Or when asked why they are smoking cigarettes when they are aware of the health risks involved, they typically reply "I only smoke occasionally," "a pack of cigarettes lasts me a week," or "I only smoke at parties."

But this is the way all smokers begin, by starting out slowly and becomming full-fledged smokers over the years. The neophyte's thinking that he or she will smoke only occasionally and then quit in a year or two is a delusion. The fact is that most people who smoke as few as two or three casual cigarettes go on to be regular, lifetime smokers.

A survey in England placed the figure at over 80 percent (Russell, 1980). And of those who do become regular smokers, even though three out of four report that they would like to quit and have tried to quit, only one in four will do so before the age of 65 (Russell, 1980). This means that out of a hypothetical population of 100 people who smoke as few as two or three cigarettes, at least 80 will go on to become regular smokers. And although 60 of these will attempt to quit, only 20 will do so by age 65. Many of those who do manage to quit will have done so too late, after having a heart attack or being diagnosed as having lung cancer or emphysema. As Russell (1980) points out, Jean Cocteau's dictum referring to opium smoking---"he who has smoked will smoke"---is equally applicable to cigarette smoking.

Why is cigarette smoking, or more generally, tobacco use, such a "mysteriously gratifying habit," one which continues to draw people into a practice and hold them there in the face of life threatening consequences? Accounts from tobacco smokers over the centuries and results from psychological studies done in the 20th century show a consistent, repetitive pattern of benefits or payoffs that smokers derive from smoking. This pattern can be roughly divided into five factors or categories: 1) Smoking has a soothing, calming effect; 2) it is an aid to concentration; 3) it can relieve hunger, thirst and fatigue; 4) it is a pleasurable activity; and 5) it can satisfy a need or craving that develops after continued smoking. Because these effects overlap and at times are concurrent, this division is in some respects an artificial one; it is made here more for convenience than as a claim that there are five separate and distinct payoffs from

smoking. (These effects follow all forms of tobacco use and later in this chapter a case will be made for nicotine as the responsible agent and for inhaling cigarette smoke as being the quickest, most efficient method yet found for getting nicotine into the bloodstream and into the brain.)

Numerous references are made in the general literature on tobacco to its ability to calm and sedate. The following examples are typical. In writing on the history of tobacco, Fairholt (1859, p. 8) refers to smoking as a "harmless sedative," a "peaceful cloud," and a "quiet and consoling habit." This is a quality that is often attributed to smoking in Bain's Tobacco in song and story (1953): "We can puff away our cares with tobacco" (p. 26); "When you irritate another, you 'put out his pipe'" (p. 27); Carlyle called it "sedative, gently soothing tobacco smoke" (p. 28); and T. H. Huxley referred to tobacco as a "sweetener and equalizer of the temper" (p. 90). This theme of "taking away one's cares" appears repeatedly.

In his monograph on tobacco's history, Brooks (1952) notes the many reports over the centuries of the "solace" to be found in tobacco. This sedating effect has not escaped the notice of nonsmokers as well: An anonymous female writer (1917) said she concealed her loathing for cigar smoke because "Your true smoker is never half so easy to deal with as when he is nicely lighted and comfortably smouldering" (p. 254). Another writer of the same period noted tobacco's ability to "blunt the edge of hardship and worry" (Towns, 1912, p. 766). Recalling the native American Indians' practice of passing the "peace pipe" whenever they gathered for a conference, Spinden (1950) called tobacco the "courtesy weed of diplomacy" (p. xiv).

This calming, sedating effect is without a doubt part of the reason why tobacco and especially cigarettes have been so popular among fighting men during times of war. Their value to servicemen has been recognized by all. Brooks (1952) notes that during the American Civil War antitobacco activity all but stopped. This happened again during World War I, at the height of Lucy Gaston's anticigarette campaign (Sobel, 1978). In both cases, tobacco opponents were afraid of being seen as subversive or unpatriotic in trying to deny the armed forces such a valuable commodity. "In every war in every land, tobacco has been enshrined as a comfort to the soldier" (Lehman Brothers, 1955, p. 22).

In the years immediately after World War I cigarette smoking became so prevalent as to be considered normal. Many physicians began to endorse cigarette smoking as an acceptable way to alleviate tension. The popular phrase of the time was that they "steadied the nerves" (Sobel, 1978). One group of physicians (Gies, Kahn & Limerick, 1921) wrote in the New York Medical Journal that "tobacco gives rise to certain pleasurable sensations; that it allays restlessness, tranquilizes emotional inquietude and fosters repose" (p. 810). This view was expressed by medical authorities in England and Europe as well. Sir Humphrey Rolleston (1926) wrote that tobacco was no longer in the pharmacopeia, "but it certainly has its uses, especially as a sedative, as every smoker knows; it may act as a charm for the fidgets" (p. 963). In Germany, Lewin (1931), whom many consider the father of psychopharmacology, noted that tobacco smoking adjusts the mind and disposition to a kind of serenity or quietude.

During this period, the psychologist Ruckmick (1924) gave a detailed account of the experience of learning to smoke, in this case a pipe. The first attempt was followed by a period of "self-sustained relaxation,---a sort of vegetative existence, with freedom from strain and effort, an attitude of composure" (pp. 404-405). Twelve hours later he again smoked and once more it was followed by a "general feeling of relaxation," of "lassitude and well-being" and "relaxed voluntary muscles" (p. 405). After many trials the noxious effects such as throat irritation and "biting" of the tongue were gone and "all that persisted was the feeling of bodily relaxation and mental composure" (p. 406). He summarized:

> When the human male organism was given a dosage of tobacco in smoked form for the first time in life, relaxation developed at once. At first it took the form of dizziness and slight incapacity for adequate motor coordination; later it became a reduced motor tonicity. At no time was the mind ideationally confused; on the contrary it appeared extraordinarily clear. The mood was then calm and abandoned (p. 406).

Tobacco's sedative effect has shown up in more contemporary research. When Sabler, Walsh and Taylor (1963) asked a large number of secondary school children why they smoked, "tension release" closely followed "conformity" as the most frequent response. McKennell (1970) gave a questionnaire to over 1,000 adolescent and adult cigarette smokers ask-them under what conditions they smoked the most. Factor analysis revealed the strongest factor was "nervous irritation smoking", which was composed of items such as "I smoke most when I am irritable," "anxious," "worried," "nervous," etc. Warburton and Wesnes (1978) found that, especially for smokers who scored high on pencil-and-paper measures of neuroticism, smokers wanted to achieve tranquilizing or sedative effects and to reduce situational anxiety by smoking.

Other studies have continued to find the sedating, tranquilizing effects of smoking. Conway, et al. (1981) and Lindenthal, Myers and Pepper (1972) found increases in smoking frequency related to perceived job stress and life crises. Smokers who have high levels of job stress are also less likely to quit smoking (Caplan, Cobb & French, 1975); this is also true for smokers who have high scores on measures of anxiety and neuroticism (Cherry & Kiernan, 1976; Kozlowski, 1979). And in smokers trying to quit, relapse typically occurs in situations described as stressful; 71 percent of relapses occur during "negative affect", with anxiety being the most frequent type (Shiffman, 1982). The tranquilizing effect of smoking is implicitly recognized in a textbook chapter on research methods; Cook and Campbell (1976) suggest counting the number of cigarette butts in ashtrays as an unobtrusive index of the tension level at a business meeting.

Some laboratory studies have corroborated the voluntary muscle relaxant effect reported by Rucmick (1924), and this could be partly responsible for tobacco's sedating effect. While using a new machine developed to measure the degree of spasticity in his patients, Webster (1964) recorded a dramatic but transient decrease in muscle spasms following cigarette smoking. And both Clark and Rand (1968) and Domino and von Baumgarten (1969) found reductions in knee jerk reflex amplitude of between 45 and 65 percent following cigarette smoking.

Another often mentioned effect of smoking is tobacco's ability to enhance concentration, although this could well be a side effect of the more general feeling of relaxation which so often accompanies

smoking. Dam (1929) reports of the traditional Indian saying that "Good thoughts come with smoking." Many commentators extol tobacco's capacity to increase sustained intellectual activity, especially so when it involves writing. Recall J. M. Barrie's assertion that, since tobacco so "clears the brain and soothes the temper" (1924, p. 9), it was responsible for the literary greatness of the Elizabethan Age, (although it appears Shakespeare neither used tobacco nor mentioned it in his writings). And from Bain (1953), several writers, among them Carlyle, speak of "gently clarifying tobacco smoke" (p. 28). Fairholt (1859) considered Pope Urban VIII's decree of excommunication for smoking in church unjust since smoking "harmlessly revives attention to a wearisome sermon" (p. 78); he goes on to say that smoking, even more than angling, is the contemplative man's recreation. In a work titled Tobacco and mental efficiency, O'Shea (1923) remarked that when mental fatigue sets in, "a few minutes with a pipe has apparently so relieved me that I have been able to read or write without any sense of fatigue for a long time" (p. 42). Gies, et al. (1921) state that

> As used by those habituated to the plant, the effect of tobacco is chiefly confined to the vascular and psychic mechanism. The immediate effect is a moderate but temporary rise in blood pressure and an increase in the power of concentration (p. 810).

Ruckmick reported that with many repetitions of pipe smoking,

> Ideationally I felt much more "clear-headed," illusory as that may have been, during the operation of smoking. There seemed to be time to consider problems coolly and carefully, without hurry or confusion. The ideas that came seemed for the most part to win approval, both then and later (p. 406).

Writing in the Lancet, Beck (1953) stated that "I used to want to smoke most of all when I was attempting a difficult piece of writing" (p. 394).

A similar theme is echoed by MacKenzie (1957) who claimed that his ability to write for ten hours straight was due to pipe after pipe of tobacco; "I know with absolute certainty that the harder I work the more I need to smoke, because tobacco is the handmaid of literature" (p. 343).

Laboratory studies have confirmed this positive effect of tobacco smoking on concentration. Hull (1924) observed an increase in the speed of mental arithmetic in his subjects after smoking a pipe of tobacco. In a series of studies, Fisher (1927) reported that smoking increased efficiency in work calling for sustained attention over time requiring accuracy and promptness of discriminatory responses. Several recent laboratory studies (Frankenhaeuser, Myrsten & Post, 1970; Frankenhaeuser, Myrsten, Post & Johansson, 1971; Heimstra, Bancroft & DeKock, 1967) have found that smoking, in these cases cigarettes, can enhance mental endurance and offset the impairment of mental performance that typically occurs under sustained monotonous conditions.

Tobacco also has a long standing reputation for relieving hunger, thirst and fatigue. The first published accounts by Amerigo Vespucci in 1499 of tobacco use in the New World, as previously noted, told of how natives chewed tobacco to relieve their thirst. In another early treatise in 1526, Oviedo reported that African slaves brought to the new territories had acquired the habit of smoking tobacco: "They grow the plant on their owners' farms and inhale its smoke, for they say that if they take tobacco when their day's work is over, they forget their fatigue" (Corti, 1931, p. 42). John Sparke, writing in 1565 about the exploration of the Florida Peninsula, observed that:

> The Floridians when they travel have a kinde of herbe dryed, which with a cane, and an earthen cup in the end, with fire and the dryed herbs put together, do sucke thorow the cane the smoke thereof, which smoke satisfieth their hunger, and therewith they live foure or five dayes without meat or drinke, and this all the Frenchmen used for this purpose (Arber, 1966, p. 85).

The previously mentioned Francisco Hernandez, who went to Mexico on the part of Philip II of Spain to search for new medicines, reported that the Indians filled hollow canes with tobacco, "which being lighted on the side where the filling is, emit smoke through the other end, and which, swallowed through the mouth, gently soothes the senses of all labor and fatigue" (Brooks, 1952, p. 232). In 1571, De l'Obel gave the first unambiguous account of tobacco smoke being inhaled (rather than being "swallowed") when he described smoking by sailors returning from the New World:

> They carry small tubes made of palm leaves or straw, in the end of which they have placed rolled up pieces or crumpled leaves of this plant; this they light with fire, and, opening their mouths wide and breathing in, they suck in as much smoke as they can; in this way they say that their hunger and thirst are allayed, their strength is restored and their spirits refreshed (Dickson, 1954, p. 44).

It is no wonder that, with the ability to relieve both anxiety and fatigue, tobacco has been "enshrined forever as the weary soldier's relief" (Lehman Brothers, 1955, p. 30).

In the 20th century, cigarette manufacturers turned the hunger allaying property of tobacco into an advertising campaign aimed at recruiting more female smokers. "Reach for a Lucky instead of a sweet" was a successful slogan of the era; physicians gave testimonials presenting cigarette smoking as a way to control the appetite and to keep a slim, attractive figure (Sobel, 1978).

In addition to tobacco's ability to tranquilize and sedate, to improve concentration and to allay hunger, thirst and fatigue, tobacco use can be a pleasurable activity. Some have claimed that the chief reason why men and women smoke is the "simple and frank one of pleasure" (Watkins, 1948, p. xii). Damon (1973) surveyed seven preliterate societies and found that, if not forbidden by religion, all adults smoked as much tobacco as they could, the single reason being for pleasure and personal gratification. When tobacco smoking spread to Turkey, it quickly joined coffee, opium and wine to make up what Turkish poets called the "four cushions on the divan of delight" (Corti, 1931). Tobacco's pleasurable effect has been likened to that of other drugs, especially alcohol. Early accounts told of Indians smoking great amounts of tobacco to the point of intoxication. In 1522, Aztec Indians educated by Spanish priests wrote a compendium of native herbs and plants used as medicines; tobacco was called picietl and was referred to as "the herb which has the power of inebriating" (Dickson, 1954, p. 32). In 1565, Konrad Gesner described his first experience with tobacco: "That leaf . . . when I only tasted it, chewing and not swallowing a small piece, had a remarkable effect on me, so that I seemed very drunk, and because of the dizziness it caused, to be floating down a river on a ship" (Dickson, 1954, p. 44). Ruckmick (1924) told of his first experiences with smoking a pipe as being like the effects of alcohol but without disturbance to the intellectual function. Bain (1953) compared tobacco to opium in that they both led "to a state of febrile exaltation, a perennial source of new pleasures" (p. 75).

The pleasure of tobacco smoking seems to be highlighted in situations where other creature comforts are scarce or missing. Fairholt (1859) called it a simple pleasure of the poor, an "anodyne of poverty." Darwin (1860/1962) remarked on the abject poverty and miserable conditions of several South American groups who had tobacco as their sole luxury, and noted that "their eagerness for tobacco was something quite extraordinary" (p. 279). Beck (1953), in recounting his own history of smoking, reports that he had resolved to give up smoking during World War II but found himself in a situation where he had to do without many things he wanted, and so decided to continue smoking for the time being because it was one of the only sources of pleasure; smoking was better than nothing.

After Beck (1953) had smoked 15 to 20 cigarettes a day for a period of several months, he discovered what most users of the plant sooner or later find---he began to feel a craving or hunger for a smoke, which became more intense during times of deprivation or stress. Cigarettes were no longer a luxury but were now essential to his well-being, and he likened the situation to "enslavement." Now part of the pleasure for him of smoking derived from an appeasement of this craving. (Both Henry Ford and Thomas Edison called cigarettes the little white slaver ---Sobel, 1978).

This development of a hunger or a craving is not confined to cigarettes or to the 20th century. In 1527, Bishop Bartolome de las Casas wrote of Spaniards in Cuba who had taken up the natives' practice of smoking rolled-up, dried tobacco leaves and who, "when reproached for such a disgusting habit, replied that they found it impossible to give

it up" (Corti, 1931, p. 43). He also made an observation that would be repeated over the centuries: "I cannot understand what enjoyment or advantage they derive from it" (p. 43).

So Russell's (1974) statement that for anyone who smokes more than two or three cigarettes, there is a "virtual inevitability of . . . escalation to regular, dependent smoking" (p. 255) is not that farfetched. The initial noxious side effects quickly abate, leaving a number of positive benefits: The smoker can achieve a calming or tranquilizing effect, can enhance concentration for demanding intellectual or vigilance activities, can allay hunger, thirst and fatigue, can enjoy smoking as a simple pleasure, and, after smoking for awhile, can relieve intense cravings or hunger that develop for tobacco. Very few, if any other substances dependably and consistently offer such a wide range of benefits or payoffs and that is why tobacco has held sway over such a large number of people for such a long time. The question arises, What is it about this plant which gives it these very special qualities?

Nicotine. To many researchers the answer is that tobacco contains as its major alkaloid, nicotine, a powerful, highly toxic pharmacological agent that distinguishes tobacco chemically from its many relatives in the Solanaceae or nightshade family, such as belladonna, eggplant, henbane, pepper, potato and tomato. The hypothesis is that people smoke tobacco to get the effects of nicotine in the same way that people smoke opium to get the effects of its major alkaloid, morphine, or smoke marijuana to get the effect of its major alkaloid, tetrahydrocannabinol. Considerable research has been conducted on the

pharmacology of nicotine and how its actions relate to the well documented charm tobacco has for so many people.

I have elsewhere reviewed the pharmacology of nicotine (Fisher, 1979) and will here give a summary of its many effects. Nicotine was was first isolated from tobacco in 1828 and, since it took only a few drops to quickly kill laboratory animals, it was appropriately dubbed the "poisonous principle" (Corti, 1931). Nicotine is a clear, odorless liquid which, when exposed to air, turns brown and takes on the characteristic tobacco odor. It constitutes more than 95 percent of all the alkaloids found in the plant (Kuhn, 1965). The amount of nicotine in tobacco leaves can vary from around one percent to as much as 10 or more percent (Aviado, 1971).

Nicotine is water soluble and for this reason can be absorbed into the bloodstream through the skin, the oral and nasal membranes, the stomach and intestines, and through the bronchial alveoli. This latter route is by far the most effective method; with inhalation of tobacco smoke, as much as 99 percent of the available nicotine is rapidly absorbed (U. S. DHEW, 1979). Armitage, Dollery, George, Houseman, Lewis and Turner (1975) had smokers inhale smoke from cigarettes with C^{14}-labelled nicotine added, and blood samples were taken after each inhalation. Arterial blood nicotine level rose steeply, peaked at around 10 minutes---roughly the time to smoke the cigarette---and then dropped off rapidly. At 20 minutes the blood level curve flattened and the decrease became more gradual. The shape of the graph was very similar to that of people given intravenous injections of nicotine. Nicotine reaches the brain faster, however, following inhalation than following intravenous injection, seven vs 15 seconds, respectively.

With pipe or cigar smoke drawn into the oral cavity but not inhaled, there is a wide range of absorptions reported, from 2.5 percent (Larson, Haig & Silvette, 1961) to 50 percent (Volle & Koelle, 1975). Accurate data are not available for other methods of tobacco use such as snuffing or chewing.

Once nicotine is absorbed into the bloodstream it is widely distributed throughout the body. Animal studies using C^{14}-labelled nicotine show initial concentrations in the brain, liver and kidneys (Schmiterlow, Hansson, Andersson, Applegren & Hoffman, 1967). Concentrations have also been found in the adrenal medulla and in the sympathetic ganglia of the autonomic nervous system (Van Lancker, 1977). Thirty minutes after nicotine administration, radioactive levels in the brain are practically gone, still high in the liver and have begun to show up in the stomach.

Nicotine, once in the system has a half-life of around 30 minutes and is rapidly metabolized to its major metabolite, cotinine, principally by the liver (Turner, 1971), although the kidneys and lungs play a small part (Van Lancker, 1977). The metabolites and remaining nicotine are excreted by the kidneys, the rate being faster when the urine is acidic (Volle & Koelle, 1975). Nicotine elimination is complete in 15 hours following smoking a single cigarette (Larson, et al., 1961).

Nicotine is one of the most toxic of all naturally occurring substances; its lethal potency is comparable to cyanide (Volle & Koelle, 1975). The acutely lethal dose of nicotine for an average human adult

is between 40 and 60 milligrams (Van Proosdij, 1960), compared to 300 milligrams for hydrocyanic acid (Rieders, 1971). Nicotine, in the form of a 40 percent solution of nicotine sulphate, has long been used as an insecticide (Aviado, 1971), and at one time was used as a paralytic to control dangerous or unmanageable animals (Feurt, Jenkins, Hayes & Crockford, 1958). Nicotine has also been tested as a shark repellent but was unacceptable because it was more incapacitating to the swimmer than to the shark (Science '81, 1981).

In acute nicotine overdose, symptoms show up rapidly (Volle & Koelle, 1975). First to appear are nausea, salivation, abdominal pain, vomitting, diarrhea, cold sweat, dizziness, disturbed hearing and vision, mental confusion and marked weakness. As the overdose approaches the fatal level, faintness and prostration ensue and a blood pressure drop is accompanied by a weak, rapid, irregular pulse. Dyspnea occurs followed by collapse and convulsions. Death can result in only a few minutes by respiratory muscle paralysis. The initial symptoms can be seen in laboratory animals given injections of nicotine, in agricultural workers who get nicotine sulphate on their skin, and are all too familiar to many tobacco use initiates. Deaths have been reported in human infants who chewed and swallowed as few as two cigarette butts (Larson, et al., 1961). In the 16th century, when tobacco was widely used as a medicinal agent in Europe, numerous deaths from overdoses were reported (Larson & Silvette, 1965). The action of nicotine was most likely responsible for the popularity of tobacco as a medicine; though probably lacking any real therapeutic value, if the patient did not die, at least their attention must have been diverted from the

original complaint. Onlookers likewise saw drastic changes in the symptoms, clear evidence of the mastery of the attending physician.

In laboratory studies of the pharmacology of nicotine, the problem has not been to find where nicotine has an effect but rather where it does not have an effect. Nicotine can affect the autonomic nervous system, both the sympathetic and parasympathetic branches, and it can affect the somatic nervous system. It can affect the functioning of the central nervous system, both in the brain and in the spinal chord. It affects the cardiovascular system, the digestive system and the endocrine system. And to further complicate matters, nicotine's action is biphasic. At the autonomic ganglia, for example, small doses lead to neuronal membrane depolarization which results in a stimulant action, while larger doses lead to hyperpolarization or depolarization blockage, which results in a depressant action. Nicotine has such a widespread variety of effects apparently because it mimics the action of the neural transmitter substance acetylcholine, which itself occurs throughout the central and peripheral nervous systems (Ginzel, 1967; Volle & Koelle, 1975).

