The Oral Self-Administration of Nicotine in Two Groups of Rats

Jay D. Hansor

Western Michigan University

Follow this and additional works at: http://scholarworks.wmich.edu/masters_theses

Part of the Psychology Commons

Recommended Citation
http://scholarworks.wmich.edu/masters_theses/1496

This Masters Thesis-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Master's Theses by an authorized administrator of ScholarWorks at WMU. For more information, please contact maira.bundza@wmich.edu.
The Oral Self-Administration of Nicotine in Two Groups of Rats

by

Jay D. Hansor

A Thesis Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Master of Arts Department of Psychology

Western Michigan University Kalamazoo, Michigan April 1984
Six, adult male, Sprague-Dawley rats served as subjects in this experiment which examined whether they would self-administer a 32 microgram per milliliter or a 64 microgram per milliliter (32 ug/ml and 64 ug/ml) nicotine tartrate solution when presented concurrently with distilled water. Subjects in Group I had access to a 32 ug/ml nicotine solution and Group II subjects had access to a 64 ug/ml nicotine solution during both phases. During Phase II an "AB" reversal was implemented to ascertain whether the subjects had a side preference or if they preferred to ingest nicotine. It was found that each subject in both groups preferred the nicotine solutions as opposed to distilled water.
ACKNOWLEDGEMENTS

I would like to acknowledge the guidance, expertise, patience, and friendship of Dr. Paul T. Mountjoy, my advisor. I would also like to give special thanks to Dr. Alan Poling for his valuable assistance and for allowing me to conduct this research in his laboratory. In addition, I would like to thank Dr. Fred Gault for his support and Dr. Norman Peterson for reading this study. A special thanks goes to Debra Grossett, Mitchel Picker, James Cleary, Earl Hall Johnson, Robert W. Sewell, and Jeff Gallus for their continuous support.

Jay D. Hansor
INFORMATION TO USERS

This reproduction was made from a copy of a document sent to us for microfilming. While the most advanced technology has been used to photograph and reproduce this document, the quality of the reproduction is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help clarify markings or notations which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure complete continuity.

2. When an image on the film is obliterated with a round black mark, it is an indication of either blurred copy because of movement during exposure, duplicate copy, or copyrighted materials that should not have been filmed. For blurred pages, a good image of the page can be found in the adjacent frame. If copyrighted materials were deleted, a target note will appear listing the pages in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed, a definite method of "sectioning" the material has been followed. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For illustrations that cannot be satisfactorily reproduced by xerographic means, photographic prints can be purchased at additional cost and inserted into your xerographic copy. These prints are available upon request from the Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases the best available copy has been filmed.
HANSOR, JAY DELOS

THE ORAL SELF-ADMINISTRATION OF NICOTINE IN TWO GROUPS OF RATS

WESTERN MICHIGAN UNIVERSITY M.A. 1984

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106
# TABLE OF CONTENTS

**ACKNOWLEDGEMENTS** .......................................... ii

**LIST OF TABLES** ............................................... iv

**CHAPTER**

I. **INTRODUCTION** ........................................ 1

II. **METHOD** ............................................... 13

   SUBJECTS AND SETTING ...................................... 13

   APPARATUS .................................................. 13

   DEPENDENT VARIABLES ...................................... 14

   INDEPENDENT VARIABLES ................................... 14

   PROCEDURE ................................................... 14

   EXPERIMENTAL DESIGN ...................................... 16

III. **RESULTS** ............................................... 17

IV. **DISCUSSION** ........................................... 20

**BIBLIOGRAPHY** .............................................. 23
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mean Amount of Milliliters Ingested by Individual Subjects from Group I</td>
<td>17</td>
</tr>
<tr>
<td>2. Mean Amount of Milliliters Ingested by Individual Subjects from Group II</td>
<td>18</td>
</tr>
<tr>
<td>3. Grouped Mean Amounts of Milliliters Ingested by Subjects from Group I</td>
<td>18</td>
</tr>
<tr>
<td>4. Grouped Mean Amounts of Milliliters Ingested by Subjects from Group II</td>
<td>19</td>
</tr>
<tr>
<td>5. Grouped Means of Milliliters Ingested Across Both Groups</td>
<td>19</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

