EFFECT OF NON-LESION ELECTROSTIMULATION ON SENSORIMOTOR AND COGNIMOTOR ACTIVITIES IN WISTER RATS

Abstract

Over the years, electricians, electrical engineers, power transmission workers, vehicle drivers using faulty electro-spark ignitions, laboratory staff *et al* often on regular bases experience one form of electrocution or the other. Security operatives at most times uses Taser (electric gun) to incapacitate suspects during crime investigation with these occurrences sending doses of electrical charges to the brain. Non-lesion electrostimulation also function by like Taser during treatments of certain neurological disorders as catatonia, schizophrenia, depression, major depressive disorders, delirium symptoms arising from Parkinson disease etc. However, effect of these charges on spatial memories, plasticity of learnings, motor functions, stress and peroxidation of lipids had not been medically elucidated. On this note this study therefore investigates the effect of non-lesion electrostimulation on sensorimotor and cognimotor activities. 25 Rats of Wistar strains were utilized and grouped into 5 at 5 rats per group. Group 1 being the control and other groups were fed with water and feeds all through the study. Group 2 further received 5mA ECT + 2mg Scopolamine i.p, Group 3 (3mA ECT), Group 4 (5mA ECT), and Group 5 was (5mA ECT + 0.3mg Adenosine i.p) for a period of 3 weeks and all made to undergo Sensorimotor and Cognimotor tests. Result from the study showed that high dose (5mA ECT), 2mg Scopolamine and 0.3mg adenosine all significantly ($\rho < 0.05$) impaired spatial learning, memory and motor coordination whereas low dose (3mA ECT) did not. However, chronic administration of low dose ECT was noted with retrograde amnesia, poor motor skills, memory attenuation etc. This study therefore conclude that non-lesion electrostimulation (ECT) is a stressor which significantly impaired brain sensorimotor and cognimotor skills in addition to alteration of neuro-electrochemistry.

Keywords: Electrocution, Scopolamine, sensorimotor, cognitomotor, memory

Introduction

In our daily routines, or at works or laboratories, humans are exposed to one form of electrocution or the other ranging from small shocks to a large scale high voltage electrocution (1). For example electricians and electrical engineers often encounter electrocutions in the course of their jobs with resultant effects on the body which often move cephalically to the brain (2).

In neuropsychiatric and mental health, particularly for the treatment of major depressive disorders, bipolar disorder, catatonia, schizophrenia, comorbid disorders, neuroleptic malignant syndrome and depression associated with Parkinson's disease such as delirium, an Electroconvulsive Therapy (ECT) formally called Electroshock which is a non-lesion electro-

stimulation techniques are often used (3). The principle of ECT therapeutic is based on intentional passage of varying small electrical current through the brain to induce brief seizures with the aim of providing treatment for the various neurological disorders outlined above (4). The procedure is often applied on pregnant women and elderly people (suffering from any of the above mentioned brain disorders) whose medication may not be safe or effective or who may be unable to tolerate the acute prophylaxis of such drugs. ECT therapeutic option are also applied in patients who prefer ECT treatment to its medications and in individual whom ECT history had been successful (5).

Although ECT technique had been largely adjudged to be safe (6), some prophylaxis and risks had also been identified and include: confusion which may last from few minutes to several minutes; memory loss also known as retrograde amnesia which describes difficulty of recalling memories of events that occurred shortly before the treatment; physical side effects include headache, muscle ache, nausea and jaw pains. During non-lesion electrostimulation using ECT, heart rates and blood pressure rise had also been reported which could be a risk factor for patients with cardiogenic disorders (7).

Having seen some effects of ECTs on the body as outlined above, it is still not clear of possible effects of non-lesion electro-stimulation on sensorimotor and cognimotor activities and lipid peroxidation. Though literatures available suggests that ECT could cause temporary loss of memory known as retrograde amnesia of the brain, yet it is still not clear of the possible effects of ECT on memory and learning demonstrated in passive avoidance, object recognition, climbing abilities, navigations, hand gripping, etc. Literatures available had also not elucidate possible nexus between ECT and lipid peroxidation despite ECT's extensive use in amelioration of the above outlined neurological disorders.

Materials and Methods

Research Design

A total of 25 rats were used for the 5 groups study with 5 rats each (n = 5) per group. The study utilized 4 experimental groups and one negative or control groups. Group 1 is the Control and did not receive either ECT or drugs except the general feed and normal water which was applicable to all groups. Group 2 to 5 were the experimental groups. Group 2 received 5mA ECT + (0.1 ml of 10 mg Scopolamine injection. Group 3 received low dose 3mA of ECT while Group

4 received high dose of 5mA of ECT. Group 5 also received high dose of ECT (5mA) with 0.1ml Adenosine injection which is a tranquilizer. Both injections administered in group 2 and 5 were done intraperitoneally. All experimental administration were done for 3 weeks with Week 1 being acute administration, Week 2 is Intermediate administration while Week 3 is Chronic Administration. Results from the study were compared with results obtained from were treated with standard drugs: scopolamine and adenosine. All 25 rats were fed with water and Topfeeds for the period of the study.

