ENUGU STATE UNIVERSITY OF SCIENCE & TECHNOLOGY

JOURNAL OF SOCIAL SCIENCES & HUMANITIES

Volume 9
Number 2,
2024

PUBLISHED BY
Faculty of Social Sciences,
Enugu State University of Science And Technology

Effects of Nicotine on Reaction Time among Albino Rats

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Abstract
Nicotine, a primary addictive compound in tobacco, is known to impact cognitive functions, including reaction time. While studies have been conducted on human subjects, animal models, such as Albino rats, provide valuable insights into the neurobehavioral effects of Nicotine. This study investigated the effects of Nicotine on reaction time in Albino rats. A factorial design was employed, involving a sample size of 20 Albino rats randomly assigned into four groups: two experimental groups and two control groups, with each group comprising male and female rats. The experimental groups were administered 5 mg of Nicotine solution, while the control groups received distilled water. Reaction time data were collected by placing each rat in a T-maze, with a food reward (mouse cube) positioned on a path for the rats to see and move toward. The data were analyzed using factorial ANOVA and independent samples t-test. Two hypotheses were tested and accepted at a significance level of p = 0.001. The results indicated that Nicotine significantly reduced reaction times in the experimental groups compared to the control groups. Additionally, the findings revealed that female Albino rats exhibited longer reaction times than male Albino rats. The study concludes that Nicotine influences the physiological, behavioral, and cognitive functions of both male and female Albino rats. It is recommended that the government and health sector stakeholders intensify efforts to inform and educate the public on the health risks associated with the continuous consumption of Nicotine-containing products.

Keywords: ***Nicotine, reaction time, Albino rats, cognitive Functions***

Introduction

Drug is any substance (with the exception of food and water) which when taken into the body alters the body function either physically or psychologically. Individuals use drugs for several reasons such as when they want to feel good, stop feeling bad, perform better at school or work. Generally, drugs are consumed to prevent, diagnose, treat or relieve symptoms of a disease or abnormal condition. The therapeutic nature of drugs depends on the type of chemical derivatives used for their extractions. This could be natural, synthetic, or semi-synthetically derived.

Reaction time is a measure of the purposeful, voluntary response to an external stimulus and is commonly used to assess the effects of drugs on living tissues (Miller & Cohen, 2017). It is defined as the time interval between the presentation of a stimulus and the occurrence of the appropriate voluntary response in a subject (Smith et al., 2021). Reaction time, measured in milliseconds, reflects the speed of neurophysiological, cognitive, and information processing systems in response to a stimulus applied to an individual's sensory system (Shevinky &

Reinagel., 2019). This process involves several stages: the receipt of sensory information (visual or auditory), its processing, decision-making, and the execution of a motor response (Petersen & Posner, 2012). Seminal work by Franciscus Donders in 1864 (as cited in Opstal, 2018) laid the groundwork for understanding reaction time by measuring the interval between the onset of a sensory stimulus and the subsequent behavioral response.

Some factors have been identified to affect reaction times in animals such as age, gender, physical fitness, fatigue, distraction, personality type, and stimulus whether auditory or visual and abuse of psychoactive drugs (Adetoro et al., 2023; James et al., 2023, Uye et al., 2023). Specifically, psychoactive drug functions in the nervous system which altered perception, mood, cognition, and behavior. Psychoactive drugs are grouped based on their effects in the brain and nervous system. These include depressants which are drugs that calm the brain, reduce anxious feelings, and induce sleepiness. Examples are alcohol and opioids (e.g., codeine and heroin). The second is a hallucinogen drug which causes change in thoughts, emotions, and consciousness and it includes mescaline, nitrous oxide, and psilocybin. The third is the stimulant which affects the brain, increasing alertness and wakefulness with examples such as caffeine, Nicotine, cocaine, and amphetamines.

Nicotine, a compound primarily extracted from tobacco, is commonly consumed through smoking, chewing, or sniffing. Its use can lead to various adverse effects, including irritation and a burning sensation in the mouth and throat, increased salivation, nausea, abdominal pain, vomiting, and diarrhea (Benowitz, 2010; Rose et al., 2017).