The drug nicotine is widely sought and self-administered by man. It has been postulated (Armitage, Hall, and Morrison, 1968; Finnegan, Larson, and Haag, 1945; Frith, 1971; Goldfarb, Jarvik, and Glick, 1970; Jarvik, Glick, and Nakamura, 1970; Kozlowski, Jarvik, and Gritz, 1975; Luchessi, Schuster, and Emley, 1967; Russell, 1971; and Schneider, Popik, Jarvik, and Gritz, 1977) that nicotine functions as a reinforcer and that the reinforcing effects of nicotine is one possible reason why human beings self-administer nicotine via the many tobacco products that are available. It is the case, however, that man is not the only species that self-administers nicotine. It has been demonstrated that different species of monkeys (Deneau & Inoki, 1967; Glick, Canfield, and Jarvik, 1970; Glick, Jarvik, and Nakamura, 1970; Goldberg, Spealman, and Goldberg, 1981; Jarvik, 1967; and Pieper & Cole, 1973) can be trained to self-administer nicotine.

Deneau & Inoki (1967) conducted an experiment with seven adult rhesus monkeys to investigate self-administration of six different doses of nicotine. All of the monkeys were fitted with indwelling catheters. Nicotine was delivered to the monkeys after a specified period of time had elapsed or after an animal pressed a lever which delivered nicotine to the animal. It was found that there was no self-administration of a 10 micrograms per kilograms (10 ug/Kg) nicotine solution. Two monkeys self-administered a
25 ug/Kg nicotine solution and one subject stopped self-administering at 50 ug/Kg, two stopped at 100 ug/Kg, and one each stopped at 500 and 1000 ug/Kg.

Glick et al. (1970) trained three adult rhesus monkeys to self-administer nicotine (i.e., to smoke cigarettes) by using a fixed ratio (FR) schedule of water reinforcement. Two monkeys were trained to puff on a tube that held a burning cigarette and a tube that delivered air. Initially, water was contingent upon a single puff on either tube. The number of puffs required for water reinforcement to be delivered were increased to 5, 10, 20, and 40 puffs on either tube. Following the initial training phase, a fixed ratio (FR-40) schedule of water reinforcement was introduced. It was found that one monkey puffed only on the air tube, one monkey puffed only on the smoke tube (99% of the trials) and the third monkey showed a random pattern of puffing with no preference for either tube.

Glick et al. (1970) trained four adult rhesus monkeys to self-administer nicotine via tobacco smoke under a fixed ratio (FR) schedule of water reinforcement. During the first phase of the experiment the monkeys were administered water following each puff on a smoke tube or an air tube. This continuous schedule of water delivery was then changed to a fixed ratio schedule of 5, 10, 20, and 30 puffs on either tube in order to obtain water. Once stable rates of puffing were established a fixed ratio 30 (FR-30) schedule of reinforcement was implemented. It was found that all four monkeys preferred smoke to air.

A recent study by Goldberg et al. (1981) demonstrated that squirrel monkeys would self-administer nicotine under a second-order
schedule of reinforcement. The subjects had venous catheters permanently implanted so that they could self-administer nicotine. Under the second-order schedule, a green light was presented at the beginning of each session, and every tenth lever pressing response (FR-10) (during a one or two minute fixed interval of time) changed the green light to amber for one second. Completion of the first fixed ratio 10 (FR-10) requirement (after the fixed interval elapsed) turned the green light off and the amber light on for one second, and an intravenous injection of 30 μg/Kg of nicotine was delivered. It was found that bar pressing and nicotine administration were high, with individual averages of responding between 0.81 and 1.58 responses per second. The individual rates of responding in each fixed ratio unit averaged between 1.22 and 4.77 responses per second.

The experimenters also examined the role of nicotine injections in maintaining bar pressing by substituting saline for nicotine injections and by pharmacologically blocking the effects of nicotine with the nicotinic antagonist mecamylamine. It was found that when saline was substituted for nicotine injections in two monkeys, the rate of responding decreased to low levels. When saline injections were replaced by nicotine injections (30 μg/Kg) responding by all three monkeys recovered to their previously high levels. When 1.0 milligram (mg) of mecamylamine per kilogram was administered
monkeys (species unidentified) were used as subjects to examine whether or not they would inhale tobacco smoke from burning cigarettes, burning pipe tobacco, and burning cigars in the absence of additional incentives. It was hypothesized that if the monkeys did in fact inhale the tobacco smoke, this finding could be interpreted as evidence that tobacco smoke and the products contained, specifically nicotine, could be viewed as a reinforcer.