Nicotine may be responsible for the calming or tranquilizing effect of tobacco smoking. This could result in part from its effects on skeletal muscles. At the motor endplates of skeletal muscles there is a brief initial stimulant action which is quickly overshadowed by a depressant action (Fischer, et al., 1959). Very high doses produce muscle paralysis. Webster (1964) found that nicotine injections produced decreases in muscle spasticity similar to those following cigarette smoking. In the Clark and Rand (1968) and the Domino and von

Baumgarten (1969) studies cited above, cigarettes with higher levels of nicotine produced correspondingly greater patellar reflex depression.

In laboratory animals nicotine has an effect similar to that of a minor tranquilizer, such as meprobamate, in facilitating the learning of avoidance responses, where the animal must learn to perform an appropriate behavior at the appropriate time in order to avoid some aversive event such as electric shock (Geller & Hartmann, 1969). One researcher remarked that "Behavioral observation of the [nicotine] treated rats during each session showed that they calmly sat near the lever between trials, pressing it efficiently in response to the buzzer" (Erickson, 1971, p. 362). Domino (1973) made the observation that nicotine's effect on acquisition of avoidance responses was reminiscent of the action of neuroleptics like chlorpromazine and other tranquilizers, although nicotine was more potent.

The administration of nicotine also reduces the behavioral disruption caused by unavoidable shock in laboratory animals in a similar way to chlordiazepoxide and chlorpromazine (Hutchinson & Emley, 1973); these researchers described the action of nicotine as having an anti-anxiety effect. A similar action was found in humans; Hutchinson and Emley (1973) recorded masseter and temporalis EMG's and found that drinking a solution of nicotine in distilled water reduced the amount of jaw clenching in response to loud noise. Nicotine injections have also been found to reduce the frequency and intensity of aggressive behaviors in rats (Silverman, 1971), and in cats (Bernston, Beattie & Walker, 1976).

Brown (1973) has conducted a series of studies on the EEG patterns of humans while taking various drugs and remarked that the patterns of cigarette smokers resemble those of people taking either minor tranquilizers or small doses of barbiturates. The only report in the medical literature of nicotine being used as a tranquilizer is that of Johnston (1942):

> Nicotine was given orally in doses of gr. 1/15 three times a day to an old-standing case of neurosis, without the patient's knowledge. She declared it was stronger and "steadied" her more than phenobarbital (gr. 1) although it was less hypnotic (p. 742).

So there is considerable evidence pointing to nicotine as the agent responsible for one of tobacco's charms, that of a calming, sedating effect. As Van Proosdij puts it, "Nicotine is one of those chemicals which holds sufficient sway over the psyche to make it less vulnerable to the strains and stresses of life" (1960, p. 22).

The possibility that nicotine contributes to the enhancement of concentration reported by tobacco users has been investigated in the context of Routenberg's (1968) dual arousal hypothesis, according to which one type of arousal is a general one where the organism is alert to a wide range of stimuli, and the second type of arousal is a narrowly focused, goal directed one. The former is thought to be mediated by the brain stem reticular formation while the latter is thought to be related to limbic system activity, especially in the hippocampus. A study by Stumpf and Gogolak (1967) showed that nicotine administration in laboratory animals produced increased theta wave electrical activity in the hippocampus. Goldstein and co-workers (Bhattacharya & Goldstein, 1970; Goldstein, Beck & Mundschenk, 1967; Nelson, Pelley &

Goldstein, 1975) have reported results which suggest that nicotine causes a shift from general to focused arousal. In one study (Nelson, et al., 1975), rats with chronically indwelling electrodes at the level of the reticular formation were trained to bar press for food pellets during signalled, five second periods of availability. When stable rates of responding were achieved, levels of reticular formation stimulation were chosen that would repeatedly disrupt appropriate responding (led to omitted responses during the signalled periods). Nicotine injections then provided protection against this disruption following the reticular formation stimulation, this being in the form of an attenuation of omitted responses. Since nicotine itself stimulates the reticular formation, the attenuation of the behavioral disruption could not result from an antagonistic (depressant) effect on reticular activity. The researchers suggest that instead nicotine's stimulation of the hippocampus allowed some goal directed or focused arousal, the type more appropriate for the task at hand, to compete with or inhibit the more inappropriate general arousal following reticular formation stimulation. This potential shift toward focused arousal in conjunction with a sedative effect could explain why nicotine has consistently been found to improve the performance of laboratory animals in acquiring a number of behavioral tasks.

There is also evidence to make a case for nicotine as the agent responsible for the fatigue allaying and hunger and thirst abating effects of tobacco. Nicotine acts on the adrenal glands, leading to an increased production of epinephrine from the medulla (Westfall, 1965), and an increase in corticosteroids from the cortex (Kershbaum, Pappajohn, Bellet,

Hirabayashi & Shafiiha, 1968; Balfour, Khular & Longden, 1975). Nicotine also produces an increase in blood sugar, along with an increase in liver and skeletal muscle levels of adenyl cyclase, an enzyme involved in changing glycogen, the stored form of sugar, into glucose, the form of sugar available for uptake by bodily tissue (Larson, et al., 1961). These actions together would result in an increased physiological readiness to deal with environmental demands, or an increase in "fight or flight" preparedness, and this may explain why a tired, weary soldier would get some relief from smoking a cigarette. This shift toward a more sympathetic autonomic arousal may also play a role in nicotine's hunger abating effects, although it has been suggested this could stem from an amphetamine-like action on so-called feeding and satiation centers in the hypothalamus (U. S. DHEW, 1979), or to subclinical stimulation of the emetic chemoreceptor trigger zone (Silvette, et al., 1962). Since higher levels of nicotine produce retching and emesis, cigarette smoking doses might produce just enough feeling of nausea to disincline the smoker from eating. Nicotine also produces increased levels of the antidiuretic hormone from the pituitary gland (Larson, et al., 1961), which may be related to tobacco users' claim that they can go for longer periods without drinking.

The evidence relating nicotine's action to the pleasurable aspects of tobacco smoking is rather shaky, in part due to the problematic nature of "pleasure" as a psychological or behavioral concept, especially with non-human species. This has not prevented speculation, however. Since nicotine does increase levels of catecholamines in the brain (Driscoll & Battig, 1973), and since there is some evidence that there

is a relationship between limbic system levels of norepinephrine and moods or affects such as depression or elation, nicotine could, by altering norepinephrine levels, provide the tobacco user with an efficient method of altering their mood to a more positive or pleasant condition (Larson & Silvette, 1968). The only evidence with human subjects which bears on this issue comes from Johnston (1942) who gave nicotine hypodermically to 35 volunteers. Nonsmokers said the "psychic sensations" were difficult to describe and used words such as "swimminess," "muzziness," and "lightheadedness," whereas smokers "almost invariably thought the sensation pleasant" (p. 742). Johnston gave himself 85 hypodermic doses, three or four a day, after which he preferred the injections to inhalation of cigarette smoke.

There is also evidence suggesting that nicotine is responsible for the hunger or craving that regular tobacco users experience, but this will be discussed in the next chapter which deals with a task that confronts most cigarette smokers at one time or another, that of quitting.

CHAPTER III

QUITTING SMOKING

Health reasons for quitting. With tobacco smoking providing such a wide variety of benefits, as detailed in the previous chapter, why would anyone give up the practice? Although some have condemned smoking on moral or religious grounds, the most frequent reason given for quitting is for the sake of one's health. But until the 1950's, most of the health warnings had one of two shortcomings. In many cases, the claims for tobacco's deleterious effects, such as sending the user to the insane asylum or driving him to suicide, were outlandish, and were dismissed by most people as the ravings of fanatics. In contrast, the more reasoned, medically sound claims usually appeared in obscure scientific or medical journals, or in other places not familiar to the general public. As early as 1722, for example, a medical treatise implicated tobacco in cancer and heart disease; a sudden increase in the number of cases of cancer of the nose and of strokes and heart attacks was said to be due to the sudden increase in the popularity of snuffing tobacco (Fairholt, 1859). Several autopsies of the period reported that tobacco smokers had lungs and brains which were blackened.

In the late 19th and early 20th centuries, physicians were recommending that their patients with heart problems give up their pipes or cigars, as was the case with Sigmund Freud; Wilhelm Fleiss told him in 1894 that his heart arrhythmia was due to his 20 cigar a day habit (Breecher, 1972). There were also reports of tobacco amblyopia, a dimness of vision found in some heavy smokers, which improved with abstinence.

In the 1920's, thoracic surgeons became concerned about an increase in the incidence of lung cancer and, based on their clinical observations, some blamed the increase on the growing number of cigarette smokers. The argument was that lung cancer had not been associated previously with tobacco smoking because the typical pipe or cigar smoke was too harsh and irritating to be inhaled. With the improved tobacco hybrids and with the advent of flue curing, the smoke from the modern cigarette could be inhaled deeply and repeatedly without undue discomfort. (One popular cigarette brand boasted a tobacco blend so mild that there was "not a cough in a carload.") And some physicians suspected that it was this deep, repeated inhalation of smoke that was the culprit in causing lung cancer. The few voices sounding the alarm, however, were lost in the storm as cigarette smoking became the preferred method of tobaccophiles the world over.

As both the number of cigarette smokers and the number of lung cancer cases grew, scientific evidence increasingly suggested a link between the two. In 1928, Lombard and Doering noted that heavy cigarette smoking was more prevalent in cancer patients than in control groups. In the 1930's, experimentation with laboratory animals began on the chemical composition and potential pathogenic effects of tobacco and tobacco smoke (U. S. DHEW, 1979). Data were published showing that heavy smokers had shorter life expectancies than nonsmokers (Pearl, 1938). In the late 1930's, large scale epidemiologic studies began on the possible relationship between cigarette smoking and disease, especially lung cancer, chronic bronchitis, emphysema and cardiovascular disease.

By the early 1950's, sufficient evidence from clinical, pathological, laboratory and epidemiologic studies was available to implicate cigarette smoking as a serious health hazard, and, in a 1952 article titled "Cancer by the Carton," Reader's Digest published the first health hazard exposé to be read by a large segment of the general populace. This prompted the establishment of several organizations to further research and assess the problem, among them the National Cancer Institute, the National Heart Institute, the American Cancer Society and the American Heart Association. The tobacco companies established the Tobacco Industry Research Committee. By the late 1950's, the evidence was so convincing that the U. S. Public Health Service went on record saying that the principal factor in the increased incidence of lung cancer was cigarette smoking (U. S. DHEW, 1979). In Great Britain, The Royal College of Physicians of London (1962) released a report which concluded that cigarette smoking caused lung cancer and bronchitis and contributed to heart disease. By now concern had reached the Presidential level and, in 1962, the White House directed the Surgeon General to form an expert committee to review and evaluate all data on smoking and health. Over 6,000 articles in the world literature were reviewed and the Advisory Committee, in January, 1964, published their now historic Surgeon General's Report on Smoking and Health. This gave official government and scientific sanction that cigarette smoking was causally related to lung cancer in men, that it was directly related to illness and death from cardiovascular and noncancerous bronchopulmonary disease in men and women, and that cigarette smoking was a health hazard of sufficient importance to warrant appropriate remedial action.

From 1964 until the present, cigarette smoking has been one of the most intensely researched health topics and, in 1979, a 15th anniversary Surgeon General's Report was released showing that cigarette smoking was a far more dangerous health hazard than was supposed in the 1964 reoprt. This 1979 report had more than 30,000 articles in the world literature available to the compilers, and their conclusions do not bode well, especially for the heavy, long-term smoker of cigarettes high in tar and nicotine.

In terms of morbidity, data summarized in the 1979 report show that, for chronic diseases, both male and female smokers are two and a half times more likely to report bronchitis and emphysema. Male smokers of all ages are one and a half times more likely to report arteriosclerotic heart disease, while this rate applies to female smokers 45 years and older. Both male and female smokers are 33 percent more likely to report chronic sinusitis. Male smokers are two times and female smokers are one and a half times more likely to report peptic ulcers. These figures are for smokers overall; in some subsets of smokers the rates go much higher. Female smokers of two or more packs a day, for example, are almost 10 times more likely to report chronic bronchitis than nonsmokers. In terms of acute illnesses, the overall rate of reports is 14 and 21 percent higher for male and female smokers, respectively, as compared to nonsmokers. The rates for work loss days are 33 and 45 percent higher. Although the data are insufficient to evaluate a causal relationship, a clear association is there between smoking and morbidity.

By the time of the 1979 report, mortality rates had been compiled from eight major prospective epidemiologic studies encompassing more

than 16 million person-years of experience and over 300,000 deaths in the U. S., Great Britain, Canada, Sweden and Japan. The overall mortality rate for cigarette smokers is 1.7 that of nonsmokers. The 30 year old two packs a day smoker has a mortality rate two times greater and a life expectancy 8.1 years shorter than a nonsmoking counterpart. The overall mortality rate for female smokers is slightly lower than that for male smokers, but this is thought to be due to an overall difference in exposure---later age of initiation, fewer cigarettes per day and use of lower tar and nicotine cigarettes---since subsets of female smokers with smoking characteristics similar to male smokers have mortality rates similar to male smokers.

The excess mortality rate is greatest for the 45 to 54 year old age group of both male and female smokers making smoking related mortality premature mortality. Coronary heart disease is the chief contributor to excess mortality rates among smokers, followed by lung cancer and then chronic obstructive lung disease. Non-inhaling pipe and cigar smoking is associated with slightly higher mortality rates due to cancer of the upper respiratory tract, including cancer of the oral cavity, larnyx and esophagus. Snuffing and chewing tobacco have not been found to be related to increased mortality rates, either overall or disease specific, in the U. S., although Asian studies have found an association between tobacco chewing and oral cancer.

The list of specific diseases in the 1979 report for which cigarette smoking has been certified to be a significant, independent risk factor is sobering. In most cases, sufficient laboratory and clinical evidence is available to piece together the role of various tobacco smoke

components in the etiology of each particular disease: This is the case for the non-neoplastic pulmonary diseases chronic bronchitis, emphysema and chronic obstructive lung disease, for cancers of the lung, larnyx, esophagus, urinary bladder and oral cancer, for peptic ulcers, and, in maternal smoking, reduced birth weight due to retardation of fetal growth. Other diseases for which cigarette smoking has been identified as a significant risk factor but which await further evidence as to their etiology include arteriosclerotic peripheral vascular disease, cancer of the pancreas, cancer of the kidney (for males only) and, for maternal smoking, increased rates of fetal or neonatal mortality.

In the foreword to the 1979 report, DHEW Secretary Califano noted that demographers had identified 80,000 deaths per year from lung cancer, 22,000 deaths per year from other cancers, 19,000 deaths per year from chronic obstructive lung diseases, and 225,000 deaths per year from cardiovascular disease, "Every single one of them related to smoking. That is why smoking is Public Health Enemy Number One in America" (U. S. DHEW, 1979, p. ii). And in the preface, Surgeon General Richmond states that "The scientific evidence on the health hazards of cigarette smoking is overwhelming. In 1979 cigarette smoking is the single most important preventable environmental factor contributing to illness, disability and death in the U. S." (p. vii).

Habit or addiction? As the evidence for the health hazards of cigarette smoking continued to accumulate, one might expect a corresponding decrease in the ranks of smokers, especially since most smokers now acknowledge the dangers in smoking and would like to quit. And there were decreases in 1953-54 after the first health warnings appeared in the

popular media and again following the highly publicized 1964 Surgeon General's Report. A drop in per capita consumption also occurred in the late 1960's when television and radio stations carrying cigarette advertising were required to give equal time to anticigarette messages and later when health warnings on cigarette products were mandated by federal law. There was some talk of cigarette smoking becoming a thing of the past. Tobacco companies took this possibility seriously and began to diversify into other product lines in case their revenues from cigarettes were severely curtailed. This, however, did not happen. The intractable nature of tobacco use seen throughout its history has remained.

Those who expected to see wholesale decreases in cigarette smoking viewed the practice as "just a habit" that people would quit once they learned it was harmful, as one would quit using a particular type of underarm deodorant if it were shown to greatly increase the risk of skin cancer. And there were precedents in the literature for such a viewpoint. Medical authorities are on record maintaining that cigarette smoking is simply a habit, that it is only "psychological," and that the smoker can stop with relative ease. The previously quoted German pharmacologist Lewin (1931) said it was

> common knowledge that the use of tobacco for smoking and chewing does not necessitate a progressive increase of the dose as is the case with other toxic substances and that the symptoms due to withdrawal of tobacco, if they occur at all, are easily overcome (p. 49).

Sir Humphrey Rolleston, who played a leading part in setting Great Britain's policy toward opiate dependence, said that "To regard tobacco as a drug of addiction may be very well in a humorous sense, but it

is hardly accurate" (1926, p. 963). In 1944 Johnson was writing that

> Smoking is a habit, not an addiction. Anyone can stop smoking with comparatively little unhappiness. Every physician has noted the comparative ease with which smoking is discontinued when a patient is told that smoking is detrimental to his heart. Somehow he loses all interest in smoking, and usually no one can make such a person touch another cigarette (p. 36).

And there are still authorities who maintain that, since the withdrawal effects attendant to smoking abstinence are not as dramatic as those with heroin or alcohol, cigarette smoking is only a product of "secondary reinforcement."

Events in the past two decades, however, have swung the balance of opinion toward cigarette smoking as an addiction. Although there were some decreases in per capita consumption in the 50's and 60's, these seemed to have bottomed out. Nearly one third of all Americans 18 and older are regular smokers (Public Health Service, 1981), and the rate of decline in per capita smoking is less than one percent per year. And this in the face of overwhelming evidence that cigarette smoking is the single, most important preventable factor in disease and death in the U. S. The message is clear: Smoke and you run a high risk of morbidity and premature mortality; quit and you reduce these risks. Yet over 50 million Americans still smoke. Surely smoking is something more than just a habit.

The lack of success of numerous quit-smoking programs in the past two decades is another factor in the growing acceptance of cigarette smoking as an addiction. There are hundreds of published articles describing a variety of techniques that have been tried in smoking-cessation studies, and these have been reviewed periodically (e. g., Bernstein, 1969; Hunt & Bespalec, 1974; Pechacek, 1979; Jaffe & Kanzler,

1981). The various strategies that have been employed in controlled experimental research on smoking cessation will next be summarized and then an evaluation of their effectiveness will follow.

Smoking cessation programs. Several drugs have been tried in smoking cessation programs, either as a substitute for smoking or to minimize withdrawal discomfort. As early as 1866, concoctions were advertised that purportedly would destroy the appetite for tobacco (Lehman Brothers, 1955). In the early 1960's, lobeline was tried as a smoking substitute. More recently, nicotine, in chewing gum or tablet form, has been used as a cessation aid. Minor tranquilizers, such as meprobamate, and stimulants, mostly amphetamines, have been used singly or in combination to prevent or reduce withdrawal discomfort in the hopes that this would reduce relapse rates.

Although hypnosis has long been used as a smoking cessation treatment, behavior modification techniques are the most frequently used non-pharmacological approaches in smoking cessation research. Many of these techniques have been chosen because of their successes in dealing with other behavioral problems. Pechacek (1979) divides these strategies into self-control techniques and aversion techniques. The former involves either; a) stimulus control techniques designed to reduce the number and strength of cues which signal smoking by restricting smoking to one specific situation or by increasing the intervals between cigarettes (e. g., Premack, 1970), or b) contingency contracting, where money is deposited and its return made contingent on reaching predetermined abstinence goals (e. g., Winett, 1973). But the latter, the aversion techniques, are the most frequent behavior modification

strategies employed in cessation programs. Cigarette smoking is typically paired with some noxious event in the hopes that smoking itself will become, by conditioning, aversive and thereby increase the smoker's incentive to quit. The first aversive stimulus to be used was electric shock (e. g., Powell & Azrin, 1968), which has been successfully used in other aversion training since the days of Pavlov. Another aversive technique tried is covert sensitization where smoking or the thought of smoking is paired with vivid and disgusting images of nausea and vomitting (e. g., Cautela, 1970).

Other attempts at aversive conditioning have used cigarette smoke itself as the noxious stimulus. One such technique employed by a large West Coast proprietary clinic involves repeatedly blowing hot, dry, stale smoke into the smoker's face while they are in the act of smoking. Another aversion strategy that seemed promising at first and has received a great deal of study is the technique of rapid smoking (e. g., Lando, 1975). Under this regime, the smoker inhales every six seconds until further smoking cannot be tolerated due to dizziness, headache, nausea or even vomitting. After a short rest period, rapid smoking occurs again and this process is repeated several times per session, with a total of around six sessions for the entire program.

Recently the trend has been toward "multiple component" programs combining two or more behavior modification techniques (e. g., Brockway, Klienmann, Edelson & Gruenwald, 1977).

To have reported the success rates for each of these treatment programs would have been redundant. In terms of the smoking abstinence rates at the end of the cessation programs and in terms of the relapse

rates in the weeks and months following the programs, a pattern has developed that is similar regardless of the particular technique used or the theoretical orientation taken. When a new strategy or technique first appears on the scene, the results are usually reported in glowing terms, both for immediate and long range success rates. Then attempts to replicate, with corrections for methodological flaws, especially in the case of verifying abstinence status with objective measures such as blood, urine or expired air analysis, find that the original claims for sucess were unfounded. The pattern that emerges is this: Regardless of the type of program, there is usually a high initial rate of abstinence, from 50 to 90 percent, but this drops rapidly in the next 90 days, and by one year follow-up, the abstinence rate is around 20 to 30 percent, roughly equivalent to abstinence rates for no-treatment controls (see Figure 1).