Some studies have investigated the effects of Nicotine and other psychoactive substances on the physiological and behavioural processes in Albino rats. For example, Hager et al. (2021) injected Nicotine solution into the liver of neonatal Albino rats and histologically examined the effects on their liver. The result revealed marked centrilobular congestion, that is, the dilatation of the central vein and the blood sinusoids, cellular degeneration with loss of trabecular arrangement in the Nicotine-treated group compared to the control group. Also, Osuh et al. (2021) investigated the effects of chronic injection of Codeine and Tramadol on the food intake and body weight of Albino rats with the specific objectives to determine their feeding behavior and body weight. The results revealed that the Codeine only group, Tramadol only group, and combined Codeine and Tramadol group significantly influenced the feeding behavior and body weights of the experimental groups compared to the control group. Furthermore, Uye et al. (2023) conducted a cross-sectional survey study on the influence of Codeine and Toluene abuse on criminal behavior among youths in Minna, Niger State and found high prevalence of Codeine and Toluene abuse to have contributed to criminal behavior among study participants.

Further studies have confirmed the influence of substance abuse as a principal cause of deviant behaviors among different populations and across different samples (Adetoro et al., 2023; Okurame et al., 2024). Finally, Mamdouh et al. (2003) found in a study that tested the effect of Nicotine on the liver of Albino rats that an experimental group exposed to Nicotine inhalation developed symptoms in hepatic parenchyma compared to the control group which was not affected.

The effects of Nicotine, a key active ingredient in cigarettes, have been studied in animal models with varied outcomes (Levin & Rezvani, 2020). However, there is a significant lack of research on the effects of Nicotine on reaction time in animals, particularly in Nigeria,

highlighting a gap in the existing knowledge (Benowitz, 2010). This study aims to experimentally assess the effects of Nicotine on reaction time in Albino rats, with potential implications for understanding how Nicotine might influence reaction times in humans who smoke or inhale the substance (Rose et al., 2017). The experiment was designed to answer two key questions:

(1) Does Nicotine injection significantly affect the reaction time of Albino rats compared to a control group?
(2) Do male Albino rats injected with Nicotine exhibit faster reaction times than their female counterparts?

The finding of this study would provide a fresh insight on the effects of Nicotine on reaction time among Albino rats. Also, experimental psychologists, neurologists, social workers and other stakeholders interested in the prevention of substance abuse would find the results of this study useful in their works.

Hypotheses
The following hypotheses were tested to examine the relationship between the variables of this study:
1. Nicotine would significantly affect reaction time among Albino rats compared to the control group.
2. Male Albino rats ingested with Nicotine would be faster on reaction time measures than female Albino rats.

Method
Design
The study design was an independent group randomized design adopting a factorial design matrix. The subjects (Albino rats) were randomly assigned to experimental (caffeine treatment) and control (Saline treatment) groups. The experiment took place at the Animal and Environmental Biology Laboratory, Federal University Oye-Ekiti, Ekiti-State, Nigeria. The independent variable was the acute administration of Nicotine to the male and female Albino rats while the dependent variable was the reaction time demonstrated by the male and female Albino rats.

Experimental Animals: Twenty Albino rats that weighed between 120g and 125g were used for the study. The rats were sheltered in separated metal cages and kept in constant environmental condition of temperature (22±1°C) and humidity throughout the period of the study. The rats were fed with mouse cubes on a constant diet and fresh clean drinking water. All rats were acclimatized for a period of three weeks before the commencement of the study to get them used to the laboratory environment different from where they were purchased.
Drugs and Technique
The drug used for the experiment was Nicotine. Nicotine was administered orally with the use of oral cannula. The rats were administered 5 mg/kg body weight of Nicotine solution.

Experimental Materials The instruments and materials used for the experiment were experimental rat cages, hand gloves, nose/face mask, distilled water, recording sheets, disposable syringes, 5 mg Nicotine, distilled water, laboratory coat, stopwatch for recording and time keeping, weighing balance for weighing rats, measuring cylinders used in diluting

and measuring the solution, mouse cubes for feeding the rat, pipette tip, T-maze, and water bottle.