During the first experiment a burning cigarette was placed into a touch sensitive cigarette holder on the left side of the chamber, and a corresponding holder that when sucked upon would only produce air was placed on the right side of the chamber. The burning cigarette was placed into the holder on the left side for the daily session and switched to the right side during the next daily session in order to ascertain if the animals had a side preference. Each subject was given two ten minute sessions per day. The results showed that each subject preferred the side in which they could obtain cigarette smoke regardless of the side that the cigarette was placed. The group puffing data were 247 puffs on the cigarette side, and 101 puffs on the air side.

In a second experiment a similar procedure was used with the addition of a time-sampling data collection procedure. This experiment was conducted for two consecutive days in which the burning cigarette was placed into a holder on the right and the air tube on the left during the first day. The positions were reversed on the second day. During each session, a cigarette was presented to each animal for a period of ten minutes. The monkeys smoking was then
recorded by the use of the time-sampling procedure. It was found that each subject puffed on the side in which the cigarette was placed during each of the 120 five second periods throughout the daily ten minute session. The group mean number of puffs on the cigarette side was 24 puffs as opposed to 22 puffs on the air tube.

The experimenter then conducted a series of experiments in which the same six subjects were exposed to tobacco smoke and other volatized substances. The first experiment in this series consisted of exposing each subject to a burning cigarette and hot air. Twenty minute sessions were conducted for a period of five days using the same procedure that was used in the first experiment. It was found that the subjects puffed on the cigarette side 73% of the time and on the hot air side 27% of the time.

Another experiment in this series allowed each subject access to a burning cigarette and a burning cigar. As a group, the monkeys did not prefer one form of tobacco over the other. The percentage of puffs on the cigarette tube were 50% and 50% on the cigar tube. One subject of six preferred the cigarette smoke as opposed to the cigar smoke. This subject puffed 934 times on the cigarette tube and 579 times on the cigar tube.

In an additional experiment, the experimenter examined whether the subjects would prefer the smoke from a low versus a high nicotine cigarette (nicotine contents of said cigarettes was not mentioned). The results indicated that there was a slight preference for the low nicotine cigarettes. As a group, the percentage of puffs on the high nicotine cigarette tube was 48% and 52% for the low nicotine tube.
The individual puffing rates showed a definite preference for the low nicotine cigarettes with the exception of one subject.

Next, Jarvik looked at whether or not the subjects would prefer the smoke from a regular cigarette or a very "fragrant" pipe tobacco. The percentage of puffs on the cigarette tube was 25% and 75% on the pipe tobacco tube.

Next, the subjects had access to a burning cigarette, hot air, pipe tobacco, and hot air over a period of eight days. The results indicated that as a group, as well as individually, the subjects preferred the burning pipe tobacco 82% of the time, hot air 30% of the time, cigarette smoke 70% of the time, and hot air 18% of the time.

In yet another experiment, the experimenter wanted to determine whether the subjects would prefer tobacco smoke as opposed to tobacco vapor. During this experiment the subjects could make four possible choices. They could puff on a burning cigarette or on a corresponding air tube, or they could puff on the vapors from a cigarette or on a corresponding air tube. The subjects puffed on the burning cigarette 968 times and on the corresponding air tube 549 times. They also puffed 414 times on the smoking machines that delivered tobacco vapor and 258 times on the corresponding air tube.

Pieper & Cole (1973) trained three apes (one male chimpanzee, one female chimpanzee, and one male orangutan) to smoke cigarettes. The subjects in this experiment were required to make a 5 second sucking response against a tube that held a lighted cigarette in order to obtain candy. Once stable rates of sucking responses were
obtained the time duration of the sucking responses for candy
delivery was gradually increased. In order to determine if the
monkeys had in fact ingested nicotine during the sessions, meth-
amphetamine was given to the animals on two successive days, once
orally and once via smoking (methamphetamine was placed in the cig-
arettes). Three urine samples were then obtained following the oral
and smoking sessions. A thin layer chromatography procedure was
used to assay the urine samples. It was found that there were
maximal amounts of methamphetamine excreted two hours after smoking,
and six hours following the oral administration. This finding
indicated that all of the subjects had ingested nicotine.