The outcomes of cessation programs have influenced thinking of cigarette smoking as an addiction for two reasons. First, the behavior modification techniques used have been successful in other areas. Consider fingernail biting, which in many ways is similar to the motor patterns involved in smoking. Several behavior modification strategies have been successful in eliminating nailbiting, both in the short and long terms. These techniques include: Self-monitoring (Katz, Thomas & Williamson, 1976; Harris & McReynolds, 1977), cue-controlled relaxation (Barrios, 1977), aversion therapy (Vargas & Adesso, 1976), covert sensitization (Daniels, 1974; Davidson & Denny, 1976; Paguin, 1977), and habit reversal (Azrin & Nunn, 1973; Nunn & Azrin, 1976). It appears there is a fundamental difference between cigarette smoking and fingernail biting.

The second reason that outcomes of smoking cessation programs have influenced thinking about cigarette smoking as an addiction concerns the nature of the relapse process. Hunt and his co-workers have examined the relapse rates following treatment programs for alcoholism (Hunt & General, 1973) and heroin addiction (Hunt & Bespalec, 1974) and have found them to be remarkably similar to the relapse rates for cigarette smoking, as can be seen in Figure 1.

Cigarette smoking is being thought of more frequently as an addiction for other reasons as well. The objective data comparing cigarette smoking relapse to alcohol and heroin relapse is corroborated by self-reports from users; both heroin addicts and alcoholics often find it more difficult to give up cigarettes than opiates or alcohol (Jaffe &

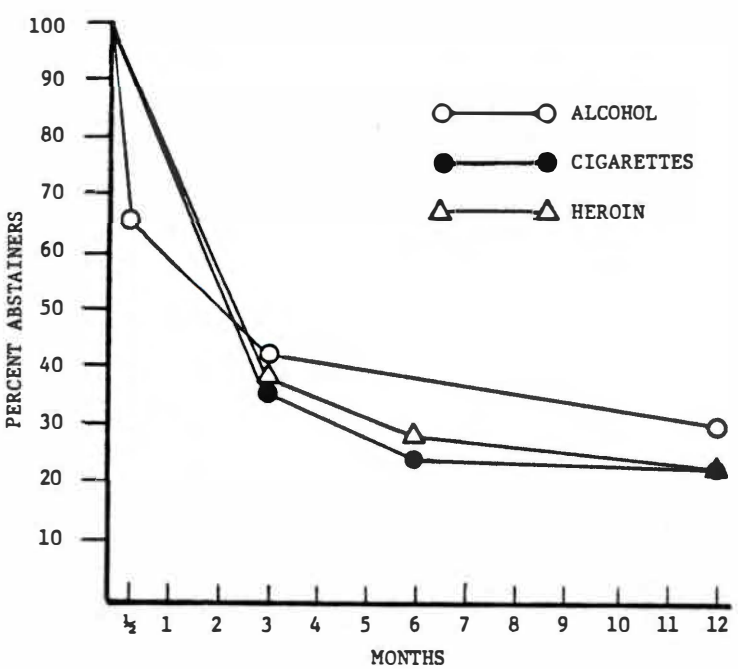


Figure 1. Relapse rates over time in percent of successful abstainers for alcohol, cigarettes and heroin.

Source: W. A. Hunt, L. W. Barnett and L. G. Branch, "Relapse rates in addiction programs", Journal of Clinical Psychology, 1971, 27, p. 456.

Kanzler, 1981). The degree of difficulty of quitting smoking is graphically demonstrated by some smokers who have Buerger's disease. This is a condition resulting from a decrease in peripheral blood circulation, especially in the legs. If an individual with this condition continues to smoke, the symptoms worsen due to the peripheral vasoconstriction effect of nicotine. Ultimately gangrene sets in. First the toes, then the foot, then the lower leg and finally the entire leg must be amputated. Gangrene may then begin in the other leg. The patient is told throughout this process that if they quit smoking the gangrene can be stopped. Yet surgeons report that it is not uncommon to find patients still smoking after two or three amputations (Breecher, 1972).

The same is apparently true for heart attack victims. One study found only 27 percent of patients who had suffered myocardial infarction and who had been advised by their doctors to quit smoking actually did so (Burt, Illingworth, Shaw, Thornley, White & Turner, 1974). And many patients with lung cancer or emphysema continue to smoke even though quitting significantly increases survival time. So smokers not only find it difficult to quit in the face of long range health risks, they also find it difficult to quit in the face of immediate, life-threatening ones. And the continued, compulsive use of a substance and the inability to quit even at the risk of personal injury is a hallmark of addiction.

Another characteristic of addiction is a withdrawal syndrome. This is a constellation of symptoms which consistently appears when the substance is discontinued, which the user finds aversive, and which can be relieved by readministering the drug. For years, experts in the field

of addiction did not classify cigarette smoking as an addiction because abstinence did not produce the dramatic, intense symptoms seen in heroin or alcohol withdrawal. Research over the past two decades has shown, however, that there is a consistent pattern of symptoms that appears upon cigarette abstinence, and what the syndrome lacks in immediate intensity, it more than makes up for in longevity. Upon smoking cessation several physiological changes ensue, among them lowered heart rate and blood pressure, and a weight gain on the average of eight pounds (Brozek & Keys, 1957). Other symptoms which are probably more aversive from the smoker's point of view are: A craving or hunger for a cigarette which at times can be quite intense and which smokers refer to as a "nicotine fit"; irritability, hostility and a lack of tolerance for even minor frustrations; restlessness and a lack of concentration; anxiety and depression; and arousal disturbances, principally drowsiness and fatigue (Jarvik, 1979; Shiffman, 1979; Jaffe & Kanzler, 1981).

The argument for cigarette smoking as an addiction can be summarized thusly: Inhaling cigarette smoke is a very efficient, quick method of getting a powerful psychopharmacological agent, nicotine, into the system; tolerance to nicotine develops so that long term smokers have systemic levels that would have been toxic initially; smokers will continue to smoke in the face of both immediate and long term life-threatening consequences; smoking abstinence produces a withdrawal syndrome which cumulatively can be more agonizing than withdrawal from alcohol or opiates; the withdrawal symptoms can instantly be alleviated by smoking a cigarette; and the post-abstinence relapse rates for cigarette smoking are very similar to those for heroin and alcohol. These

facts qualify cigarette smoking as an addiction in every sense of the word.

But lest the pendulum should swing too far away from a behavioral toward a pharmacological conceptualization of cigarette smoking, it should be kept in mind that there are behavioral aspects unique to cigarette that distinguish it from other addictions. Chief among these is the frequency with which the smoking behavior occurs. An individual who smokes a pack a day and takes an average of 10 inhalations per cigarette would have around 73,000 inhalations per year. In 20 years of smoking, which is far from uncommon, the smokers would have had an astounding 1,460,000 inhalations. There are very few behaviors in the human repertoire which occur with anything near this frequency.

In behavioral terms, this high frequency of occurrence has several implications. From an operant conditioning point of view, many of these thousands or millions of inhalations produce consequences which are reinforcing, each one strengthening or increasing the future probability of the smoking response. These would be of both a positive and a negative reinforcement nature. Coincidental with the former, the smoker would report that smoking produced rewarding or pleasurable payoffs and coincidental with the latter that smoking alleviated some aversive condition, such as anxiety, fatigue or a hunger or craving for a smoke.

The many repetitions of the smoking response would also set the stage for conditioning a vast array of discriminative stimuli, or cues which would come to signal or call for the response-reinforcement sequence. For the heavy smoker, there are very few activities or

situations in the daily routine which do not become associated with smoking. The sound of the morning wake-up alarm, the smell of freshly brewed coffee, picking up the newspaper, finishing breakfast, starting the car, getting to work, and so on, can all call for or elicit the smoking response.

The sheer number of smoking repetitions makes this a motor pattern habit of enormous magnitude. This is analagous to a build-up of inertia or a "flywheel effect," in the sense of William James, whereby the initial performances build up a supply of energy, so to speak, and this ensures that the behavior will continue to run on, as it were, with no additional effort. This is also similar to the psychological concept of "functional autonomy," whereby an often repeated behavior comes to have a "life of its own."

The enormous number of repetitions also produces a highly stereotypic or ritualistic character to the smoking response and, if the ethologist Konrad Lorenz is correct, rituals are a comfort to humans and animals alike. So not only does the smoker seek the immediate consequences of smoking, but all the motions and sensations attendant to the smoking ritual, such as opening the cigarette pack, the smell of the tobacco, the feel of the cigarette, striking the match or lighter, etc., become desiderata also, in the same sense that not only do we seek the consequences of eating, but we also come to enjoy and to look forward to preparing the food, sitting at the table, and so on.

This combination of the powerful, addictive psychopharmacological agent nicotine and the unusual long-term behavioral characteristics of getting it into the system, makes cigarette smoking a deeply ingrained

behavior of irresistible momentum with a probability of continued occurrence of great magnitude. It should be no suprise that millions still smoke regardless of the health hazards involved. And when smokers attempt abstinence, it should be no suprise that there is a high relapse rate. The strength of the behavior through many thousands of reinforcements, through a panoply of highly conditioned discriminative stimuli, and through the enormous "flywheel effect" of the motor-pattern-ritual, make cigarette smoking a response that will literally take years to extinguish or to become a very low probability, weak behavior. It will literally be years before abstaining smokers can truly call themselves successful ex-smokers.

The realization of the intractable nature of cigarette smoking for many people and that a significant part of the population is likely to continue smoking has led some to conclude that if you can not persuade people to give up a hazardous practice, perhaps you can make the practice less hazardous.

CHAPTER IV

LESS HAZARDOUS SMOKING

A number of studies have shown a dose-response relationship between cigarette smoking and health risks (U. S. DHEW, 1979). Health risks increase with: 1) Early onset of smoking; 2) total number of years smoking; 3) number of cigarettes smoked per day; and 4) depth of inhalation. In other words, health risks increase with increases in the degree of overall exposure to cigarette smoke. Smoking related diseases apparently develop over time in response to the cumulative effect of repeated exposure to the toxic substances in cigarette smoke. If this is the case, a reduction in exposure will mean a reduction in health risks, and one can theoretically specify a "safe" level of smoking, or an exposure rate which is below the threshold for disease production (Gori, 1976; Gori & Lynch, 1978).

Reduced exposure could be achieved by a later age of smoking onset, a shorter overall smoking career, smoking fewer cigarettes per day, or by reducing the extent of inhalation. But these parameters can be difficult to control. Another, more direct way to reduce exposure has been suggested---reduce the amounts of harmful substances in the cigarette smoke itself.

Over 2,000 compounds have been identified which are generated when cigarette tobacco is burned (Gori, Lynch, Nightingale, Ellis & Hoffman, 1979). For purposes of analysis, the smoke is divided into a gas and a particulate phase, the former passing through and the latter being retained by a conventional Cambridge glass filter set to trap

particles greater than one micron in size with a 99.9 percent efficiency. The 14 toxic compounds identified in the gas phase include several N-nitrosamines, hydrazine, vinyl chloride, urethane, formaldehyde, hydrogen cyanide, acrolein, acetaldehyde, nitrogen oxides, ammonia, pyridine, carbon monoxide, acrylonitrile and 2-nitropropane (Gori, et al., 1979). The particulate phase is further subdivided into nicotine, water and all the remaining particulate matter, collectively referred to as tar. Tar contains a number of toxic substances of which the polynuclear aromatic hydrocarbons are generally accepted as being responsible for a substantial portion of the carcinogenic properties of the total tar (Gori, et al., 1979).

Over the past two decades, technological advances in tobacco growing and curing, the introduction of filtered cigarettes, and the development of tobacco additives have produced a new generation of low tar and nicotine cigarettes (LTNC's). When smoked on machines, these cigarettes do generally deliver smaller amounts of selected toxic substances such as tar, hydrogen cyanide and carbon monoxide (Gori & Lynch, 1978). All things being equal, the smoker could achieve a reduced exposure, and hence, a reduced health risk, by switching to the LTNC's. And in 1976, Hammond, Garfinkel, Seidman and Lew presented data which support this assumption. They followed nearly 900,000 men and women in 23 states from 1960 to 1972 and compared the mortality rates for smokers and nonsmokers. Smokers were divided into three groups: The "high" tar and nicotine (T/N) group, those smoking cigarettes with 2.0 to 2.7 mg nicotine and 25.8 to 35.7 mg tar; the "low" T/N group, those smoking cigarettes with less than 1.2 mg nicotine and

less than 17.6 mg tar; and the "medium" group, those smoking cigarettes with T/N levels in between the "high" and "low" groups.

For both men and women, there was a lower overall mortality rate for the "low" T/N group as compared to the "high" T/N group. The mortality ratios for the "low" T/N group ranged from 81 to 88 percent of the mortality ratios of the "high" T/N group. The differences in the mortality ratios between the "low" and the "high" T/N groups were more pronounced for lung cancer than for coronary heart disease. Nonsmokers, however, fared much better than the "low" T/N group; they had mortality ratios for lung cancer which were nine percent of the males and from 22 to 43 percent of the females in the "low" T/N group. The researchers concluded that reducing T/N levels did not make smoking safe, but short of quitting, it was a step in the right direction.

The logic of reducing health risks by smoking LTNC's is appealing and the results of the Hammond, et al. (1976) study are encouraging. The issue is more complicated, however, than might first appear. The time period of the Hammond, et al. (1976) study was an era when cigarette smokers were just beginning to adopt filtered cigarettes. The "high" T/N group could just as accurately be called the nonfiltered group and the "low" T/N group called the filtered group. The conclusion could then be restated to say that it is less hazardous, in terms of mortality rates for lung cancer and heart disease, to smoke filtered cigarettes than it is to smoke nonfiltered ones. But what about more recent cigarettes, which are almost all filtered? The upper limit of the Hammond, et al. (1976) "low" T/N group was 1.2 mg nicotine and 17.6 mg tar, a level that in the age of the "ultra-low" T/N cigarette would

be considered "high." Given that filtered cigarettes are somewhat less hazardous than nonfiltered cigarettes, the question remains: Are filtered cigarettes with, say 0.4 mg nicotine and 4.0 mg tar, like Vantage Ultra-Lights, less hazardous than those with, say 0.8 mg nicotine and 11.0 mg tar, like Marlboro Lights? Two factors preclude what might otherwise be a straightforward "yes" to this question. The first factor involves the use of additives of an unspecified nature to the very low T/N cigarettes to improve their "taste." These additives could themselves be toxic thereby making the very low T/N cigarette more harmful than a higher T/N cigarette without these additives. This question remains unanswered because the tobacco companies as yet do not have to divulge what ingredients are being used in these additives and there is no immediate way to assess their potential health hazards.

The second factor involves the possibility of titration or regulation of systemic levels of nicotine. The nicotine, tar and gas yields of cigarettes are determined by a smoking machine which smokes cigarettes in a fixed pattern, 35 ml puffs of two seconds duration every 60 seconds, regardless of the potential yields of these substances per cigarette. So the smoking machine would enjoy a reduced exposure, so to speak, by switching to LTNC's. But the smoking human is another story. Smokers switching to lower T/N cigarettes might change their smoking patterns to maintain a given level of systemic nicotine. The changes could be increases in the number of cigarettes smoked per unit of time, increases in the number, intensity or duration of puffs per cigarette, or increases in the depth or duration of inhalations. These changes could offset any potential reduction in exposure to harmful

substances from the LTNC's. The compensatory changes could result in overall tar and nicotine exposures equivalent to or little different from those of higher T/N brands. And any changes in smoking patterns might result in net increases in exposure to poisonous gases in the cigarette smoke (Prue, Krapel & Martin, 1981). Increased puff intensity and duration, for instance, could produce higher tobacco combustion temperatures leading to increased levels of gases such as carbon monoxide, hydrogen cyanide and nitrous oxides, and the gas phase of cigarette smoke is considered a greater health hazard than the tar or nicotine phase (U. S. DHEW, 1979).

Discovering the role nicotine levels play in smoking patterns is critical in deciding what is the best approach to less hazardous smoking. If the "nicostatic" model is correct and, as Schachter (1978) maintains, long term, serious smokers smoke only to keep a given systemic level of nicotine, then perhaps a low tar, high nicotine cigarette should be the course taken (Breecher, 1972; Consumer Reports, 1976). The rationale for the low tar, high nicotine cigarette is that, since the health hazards of nicotine are unknown or undefined (Russell, 1974), smokers could maintain the same level of systemic nicotine while smoking fewer cigarettes per unit of time, with fewer puffs of less intensity and shorter duration, and with shorter, shallower inhalations. In consequence there would be a lower level of exposure to tar and toxic gases. If, however, the opposite is true and, as Garfinkel (1979) maintains, "nicotine dependency plays a minor role in determing the smoking habits of those who continue to smoke on a long term basis"

(p. 1274), the LTNC's would be the preferred choice for minimizing exposure to harmful cigarette smoke components.

Demonstrating experimentally which of these opposing views is correct has turned out to be more troublesome than one might expect. Research into the role of nicotine in smoking patterns and how this relates to the level of exposure to harmful substances in cigarette smoke has encountered difficulties in two areas.

In the first place, there are several possible techniques whereby smokers can make compensatory changes in their smoking patterns. The most obvious would be to change the number of cigarettes smoked per unit of time. This is also the easiest variable to measure outside the laboratory. Goldfarb and Jarvik (1972), for example, asked smokers to record the number of cigarettes smoked per day while smoking as usual, while smoking only the first half of each cigarette, and while smoking cigarettes which had half the distal end cut off. The researchers assumed that on the latter two regimes the smokers would have to double their number of cigarettes per day in order to maintain their usual nicotine levels. There was a small but statistically nonsignificant increase in the number of cigarettes per day, from 25.5 to 28.6. There was no way to tell, however, if the smokers had compensated in other smoking parameters.

As researchers became more aware that there were a number of compensatory techniques available to the smoker, the research strategy focused on laboratory studies where a more fine-grained analysis could be made of the various smoking elements to study the effects of nicotine manipulation on smoking patterns.

At first, the number of puffs per cigarette and number of cigarettes per unit of time were the dependent measures (e. g., Ashton, Watson, Marsh & Sadler, 1970; Stolerman, Goldfarb, Fink & Jarvik, 1973; Jarvik, Popek, Schneider, Baer-Weiss & Gritz, 1978). More recently the trend has been toward using special cigarette holders, often stationary ones. These are connected to machines which automatically record the number, intensity and duration of the puffs via the pressure drop created in the holder when the smoker takes a puff (e. g., Kumar, Cook, Lader & Russell, 1977; Comer & Creighton, 1978; Rawbone, Murphy, Tate & Kane, 1978; Fagerstrom & Bates, 1981). Pneumographs have also been employed to measure inhalation characteristics (e. g., Guillerm & Radziszewski, 1978). The problem with these strategies is one of measurement reactivity; being in a laboratory setting and smoking cigarettes which are being held in a stationary holder and being in a pneumograph harness can itself substantially influence smoking patterns (Comer & Creighton, 1978; Dunn & Frieislaben, 1978; McMorrow & Foxx, 1983), thereby threatening the validity of these studies.

The first major hurdle in studying the relationship between cigarette nicotine levels and smoking parameters, then, is finding a way to measure the various compensatory techniques available to the smoker while at the same time avoiding the problem of measurement reactivity, i. e., not having the act of measuring create an additional influence on the behavior being studied.

The second difficulty facing researchers interested in nicotine's role in smoking parameters and the corollary issue of less hazardous smoking again involves measurement, but, in this case, of systemic

levels of nicotine and suspected pathogenic substances. Direct measurement of systemic nicotine levels is necessary to determine if smoking pattern compensations actually do result in titration or nicotine regulation (McMorrow & Foxx, 1983), and direct measures of suspected pathogenic substances such as the polynuclear aromatic hydrocarbons, carbon monoxide and hydrogen cyanide, would be most helpful in making decisions concerning less hazardous smoking.

The technology for these measurements is still in the developmental stages. Initial attempts to measure systemic nicotine have used plasma or urinary levels of nicotine itself as the dependent measure (e. g., Gritz, Baer-Weiss & Jarvik, 1976; Russell, Wilson, Patel, Feyerabend & Cole, 1975; Goldfarb, Gritz, Jarvik & Stolerman, 1976; Sutton, Feyerabend, Cole & Russell, 1978). The difficulty with direct measures of nicotine is one of wide fluctuations, both in terms of a relatively short half-life of 20 to 30 minutes, and in terms of the pH of the urine affecting nicotine levels; a lower level of urine pH results in a higher level of nicotine. So direct measurement of systemic nicotine requires a highly controlled laboratory setting and one is back to the problem of measurement reactivity.

Some researchers have measured the amount of carbon monoxide to gauge the level of systemic nicotine. This has been tried with expired air levels (e. g., Henningfeld & Griffiths, 1979; Martin, Prue, Collins & Thames, 1981; Prue, Krapfl & Martin, 1981), and with carboxyhemaglobin levels (e. g., Turner, Sillett & Ball, 1974). The problem is that carbon monoxide is not well correlated with nicotine levels (McMorrow & Foxx, 1983), and other factors, such as recent exposure to

automobile exhaust can further confound the relationship between carbon monoxide and nicotine levels. Attempts to gauge nicotine regulation by measuring levels of thiocyanate (e. g., Prue, Krapfl & Martin, 1981) have also proved unsuccessful since other factors, such as diet, can affect thiocyanate levels. Measurement of cotinine, the major metabolite of nicotine, shows promise since it has a half-life of 30 hours and is not affected by urine pH. But this is a relatively new measurement (Hill & Marquardt, 1980), and awaits further study for evaluation.

The difficulties facing the researcher interested in nicotine regulation and its implications for less hazardous smoking can be summarized as follows: There are several ways smokers can alter their smoking patterns to compensate for changes in nicotine deliveries; since measuring all these parameters requires a controlled setting, most research on nicotine regulation has been conducted in laboratories; but this brings in the problem of measurement reactivity and because of this, compensation or a lack of it may not be reflective of what would occur outside the laboratory; direct measure of systemic nicotine, especially blood or urine samples, can be invasive, further contributing to measurement reactivity; and these measures have yet to be standardized, so there is a problem with reliability when comparing different studies.