Experimental Procedure

Prior to the commencement of the experiment, the experimental rats were brought into the laboratory and left to acclimatize in the laboratory for 21 days. During this period, the rats were allowed free access to feeds and water without any form of deprivation under the normal day-night or 24-hour cycle. The rats were then randomly assigned into 4 groups: Male experimental group, female experimental, male control group and female group. The experimental group were administered 5 mg/kg Nicotine, and the control group were administered distilled with 5 rats in each group. Each cage was clearly labeled with the drug category. Also, the rats were marked for identification and rats in each cage were labeled 1 to 5 according to their groups.

The experiment started with the training of the rats on the process of exploring the T-Maze for 7 days before exposing them to drug treatment. The rats were deprived of food for 24 hours to make them sufficiently hungry because the feeds were used as the motivation for the rats to explore the maze. During each experimental period, the rats were put in the starting point of the T-Maze and allowed 5 minutes to explore the maze to locate the feeds placed in one of the arms of the maze. The time taken by each rat to locate the feeds within the 5 minutes' interval was recorded for each rat using the stop clock. A rat is scored zero if it was not able to locate the feeds in the arm within the 5 minutes allotted. Each rat was given 3 trials during each experimental period. Feeds were restored to the rats at the end of each experimental period. On each day of the experiment, each rat was weighed and recorded. This was to determine what dose of drug to administer to each rat. The drug was then administered to each experimental group of rats according to their body weights. The control group was given normal distilled water.

After the drug administration, the rats were allowed 30 minutes before the commencement of data collection to give enough time for the onset of drug action. They were then run on the T-Maze to measure the reaction time or time taken to explore the maze. The process of treatment and data collection was repeated every day for 14 days. At the end of the experiment, all the rats were discarded following the procedures recommended for disposal of animals used for research purposes by the cruelty to animal act.

Data Analysis

IBM SPSS version 23 was used for data analysis. Inferential statistics was used to test the stated hypotheses. Data were analyzed using factorial ANOVA and hypotheses were accepted at p value = 0.001.

Ethical Consideration

The study adhered strictly to the animal protocols and followed the National Institutes of Health Guide for the Care and Use of Laboratory Animals and facilities.

Results

The hypothesis which stated that Nicotine would significantly affect reaction time among Albino rats compared to the control group was analyzed using factorial ANOVA and the result is presented in Table 1.

Table 1: *Factorial ANOVA showing the effects of Nicotine on reaction time among Albino rats*

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Treatment	356160.203	1	356160.203	56.794	<.001	.890
Treatment * Gender	11972.584	1	11972.584	1.909	.210	.214
Error(Treatment)	43897.686	8	6271.098			
Gender	60989.404	1	4691.493	2.232	.014	.242
Time * Gender	55806.293	1	4292.792	2.042	.026	.226
Error(Gender)	191283.136	8	2102.012			
Treatment * Time	59680.930	13	4590.841	1.711	.072	.196
Treatment * Time * Gender	49338.105	13	3795.239	1.414	.168	.168
Error(Treatment*Time)	244186.514	91	2683.368			

The result in Table 1 shows that rats exposed to a 5 mg dose of Nicotine significantly increased reaction time which varied significantly across points in time ($F(1, 7) = 56.79$, $p = .00$).
A post-hoc pairwise comparison was conducted using the Bonferroni correction and the result is presented in Table 2.

Table 2: *LSD Post-Hoc Comparison Analysis of Reaction Time Showing the Mean Difference between Rats Exposed to Nicotine and Control Group.*

	Mean	S.E.M	LSD HOC	POST	Sig.
Control	102.414	8.445	72.02*		.000
Nicotine	30.393	2.641			

Significant at p = .001

In Table 2, the mean differences showed that rats in the control (102.414) significantly displayed faster reaction time compared to rats ingested with Nicotine (30.393). The mean differences were significant. Therefore, the hypothesis was confirmed.
The hypothesis which stated that female Albino rats injested with Nicotine would be faster in reaction times than male Albino rats was tested using t-test of independent samples and the result is presented in Table 3.