Based upon the above findings, it is possible to conclude that
different species of monkeys will self-administer nicotine.

It has also been demonstrated that different strains of lab-
oratory rats (Clark, 1969; Lang, Latiff, McQueen, and Singer, 1977;
and Sanger, 1978) can be trained to self-administer nicotine
solutions on a regular basis.

Clark (1969) used male, hooded Lister rats in a nicotine self-
administration experiment. Nicotine solutions were self-administered
by either drinking water or through implanted catheters. The rats
were trained to obtain their total water requirements in their home
cages by pressing levers. In the first experiment, two wells
provided water, and the rats, kept either singly or in groups of
four, usually drank more from one well than the other. Once stable
rates of drinking were established, a nicotine solution (nicotine
acid tartrate) of 50 ug/ml replaced water in one of the wells. It
was found that more of the nicotine solution was consumed than water in four groups of rats and in three of five rats that were kept in single cages.

In a second experiment, twelve rats were fitted with catheters. These rats had to press a lever to obtain nicotine. It was found that the rate of lever pressing increased by more than one-fifth in six rats when the dose of nicotine obtained for each bar press was reduced from 10 to 5 ug/Kg.

In a third experiment, twelve rats were trained to press a lever for their water during a one hour session. Once stable rates of responding were obtained, polyethylene catheters were implanted in the animals. A lever press injected saline simultaneously with water. Once stable rates of responding were established the water was removed. Half of the rats received a saline injection and the other half received a 1 ug nicotine injection. It was found that the bar pressing of the saline rats totally extinguished and the nicotine rats consumed about 50 ug of nicotine during each trial.

Lang et al. (1977) conducted four nicotine self-administration experiments with rats. These experiments were conducted to see if rats would self-inject nicotine or saline under normal body weight and reduced body weight conditions as well as when the injections were adjunctive to a food delivery schedule. In the final series of experiments, the oral intake of nicotine under the condition of a food delivery schedule was examined.

In experiment 1, the rate of self-injection of nicotine at doses of 0.05 and 0.1 mg/Kg for each bar press was compared with the rate
of the self-injection of a 0.07 ml solution of saline. Ten Listar hooded rats with venous cannulae were used as subjects in this experiment. The rats were placed into "Skinner" boxes for a continuous ninety hour session. Nicotine was made available through bar pressing and saline was made available to nine control rats through bar pressing. Six rats were given an initial priming dose of 0.05 mg/Kg of nicotine prior to running. There appeared to be active and inactive periods during the 90 hour session with three or more responses per hour considered to be an active period. The total number of bar presses per session was found to be 1 - 2 per hour. During the active periods it was found that the rats bar pressed for nicotine from 3 - 16 times per hour, which was equivalent to 0.15 - 0.8 mg/Kg per hour. Three rats failed to make bar presses during the first 48 hours of the session and three of the other four rats that were given an initial 0.1 mg/Kg dose of nicotine bar pressed at an average rate of 0.3 - 1 injection per hour. It was also found that during the active periods these rats bar pressed at rates that varied from 3 - 7 injections per hour which was equivalent to 0.3 - 0.7 mg/Kg of nicotine per hour. The rats in the saline control group responded similarly. Three of the control rats recorded a "similar" number of bar presses to the nicotine rats and the remaining six rats showed negligible responses that were similar to the nicotine rats.

Experiment 2 was concerned with examining the rates of the self-injection of nicotine (0.1 mg/Kg) in comparison to the rates of the self-injection of saline. Nine Listar hooded rats, maintained at
eighty percent of their free feeding weights, were used as subjects. Each subject was fitted with a venous cannula and placed into a "Skinner" box. Nicotine was made available for self-administration to three rats while six control rats had saline available to them. It was found that all three of the rats under the nicotine condition bar pressed for nicotine at a greater rate than those that bar pressed for nicotine in experiment 1. The subjects bar pressed for nicotine injections 10 - 35 times an hour, which was equivalent to an intake of 1.0 - 3.5 mg/Kg of nicotine per hour. The six saline control rats bar pressed for saline at a rate that was similar to the bar presses for nicotine and saline by the subjects at 100% of their body weights in experiment 1.