The results of nicotine regulation research reflect these difficulty ties. In a review of 45 studies on nicotine regulation published since 1942, McMorrow and Foxx (1983) state that although basic research has generally shown some nicotine regulation, applied research has offered

essentially no support for regulation, and that, overall, "research on regulation has been inconclusive" (p. 302). The authors add that:

> Contrary to the stated rationale for studying nicotine regulation---the potential health hazards of smoking low-T/N cigarettes---neither basic or [sic] applied research has adequately addressed this issue (p. 324).

There is one kind of data that would be helpful in this area that is conspicuously missing in research on nicotine regulation, on less hazardous smoking, and on cigarette smoking in general, and that is data from naturalistic observations of cigarette smoking in everyday, uncontrived situations. If a method could be developed that would accurately measure the various elements of cigarette smoking, i. e., the puffs, inhales, exhales and intervals between puffs, and would do so in "real world" settings without the smoker being aware that he or she was being observed, this would circumvent the thorny problem of measurement reactivity that has plagued much of cigarette smoking research. And once these data on how people smoke cigarettes in naturalistic settings were available, then laboratory researchers could have the best of both worlds. They would enjoy the control and precision that can be achieved in the lab while at the same time having standards for smoking parameters that would reflect how people smoke in the day-to-day world.

Consider research using smoking machines. There is considerable potential here for measuring the yields not only of tar and nicotine of commercial cigarettes but also of the toxic gases as well. But instead of using a single, fixed smoking schedule, as is now the case with the Federal Trade Commission method for assaying tar and nicotine levels, the researcher could use the normative data from

naturalistic observations as a reference to select a range of smoking schedules. For example, the researcher could choose five different smoking patterns, in terms of the number and durations of puffs, inhale and exhale durations, and intervals between puffs. The machine settings could then be set to mimic the average or modal pattern seen in the naturalistically observed smokers, and then there could be one machine setting each for, say one and two standard deviations above and below the average pattern. Then, given the appropriate technology, the researcher could use these five settings, test all the commercially available cigarettes, and measure the tar, nicotine and poisonous gas deliveries for each cigarette brand at each setting. This would provide a table of accurate measures for these substances for cigarettes smoked at a number of "real world" topographies. This would be an invaluable step forward in assessing less hazardous smoking in terms of choosing a combination of cigarette brand and smoking pattern that would minimize exposure to pathogenic substances.

In view of the potential usefulness of this kind of data, a research project was designed and carried out which unobtrusively recorded cigarette smoking in a large number of smokers in several everyday, uncontrived situations. The methods, results and discussion of this study are reported in the following pages.

CHAPTER V

METHODS

Observation sites. The objective of the study was to observe and record the times for the puffs, inhales, exhales and the intervals between puffs for the entire smoking episode, from the beginning of the first puff until the end of the last exhale, and to do this in an unobtrusive manner, that is, without the smoker knowing that he or she was being observed. In order to achieve this objective, a location where smokers could be observed had to meet three criteria: First, it had to be a public place where anyone who cared to could watch people smoking without any question of invasion of privacy; second, it had to be a place where potential observees would likely remain long enough to smoke an entire cigarette; and third, it had to be a place where the observer could be stationed so as to be close enough to clearly see the cigarette being smoked while at the same time being out of the direct line of sight of the observee. After some preliminary observations, six locations were chosen: Two cafeterias, two restaurant lounges, a university student center, and a minor league baseball park. The two cafeterias and the student center were located on or near a large university campus, the University of Tennessee, Knoxville, while the two restaurant lounges and the baseball park were located away from the campus in the city of Knoxville, Tennessee.

Equipment. Since the smoking sequence is a fixed chain, that is, the puff must come before the inhale, the inhale before the exhale, and

so on, the recording technique required only a single signal on a single channel. A simple method would be a tap or click recorded on a tape recorder. A Sony TC-140 Cassette-Corder was used for initial pilot observations. This had an over-the-shoulder strap which made it easy to carry and it had a built-in microphone which could be tapped with the index finger to produce a clear, sharp signal marking the beginning and end of each of the smoking elements. This model tape recorder proved to be too large and noisy. The operation of the controls could be heard by smokers within visual range and it soon became apparent that someone entering a lounge or cafeteria with a large tape recorder over his shoulder was anything but unobtrusive. The purchase of a Sony Micro Cassette-Corder, the smallest recorder available at the time, solved these problems. It was small enough to be held in the hand and could easily be concealed from sight. The controls were very quiet and could be operated with one finger, and the built-in microphone could be tapped with the same finger. With practice, this micro-cassette recorder and tapping technique turned out to be well suited for recording the various elements of the cigarette smoking episode.

Pilot observations and data collection form. Since the main purpose of the study was to collect normative data on the temporal patterns of smoking, the 15 formal pilot observations emphasized developing and refining procedures for recording the smoking elements, and for timing and transcribing these recordings. During these pilot observations it became evident that there were a number of other kinds of data that could also be profitably collected, such as the sex of the smoker, the brand of the cigarette smoked, whether the smoker was alone or with other

smokers, and so on. From these pilot observations a standard data collection form was developed, which can be seen in the Appendix.

Data collection. The data collection proper then began. A typical observation involved going to one of the locations and finding a promising site. This was usually a seat within roughly 10 meters of any potential smokers. A greater distance made critical cues such as cigarette combustion area glow and exhaled smoke difficult to see. The seat also had to be no closer than roughly 45 degrees within the potential observee's straight ahead line of vision. A position closer than this to their straight ahead line of vision made it difficult to observe their smoking without engaging frequent eye contact, which would have made the observations obtrusive. The optimum orientation was directly off to the side, roughly 90 degrees from their straight ahead line of vision, although observations could be made from as much as 140 or so degrees away from the smoker's straight ahead line of vision.

On location, there were rarely more than four or five potential observees who were within appropriate visual orientation and distance at any one time. These were scanned more or less continuously for any signs or preliminary movements to lighting a cigarette, such as reaching into a pocket or purse, or reaching for an ashtray. (The amount of time from first arriving on location until an observation began varied from a few minutes to as much as an hour, depending on how many people were within view and how many of these were actually smokers.) If an individual followed through the preliminary movements and began to light a cigarette, the "record" button of the tape recorder was activated and the microphone given a series of five or six rapid taps. At the beginning

of the first puff, as indicated by a sharp increase in the glow from the combustion area of the cigarette, the microphone was given a single tap. A second tap marked the end of the puff and the beginning of the inhale, as indicated by smoke being drawn from the mouth into the lungs. A third tap marked the end of the inhale and the beginning of the exhale, as indicated by the first signs of smoke being blown out. A fourth tap marked the end of the exhale, as indicated by the last visible signs of smoke being blown out. This process began anew with the beginning of the next puff and was repeated until the cigarette was extinguished, which was marked by another series of five or six rapid taps.

Immediately following the tape recording, other relevant information about the smoker and situation was recorded on the front of the data collection form (see Appendix A). This began with the observation number followed by the date, time of day, the location and the activity of the smoker. The tape cartridge side and the beginning and ending footage readouts were recorded. The sex of the smoker was recorded and their age and weight estimated. This was followed by noting if the smoker was alone or with other people, and if so, whether any of the others smoked during the time the observee was smoking.

If the cigarette end, the filter in most cases, just barely touched the lips and if there was little or no pursing of the lips around the cigarette end during puffing, the "L" after "PUFF" on the data collection form was circled, indicating a light puffing style. If the lips clearly closed over the cigarette end and there was a dropping of the jaw and some cheek indentation, the "D" was circled, indicating a deep puffing style. Otherwise the "M" was circled, indicating a medium puffing

style. If, at any time during the episode, the smoker took a puff, inhaled the smoke, and immediately took another puff and inhale, with no exhale in between, the "DBL" was circled to indicate a double puff.

A circled "N" after "INHALE" indicated a non-inhaler. If there was little if any chest expansion on inhaling, the "S" was circled to indicate a shallow inhaling style. If there was pronounced chest expansion and perhaps some backward tilting of the upper body, the "D" was circled to indicate a deep inhaling style. Otherwise the "M" was circled to indicate a medium inhaling style.

The exhale was marked "S" if the smoke from each puff-inhale was blown out in a single breath. If the smoke from each puff-inhale was blown out with two or more breaths, the "M" was circled to indicate a multiple exhaling style. A circled "SM" indicated that both single and multiple exhales were used. If the smoke was blown out through the mouth only, the next "M" was circled; an "N' indicated that the smoke was blown out through the nose only; and an "NM" indicated that both occurred.

If the sidestream and exhaled smoke was light and indistinct, an "L" was circled. If the smoke was heavy and thick, an "H" was circled. Otherwise and "M" was circled.

The smoker's activity level was judged on a three point scale. A "1" indicated a low activity level with little if any movement extraneous to smoking. A "3" represented a high, "nervous" activity level with almost constant, usually fidgety movement of some kind. A "2" indicated a moderate level of activity for those not clearly falling into one of the other categories.

The brand and type of cigarette was next recorded, (relative nicotine level was later ascertained from Federal Trade Commission documents) with a notation whether the brand was determined before or after the tape recordings were made. At times the cigarette pack could be seen clearly enough to determine the brand as the smoker lit up. On other occasions, however, the brand was determined afterwards. If the cigarette pack was out on the table or bar, the observer walked casually by to see what the brand was. More often than not it was necessary to wait until the observee left and then retrieve the cigarette butt from the floor, ashtray, coke cup, mashed potatoes, etc. Unless a positive, unequivocal identification of the cigarette brand and type was made, the record was disqualified for analysis.

How the cigarette was held was recorded next. A circled "R" indicated the cigarette was held in the right hand only, a circled "L" in the left hand only, and a circled "RL" in each hand at one time or the other. A circled "TI" indicated that the cigarette was held between the thumb and index finger; a "TMI" the thumb, index and middle finger; an "IM" the index and middle finger; and more than one circle indicated a combination of holding positions. A circled "LIP" indicated that at some point during the episode the cigarette was held in the lips. If the cigarette was held continuously throughout the episode, a "CONT" was circled. A circled "DOWN" meant that the cigarette was put down, say in an ashtray at some point during the episode.

If the initial puff, the one used to light the cigarette, was inhaled, a "YES" after IPI" was circled; otherwise a "NO" was circled. If the cigarette was lit with a match, "MATCH" was circled; "DISP"

indicated that a disposable butane lighter was used; "ZIP" was circled if a nondisposable, mechanical lighter was used; and if another method was used to light the cigarette, it was noted. A circled "ATC" after "EXTING" meant that the cigarette was extinguished by crushing it in an ashtray. An "FC" meant it was crushed under foot on the floor. "FLIP" meant it was dropped, flipped or thrown away while still burning. If another method was used, it was noted.

The predominant position of the arm and hand holding the cigarette was next recorded. Circling the first figure after "ARM" indicated that the elbow was bent approximately 90 degrees with the hand up and the forearm roughly perpendicular to the floor. The second figure indicated that the forearm was roughly parallel to the floor, elbow slightly bent and the hand away from the body. The third figure indicated that the hand and arm was pointed downward with no bend at the elbow. Any additional information was noted in the space at the bottom of the form.

Timing and transcribing the data. Periodically the tape recordings were timed, usually after around 10 separate recordings were made. Four stopwatches were used. At the first tap after the series of five or six rapid taps, the first stopwatch was started; at the second tap the first stopwatch was stopped and the second started; at the third tap the second watch was stopped and the third started; at the fourth tap the third watch was stopped and the fourth started; and at the fifth tap---signalling the beginning of the next puff---the fourth watch was stopped along with the recorder playback. At this time there was a readout on the four stopwatches, to the nearest tenth of a second, for the first puff,

inhale, exhale and interval to the beginning of the next puff. These were transcribed on the back of the data collection form, along with the recorder footage readout for the beginning of the next puff. The stopwatches were reset, the recorder reversed briefly, playback begun, and the timing process repeated for each of the puff-inhale-exhale-interval segments until another series of five or six rapid taps signalled the end of that smoking episode. A log was kept of the date and time of the observations and timings.

Subject selection. Practical considerations extended the criteria stated earlier in determining the locations and times for observations. This was due to several constraints, one being a personal work schedule which did not allow complete freedom as to where and when observations could be made. Another was the nature of the locations which met the criteria: The cafeterias were open during the day and early evening; the restaurant lounges were open in the late afternoons and evenings; the baseball park was open during scheduled games on weekday evenings and weekend afternoons; and the university student center was open on weekdays. These constraints required choice of time and place on the basis of opportunity rather than compliance with a predetermined schedule. Once on site at whichever time and location was most accessible, the first person seen lighting a cigarette would be selected for observation. This choice of the first person to smoke ensured that any observer bias in the selection of subjects was minimized. When a running record began to show an imbalance in the number of males and females at various locations, an additional constraint---sex of the smoker---was added to choosing whom to observe. In so doing, a satisfactory

balance for males and females was achieved for all locations except the baseball park. Not many females attended the games and the season ended before an equal number of observations for males and females could be attained.

A total of 235 observations were made over a period from June, 1981 to October, 1982. Of these, 35 were not included in the data analysis for various reasons: Fifteen were pilot observations; 11 observees left before finishing their cigarettes; for four observations, the cigarette brand could not be unequivocally identified; one observation was made with the recorder controls on "pause"; one observee lit his cigarette but never took a puff; one observee let the cigarette go out in the ashtray and then re-lit it after the recording had been terminated; the view was blocked during one recording; and one observation was disqualified because the Federal Trade Commission documents did not list a nicotine content for the brand that was smoked. This left a total of 200 observations for data analysis. (A breakdown of the observations by sex, estimated age and weight, location, etc., is presented below under Results.

Reliability checks. Ten observations, numbers 82 through 91, were timed twice to get some indication of the reliability of the timing procedure. They were first timed on November 17, 1981 and again on December 14, 1981. Total times for each of the 10 observations were computed for the puffs, inhales, exhales, and intervals between puffs for both timings. These were compared and the percentages of absolute erors between the two timings were calculated, and these are reported below, under Results.

The batteries of the Sony M-400B recorder were changed every 30 observations, even though the battery indicator showed that they were still good.

After all observations were made and the recordings timed, the data were coded, input into a computer, and analyses performed using commonly available packaged statistical analysis programs.

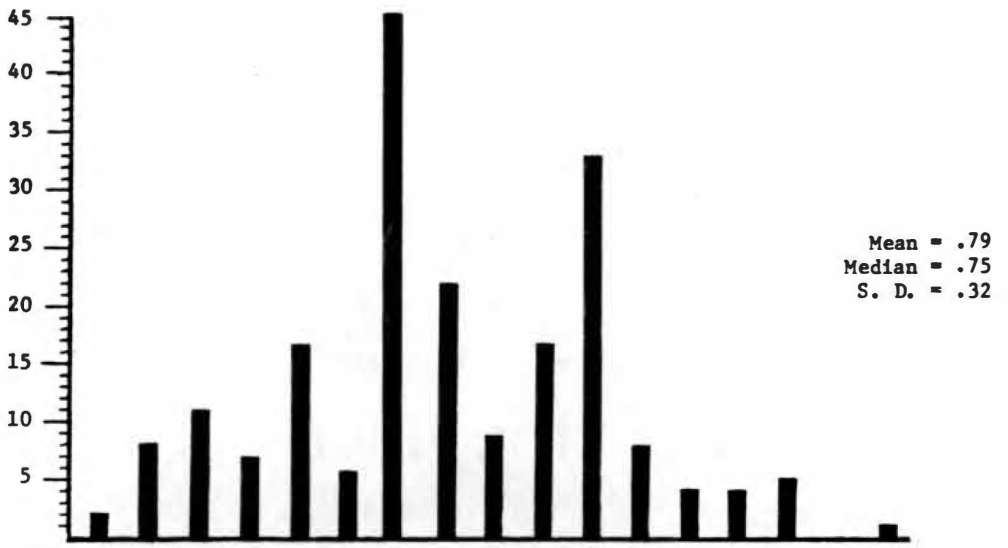
CHAPTER VI

RESULTS

Before presenting the main results, some characteristics of the sample population will be given. As can be seen in Figure 2, in terms of the Federal Trade Commission (FTC) listing of the nicotine ratings of commercially available cigarettes, a majority (63%) of the observees smoked cigarettes within the range of from 0.7 to 1.1 mg nicotine. These two values represent the nicotine ratings of some of the more popular cigarette brands, such as Marlboro Light 100's (.74 mg), Merit 100's (.70 mg), and Vantage (.71 mg), and Benson & Hedges (1.09 mg), Marlboro (1.05 mg) and Winston (1.11 mg), and this may account for the two peaks in what otherwise might be a bimodal distribution. These brands also ranked in the top ten leading national cigarette brands during 1982 (Standard & Poor's, 1984).

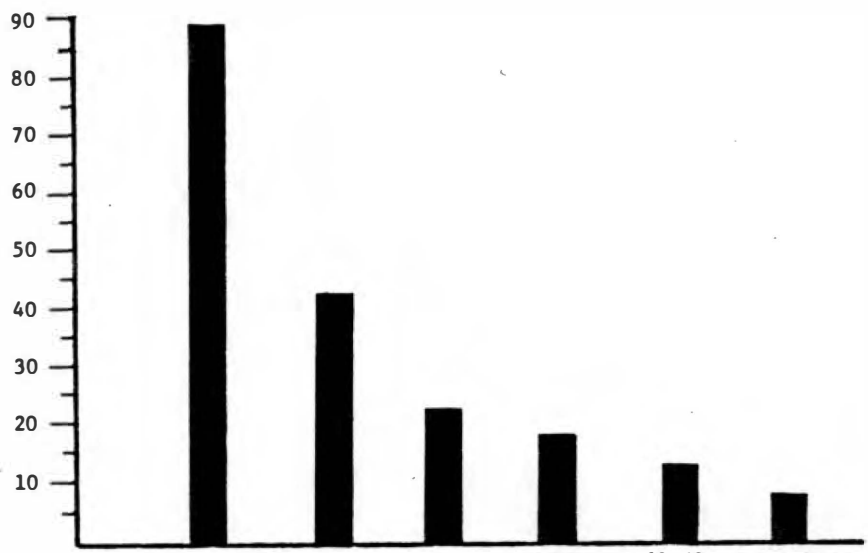
Of the final sample of 200 observees, the depth of inhalation was judged "shallow" for 29 (14.5%), "medium" for 101 (50.5%) and "deep" for 69 (34.5%). Only one observee (0.5%) did not inhale to some extent. This gave an N of 199 observees for the analyses.

The final sample consisted of 101 males and 98 females, 50.8% and 49.2% of the total, respectively. Figure 3 shows the distribution of the estimated ages of the observees in 10 year brackets. Since the frequencies of observations in the higher age brackets were relatively small, the number of brackets was reduced from six to four, in order to have sufficient cell sample sizes in subsequent analyses. This



NIC	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7
FREQ	2	8	11	7	17	6	45	22	9	17	33	8	4	4	5	0	1
CUM%	1	5	11	14	23	26	48	59	64	72	89	93	95	97	99	99	100

Figure 2. FTC nicotine levels (NIC), to the nearest tenth milligram, with frequency of observations (FREQ) at each value, and with cumulative percentages (CUM%).



AGES	29 & Under	30-39	40-49	50-59	60-69	70 & Over
FREQ	89	44	24	19	14	9

Figure 3. Estimated ages of observees, with frequency of observations (FREQ) at each level.

resulted in an n of 89 for ages 29 and under, 44 for ages 30 to 39, 43 for ages 40 to 59, and 23 for ages 60 and over.

Of the 199 observations, 64 (32.2%) were made in the two cafeterias, 41 (20.6%) at the baseball park, 53 (26.6%) in the student center, and 41 (20.6%) in the restaurant lounges. Forty-three (21.6%) observations were made in the morning (9 a.m. until noon), 79 (39.7%) in the afternoon (12:01 p.m. until 7 p.m.) and 77 (38.7%) in the evening (7:01 until 11 p.m.).

In reporting the main results, the following terminology will be used: An element refers to the smallest unit of the smoking act, the puff, inhale or exhale; a segment refers to a single puff-inhale-exhale sequence ("Segment" has been chosen here rather than "puff," which is the term usually found in the literature on cigarette smoking research, because in this report the puff, the inhale and the exhale receive both separate and aggregate analyses---a "segment" refers to the latter case.); an interval refers to the time from the end of one puff-inhale-exhale segment to the beginning of the next; and an episode refers to the smoking of the entire cigarette, from the beginning of the first puff to the end of the last exhale, and thus constitutes one observation.

The main results will be presented in terms of eight smoking parameters of the smoking act, each calculated on a per episode basis. (Since each smoker was observed smoking only one cigarette, per episode is equivalent to per smoker.) The eight parameters are: The number of puff-inhale-exhale segments (NSEG), mean puff durations (PFTM), mean inhale durations (INTM), mean exhale durations (EXTM), mean puff-inhale-exhale segment durations (SGTM), total puff-inhale-

exhale segment durations (SGTL), mean interval durations (INTV), and total episode durations (EPTM).

Table 1 presents the correlation coefficient matrix between FTC listed nicotine ratings and the eight smoking parameters. With an N of 199, a correlation coefficient of only .18 will be statistically significant at the .01 probability level. Some of the coefficients in Table 1 are spuriously high since they are derived from two variables which are not independent of each other, i. e., one is used in the calculation of

TABLE 1

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENT MATRIX FOR NICOTINE AND THE EIGHT SMOKING PARAMETERS

	NSEG	PFTM	INTM	EXTM	SGTM	SGTL	INTV	EPTM
NICOTINE	-.11	-.03	.03	.09	.05	-.06	.26*	.19*
NUMBER OF SEGMENTS (NSEG)	-.15	-.18*	-.04	-.17	.62	-.65*	.12	
MEAN PUFF DURATION (PFTM)	.20*	.20*	.54[a]	.31[a]	-.02	-.04		
MEAN INHALE DURATION (INTM)	.36*	.80[a]	.41[a]	.08	.07			
MEAN EXHALE DURATION (EXTM)	.76[a]	.57[a]	-.11	-.01				
MEAN SEGMENT DURATION (SGTM)	.61[a]	-.02	.02					
TOTAL SEGMENT DURATION (SGTL)	-.51*	.11[a]						
MEAN INTERVAL DURATION (INTV)	.48[a]							
EPISODE DURATION (EPTM)								

*Significant with $p < .01$.