Table 3. *T-Test of Independent Samples of Difference Between Gender and Reaction Time*

Gender	**Treatment**	**Mean**	**Std. Error**	**95% CI Lower Bound**	**95% CI Upper Bound**
Female	Control group	85.314	11.943	57.773	112.855
	Treatment group	30.800	3.735	22.188	39.412
Male	Control group	119.514	11.943	91.973	147.055
	Treatment group	29.986	3.735	21.374	38.598

Table 3 shows the difference between male and female Albino rats and reaction time. The result showed a significant gender difference in reaction time such that female Albino rats in the control group score higher (M= 85.314, SE = 11.943) compared to the experimental

group (M=30.800, SE = 3.735). Also, male Albino rats in the control group scored higher in reaction time (M =119.514, SE = 11.943) compared to those in the treatment group (M= 29.986, SD= 3.735). Overall, there was a marginal difference in reaction time between the female treatment group (M= 30.800, SD =3.735) and male treatment group (M= 29.986, SD= 3.735). The hypothesis was partially supported.

Table 4. *Comparisons of Reaction Time by Gender, Treatment and Control Groups*

Gender	(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% CI Lower Bound	95% CI Upper Bound
Female	Control group	Treatment group	54.514*	13.536	.004	23.301	85.728
Male	Control group	Treatment group	89.529*	13.536	<.001	58.315	120.742

*Based on estimated marginal means

A pair wise comparison was conducted to explore the differences in reaction time between experimental and control groups. As shown in Table 4, there was a significant difference between the control group (M = 85.314, SE = 11.943) and the treatment group (M = 30.800, SE= 3.735), with a mean difference of MS=54.514 (SE = 13.536, p = .004, 95% CI [23.301, 85.728] for the female Albino rats. Similarly, among male Albino rats, a significant difference was observed between the control group (M = 119.514) and the treatment group (M = 29. 986) with a mean difference of MS= 89.529 (SE = 13.536, p < .001, 95% CI [58.315, 120.742]. These findings indicated that female rats exposed to the treatment of Nicotine drug exhibited a significantly faster reaction time compared to those in the control group. Similarly, male Albino rats exposed to the treatment showed a significantly faster reaction time compared to the control group.

Discussion

This study was carried out to determine the effects of Nicotine on reaction time among male and female Albino rats. The study used a 2x2 factorial design. Two hypotheses were tested to determine the relationship between the variables.

The hypothesis that Nicotine would significantly affect reaction time among Albino rats compared to the control group was accepted. Rats in the control group (102.414) significantly displayed faster reaction time compared to rats ingested with Nicotine (30.393). The results of this study indicate that Nicotine significantly affects reaction time in Albino rats, supporting the hypothesis that Nicotine administration would alter reaction times compared to a control group. Specifically, the control group exhibited a significantly faster reaction time (102.414 ms) compared to the Nicotine-treated group (30.393 ms), suggesting that Nicotine impairs the cognitive processing speed of the rats. These findings aligned with the current body of literature, which suggests that Nicotine has complex effects on cognitive function. Nicotine is known to interact with nicotinic acetylcholine receptors (nAChRs) in the brain, which play a crucial role in modulating neurotransmitter release and cognitive processes such as attention, learning, and reaction time (Levin & Rezvani, 2020). However, while Nicotine is often associated with enhanced cognitive performance in certain tasks, it

can also have detrimental effects depending on the dosage and the specific cognitive function being measured (Benowitz, 2010).

The observed decrease in reaction time among Nicotine-treated rats in this study contrasts with some reports that have shown Nicotine to enhance certain aspects of cognitive function, such as attention and memory (Rose et al., 2017). This discrepancy could be due to several factors, including the dosage of Nicotine administered, the duration of exposure, and the specific behavioral paradigms used in different studies. In this experiment, the significant reduction in reaction time suggests that Nicotine may have induced a state of cognitive over arousal or stress, leading to impaired performance. This is consistent with findings that high doses of Nicotine can produce anxiogenic effects, which may negatively impact cognitive functions such as reaction time (Rezvani & Levin, 2020).