Experiment 3 was concerned with the use of a schedule induced polydipsia procedure as a possible method of inducing nicotine self-administration of two concentrations (32 and 64 ug/ml) of nicotine solutions by rats. Four Wistar rats at eighty percent of their free feeding weights were used as subjects. The rats were placed into a Skinner box for one hour on a fixed interval 60 second (FI-60") food delivery schedule. Once lick rates and water intakes stabilized, their water was replaced by nicotine solutions (32 ug/ml and 64 ug/ml). Lick rates and fluid intakes were recorded for each session. The rats were kept on 32 ug/ml for three days and returned to water for three days. They were then presented with the 64 ug/ml nicotine solution for three days and then returned to water for three days. It was found that the lick rates of two subjects remained stable, and the lick rates for the remaining two rats
slightly increased when exposed to the 32 ug/ml solution of nicotine. At 64 ug/ml, the lick rates and fluid consumption was reduced in all of the subjects.

In experiment 4, twelve Lister hooded rats comprised the first two groups. In the first group, eight rats could self-inject themselves with a 0.1 mg/Kg nicotine solution after each bar press. In the second group, four rats self-injected a saline solution following each bar press. The subjects were maintained at 80% of their free feeding weights and were then placed on a fixed interval 60 second (FI-60") food delivery schedule during a two hour session. Eight additional rats comprised the second two groups with four animals per group. These rats were maintained at 80% and 100% of their free feeding weights. They were then placed into operant chamber without the food delivery schedule. Four rats in each group received nicotine for each bar press and four received a saline solution. In summary, three groups of rats self-administered nicotine, and three groups self-administered saline. It was found that the rate of bar pressing for nicotine by the three groups was significantly different from that of the three groups that bar pressed for saline. Bar pressing rates for nicotine were significantly higher under the food delivery schedule when they were compared to the rats that were at eighty percent of their free feeding weights, without the food delivery schedule and when compared to the subjects that were maintained at 100% of their free feeding weights. Self-injection rates for saline were significantly lower than the nicotine self-injection rates.
Based upon the above findings, it may be said that different strains of laboratory rats will self-administer nicotine under laboratory conditions.

The present procedure was a variation of the Lang et al. (1977) schedule induced polydipsia procedure. This procedure was designed to give the animals a choice between two substances in order to compare the amount of liquid consumed from each tube. Based upon the findings of Lang et al. (1977), the researcher hypothesized that the rats that had access to the 32 ug/ml solution would prefer it instead of distilled water. It was also hypothesized that the animals that had access to the 64 ug/ml nicotine solution would prefer distilled water. The doses that were used in this study were taken directly from the Lang et al. (1977) study. The design of this experiment allowed the researcher to see in a very short time if the nicotine solutions were preferred to the distilled water, particularly if the drink tubes were switched. By alternating the positions of the drink tubes it was possible to determine whether or not the substances might have been reinforcing to the animal or that the animals had a side preference for drinking.
CHAPTER II

METHOD

Subjects and Setting

Six, adult male, Sprague-Dawley rats (Subjects 2RC, MT, BT, TT, NT, and LT) of Harlan Industries stock (Indianapolis, Indiana) served as subjects. The subjects were housed in individual home cages in a colony room that had a 24-hour day cycle. All of the subjects were nine-months old at the beginning of the experiment. Prior to the initiation of the experiment, the subjects were given free access to food and water, with free access to water only during the experiment. During the experiment, each subject was food deprived to 80 percent of its free feeding weight and obtained sufficient food during the daily experimental sessions to maintain each animal's weight at 80 percent.

Apparatus

The experimental apparatus consisted of two cages with two drink tubes affixed to the front of each. The chambers were 18.5 centimeters wide, 14.5 centimeters tall, and 24.25 centimeters deep. The two holes for the drink spouts were 2.25 centimeters from the floor of the chambers, 3.5 centimeters from the two side walls, and 11.25 centimeters apart.
Dependent Variables

The dependent variables examined were the number of milliliters of liquid consumed from a drinking tube that contained distilled water and a drinking tube that contained a nicotine tartrate solution of either 32 ug/ml or 64 ug/ml.