[a]Correlations between non-independent variables.

the other. This is the case, for example, with the correlation between mean inhale and mean segment durations, the former being a part of the latter.

The distributions for the eight smoking parameters are presented on the following pages in Figures 4 through 11. Each figure consists of a bar graph and a series of descriptive statistics. The bar graph gives a visual display of the distributions of the values for each parameter, with the frequency of observations at each value of the parameter, and with the cumulative percentage at each value. Under "DESCRIPTIVE STATISTICS" for each figure, "N," "MEAN" and "STD DEV" refer to the number of observations, the arithmetic average or mean and the standard deviation, respectively. "COEF VAR" is the coefficient of variation, a statistic derived by dividing the standard deviation by the mean and expressing the quotient in percent. "SKEWNESS" is a measure of the degree to which the length of one tail of the distribution is disproportionate to the other (Hayes, 1973). A positive value indicates a distribution that is skewed to the right, i. e., the right tail of the distribution is longer than the left, observations tend to cluster in the lower range of values and the median is less than the mean. A negative value for skewness would indicate the reverse of this. A value of zero for skewness would obtain with a normal or "bell-shaped" distribution. "KURTOSIS" is a measure of the degree to which the distribution is flattened out over the range of scores or peaked around the measures of central tendency (McNemar, 1969). A positive value for kurtosis indicates a peaked or leptokurtic distribution, a negative value indicates a flat-topped or platykurtic distribution, and

a value of zero would indicate a normal, "bell-shaped" distribution. Some statistics are also presented which describe the nature of the distribution in more detail. These are the lowest score in the distribution or the zero percentile ("0% MIN"), the 25th percentile or first quartile ("25% Q1"), the 50th percentile or median ("50% MED"), the 75th percentile or third quartile ("75% Q3"), and the highest score in the distribution or the 100th percentile ("100% MAX"). "RANGE" gives the span from the lowest to the highest score.

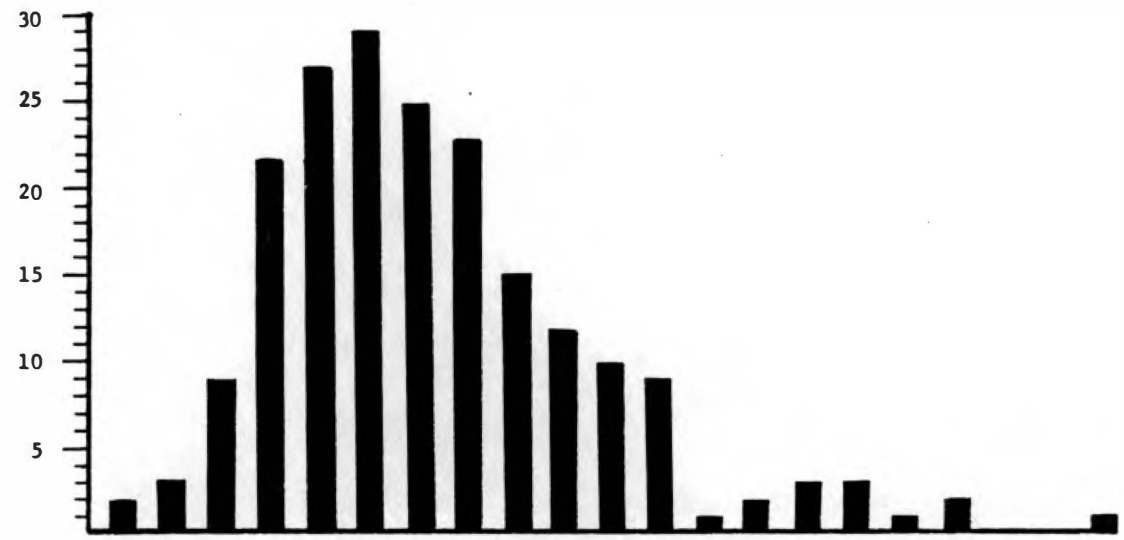
Another statistic that will be used to describe the distributions is the Kolmogorov D statistic, which is a goodness of fit test for the null hypothesis that the observed distribution is a random sample drawn from a normally distributed population (Gibbons, 1976). The test value can range from 0.00 to 1.00, the former for a normal distribution and the latter for a distribution radically different from a normal one. It should be kept in mind, however, that with a sample size of 199, quite small D values will be statistically significant, i. e., even slight deviations from a normal distribution will lead to a rejection of the null hypothesis at the .05 probability level.

Since, as will be seen, the distributions for several of the smoking parameters are skewed, some remarks are in order whether arithmetic or geometric means should be used. An arithmetic mean can be misleading if it is used as the only indicator of central tendency for a distribution that is skewed, and in that case the geometric mean is more appropriate. When, however, the arithmetic mean is used with other central tendency measures, with a number of measures of variability, and with a visual display of the complete distribution, as is the

case in this report, this is no longer a problem and, in the interest of simplicity, the arithmetic mean should suffice.

Figure 4 presents the distribution for the number of puff-inhale-exhale segments per episode. Two smokers had the lowest value of three segments, nearly two standard deviations below the mean. One smoker had the highest value of 23 segments, exactly four standard deviations above the mean. A positive 1.09 value for skewness verifies numerically what is visually a distribution skewed to the right, with increasing values for the mode, median and mean of 8, 9 and 9.4, respectively. The kurtosis value of 1.63 indicates a peaked or leptokurtic distribution; here 80 percent of the cases fall within a range of 6 to 13 segments, roughly between a plus and minus one standard deviation. Another indication of the leptokurtic nature of the distribution is that the interquartile range, from the 25th to the 75th percentiles, is only four out of a total range of 20. As might be expected, a Kolmogorov D value of .134 leads to a rejection of the null hypothesis that the distribution for number of segments was randomly drawn from a normally distributed population, in this case at the .01 probability level.

The total duration of all the puffs was calculated for each observee and this sum divided by the number of segments to provide a mean puff duration per episode. The results are presented in Figure 5. Again the distribution is positively skewed, leptokurtic and with a statistically significant Kolmogorov D value of .141 ($p < .01$). Nearly one-fifth of all the cases fall at the modal value, 1.2 seconds. Just over half the cases fall between 1.0 and 1.4 seconds duration.

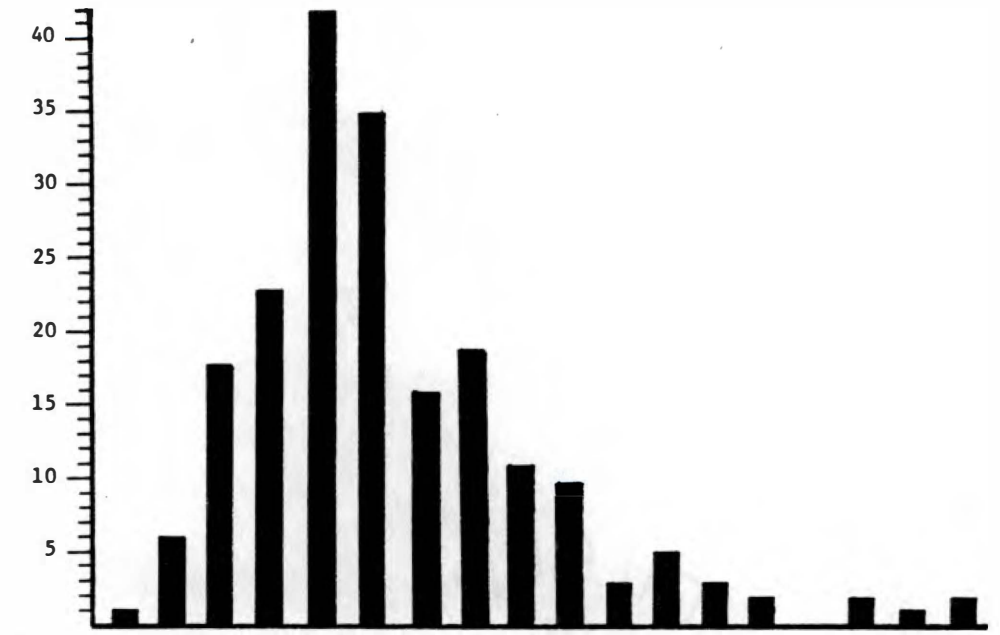


NSEG	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
FREQ	2	3	9	22	27	29	25	23	15	12	10	9	1	2	3	3	1	2	0	0	1
CUM%	1	3	7	18	32	46	59	70	78	84	89	93	94	95	96	97	98	99	99	99	100

DESCRIPTIVE STATISTICS

N = 199	100% MAX = 23
MEAN = 9.4	75% Q3 = 11
STD DEV = 3.4	50% MED = 9
COEF VAR = 36.2%	25% Q1 = 7
SKEWNESS = 1.09	0% MIN = 3
KURTOSIS = 1.63	RANGE = 20

Figure 4. Bar graph of the number of segments (NSEG), or the number of puff-inhale-exhales, per episode, with frequency of observations (FREQ) at each value, with cumulative percentages (CUM%) to the nearest 1.0 percent, and with descriptive statistics.



PFTM	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8
FREQ	1	6	18	23	42	35	16	19	11	10	3	5	3	2	0	2	1	2
CUM%	1	4	13	24	45	63	71	80	86	91	92	95	96	97	97	98	99	100

DESCRIPTIVE STATISTICS

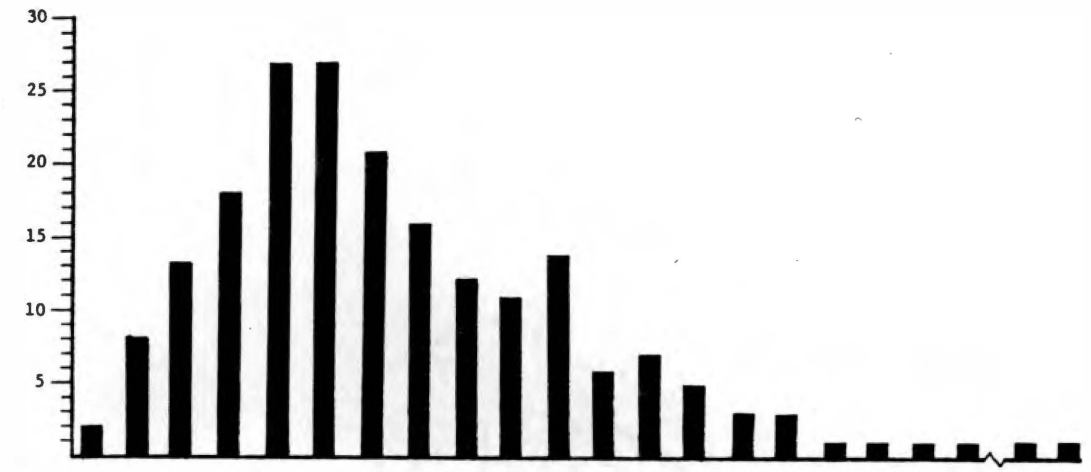
N = 199	100% MAX = 3.9 seconds
MEAN = 1.5 seconds	75% Q3 = 1.8 seconds
STD DEV = 0.6 second	50% MED = 1.3 seconds
COEF VAR = 40.0%	25% Q1 = 1.1 seconds
SKEWNESS = 1.40	0% MIN = 0.5 second
KURTOSIS = 2.46	RANGE = 3.4 seconds

Figure 5. Bar graph of the mean puff durations (PFTM) per episode, to the nearest .2 second, with frequency of observations (FREQ) at each value, with cumulative percentages to the nearest 1.0 percent, and with descriptive statistics to tne nearest .1 second.

The total inhalation duration was computed for each observee and this sum divided by the number of segments to provide a mean inhale duration per episode. Figure 6 again shows a positively skewed, leptokurtic distribution with a statistically significant Kolmogorov D value of .127 ($p < .01$). This pattern is repeated once more for mean exhale durations per episode. As can be seen in Figure 7, the distribution is positively skewed, leptokurtic and has a Kolmogorov D value of .140 ($p < .01$).

Figure 8 shows the distribution for mean segment durations, which were calculated by adding the total durations for puffs, inhales and exhales for each smoker and dividing this sum by the number of segments for that smoker. Unlike the previous distributions, this one is closer to a normal distribution, both visually and statistically. There is still some positive skewness, though less pronounced. For the first time, the distribution is on the platykurtic side. The Kolmogorov D value of .063 is not quite statistically significant ($p = .055$).

Figure 9 shows the distribution for total segment duration for each smoker. This is equivalent to the total amount of time that cigarette smoke was in the oral, nasal or broncho-pulmonary passages per episode. The distribution appears to be bi-modal at 40 and 60 seconds. It also has the largest value for skewness, 1.64, of all the distributions, although this is not visually obvious. This high skewness score most likely results in part from the one outlier at 210 seconds, a full 6.6 standard deviations above the mean. The two distinctive modes are apparently responsible for the large leptokurtic value of 8.37. Visually the distribution is closer to normal than the skewness and kurtosis

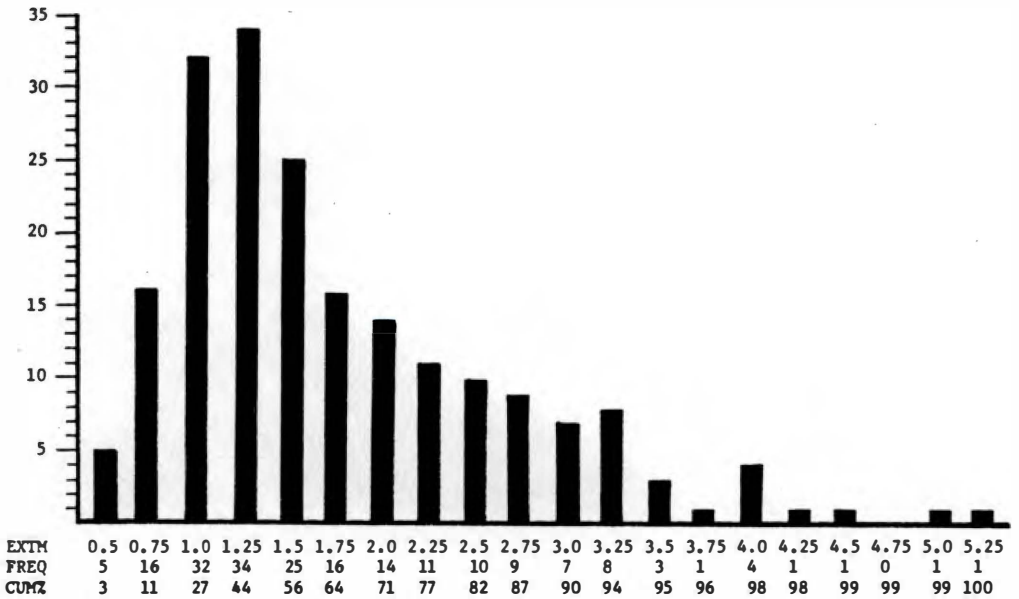


INTM	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0	3.25	3.5	3.75	4.0	4.25	4.5	4.75	5.0	5.25	5.5	5.75	6.75	7.0
FREQ	2	8	13	18	27	27	21	16	12	11	14	6	7	5	3	3	1	1	1	1	1	1
CUM%	1	5	12	21	34	48	58	66	72	78	85	88	92	94	95	97	97	98	98	99	99	100

DESCRIPTIVE STATISTICS

N = 199	100% MAX = 7.1 seconds
MEAN = 2.6 seconds	75% Q3 = 3.2 seconds
STD DEV = 1.0 second	50% MED = 2.4 seconds
COEF VAR = 38.5%	25% Q1 = 1.9 seconds
SKEWNESS = 1.27	0% MIN = 0.9 second
KURTOSIS = 2.43	RANGE = 6.2 seconds

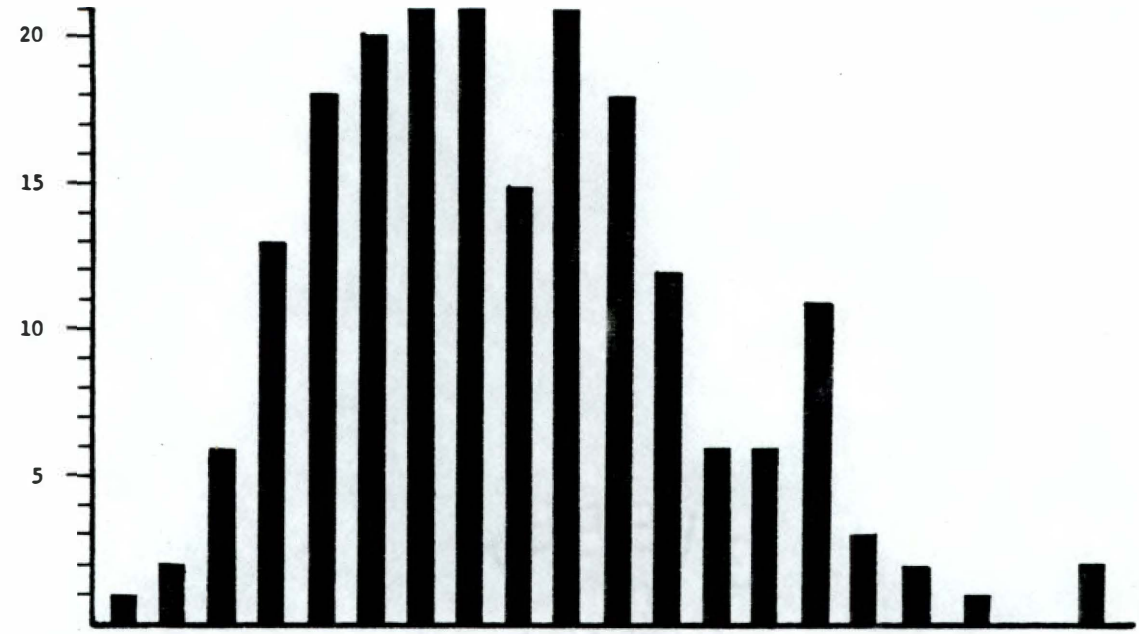
Figure 6. Bar graph of the mean inhale durations (INTM) per episode, to the nearest .25 second, with frequency of observations (FREQ) at each value, with cumulative percentages (CUM%) to the nearest 1.0 percent, and with descriptive statistics to the nearest .1 second.



DESCRIPTIVE STATISTICS

N = 199	100% MAX = 5.3 seconds
MEAN = 1.8 seconds	75% Q3 = 2.3 seconds
STD DEV = 0.9 second	50% MED = 1.5 seconds
COEF VAR = 50.0%	25% Q1 = 1.1 seconds
SKEWNWSS = 1.21	0% MIN = 0.5 second
KURTOSIS = 1.36	RANGE = 4.8 seconds

Figure 7. Bar graph of the mean exhale durations (EXTM) per episode, to the nearest .25 second, with frequency of observations (FREQ) at each value, with cumulative percentages (CUM%) to the nearest 1.0 percent, and with descriptive statistics to the nearest .1 second.

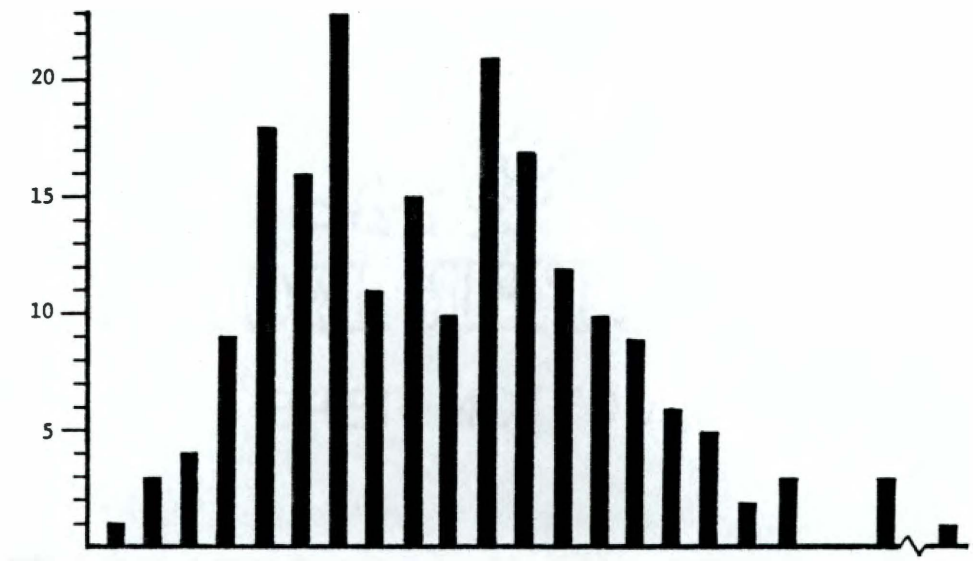


SGTM	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5
FREQ	1	2	6	13	18	20	21	21	15	21	18	12	6	6	11	3	2	1	0	2
CUM%	1	2	5	11	20	30	41	51	59	69	78	84	87	90	96	97	98	99	99	100

DESCRIPTIVE STATISTICS

N = 199	100% MAX = 11.7 seconds
MEAN = 5.9 seconds	75% Q3 = 7.1 seconds
STD DEV = 1.8 seconds	50% MED = 5.7 seconds
COEF VAR = 30.5%	25% Q1 = 4.5 seconds
SKEWNESS = 0.51	0% MIN = 2.2 seconds
KURTOSIS = -0.10	RANGE = 9.5 seconds

Figure 8. Bar graph of the mean segment durations (SGTM) per episode, to the nearest .5 second, with frequency of observations (FREQ) at each value, with cumulative percentages (CUM%) to the nearest 1.0 percent, and with descriptive statistics to the nearest .1 second.