This finding contributes to the growing evidence that Nicotine can impair certain aspects of cognitive performance, such as reaction time, especially at certain doses. These results underscore the need for further research to explore the mechanisms underlying Nicotine's effects on cognitive function and to determine how factors such as dosage, duration of exposure, and individual differences may influence these outcomes.

The finding that female Albino rats injected with Nicotine demonstrated faster reaction times compared to male Albino rats supports the hypothesis that sex differences may influence Nicotine's effects on cognitive performance. This result aligns with recent literature that suggests sex-related variability in Nicotine's impact on cognitive and behavioral functions. Recent studies have increasingly highlighted that Nicotine can have differential effects based on sex. Research shows that female rodents often exhibit different behavioral and cognitive responses to Nicotine compared to males. For instance, studies have demonstrated that female rats tend to have enhanced cognitive performance in certain tasks when exposed to Nicotine, possibly due to hormonal influences or differences in Nicotine metabolism (Gorini et al., 2014).

Nicotine acts primarily through nicotinic acetylcholine receptors (nAChRs), which are differentially expressed in the brains of males and females. For example, research indicates that hormonal fluctuations, such as those associated with the estrous cycle in females, can modulate the sensitivity of nAChRs, affecting cognitive outcomes (Morris et al., 2020). This could explain why female rats in the current study exhibited faster reaction times compared to their male counterparts. Additionally, differences in the density and distribution of nAChRs in male and female brains might contribute to the observed sex differences in Nicotine’s effects (Picciotto et al., 2012).

The faster reaction times observed in female rats align with some studies suggesting that females may benefit more from the cognitive-enhancing effects of Nicotine under certain conditions (Gorini et al., 2014). However, it's essential to consider that these effects can be complex and influenced by multiple factors, including dose, exposure duration, and baseline cognitive function (Frye et al., 2008).

These findings have implications for understanding Nicotine's effects on human cognition, as sex differences are also present in humans. For example, some research suggests that women may experience different cognitive effects from Nicotine compared to men, potentially affecting the development of smoking cessation strategies or the understanding of Nicotine's impact on mental performance (Dewitt et al., 2019). The observation that female Albino rats exhibited faster reaction times than male rats in response to Nicotine reinforces the

importance of considering sex as a critical variable in studies of Nicotine's effects. Further research is needed to explore the underlying mechanisms behind these sex differences and their potential implications for both preclinical and clinical studies.

Limitations for the study

The study has some limitations that need to be addressed in further studies. To begin with, only one Albino rat with sample size of 20 was used in the experiment which hindered generalization of the study findings. Further studies should compare different animals with increased sample size for comparative analysis and generalization of study findings. Furthermore, only one type of drug (Nicotine) was used in the study. Further studies should include two drugs to compare their effects on the experimental animals. Finally, non-availability of funds to purchase the necessary materials and equipment was a major constraint in this study. Therefore, more funds should be allocated for pure research like the present study.

Conclusion

The study has experimentally determined that Nicotine significantly reduces the reaction time of Albino rats. Also, female Albino rats injected with Nicotine showed significantly faster reaction time compared to male Albino rats. This finding has implications for the physiological well-being of the Albino rats and for human beings who consume Nicotine through smoking, snuffing or drinking liquor. It is recommended that government agencies and other stakeholders in the health sector should intensify efforts to inform and educate the general population on the health hazards of continuous consumption of Nicotine-containing products.

References

Adetoro, A. O., Olapegba, P. O., & Uye, E. E. (2023). Personality traits, perceived stress and social network as predictors of alcohol addiction among youths in Ibadan, Nigeria. *African Journal of Alcohol & Drug Abuse, 10*, 3-15.

Benowitz, N. L. (2010). Nicotine Addiction. *New England Journal of Medicine,* 362(24), 2295-2303.

Dewitt, S. J., McCabe, S. B., & Anderson, C. L. (2019). Sex differences in Nicotine addiction and treatment response. *Frontiers in Psychiatry*, 10, 34.