Independent Variables

The independent variables implemented in this experiment consisted of four to five food pellets, distilled water, and two concentrations of a nicotine tartrate (32 ug/ml and 64 ug/ml) solution prepared for oral administration by dissolution into distilled water.

Procedure

The procedure consisted of making available to each subject on a concurrent basis a drink tube that contained distilled water, and a drink tube that contained one of two nicotine tartrate solutions.

There were two groups of subjects, each composed of three animals. Animals were randomly assigned to one of the two groups. The first group had a 32 ug/ml nicotine solution available to it, and the second group had a 64 ug/ml nicotine solution available to it during each 60 minute experimental session. Each animal had its daily food allowance presented during each experimental session.

Before the experiment was instituted, each animal was allowed to "free feed" until their free feeding weights had stabilized. Once weight had stabilized, each subject was given two food pellets

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
per day in order to reduce their weights to 80%. After stabilization was obtained, each subject's water supply was replaced by a 32 ug/ml nicotine solution. Each subject had access to the nicotine tartrate solution for 24 hours for a period of 8 days. Once drinking stabilized for each subject the first phase of the experiment was implemented.

The six subjects in this experiment were studied in daily 60 minute sessions.

Phase 1

During Phase 1, each subject in Group 1 was placed into the experimental chambers (one subject per chamber) along with it's daily food allotment. Each subject had access to a drink tube that contained a 32 ug/ml nicotine tartrate solution. During this phase, the tube that contained the nicotine solution was always placed on the left side of the front of the cage. The distilled water was always placed on the right side of the cage. The conditions of this phase were in effect for a period of 9 days. Upon the completion of each daily session the number of milliliters of liquid consumed from each tube was recorded, each subject was weighed and returned to it's home cage. The procedure for Group II was the same with the exception of the nicotine concentration, which was a 64 ug/ml concentration of nicotine tartrate.

Phase II

During this phase, the procedures remained the same for both
groups with the exception of drink tube position. A "reversal" occurred in which the experimenter simply reversed the positions of the tubes. This phase was conducted for a period of 6 days for both groups.

Experimental Design

The experimental design was an "AB" reversal design. A nicotine tartrate concentration was made available concurrently with distilled water. During Phase I the nicotine was always on the left of the cage and the distilled water on the right side of the cage for a period of 9 days. During Phase II the positions of the drink tubes were switched for a period of 6 days.

This switch was instituted to control for the development of a side preference and also to see if the animals would make a reversal to the tube that they had each "preferred" during Phase I.
CHAPTER III

RESULTS

Examination of Table 1 indicates that in both Phase I and II each subject in Group I consumed a greater volume of the nicotine solution than of the distilled water.

Table 1

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects</td>
<td>32 ug/ml Nicotine</td>
<td>Distilled Water</td>
</tr>
<tr>
<td>2. R. C.</td>
<td>9.88</td>
<td>1.0</td>
</tr>
<tr>
<td>M. T.</td>
<td>4.33</td>
<td>3.66</td>
</tr>
<tr>
<td>B. T.</td>
<td>10.55</td>
<td>4.55</td>
</tr>
</tbody>
</table>

Table 2 shows the mean amount of milliters of liquid ingested by each subject in Group II. It can be seen that subjects T. T., and N. T. consumed more distilled water than nicotine in Phase I only. All subjects in Group II consumed more nicotine than water in Phase II. (Note: Table 2 may be found on page 18).
Table 2
Mean Amount of Milliliters Ingested by Individual Subjects From Group II

<table>
<thead>
<tr>
<th>Group II</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>64 ug/ml</td>
<td>64 ug/ml</td>
</tr>
<tr>
<td>T. T.</td>
<td>1.88</td>
<td>7.16</td>
</tr>
<tr>
<td>N. T.</td>
<td>8.33</td>
<td>13.0</td>
</tr>
<tr>
<td>L. T.</td>
<td>11.33</td>
<td>19.66</td>
</tr>
</tbody>
</table>

Table 3 shows the grouped mean amounts in milliliters of nicotine and distilled water ingested by subjects in Group I.