DESCRIPTIVE STATISTICS

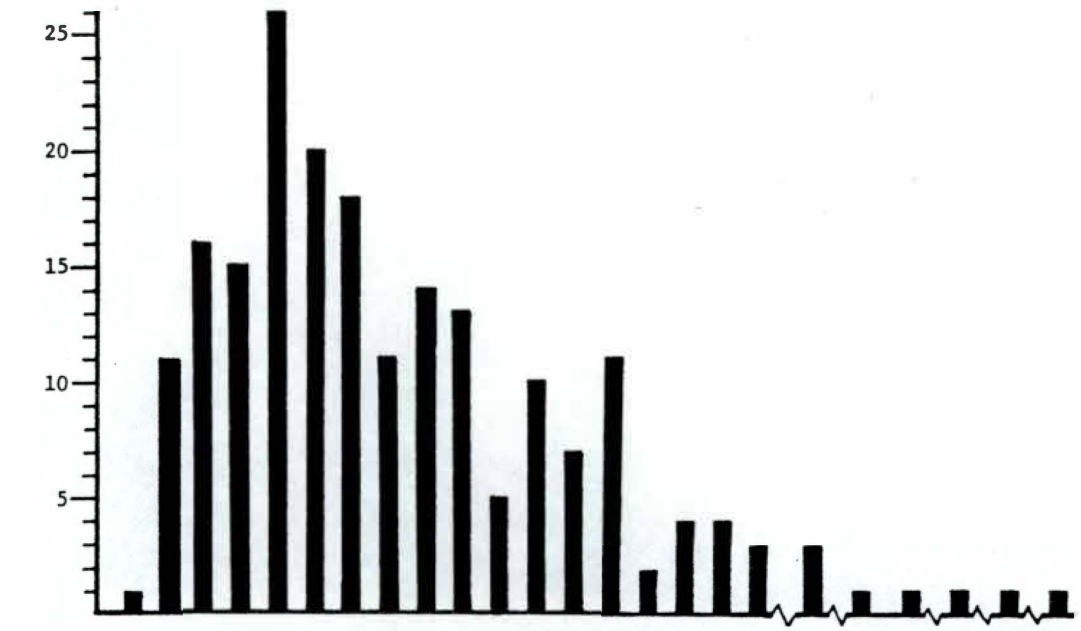
N = 199	100% MAX = 210.4 seconds
MEAN = 54.5 seconds	75% Q3 = 67.8 seconds
STD DEV = 23.7 seconds	50% MED = 52.0 seconds
COEF VAR = 43.5%	25% Q1 = 37.2 seconds
SKEWNESS = 1.64	0% MIN = 10.1 seconds
KURTOSIS = 8.37	RANGE = 200.3 seconds

Figure 9. Bar graph of the total segment durations (SGTL) per episode, to the nearest 5.0 seconds, with frequency of observations (FREQ) at each value, with cumulative percentages (CUM%) to the nearest 1.0 percent, and with descriptive statistics to the nearest .1 second.

scores would lead one to believe. And this is borne out by a relatively small although still statistically significant Kolmogorov D value of .068 ($p = .024$).

Figure 10 shows the distribution for the mean interval per episode. Here we are back to a positive skewness seen in the earlier figures. The distribution is also again leptokurtic and the Kolmogorov D value of .112 is statistically significant ($p < .01$). And Figure 11 shows the distribution for the total episode durations, calculated as the amount of time from the beginning of the first puff until the end of the last exhale. With the exception of a few positive outliers, the distribution appears close to normal and this is the case statistically with relatively low values for skewness and kurtosis and with a nonsignificant Kolmogorov D value of .059 ($p = .09$).

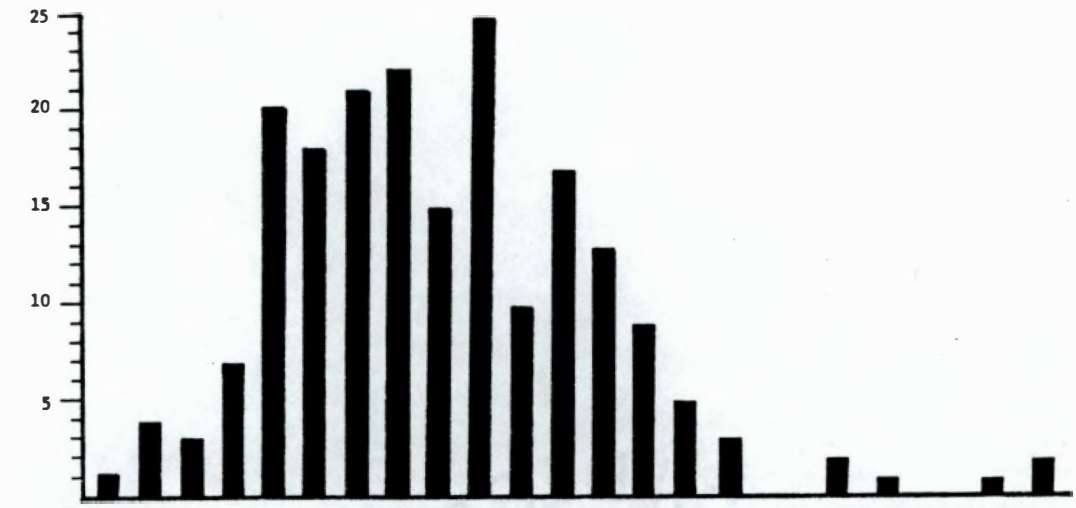
Observations numbers 82 through 91 were timed on two occasions, first on 11-17-81 and again on 12-14-81. The total durations were computed for puffs, inhales, exhales and intervals for both timings. These were compared for each observation and the percent of absolute errors calculated. This resulted in 40 different error percentages, one for each puff, inhale, exhale and interval across the 10 observations. The average absolute error was 2.34% for puff duration with a range from 0.8% to 5.0%; 1.5% for inhale duration with a range from 0.3% to 3.8%; 1.7% for exhale duration with a range from 0.0% to 3.9%; and 0.6% for interval duration with a range from 0.05% to 1.5%. The overall average absolute error rate was 1.54%, the median 1.05% and the range from 0.0% to 5.0%.



DESCRIPTIVE STATISTICS

N = 199	100% MAX = 204.9 seconds
MEAN = 47.8 seconds	75% Q3 = 61.8 seconds
STD DEV = 28.2 seconds	50% MED = 40.6 seconds
COEF VAR = 59.0%	25% Q1 = 29.6 seconds
SKEWNESS = 1.95	0% MIN = 12.4 seconds
KURTOSIS = 6.26	RANGE = 192.5 seconds

Figure 10. Bar graph of the mean interval durations (INTV) per episode, to the nearest 5.0 seconds, with frequency of observations (FREQ) at each value, with cumulative percentages (CUM%) to the nearest 1.0 percent, and with descriptive statistics to the nearest .1 second.



EPTM	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
FREQ	1	4	3	7	20	18	21	22	15	25	10	17	13	9	5	3	0	2	1	0	1	2
CUM%	1	3	4	8	18	27	37	48	56	68	73	82	88	93	95	97	97	98	98	98	99	100

DESCRIPTIVE STATISTICS

N = 199	100% MAX = 13.2 minutes
MEAN = 6.6 minutes	75% Q3 = 7.8 minutes
STD DEV = 1.9 minutes	50% MED = 6.4 minutes
COEF VAR = 28.8%	25% Q1 = 5.2 minutes
SKEWNESS = 0.65	0% MIN = 2.7 minutes
KURTOSIS = 0.85	RANGE = 10.5 minutes

Figure 11. Bar graph of the total episode durations (EPTM), to the nearest .5 minute, with frequency of observations (FREQ) at each value, with cumulative percentages (CUM%) to the nearest 1.0 percent, and with descriptive statistics to the nearest .1 minute.

Figures 4 through 11 have presented the main results of this study. Additional information was collected and analyzed and these results are presented next. These analyses frequently use *t* tests and analysis of variance F tests. An assumption of both these tests is a normal distribution of scores for the variables involved. Since several of the distributions for smoking parameter scores are skewed and leptokurtic, the question arises, will this threaten the validity of these tests? In the present case there are two reasons why the departure from normality of the distributions will not threaten the validity of the tests. The first reason is the relatively large sample size which in itself reduces any threat of a non-normal distribution to the validity of the *t* and F tests. The second reason is the robustness of these tests to violations of the assumption of normally distributed scores. In the case of the *t* test, "So long as the sample is even moderate for each group, quite severe departures from normality seem to make little practical difference in the conclusions reached" (Hayes, 1963, p. 322). And regarding the F test, "There is ample evidence that marked skewness [or] departures from normal kurtosis do not greatly disrupt the F test as a basis for judging significance in the analysis of variance" (McNemar, 1969, p. 288). For these reasons, the large sample size and the robustness of the tests, analyses were conducted using untransformed raw scores for the various smoking parameters.

There is considerable interest in the role of nicotine level in cigarette smoking and several analyses were conducted to see what light the present data could shed on this issue. As can be seen in Table 1 (p. 92), all correlations between nicotine level and the smoking

parameters are quite small, and only two, the ones for mean interval duration (.26) and for episode duration (.19), are statistically significant.

The low correlation coefficients could be partly due to the fact that the bulk of the cases fall in the middle ranges for nicotine levels and this may mask or wash out any relationship between the lower or higher nicotine levels and smoking parameters. With this possibility in mind, nicotine level was converted from a continuous scale to a four-level nominal one. The lowest level, designated "ANICLEV," contains smokers of brands with FTC nicotine ratings of .45 mg and below and has an n of 28; "BNICLEV," those with FTC ratings from .46 to .75 mg nicotine with an n of 82; "CNICLEV," those with FTC ratings from .76 to 1.15 mg nicotine with an n of 67; and "DNICLEV," those with FTC ratings of 1.16 mg nicotine and over with an n of 22.

Analyses of variance (ANOVA's) were conducted for the eight smoking parameters across the four nicotine levels and, as can be seen in Table 2, three parameters, the number of segments, the mean interval per episode and episode duration, produced statistically significant F ratios. Duncan's Multiple Range Test (DMRT) shows that the differences in two cases come from the DNICLEV group. Apparently smokers of the higher range nicotine cigarettes took fewer puff-inhale-exhales and these at longer intervals than those smoking the lower level nicotine cigarettes. According to the DMRT, the mean interval duration for ANICLEV of 35.8 seconds is not statistically significant, although it is 29.2 seconds shorter than the mean interval duration for DNICLEV. In other words, there is an 81.6% increase in the mean interval durations

TABLE 2

MEANS AND F RATIOS FOR NUMBER OF SEGMENTS (NSEG), MEAN INTERVAL DURATIONS (INTV), BOTH PER EPISODE, AND EPISODE DURATIONS (EPTM), ACROSS NICOTINE LEVELS

NICOTINE LEVEL	N	NSEG[1]	INTV[2]	EPTM[2]
ANICLEV (.45 mg & below)	28	9.3	35.8	328.5*
BNICLEV (.46 mg to .75 mg)	82	9.5	47.5	393.4
CNICLEV (.76 mg to 1.15 mg)	67	9.9	47.5	420.1
DNICLEV (1.16 mg & over)	22	7.5*	65.0*	399.1
		F = 2.85 (p = .038)	F = 4.66 (p = .004)	F = 4.62 (p = .004)

[1]To the nearest .1.

[2]To the nearest .1 second.

*Significantly different by Duncan's Multiple Range Test with alpha = .05.

going from the lowest to the highest nicotine level, and although this is not a statistically significant difference according to the DMRT, this may be a case where clinical or research considerations may outweigh statistical ones. The mean episode duration for ANICLEV did reach significance as the shortest of the four groups.

Nicotine level is also associated with two other variables, sex and estimated age of the smoker. Males smoked cigarettes delivering a mean of .84 mg nicotine while females smoked cigarette delivering a mean of

.75 mg nicotine (t = 2.12, p = .035). The oldest age group, those estimated to be 60 and over, smoked cigarettes delivering a mean of .99 mg nicotine, a value that is significantly different (F = 3.49, p = .017) from the means of the three younger levels, .79 mg for ages 29 and under, .77 mg for ages 30 to 39, and .73 mg for ages 40 to 59.

No statistically significant differences were found between males and females for the eight smoking parameters. Females were, however, more likely to smoke 100mm brand cigarettes than were males (chi^2 = 12.4, p = .0004). Although no sex differences were found for puffing or inhaling styles, males were more likely to have all multiple exhales than were females (chi^2 = 12.5, p = .002). Males were also more likely than females to exhale through the nose only or through the mouth and nose while females were more likely to exhale through the mouth only (chi^2 = 16.3, p = .0003).

Some other sex differences in smoking style turned up, the most consistent being a difference in the way the cigarette was held. Females were far more likely to hold their cigarette between the index and middle fingers only (92 out of the 98 females held their cigarette in this manner), while males were more likely to hold their cigarette in a combination of ways, i. e., to switch the cigarette, say from an index-middle finger position to a thumb-index or thumb-index-middle finger position (chi^2 = 36.7, p = .0001). Males were more likely than females to hold their cigarette in their lips at some point during the episode; 15 out of 101 males while 6 out of 98 females did so (chi^2 = 4.63, p = .05). In terms of how smokers extinguished their cigarettes, males were more likely than females to do so by flipping or throwing away the still lit

butt (chi^2 = 6.53, p = .01). And finally, in terms of the arm position of the hand holding the cigarette, more males than would be expected held theirs perpendicular to the floor, while more females than would be expected held theirs parallel to the floor or in a combination of positions (chi^2 = 13.68, p = .005).

Some other variables turned out to be related to smoking parameters and styles. Both number of segments per episode and total segment durations per episode differed significantly across time of day. The mean number of segments was 10.4 in the morning, 9.5 in the afternoon and 8.8 in the evening (F = 3.08, p = .048). The DMRT showed that the morning differed significantly from the afternoon and evening and that the evening differed significantly from the morning and afternoon. The total segment duration was 63.8 seconds in the morning, 53.8 seconds in the afternoon and 50.1 seconds in the evening (F = 4.83, p = .009). The DMRT showed that the total segment duration per episode for the morning was significantly different from those in the afternoon and evening.

Four parameters, number of segments, mean exhale durations, mean segment durations and total segment durations, all per episode, differed significantly across locations. These results are presented in Table 3. According to the DMRT's, the mean number of segments was greatest for smokers in the student center (10.7), the mean exhale duration was shortest for smokers in the lounges (1.3 seconds), the mean segment duration was shortest for smokers in the lounges (5.2 seconds) and in the student center (5.7 seconds), and the total segment duration was shortest for smokers in the lounges (44.3 seconds).

TABLE 3

MEANS AND F RATIOS FOR NUMBER OF SEGMENTS (NSEG), MEAN EXHALE DURATIONS (EXTM), MEAN SEGMENT DURATIONS (SGTM), AND TOTAL SEGMENT DURATIONS (SGTL), ALL PER EPISODE, ACROSS LOCATIONS

	N	NSEG[1]	EXTM[2]	SGTM[2]	SGTL[2]
CAFETERIAS	64	9.2	1.9	6.4	57.6
BALL PARK	41	8.9	2.0	6.1	54.3
STUDENT CENTER	53	10.7*	1.8	5.7*	59.0
LOUNGES	41	8.6	1.3*	5.2*	44.3*
		F = 3.85 (p = .010)	F = 5.30 (p = .002)	F = 3.71 (p = .012)	F = 3.68 (p = .013)

[1]To the nearest .1.

[2]To the nearest .1 second.

*Significantly different by Duncan's Multiple Range Test with alpha = .05.

Compared to the 145 smokers whose cigarette was not the first cigarette after finishing a meal, the 51 observees smoking their first cigarette after a meal (3 had missing data) had a longer mean puff duration (1.7 vs 1.4 seconds), a longer mean inhale duration (2.9 vs 2.6 seconds) and a longer mean exhale duration (1.9 vs 1.7 seconds). Of these, only mean puff durations reached statistical significance, but when the three are added to give mean segment durations, the resulting 6.5 vs 5.7 seconds is statistically significant (t = 2.34, p = .02).

Four smoking parameters are related to the estimated age of the smokers (see Table 4). The 29 and under group differed significantly from

TABLE 4

MEANS AND F RATIOS FOR MEAN PUFF DURATIONS (PFTM), MEAN EXHALE DURATIONS (EXTM), MEAN SEGMENT DURATIONS (SGTM), AND TOTAL SEGMENT DURATIONS (SGTL), ALL PER EPISODE, ACROSS AGES

AGES	N	PFTM[1]	EXTM[1]	SGTM[1]	SGTL[1]
29 & UNDER	89	1.3*	1.6*	5.4*	49.9*
30 - 39	44	1.5	1.9	6.0	54.9
40 - 59	43	1.8*	1.9	6.6*	61.5*
60 & OVER	23	1.7	2.0*	6.4	58.5
		F = 6.84 (p = .0003)	F = 2.52 (p = .058)	F = 5.11 (p = .002)	F = 2.66 (p = .048)

[1]To the nearest .1 second.

*Significantly different by Duncan's Multiple Range Test with alpha = .05.

the other three groups by having the lowest values on all four parameters, 1.3 seconds for mean puff duration, 1.6 seconds for mean exhale duration, 5.4 seconds for mean segment duration and 49.9 seconds for total segment duration. (Even though the F ratio for mean exhale durations was of "borderline" significance---p = .058---since the DMRT with alpha at .05 still showed significance, it was included in Table 4.) The 40 to 59 group had the highest values on three parameters, 1.8 seconds for mean puff duration, 6.6 seconds for mean segment duration and 61.5 seconds for total segment duration. The 60 and over group had the longest mean exhale duration of 2.0 seconds.

Since the estimated weight of the smokers was not independent of their sex, i. e., males tended to have higher estimated weights, the analyses were performed across weight by sex. In order to have sufficiently large cell sizes, estimated weight was divided into four levels; 125 lbs. (56.7 kg) and under, 126 to 145 lbs. (57.2 to 65.8 kg), 146 to 165 lbs. (66.2 to 74.8 kg), and 166 lbs. (75.3 kg) and over. No significant differences were found for the smoking parameters across weight by sex.

Thirty-seven of the observees were alone while smoking, 71 were with one or more others, at least one of whom was smoking coincidentally with the observee, and 91 were with one or more others, none of whom were smoking coincidentally with the observee. No significant differences were found for any of the smoking parameters across the three groups.

Twenty-nine observees took puffs that were judged "light," 101 "medium" and 69 "deep." As can be seen in Table 5, comparisons across these three groups produced statistically significant differences in six smoking parameters and a "borderline" difference in a seventh parameter. Deep puffers smoked cigarettes with significantly lower nicotine yields. Light puffers had the highest number of segments per episode. All three groups differed significantly on mean puff durations, light puffers having the shortest and deep puffers having the longest. Light puffers had the shortest mean durations for inhales, exhales and segments, while deep puffers had the longest total segment duration per episode. This latter difference produced an F ratio of 2.79 with $p = .064$, but the difference is more than 10 seconds greater than for the light puffers, and the DMRT showed a statistically significant difference with alpha = .05, and for these reasons it was included in Table 5.

TABLE 5

MEANS AND F RATIOS FOR NICOTINE (NICO), NUMBER OF SEGMENTS (NSEG), MEAN PUFF DURATIONS (PFTM), MEAN INHALE DURATIONS (INTM), MEAN EXHALE DURATIONS (EXTM), MEAN SEGMENT DURATIONS (SGTM), AND TOTAL SEGMENT DURATIONS (SGTL), ALL PER EPISODE, ACROSS PUFF

PUFF	N	NICO[1]	NSEG[2]	PFTM[3]	INTM[3]	EXTM[3]	SGTM[3]	SGTL[3]
LIGHT	29	.86	10.9*	1.1*	2.2*	1.4*	4.7*	49.7
MEDIUM	101	.84	9.1	1.4	2.6	1.8	5.9	52.3
DEEP	69	.69*	9.1	1.8*	2.8	1.9	6.5	59.8*
		F = 5.31 (p = .006)	F = 3.40 (p = .035)	F = 19.95 (p < .0001)	F = 3.85 (p = .023)	F = 3.98 (p = .020)	F = 11.91 (p < .0001)	F = 2.79 (p = .064)

[1]To the nearest .01 mg.

[2]To the nearest .1.

[3]To the nearest .1 second.

*Significantly different by Duncan's Multiple Range Test with alpha = .05.

Only 22 out of the 199 observees took one or more double puffs during their smoking episodes. Taking a double puff was not significantly related to the sex of the smoker or the nicotine rating of the cigarette. As would be expected, when compared to single puffers, double puffers had a significantly longer mean puff duration, 2.3 vs 1.4 seconds ($\underline{t} = 5.34$, $p < .0001$). Double puffers also had longer mean and total segment durations, 7.1 vs 5.8 seconds ($\underline{t} = 3.33$, $p = .001$) and 71.7 vs 52.4 seconds ($\underline{t} = 2.47$, $p. = .021$), respectively. And finally, double puffers had a shorter mean interval duration than did single puffers, 30.3 vs 42.4 seconds ($\underline{t} = 2.53$, $p = .012$).

Thirty-five observees took inhales that were judged "shallow," 152 that were judged "medium" and only seven that were judged "deep" (five had missing values). Depth of inhale was not related to the sex of the smoker or to the cigarette's nicotine rating. It was related to puff intensity, with more shallow inhalers taking light puffs than would be expected, more medium inhalers taking medium puffs than would be expected, and more deep inhalers taking deep puffs than would be expected ($chi^2 = 86.53$, $p < .0001$). As can be seen in Table 6, depth of inhale is related to three smoking parameters, although in this case the F ratios are statistically significant while the DMRT's are not. This is most likely due to the small cell size for deep inhalers. Because of this, the most reliable comparisons would be between the shallow and medium inhalers, with the shallow inhalers having the lower values for mean inhale, exhale and segment durations per episode.