Frye, C. A., Walf, A. A., & Koonce, C. J. (2008). Estrogen's effects on cognition and mood. *Brain Research Reviews*, 57(1), 103-120.

Gorini, G., Pessione, A., & Melchiorri, D. (2014). Sex differences in Nicotine-induced cognitive enhancement and behavioral responses. *Behavioural Brain Research,* 275, 282-290.

James, O.O., Olapegba, P.O., & Uye, E. E**.** (2023). Family functioning, self- esteem and peer pressure as predictors of substance abuse among in-school adolescents in Lafia Metropolis, Nasarawa State. *Nigerian Psychological Research, 8*(2), 11-25.

Levin, E. D., & Rezvani, A. H. (2020). Nicotine effects on cognitive function: Behavioral characterization, pharmacological specificity, and implications for human health. *Pharmacology, Biochemistry and Behavior*, 193, 172908.

Mamdouh, S.G.,ElSlayed, G.K.,& Ahmed, A.A.(2003). A comparative study of nicotine effect on the liver of albino rat. Egyptian Journal of Hospitaly Medicine, 10, 130-144. https://doi.org/10.21608/ejhm.2003.18738

Marzouk, H.S., Awaad, A.S., Abo-Eleneen, R. E., & eli-Bakry, A. (2021). Effects of experimentally induced Nicotine on the liver of neonatal Ablbino rat. Advances in

Animal & Veterinary Sciences,10(1), 151-159 https://doi.org/10.17582/journal.aavs/2022/10.1.151159

Miller, E. K., & Cohen, J. D. (2017). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience,* 30, 167-202.

Morris, M. J., Li, D., & Moran, T. H. (2020). Hormonal modulation of Nicotine's effects on cognitive function: Implications for understanding sex differences in Nicotine dependence. *Neuropharmacology,* 163, 107767.

Okurame, D. E., Oladipo, M., & Uye, E. E. (2024). Self-esteem, health locus of control and resilient personality as predictors of substance abuse among in-school adolescents in Ibadan, Nigeria. *African Journal Alcohol & Drug Abuse, 11*(1), 107-119.

Opstal, A.J.(2018). 200 years Fransiscus Donders *Strabismus, 26*(4), 159-162 https://doi.org/10.1080/09273972.2018.155177

Osuh, J. I., Balogun, S.K., & Lanre-Abass, A. A. (2021). Separate and combined effects of chronic administration of Codeine and Tramadol on food intake and body weight in male Albino rats. *African Journal of Alcohol & Drug Abuse, 5*(1), 17-30.

Picciotto, M. R., Brunzell, D. H., & Caldarone, B. J. (2012). Neurobiology of Nicotine addiction: Insights from animal models. *Progress in Neurobiology,* 98(1), 3-16.

Rezvani, A. H., & Levin, E. D. (2001). Cognitive effects of Nicotine. *Biological Psychiatry,* 49(3), 258-267.

Rose, J. E., Behm, F. M., Westman, E. C., & Johnson, M. (2017). Nicotine-mecamylamine treatment for smoking cessation: The role of pre-cessation therapy. *Clinical Pharmacology & Therapeutics,* 102(5), 798-805.

Shevinsky, C.A. & Reinagel, P.(2019). The interaction between elapsed time and decision accuracy differs between humans and rats. *Frontiers in Neuroscience, 19*(13), 1211 https://doi.org/10.3389/fnins.2019.01211

Smith, A., Smith, P., & Jones, R. (2021). Cognitive and behavioral effects of pharmacological interventions: Reaction time as a measure. *Journal of Experimental Psychology*: General, 150(3), 545-556.

Staley, J. K., & Mash, D. C. (2017). Sex differences in the effects of Nicotine on cognition. *Frontiers in Behavioral Neuroscience,* 11, 237.

Uye, E. E., Ogundipe, O. O., & Olapegba, P. O. (2023). Influence of Codeine and Toluene on criminal behaviour among youths in Minna, Niger State, Nigeria. *African Journal of Alcohol & Drug Abuse 9*(1), 60-71.