Table 3
Grouped Mean Amounts of Milliliters Ingested by Subjects From Group I

<table>
<thead>
<tr>
<th>Group I</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32 ug/ml</td>
<td>32 ug/ml</td>
</tr>
<tr>
<td></td>
<td>Distilled</td>
<td>Distilled</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>8.25</td>
<td>11.0</td>
</tr>
<tr>
<td></td>
<td>3.02</td>
<td>2.66</td>
</tr>
</tbody>
</table>

Upon the examination of Table 4, it can be seen that the subjects in Group II consumed less of the nicotine solution than distilled water during Phase I but consumed more of the nicotine
solution than distilled water during Phase II.

Table 4

Grouped Mean Amounts of Milliliters Ingested by Subjects From Group II

<table>
<thead>
<tr>
<th>Group II</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>64 ug/ml Nicotine</td>
<td>64 ug/ml Nicotine</td>
</tr>
<tr>
<td></td>
<td>Distilled Water</td>
<td>Distilled Water</td>
</tr>
<tr>
<td></td>
<td>7.18</td>
<td>13.27</td>
</tr>
<tr>
<td></td>
<td>7.55</td>
<td>3.33</td>
</tr>
</tbody>
</table>

Table 5 represents the amounts of liquid ingested across both phases of the experiment by both groups. It can be seen that both groups ingested a greater volume of nicotine than distilled water during the experiment.

Table 5

Grouped Means of Milliliters Ingested Across Both Groups

<table>
<thead>
<tr>
<th>Experiment Wide</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32 ug/ml Nicotine</td>
<td>64 ug/ml Nicotine</td>
</tr>
<tr>
<td></td>
<td>Distilled Water</td>
<td>Distilled Water</td>
</tr>
<tr>
<td></td>
<td>9.35</td>
<td>9.62</td>
</tr>
<tr>
<td></td>
<td>2.88</td>
<td>5.86</td>
</tr>
</tbody>
</table>
CHAPTER IV

DISCUSSION

The basic conclusion that was drawn from this experiment was that Sprague-Dawley rats will self-administer nicotine via the oral route. This finding adds support to the experiments (Clark, 1969; Lang et al. 1977; and Sanger, 1978) that were conducted with different strains of laboratory rats.

The experimenter's hypothesis was only partially correct in that it was predicted that the subjects that had access to the 32 ug/ml nicotine solution would consume more of this substance than distilled water. This was found to be the case for the rats that were in Group I. This finding was similar to the findings of an experiment that was conducted by Lang et al. (1977) in which the oral intake of a 32 ug/ml nicotine solution was examined by the use of a schedule induced polydipsia procedure.

The finding that the subjects in Group II did not seem to prefer the 64 ug/ml solution during the first phase was also supported by the Lang et al. (1977) study. However, during the second phase, these subjects preferred to drink the 64 ug/ml nicotine solution as opposed to distilled water.

It was the case that five of the subjects in the present study drank only from one tube. Drinking was concentrated on a particular tube only after the animals had consumed liquid from both tubes.

What are some possible explanations for this drinking behavior?
One possibility might be that the nicotine solutions exuded a "sweet" odor for the fact that the tartrate had a sweet odor to the experimenter. It may have been the case that the animals drank from the tube that had a different odor than the water tube. It might also have been the case that the animals established a side preference and would only drink from a specific side of the chamber. This possibility seems unlikely since when the bottle positions were changed the subjects would make the discrimination and continue to drink from the side that the nicotine solution was on. The final, and most important possibility concerns the issue of nicotine functioning as a reinforcing stimulus. In the present case, the results seem to support the claim that the nicotine did in fact function as a reinforcing stimulus. If the nicotine was an aversive or noxious stimulus, the animals would not have continued to ingest the nicotine in the amounts that were ingested.

There were a number of problems with the present study. The first problem concerns the length of the phases. It would have been preferable to have extended the phases so that stable rates of drinking could have been established. It would have also been preferable to have instituted an "ABAB" design in order to see if the subjects would have continued to drink from the nicotine tubes following each phase change.

This study does, however, have some strengths. The first strength concerns the fact that the nicotine intake of the animals persisted after the inducing procedure was terminated. It is also
the case that the nicotine was consumed orally which make it somewhat analogous to the way in which humans ingest nicotine.

There have been very few studies that have examined the oral self-administration of nicotine. This study will hopefully lead to more detailed experiments that ask the question, is nicotine a reinforcing stimulus?
BIBLIOGRAPHY