One hundred and twenty-eight observees had all single exhales, 45 had all multiple exhales and 26 had some of both. Type of exhale was

TABLE 6

MEANS AND F RATIOS FOR MEAN INHALE DURATIONS (INTM), MEAN EXHALE DURATIONS (EXTM), AND MEAN SEGMENT DURATIONS (SGTM), ALL PER EPISODE, ACROSS INHALE

INHALE	N	INTM[1]	EXTM[1]	SGTM[1]
SHALLOW	35	2.1	1.4	4.8
MEDIUM	152	2.7	1.9	6.1
DEEP	7	2.7	1.3	5.6
		F = 5.72 (p = .004)	F = 4.96 (p = .008)	F = 7.40 (p < .001)

[1]To the nearest .1 second.

related to the sex of the smoker, with more males and fewer females taking all multiple exhales than would be expected, and more females and fewer males taking both single and multiple exhales than would be expected ($chi^2 = 12.53$, $p = .002$). Type of exhale was not related to the nicotine rating of the cigarette. Whether the smoker took all single, all multiple or some of both types of exhales was related to whether the smoke was exhaled only through the mouth or exhaled through the mouth and nose. For those with single exhales only, more than would be expected exhaled through the mouth only and fewer than would be expected through the mouth and nose; and for those with all multiple exhales, fewer than would be expected exhaled through the mouth only and more than would be expected exhaled through the mouth and nose ($chi^2 = 63.26$, $p < .0001$). In other words, those who exhaled in a single breath tended

to do so through the mouth while those who exhaled with two or more breaths tended to do so through both the mouth and nose.

Four smoking parameters showed statistically significant differences across exhale type and these are presented in Table 7. Smokers with all single exhales have the lowest values for mean inhale, mean exhale, mean segment and total segment durations. Smokers with all multiple exhales have the highest values for mean exhale, mean segment and total segment durations, while smokers with some of both types of exhales are intermediate on these parameters.

Seven smokers exhaled through their noses only, 120 through their mouths only and 72 through some of both. The exhale through the mouth

TABLE 7

MEANS AND F RATIOS FOR MEAN INHALE DURATIONS (INTM), MEAN EXHALE DURATIONS (EXTM), MEAN SEGMENT DURATIONS (SGTM), AND TOTAL SEGMENT DURATIONS (SGTL), ALL PER EPISODE, ACROSS TYPE OF EXHALE

TYPE OF EXHALE	N	INTM[1]	EXTM[1]	SGTM[1]	SGTL[1]
ALL SINGLE	128	2.4*	1.4*	5.2*	47.5*
ALL MULTIPLE	45	3.1	2.9*	7.5*	71.0*
SOME OF BOTH	26	3.1	1.9*	6.5*	60.1*
		F = 10.98 ($p < .0001$)	F = 81.40 ($p < .0001$)	F = 37.16 ($p < .0001$)	F = 21.06 ($p < .0001$)

[1]To the nearest .1 second.

*Significantly different by Duncan's Multiple Range Test with alpha = .05.

only group had the shortest mean exhale duration of 1.4 seconds as compared to 2.6 seconds for the nose only group and 2.3 seconds for the some of both group ($F = 31.29$, $p < .0001$). A similar pattern turned up for mean segment duration, with 5.5 seconds for the mouth only group, 6.8 seconds for the nose only group and 6.6 seconds for the some of both group ($F = 9.03$, $p = .0002$).

The exhaled and sidestream smoke was judged "light" for 61 smokers, "medium" for 103 and "heavy" for 31 (four had missing values). The mean nicotine rating of the cigarettes for those whose smoke was judged light is significantly lower than for the other two groups, as can be seen in Table 8. Three smoking parameters also differed across smoke intensity

TABLE 8

MEANS AND F RATIOS FOR NICOTINE (NICO), NUMBER OF SEGMENTS (NSEG), MEAN EXHALE DURATIONS (EXTM), AND TOTAL SEGMENT DURATIONS (SGTL), ALL PER EPISODE, ACROSS SMOKE

SMOKE	N	NICO[1]	NSEG[2]	EXTM[3]	SGTL[3]
LIGHT	61	.67*	10.3*	1.7	61.6*
MEDIUM	103	.83	9.1*	1.7	51.1
HEAVY	31	.95	8.4*	2.1*	50.1
		F = 5.31 (p = .006)	F = 3.85 (p = .023)	F = 3.11 (p = .047)	F = 4.21 (p = .015)

[1]To the nearest .01 mg.

[2]To the nearest .1.

[3]To the nearest .1 second.

*Significantly different by Duncan's Multiple Range Test with alpha = .05.

levels. Observees whose smoke was judged light had the highest number of segments and the longest total segment duration, while those whose smoke was judged heavy had the lowest number of segments and the longest mean exhale duration.

The activity level of 44 smokers was judged "low," 130 "moderate" and 24 "high" (one had a missing value). More smokers of cigarettes in the two higher nicotine levels were judged low on activity level than would be expected ($chi^2 = 12.61$, $p = .049$). Activity level was also associated with four smoking parameters, as can be seen in Table 9. Those judged low on activity level had the lowest mean number of segments, but with the longest mean puff, inhale and segment durations.

TABLE 9

MEANS AND F RATIOS FOR NUMBER OF SEGMENTS (NSEG), MEAN PUFF DURATIONS (PFTM), MEAN INHALE DURATIONS (INTM), AND MEAN SEGMENT DURATIONS (SGTM), ALL PER EPISODE, ACROSS ACTIVITY LEVEL

ACTIVITY LEVEL	N	NSEG[1]	PFTM[2]	INTM[2]	SGTM[2]
LOW	44	8.5*	1.8*	3.1*	6.9*
MODERATE	130	9.4*	1.4	2.5	5.6
HIGH	24	10.5*	1.4	2.6	5.6
		F = 2.91 (p = .057)	F = 5.81 (p = .004)	F = 6.47 (p = .002)	F = 9.04 (p = .0002)

[1]To the nearest .1.

[2]To the nearest .1 second.

*Significantly different by Duncan's Multiple Range Test with alpha = .05.

Those judged high on activity level had the highest mean number of segments while those judged moderate on activity level were intermediate on mean number of segments.

One hundred and eight observees smoked "king-sized," 87mm filtered cigarettes, 85 smoked the 100mm cigarettes, while only six smoked unfiltered brands. Length of cigarette was associated with three smoking parameters; compared to those smoking 87mm cigarettes, smokers of 100mm cigarettes had a higher mean number of segments, 10.6 vs 8.5 ($\underline{t}$ = 4.73, $p < .0001$), a higher total segment duration, 59.5 vs 51.1 seconds ($\underline{t}$ = 2.38, $p = .019$), and a longer episode duration, 425 vs 370 seconds ($\underline{t}$ = 3.34, $p = .001$).

Forty-seven smokers put their cigarette down at some point during the episode while 152 held their cigarette continuously. This variable, however, was not associated with any significant differences in any of the smoking parameters.

In terms of holding styles, seven held their cigarette between their thumb and index finger, one between her thumb, index and middle finger, 147 between their index and middle finger, and 41 used a combination of holding styles (three had missing values). Twenty-one held the cigarette in their lips at some point during the episode, while the remaining 178 never did so. Eighty-four held their cigarette solely in their right hand, 57 solely in their left hand, and 57 some of both (one had a missing value). Forty-six smokers inhaled the smoke from the initial light-up puff, while 140 waited until the second or third puff before inhaling (13 had missing values). Forty-three lit their cigarette with safety matches, 91 with disposable lighters, five with mechanical "Zippo" type lighters, and two with someone else's cigarette (58 had missing values).

One hundred smokers extinguished their cigarettes by crushing them in ashtrays, 31 by crushing them on the floor by foot, 11 by flipping or throwing away the still lit butt, and 24 by some other method such as stuffing it into their mashed potatoes or dunking it into a coke cup (33 had missing values). And finally, 104 held the forearm of the hand with the cigarette perpendicular to the floor all during the episode, 32 parallel to the floor (except while puffing), four downward toward the floor, and 50 held their forearm in a combination of positions (9 had missing values).

CHAPTER VII

DISCUSSION

The discussion of the main results presented in the previous chapter will first look at how they address the issue of the external validity of laboratory studies of cigarette smoking, then how the results compare to other observational studies of cigarette smoking, then assess the adequacy of the recording techniques here employed, then comment on the nature of the eight smoking parameters, and then look at how the results relate to a smoker typology. The chapter will continue with a discussion of the secondary results, i. e., the relationship between the smoker and situational variables and the smoking parameters and patterns. And finally, limitations of the study will be discussed with suggestions for further research.

External validity. During a study of the effects of smoking on blood flow in the hand, Shepherd (1951) asked his subjects how often they normally inhaled during smoking. The usual reply was about every 15 seconds. Shepherd adopted this rate of inhalation in a preliminary series of experiments. He observed, however, that

> generalized reactions, notably dizziness, nausea, and a feeling of faintness, commonly followed inhalation at this rate. Two subjects would probably have lost consciousness if the experiment had not been terminated. A series of observations was therefore made to determine the normal rate of inhalation. Fifty males were surreptitiously observed inhaling tobacco smoke in buses, restaurants and public and private houses. The average rate of inhalation was determined for each subject, and the results are shown in Figure [12]. . . . The average of all observations was 66 seconds (p. 1008).

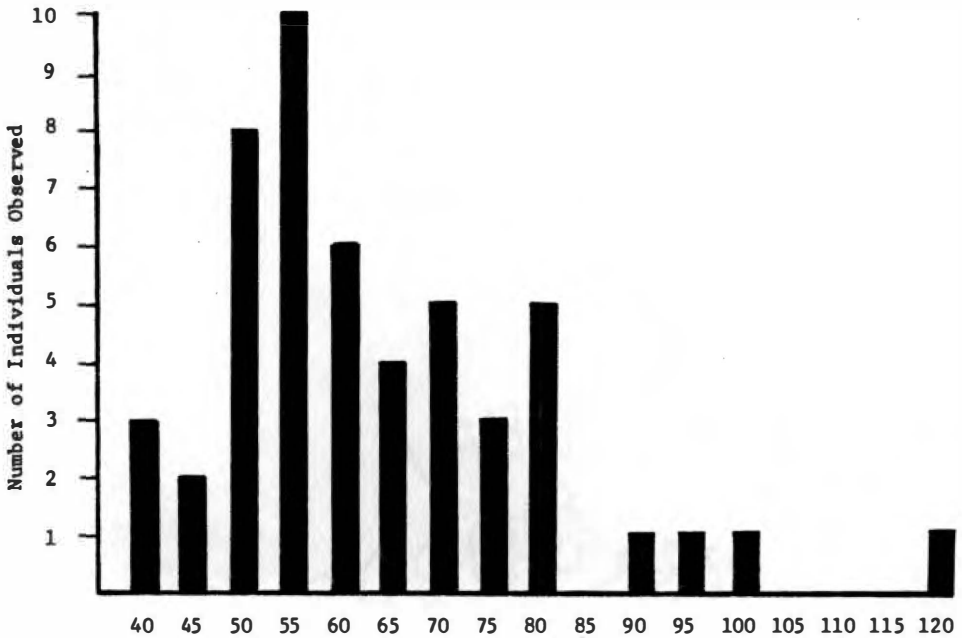


Figure 12. Average interval between inhalations (Seconds).

Shepherd (1951) ran another series of experiments using a 60 second interval, and with this schedule there were neither signs of acute toxic reactions nor any significant decrease in hand blood flow, the latter having been reported in several previous studies. When Shepherd changed the schedule to 20 second intervals between inhalations, hand blood flow was reduced.

> The reason for the discrepancy seems to be the difference in the frequency of inhalation. In order to determine the effect of normal cigarette smoking on circulation, it is essential that the subject should inhale at his normal rate, and it appears from the literature that in the past insufficient attention has been given to this point (p. 1010).

Apparently Shepherd's advice did not reach a wide audience or else it was quickly forgotten because the attention given to this point by cigarette smoking researchers has continued to be insufficient. For

example, another discrepancy in results in the cardiovascular area involves the effects of cigarette smoking on heart rate. Many studies over the years have reported increases in heart rate following cigarette smoking in laboratory settings (e. g., Fisher, 1927; Roth, McDonald & Sheard, 1944; Elliot & Thysell, 1968; Frankenhaeuser, Myrsten & Post, 1970). But when Erwin (1971) measured heart rate using radiotelemetry, which allowed the smokers to move about their hospital ward and to smoke under more naturalistic conditions, he found no increases in heart rate following cigarette smoking. Erwin proposed, as had Shepherd 20 years earlier, that the discrepancy was due to higher than normal smoking rates in the laboratory studies.

And it is to this issue of external validity, of using standardized smoking patterns in the laboratory which are like those occurring outside the lab that the main results of the present study most profitably address. Many studies of the effects of cigarette smoking are of questionable value because of their suspect external validity. Some reports give little or no information about smoking schedules: "All but one inhaled the smoke with the depth and frequency to which they were accustomed" (Rehder & Roth, 1959, p. 225); "The smokers all smoked a cigarette" (Krut, Perrin & Bronte-Stewart, 1961, p. 384); "The patient was given a nonfilter cigarette and instructed to smoke rapidly" (Webster, 1964, p. 906); "The subject was instructed to inhale in his usual manner" (Frankenhaeuser, Myrsten, Post & Johansson, 1971, p. 2); or "Each smoker was asked to try to puff in his usual way, and nonsmokers were asked to inhale as deeply as possible" (Armitage, Dollery, George, Houseman, Lewis & Turner, 1975, p. 314).

For many of the studies on cigarette smoking which do provide information on the smoking schedules used, it appears in the light of the present data that they have chosen unusual or atypical ones. In a study on the effects of cigarette smoking on the patellar reflex, for example, Domino and von Baumgarten (1969) advised their subjects "to smoke each cigarette in a series of deep inhaling puffs within a period of 4 minutes" (p. 73). Compared to the present results, where only seven smokers (3.5%) were judged to be deep inhalers and only 15 (7.5%) smoked their cigarette in four minutes or less, Domino and von Baumgarten's schedule is not a representative one.

In a study of the effects of cigarette smoking on muscle tonus, Fagerstrom and Gotestam (1977) had interpuff intervals of 10 seconds for one group and 20 seconds for two other groups. Again this is an atypical smoking schedule; as can be seen in Figure 10 (p. 104), only one smoker out of 199 had a mean interval of 10 seconds and a 20 second interval falls at the 14th percentile.

In a study of the effects of cigarette smoking on free recall (Houston, Schneider & Jarvik, 1978), the subjects took 12 puffs, "a puff every 25 seconds and held the smoke in for 5 seconds" (p. 221). Compared to the present data, Houston et al.'s parameters fall at the 84th percentile for number of puffs (segments), the 22nd percentile for intervals and the 97th percentile for inhale duration.

In all these examples, a lack of information about the smoking schedules used or the atypical nature of those schedules which are described casts doubts on the validity of their results. An exhaustive review would include many more examples.

Another case where the present data suggest that atypical smoking schedules are being used is with the FTC's measurement of tar and nicotine deliveries of commercially available domestic cigarettes. This is done by collecting the particulate phase of cigarette smoke using a machine programmed to "smoke" cigarettes at the rate of a two second puff every 60 seconds. (The cigarettes are smoked to a given butt length, so the number of puffs per cigarette is not specified.) These parameters fall at the 86th and 75th percentiles, respectively, of the distributions for mean puff and interval durations (Figure 5, p. 107 and Figure 10, p. 104). The FTC figures may provide a relative ranking of tar and nicotine yields, but they do not provide accurate figures in terms of the machine settings being representative of the smoking patterns of the smokers observed in the present study.

Comparison to other studies. Another topic of discussion is how do the present data compare to the results of other unobtrusive studies of cigarette smoking. I have found only three studies reporting observations of cigarette smoking in naturalistic settings, only one of which (Shepherd, 1951) had come to my attention before the present data were collected. In all three cases "surreptitiously" is the word used to describe their method of observation. Shepherd's (1951) study has already been discussed; his overall average interval between puffs of 66 seconds is 18.2 seconds more than the average interval of 47.8 seconds reported in Figure 10 (p. 104). But this is not as discrepant as it might first appear. The cigarettes smoked by Shepherd's observees most likely were nonfiltered, since filtered cigarettes were rare in 1951 or earlier. The nicotine rating of popular brands of that period were between 1.8

and 2.4 mg (U. S. DHEW, 1973). Compared to the 1.16 mg nicotine and over group (1.72 mg was the highest) in Table 2 (p. 108), which had a mean interval of 65 seconds, there is only a one second difference. Shepherd's results and the present data suggest a pattern of decreasing intervals between puffs with decreases in nicotine ratings. And, since the overall shapes of the two distributions are similar---skewed to the right and leptokurtic---it is tempting to speculate that the two studies show that the overall distributions for average interval durations has not changed over the three decades, but rather has shifted to the left or toward lower measures of central tendency, a shift concommittent with a shift toward lower nicotine ratings of commercially available cigarettes. This could be interpreted as a form of compensation to maintain a constant nicotine intake by an increase in smoke exposure per unit of time to make up for a reduced amount of nicotine per unit of smoke volume.

As part of a study of cigarette smoking under various conditions by the British researchers Comer and Creighton (1978), smokers "were surreptitiously observed while they smoked in a coffee lounge at work, during lunch time. . . . Subjects were unaware of the observations being made" (p. 77). The observations were "accomplished using small tape recorders and hand-held controls concealed in the handbags of trained female observers" (p. 76). Although they do not state how it was the case, all smokers reportedly smoked the same type of cigarette, a king-sized filter-tipped one with a rating of 1.7 mg nicotine. A total of 66 smokers was observed, 47 males and 19 females, smoking one to four cigarettes. Average puff numbers, puff durations and interval durations are reported,

these being 9.1, 1.9 seconds and 50.5 seconds. The first and second figures are a bit high compared to the present data for those smoking 1.16 mg nicotine and over cigarettes of 7.5 average number of puffs and 1.6 seconds average puff durations. The average interval of 50.5 seconds in Comer and Creighton (1978) study is somewhat lower compared to the average interval of 65.0 seconds for the 1.16 mg nicotine and over group in the present study.

And in Hamburg, Germany, 100 smokers in 1971 and 218 smokers in 1974 "were observed surreptitiously and puff number, puff duration and puff interval were measured. . . . Observations were made in public houses, railway stations, on the road or at work" (Schultz & Seehofer, 1978, p. 261). For the 1971 and 1974 observations, respectively, average number of puffs were 10.5 and 11.8, average puff durations were 1.4 and 1.3 seconds, and average puff intervals were 50.3 and 41.5 seconds. Compared to the present data, smokers in Hamburg took significantly more puffs, both in 1971 and 1974, but the durations for puffs and intervals are not very different from those in the present data.

Adequacy of recording techniques. The recording techniques used in the present research seem for the most part adequate for the main purpose of the study, i. e., gathering normative data on naturally occurring smoking patterns. The number of segments, or puff-inhale-exhales, is the easiest to record and the least susceptible to error, the one necessity being a constant vigilance during the smoking episode. The puff duration is also easily observed and recorded, the following statement by Schultz and Seehofer (1978) notwithstanding: "It is considerably more difficult to measure puff duration as the actual drawing of

the puff does not have to be identical with the time the cigarette is held in the mouth or with a visible onset of glow" (p. 261). I agree that the actual draw need not be identical with the time the cigarette is held in the mouth, but from my experience as a cigarette smoker and as a systematic observer of others smoking, the highly visible increased glow of the combustion area coincides exactly with the actual draw or puff duration. The puff duration, in my opinion, can be judged as accurately as could the duration a light bulb is on. For their study, Schultz and Seehofer (1978) defined puff duration as "the time for which the cigarette is held in the mouth" (p. 261), which would tend to overestimate the actual draw or puff duration.

For most smokers, inhale duration is also easy to observe and record accurately, but there is more room for error than with number of segments or puff duration. This is especially so for the 22 (11%) observees who took at least one double puff, i. e., taking a puff, inhaling, and taking another puff, with no exhale in between. But the overall error would be small since most of the double puffers did so only once or twice at most. (One smoker took one triple puff.) The error in inhale duration for double puffers arises because during the second puff, smoke has already been inhaled, but for the record this is still part of the puff duration. This means that on double puffs, inhale duration is underestimated by about 1.0 to 1.5 seconds.

For the 128 (64.3%) smokers who had all single, distinct exhalations, exhale duration could be easily and accurately recorded. But for the 45 (22.6%) who had all multiple exhalations, this was not the case. The typical multiple exhaler had no clearly demarcated exhale, but usually

returned to more or less normal breathing after the inhale, and the visible smoke would gradually taper off, making it difficult to establish a precise end for exhale duration. For these smokers, some exhale durations could be over or underestimated by two to three seconds. The remaining 26 (13.1%) who had both types of exhalation were not as difficult to record. For most of this group, there were only one or two multiple exhales and these were of the more distinct type of articulated exhalation rather than the return-to-breathing style of the multiple exhalers.

Because of the relatively longer length of time involved, interval duration is less susceptible to error than the much shorter puff, inhale and exhale durations. Whereas the error percentage for one or two seconds for one of these elements would be large, it would be much less so for interval duration. Therefore interval duration should be accurate for all observees.

The smoking parameters. In general, the shapes of the distributions for the eight smoking parameters are encouraging for the adequacy of a sample size of 199 to capture the major characteristics of how people smoke cigarettes. The impression is that additional observations would not change the overall nature of the distributions. A larger sample size would be needed to get a better fine grained picture, however. There is a hint of a bi-modal distribution in several parameters and additional observations would either highlight these or show them to be due to sample fluctuations. In the distribution for number of segments (Figure 4, p. 96), for example, is the sudden drop in frequency of observations at 15 segments and then a slight resurgence at 16 through

20 segments due to chance or suggestive of a small subset of high rate puffers?

There clearly is a modal smoker in terms of number of segments per episode (Figure 4, p. 96); 126 (63.3%) of the observees fall between six and 10 segments, a range of only four out of a total range of 20. Very few smokers settle for less than five segments per cigarette. The two smokers having only three segments were both smoking cigarettes with relatively high nicotine ratings, Pall Mall unfiltered (1.52 mg) and Kool (1.24 mg). These two undoubtedly contributed to the statistically significant lower number of segments for the highest nicotine level cigarettes (Table 2, p. 108). Two of the three observees having only four segments did not appear to be "serious" smokers; they both had light puffs and shallow inhales. And, although females tended to be lighter smokers than males in some respects, four out of the five smokers at the two lowest values for number of segments were males.

No sex differences emerged for the 13 smokers having 15 or more segments; seven were female and six were male. All but one of these were smoking 100mm cigarettes, and this is reflected in the statistically significant greater number of segments for smokers of 100mm vs smokers of 87mm cigarettes, 10.6 vs 8.5, respectively. The outlier at 23 segments was quite nervous, talked rapidly, and had an equally rapid smoking style. Considerable smoke escaped from his mouth between each puff and inhale.

The distribution for mean puff duration (Figure 5, p. 97) again portrays a strong modal picture, with 153 (77%) of the smokers falling within one second of each other, from .8 to 1.8 seconds. Much of the

positive skew in this distribution comes from the 22 double puffers who had a mean puff duration nearly a full second, 2.3 vs 1.4, longer than the single puffers. The fact that 177 (88.9%) took all single puffs of a relatively short duration and that 130 (65.3%) had puffs judged light or medium attests to the "easy draw" of commercial cigarettes.

The distribution for mean inhale duration per episode (Figure 6, p. 99) indicates that most smokers are holding the smoke in their lungs longer than the normal breathing inhale duration of one or two seconds. On the other hand, smoke is not being held in for protracted periods as is the case with marijuana cigarette smoking. This is in keeping with the hypothesis that nicotine is at least part of the reason why people inhale cigarette smoke; smoke is being held in the lungs long enough to get nicotine into the system, and since nicotine is water soluble, absorption takes place relatively quickly. (The fact that tetrahydrocannibanol is not water soluble could be the reason why marijuana smokers typically hold the smoke in for much longer periods than do typical cigarette smokers.)

The distribution for mean exhale durations per episode (Figure 7, p. 100) again has a strong modal character, but whereas the smoke is being held in the lungs slightly longer than is the case with air in normal breathing, here most smokers are blowing the smoke out at a rate somewhat faster than in normal breathing exhalation. An at rest exhale duration of three seconds is not unusual, but for cigarette smoke exhalation this falls at the 90th percentile. The overall inhale-exhale pattern is consistent with the nicotine hypothesis; hold the smoke in long enough to absorb the nicotine and then get rid of it quickly to

minimize any adverse effects of irritants or other noxious substances in the smoke.

It might be expected that smokers would fall into groups of fast, moderate or slow puff-inhale-exhalers, but this is not the case as can be seen in Figure 8 (p. 101), which presents the distribution for mean segment durations per episode. If it were the case, the distribution would be positively skewed and leptokurtic as it is for each of the three elements which, together, make up the segments. Instead, the distribution has the lowest value for skewness of any of the distributions and is slightly platykurtic. This indicates that some smokers who, for instance, have relatively long puff durations have relatively short inhale durations and vice versa. Or smokers with relatively long inhale durations have relatively short exhale durations and vice versa. This is corroborated by the low correlation coefficients (Table 1, p. 92) between mean puff and inhale durations of .20, between mean puff and exhale durations of .20, and between mean inhale and exhale durations of .36. This again is in keeping with the nicotine hypothesis, i. e., smokers seek to get a relatively constant level of nicotine and will compensate for a low value in one parameter by a higher value in another. If compensation is occurring, it is not a very strong effect, or the coefficients would be negative ones.

The distribution for total segment durations (Figure 9, p. 102) visually appears similar to the distribution for mean segment durations with two exceptions. First, it has a distinct bi-modal appearance, with those occurring at 40 and 60 seconds. These are most likely responsible for the high leptokurtic value of 8.37, and they most likely

derive from the differences in total segment durations for smokers of 87mm vs smokers of 100mm cigarettes. And second, there is one outlier at 210 seconds, which contributes to an inflated skewness value of 1.64 for what otherwise appears to be a fairly normally distributed bar graph. This outlier was by far the heaviest smoker of the entire sample. Most puffs were deep, double ones, and one was a triple puff timed at 6.6 seconds duration. He had 18 segments, and discounting a 92.5 second interval after segment 10, the mean interval duration was 10.9 seconds.

In the bar graph for mean interval durations (Figure 10, p. 104), there is a return to the previous patterns of leptokurtic, positively skewed distributions, but here more strongly so. There is also more variability in this distribution; the 59% coefficient of variation is the highest of all the distributions.

The distribution for episode durations (Figure 11, p. 106) is very similar to the one for mean segment durations (Figure 8, p. 101); both have relatively low values for skewness and kurtosis and both have non-significant Kolmogorov D values.

The distributions for number of segments and for mean puff, inhale, exhale and interval durations show that people do not smoke cigarettes in a random fashion. There are constraints on these elements of the smoking episode, and the constraints are of a "floor effect" variety, as is indicated by the strong positive skewness of these distributions. Nicotine is a likely candidate as the main factor constraining these smoking elements. In other words, it appears that there are minimum values for the number of segments, for puff, inhale and exhale

durations, and for the interval until the next segment in order for the smoker to absorb sufficient nicotine to get the accustomed "kick" or "fix." Once the minimum or floor value is reached, a modal pattern quickly develops, i. e., there is a steep rise, starting no later than the 10th percentile and usually earlier, in the frequency of observations, with the majority of cases then clustering around a central value, as is attested to by the leptokurtic nature of these distributions. The frequency of observations then begins to taper off, usually around the 60th percentile, and gradually diminishes until around the 96th percentile, with the remaining three or four percent outliers at the very high values.

Smoker typology. The nature of these distributions reinforces an impression that developed as the observations proceded that, in terms of smoking a single cigarette, there are four types of smokers, the "light," the "modal" or "average," the "heavy," and the "atypical" smoker. If a statistical criterion is used for normality, where cases falling between plus and minus one standard deviations are average, those between minus one and minus two standard deviations are below average, those between plus one and plus two standard deviations are above average, and those outside plus or minus two standard deviations are atypical, a consistent pattern emerges for the percentages of observations falling in these categories for the distributions for nicotine level and the eight smoking parameters (Table 10). An average of roughly 74 percent or nearly three-fourths of the observees are average or modal smokers, nearly 13 percent are below average or light smokers, around nine percent are above average or heavy smokers, and about four percent are atypical smokers.

TABLE 10

PERCENTAGES OF OBSERVATIONS IN EACH STANDARD DEVIATION BRACKET FOR NICOTINE AND THE EIGHT SMOKING PARAMETERS

STANDARD DEVIATION	BELOW -2	TO -2	BETWEEN -1 AND +1	TO +2	ABOVE +2
NICOTINE	1	13	75	8	3
NUMBER OF SEGMENTS	0	7	82	6	5
MEAN PUFF DURATIONS	0	13	73	9	5
MEAN INHALE DURATIONS	0	12	73	11	4
MEAN EXHALE DURATIONS	0	11	71	14	4
MEAN SEGMENT DURATIONS	.5	11	73	13	2.5
TOTAL SEGMENT DURATIONS	0	18	72	8	2
MEAN INTERVAL DURATIONS	0	14	75	7	4
EPISODE DURATIONS	.5	17	71	8.5	3
OVERALL AVERAGE	.2%	12.9%	73.9%	9.4%	3.6%

The average or modal smoker goes about smoking in an efficient, business-like fashion. Smoking does not seem to require a great deal of attention on the part of the smoker. The cigarette is rarely looked at directly except when it is being lit and extinguished. The modal smoker typically places their elbow on the table, bar or chairarm and holds the cigarette near their face with the burning end up and slightly

above eye level. (Only one smoker in the entire sample showed signs of getting smoke in the eyes.) In this position the smoker can get a puff by a small movement of the arm and rotation of the wrist. The modal smoker belies any "orality" of smoking; the contact between the cigarette and lips is minimal, just enough to take a puff, and then the cigarette is moved back to the typical arm-hand position. This characteristic is also true of manual manipulation; there is very little handling or fiddling with the cigarette beyond that which is necessary to light, smoke, flick the ashes and extinguish it.

As might be expected, the modal smoker's cigarette was in the middle range of the FTC nicotine ratings; 75 percent of the observees smoked cigarettes rated from .45 to 1.15 mg nicotine. The puffing intensity of the modal smoker was usually judged medium or occasionally deep, and there were very few double puffers. The inhale almost always was judged medium, the exhale all singles or some of both single and multiples, and these most frequently through the mouth only.

The light smokers comprise a relatively distinct group. Their handling of the cigarette is often less efficient than the modal smoker in that there is often more manipulating or toying with the cigarette extraneous to puffing. They seem to be more conscious of the fact that they are smoking. The light smoker gives every indication of being a neophyte smoker, and their smoking patterns have yet to take on the polished stereotypy that comes with thousands of repetitions of the simple motor act.

Light smokers smoke cigarettes primarily in the lowest nicotine bracket, .45 mg and below. The most definitive characteristics of the

light smoker are taking light puffs and shallow inhales. The light smoker almost always has short, single exhales through the mouth only with exhaled and sidestream smoke judged light.

Heavy smokers, in contrast to light smokers, do not constitute a distinct group, but rather seem to merge by degrees with modal smokers. The heavier of the heavy smokers, as would be expected, smoke cigarettes with higher nicotine ratings, take long, deep, often double puffs, have medium to deep inhales, have all multiple exhales through both the mouth and nose, and have exhaled and sidestream smoke judged heavy. Heavy smokers are often judged low on activity level and this could possibly be related to the depressant action of nicotine at higher doses. Often the heavy smoker appears to be a more serious or a more intense modal smoker.

The atypical smoker is usually one who falls at the extreme higher values for one or more of the smoking parameters. As can be seen in Table 10, a negligible percentage occurs in the low, below minus two standard deviations range. Although the atypical smoker is usually a very heavy smoker, this is not always the case. Four of the atypical smokers were so in that they had very long mean interval durations and three of these had either three or four segments, the two lowest values for that parameter.

Secondary results. The results for the analyses of nicotine level and its relationship with smoking variables are consistent with the overall pattern of results from many laboratory studies of nicotine regulation, and that pattern is little or no effects from modest reductions in nicotine level, and with any significant effects coming from increases

or drastic reductions in nicotine level, as is the case here; the highest nicotine level is responsible for the lowest mean number of segments and the longest mean interval durations. That the mean interval of 35.8 seconds for the .45 mg nicotine and under group was not significantly lower than the mean interval of 65.0 seconds for the 1.16 mg nicotine and over group is surely a statistical fluke, especially since episode duration, which correlates at .48 with mean interval duration, reached statistical significance for the .45 mg nicotine and under group, while having a lower percentage difference from the mean episode duration for the 1.16 mg nicotine and over group than the percentage difference between the lowest and highest mean interval durations (Table 2, p. 108).

Some differences were found between males and females in how they smoked, but these were overshadowed by the similarities between female smokers and their male counterparts. There were no significant differences on any of the eight smoking parameters between males and females. It appears that on the eight smoking parameters, there are not male and female smokers but rather just smokers. The strongest gender effect is in how the cigarette is held, with males using a variety of styles while females nearly all held their cigarette between the index and middle fingers.

Analyses across time of day and location showed heavier smoking in the morning in the student center and lighter smoking in the evening in the lounges. This latter finding is somewhat surprising, since all the observees in the lounges were drinking some type of alcoholic beverage and smokers uniformly report smoking more when drinking alcohol. If smokers do smoke "more" while drinking, it appears that it would have

to be across the total number of cigarettes per unit of time and not within the single smoking episode.

Younger smokers are somewhat lighter smokers than older smokers (Table 4, p. 112), which would be expected since the novice smoker is more likely to be in their teens or early twenties. And as every beginner knows, it takes time to adjust to the noxious side effects of tobacco and develop into a full-fledged smoker.

It is a cardinal rule of psychopharmacology to equate the dose of a drug under study with the body weight of the test organism. If a similar phenomenon occurs with cigarette smokers then one would expect that heavier smokers would take more or longer puffs, inhales or exhales, or differ in other respects that would indicate that they were getting more nicotine into their systems than lighter weight smokers. Since there were no statistically significant differences in smoking parameters across weight levels, this does not seem to be the case, although the measures used here are rather crude compared to those in the psychopharmacologist's laboratory.

It is a truism of social psychology that the presence or absence of others can affect the behavior of an individual, and several studies have shown this to be the case with cigarette smoking (Fors, 1973; Glad & Adesso, 1976; Comer & Creighton, 1978). The results of these studies showed smokers smoking more in the presence of other smokers. But this did not hold true in the present study; all smoking parameters were similar for smokers smoking alone, with others, none of whom were smoking, and with others, some of whom were smoking.

Although putting the cigarette down in an ashtray between puffs might be a simple, effective way to reduce smoking rates within the single smoking episode, smokers in the present study who did so had very similar smoking parameters to those who held their cigarette continuously. This is not, however, a definitive test of the hypothesis, since the two groups comprised those who held their cigarette continuously and those who put theirs down at least once during the episode. Only one smoker out of the 199 put his cigarette down between every puff, and this because he was using both hands to work on some math problems.

Limitations of the study and suggestions for further research. The main limitation of the present study is the sample size of 199. It is sufficient to provide normative data on naturally occurring smoking patterns, i. e., to give an accurate picture of the central tendencies and variability, and to capture the overall shapes of the distributions of the eight smoking parameters. But a larger sample size is needed to more adequately answer questions, for instance, about nicotine levels and their relationship with smoking parameters. A larger sample size would be needed to provide an adequate number of observations in the very low and very high nicotine brackets. It is possible that the reason more parameters did not show statistically significant differences was the relatively small number of observations at these levels. A larger sample size also would provide more observations at the higher values for weight and age to more adequately assess the relationship between these variables and smoking patterns. And a larger sample size would insure sufficient cell sizes to do more fine grained analyses, such as looking at the variable nicotine for, say male smokers 60 years

and older or for female smokers of 87mm vs 100mm cigarettes. So the first research suggested by the present study is an extension of the observations to a sample size of, say 1000. This would also allow for a broader "casting of the net" in terms of sampling more locations, time of day, etc. Multiple observers would be needed since going on location and maintaining the constant surveillance necessary to catch smokers as they light up and then recording the entire episode without missing any elements can be a long, tedious procedure, and fatigue or "burn out" can be a problem.

The basic design and procedures used in the present study can be applied to other smoking research projects as well. For example, do special groups, such as air traffic controllers or mental institution residents, smoke differently from the general population? Or are there cross-cultural differences in smoking parameters and patterns? Perhaps the most fruitful extension of the present study would be to observe individuals smoking more than one cigarette; some smoking differences across nicotine levels, locations, time of day, etc., could occur between rather than within episodes.

Summary. The main finding of this study is that the smoking patterns observed in "ordinary life" settings are at variance with the patterns employed in a number of frequently cited laboratory studies of cigarette smoking. One such example is the smoking machine settings used to assay the tar and nicotine delivered by commercially available cigarettes and which is reported bi-yearly by the Federal Trade Commission. The normative data collected in the present study may serve as guidelines

for laboratory investigators who want to use smoking parameters that better reflect how people actually smoke.

A corollary finding is that there are a number of results consistent with the hypothesis that nicotine plays a central role in cigarette smoking. Foremost is the fact that 199 out of the 200 observed smokers inhaled the cigarette smoke. And research has shown that inhaling cigarette smoke is the easiest, quickest way to get nicotine into the bloodstream and into the brain, even more so than by intravenous injection.

The way people inhaled and exhaled the cigarette smoke is also what would be expected of smoking-to-ingest-nicotine. In a typical sequence, the inhaled smoke is held in the lungs slightly longer than is air in normal breathing, just long enough for the readily absorbable, water soluble nicotine to be taken up. The smoke is then quickly exhaled at a faster rate than in normal breathing, which minimizes bronchial irritation or other untoward side effects of the smoke.

Another indication that nicotine influences cigarette smoking is an apparent minimum level or floor effect for several smoking parameters. Few smokers fall below these values and once the minimum is reached, a modal point quickly appears around which the majority of cases fall. The distribution for mean puff duration illustrates this pattern; only 13 percent of the sample had averages under 1.0 second while the interval from 1.0 to 1.8 seconds contained 68 percent of the cases, and this out of a total range of 3.4 seconds. A repetition of this pattern in several of the smoking parameters suggests that there is an optimum exposure level to cigarette smoke in order for the smoker to get their accustomed nicotine "fix."

Another result in keeping with the nicotine hypothesis is what seems to be compensation in some smoking patterns. That is, if a smoker falls short on one measure of smoke exposure, he or she often makes up for it by scoring relatively high on another measure, or vice versa. Smokers judged light puffers, for example, had the highest mean number of puff-inhale-exhales. Those judged deep puffers, on the other hand, smoked cigarettes with the lowest FTC nicotine ratings. Compensation may also be demonstrated when the distributions for mean puff, inhale and exhale durations are combined. Although the distributions for each of these elements are positively skewed, when they are added together the resultant distribution is much less skewed. This would only occur if some smokers with relatively short puff durations had relatively long inhale or exhale durations, and so on.

A final outcome in favor of the nicotine hypothesis is a direct relationship between FTC nicotine ratings of the cigarettes and three smoking parameters; smokers of cigarettes rated at or below .45 mg nicotine, when compared to those at or above 1.15 mg nicotine, averaged nearly two puff-inhale-exhales more per cigarette, averaged about one-half the interval between puffs, and had total smoking episode durations over one minute shorter.

So these results suggest that people smoke cigarettes to get nicotine, and that there is a relatively constant optimum smoke/nicotine exposure level for the majority of smokers for which they have a number of ways at their disposal to regulate, such as choice of cigarette brand, number of puffs per cigarette, degree and duration of inhalation, and so on.

A third and final result is that, in terms of the single smoking episode, smokers fall into four classes: Light, modal, heavy and atypical.

About 75 percent of the sample were modal or average smokers who fell within one standard deviation of the mean on the smoking parameters. That is, roughly three out of four smokers were very similar to each other in the number of puffs, the inhale durations, etc. The modal smokers displayed a polished, stereotyped smoking pattern, an efficient business-like one with a minimum of manual manipulation and cigarette-mouth contact extraneous to lighting, smoking and extinguishing the cigarette. This belies any desire for "oral sensuality" or "having something to do with ones hands," factors sometimes reported in the literature as being important to cigarette smokers.

Modal smokers are not differentiable on the basis of gender. Although females hold their cigarettes differently from males, and on average smoke cigarettes slightly lower in FTC nicotine ratings, in all other respects measured, such as number of puffs, number and duration of inhales and exhales, etc., females smoke as do males. This is in keeping with the latest health statistics which show that smoking related disease rates for females are now approaching those for males.

Heavy smokers, the nine or so percent of the sample between plus one and plus two standard deviations on the smoking parameters, do not appear to be a distinct class, but rather one which merges by degrees with and seems to be a more intense variation of the modal smoker. Light smokers, on the other hand, do appear to be a distinct class, one with all the earmarks of being novice smokers. Light smokers comprised roughly 13 percent of the sample falling between minus one and

minus two standard deviations on the smoking parameters. And the atypical smokers, those outside plus or minus two standard deviations of the smoking parameters, comprised about four percent of the sample, most of whom fell in the upper ranges on one or more of the smoking parameters.

The present study suggests two further studies using unobtrusive observations. One would follow the same methods (observing each smoker smoking one cigarette) but with a larger sample size which could provide a higher powered analysis of the interrelatedness of smoker, cigarette and setting. A second study would record each smoker smoking a number of cigarettes through the course of one or more days. This would allow a determination of whether smokers maintain a relatively constant smoke/nicotine exposure over time, and whether light, modal, heavy and atypical single episode smokers are also that way across multiple episodes.

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APPENDIX

DATA COLLECTION FORM: FRONT

O# ____

DATE ____ TIME ____ PLACE ____

ACTIVITY ____

SIDE: 1 2 A B BEGN ____ END ____

♂ ♀ AGE ____ WEIGHT ____

ALONE W S♂ ____ S♀ ____ NS♂ ____ NS♀ ____

PUFF: L M D DBL INHALE: N S M D

EXHALE: S M; M N SMOKE: L M H

ACTIVITY LEVEL 1 2 3

BRAND ____ NIC ____

DETERMINED BEFORE AFTER

HOLD: R L; TI TM IM; LIP;

CONT DOWN IPI: YES NO

LIGHT: MATCH DISP ZIP OTHER ____

EXTING: ATC FC FLIP OTHER ____

ARM: 

DATA COLLECTION FORM: BACK

FOOTAGE	#	PUFF	INHALE	EXHALE	IPI
	1				
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	3				
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VITA

Robert Fisher was born in St. Joseph, Missouri on October 30, 1944. He moved to Rock Island, Tennessee, and there attended Cambridge and Midway elementary schools. In 1962, he graduated from Central High School in McMinnville, Tennessee, with majors in math and science.

In 1964, after two years at Martin Junior College in Pulaski, Tennessee, he joined the U. S. Navy and served four years aboard the U.S.S. Coontz (DLG-9) and U.S.S. Robison (DDG-12), eighteen months of which were spent overseas during the Vietnam War. He was honorably discharged as an E-5 Sonar Technician.

From 1968 to 1971, he was employed as an Electronics Maintenance Technician in Chula Vista, California. He returned to college and in 1973 received the B. A. degree from San Diego State University with a major in Psychology and a minor in Spanish.

In 1973, he enrolled as a graduate student in the Experimental Psychology program in the Department of Psychology, University of Tennessee, Knoxville. He has since worked as a Research Assistant in the Department and has taught psychology courses at the University, at Knoxville College, and at Maryville College, Maryville, Tennessee. He has also been employed at times as a bartender and self-employed as a landscaper.