Study Design

Chart 1: Research design

Group	Description	Administration
1	Negative (Control) Group	Normal Water and Feeds
2	ECT + Drugs1 Group	2mg Scopolamine + 5mA ECT + Normal Water and Feeds
3	Low Dose ECT Group	3mA + Normal Water and Feeds
4	High Dose ECT Group	5mA + Normal Water and Feeds
5	ECT + Drugs2 Group	0.3mg Adenosine + 5mA + Normal Water and Feeds

Before the commencement of the research, the rats were pre-exposed (pre-trial or pre-trained) to the various activities under sensorimotor and cognimotor for a period of one week. Thereafter, the rats were subjected to the various tests after it was induced with ECT seizure and drugs. Trials on sensorimotor activities conducted were Climbing test, Hand Grip, Rotarod and Inverted Screen Tests while under Cognimotor Activities were Passive Avoidance, Navigation, Barnes Maze and Object Recognition Tests. Time taken for completion of tasks for both sensorimotor and cognimotor activities were pegged at 5 minutes (300 Seconds) as completion time. As a

result, all tasks performed correctly or incorrectly before or after the 5 minute elapsed were recorded.

Lipid peroxidation for oxidative stress markers including malondialdehyde (MDA), Catalase (CAT), Superoxide dismutase (SOD) and Glutathione (GSH) were evaluated at the end of the study with results also recorded.

Drugs (Adenosine and Scopolamine) Administration and Mode

There were two Groups in the study that received drugs out of the 5 Groups. The Drugs Groups were Group 2 and Group 5. Group 2 was administered ECT and 0.1ml Adenosine injection while Group 5 was administered 0.1 ml Scopolamine injection. Mode of administration for both drugs were intraperitoneal. The process was repeated on other mice in the two respective groups.

Administration of Electroconvulsive Therapy using Automatic Reflex Conditioner

For demonstration of non-lesion electrostimulation in order to inducing seizure, a rats was picked one after the other and placed on a board. A pair of two terminals electrodes of automatic reflex conditioner for electroconvulsive therapy was clipped on the superior end of both ears of the rat. Thereafter, a tiny current of either 3mA or 5mA electroshock (depending on their group) was released from the machine into the rat. The electroshock was targeted at inducing brief seizure in the mice and to check if the seizure will affect memory or learning. Immediately that was done, the animal was transferred to the next stage being Passive Avoidance box for Cognimotor activities investigation. The procedure was repeated for all rats except Group 1.

Determination of Cognimotor and Sensorimotor Activities

Cognitomotor and sensorimotor activities were determined using, Passive avoidance, Navigation test, Barnes Maze and Object recognition test, and Inverted Screen Tests was conducted using their respective principles and procedures outlined below.

Passive Avoidance Procedures

Principles: The box is made of 2 chambers, lever arm and led light. The first chamber is white while the second is black. Naturally, rats are usually attracted to dark areas and as tradition, if placed in the white chamber, the rat is expected to naturally migrate to the dark compartment. The lever arm produces a kaka-sound as an indication that the rat had moved from one chamber to another while the led light flashes to indicate when the machine is about to shock.

Procedures: Having undergone electroconvulsive treatment from the automatic reflex conditioner, the rat was transferred to the passive avoidance box. Following the aforesaid principles, a rat each was placed in the white/bright compartment, after a while, it naturally moved to the black box area. Soon after, the dark side releases an electroshock at the foot of either 3mA or 5mA depending on their group. This then made the rat ran back from the dark to white compartment for escape and safety. If the cognimotor system (spatial memory and

learning) remains intact after the ECT administration, the animal may decide to remain in the white box but if the spatial memory becomes impaired to learn, within a period of 5 minutes following the earlier ECT administration, the rats will return to the black compartment. Time taken for the rats to return to the black side and number of times returned within 5 minutes were noted and recorded. Please not that if the rat spend 5 minutes without returning to the black box, it was recorded as "Completed" (CT) which means the rat had learned and spatial memory still intact. Some of the rats however returned to the black compartment in less than 5 minutes and the time taken for the return was also recorded. Lastly, some rats remained in the black box despite receiving a maximum shocks of 3 consecutive administration; such conditions were observed and recorded as "Incomplete" (IT)

Navigation Test Procedures

Principle: the navigation box is made of various chambers interconnected and interwoven to a final compartment. A rat with a normal neurologic condition will be expected to navigate to the last compartment within 5 minutes while those with partial seizure or memory impairment would not be able to do so despite being pre-exposed.

Procedure: After the passive avoidance, the rats each were introduced into the navigating box test. This was done by opening the entrance of the box with the rat placed in the first chamber. The time taken for the rat to move or navigate from the first to the last compartment was noted.

Rats that navigated within a set time of 5 minute were recorded as Complete" (CT) while those that could not remember the routes and navigate within the set 5 minute time were recorded "Incomplete" (IT).

Barnes Maze Test Procedures

Principle: the principle of this test is based on the fact that rats naturally love to live in darker and secluded enclosures devoid of human interference. However, the top of the Barnes Maze is open and bright with about 6 holes for easy penetration into a box below the top. The little box is an enclosure without much interference and do not have much bright lamination. Under nervous control, trained rats placed on the top of the maze would easily find its way through any of the 7 holes and relocate downward into the secluded box. However, trained rats with memory impairment would stagger at the top and not able to find its way out of the top.

Procedures: After Inverted Screen Test was done, the rat was placed at the centre top of the Barnes maze round spinning top. Thereafter, the round top panel was gently spanned for 8 seconds and allow to stop naturally. Immediately the spinning stopped, a time piece was started while the rat was still on the top of the Barnes maze trying to find its way through a hole to a safe box located below the round top. Rats that were able to locate the box below the hole within the set 5 minutes time were recorded as "COMPLETE (CT)" while rats that could not locate the box below the spanning top were recorded as "INCOMPLETE" (IT) after 5 minutes was elapsed.

Rotarod Test Procedures

Principle: the principle of this test is to determine animal's motor coordination for balance, muscle strength and stamina after ECT administration. The animal's physical resilience after receiving ECT is expected to be uncoordinated (distorted) and so ability to remain on the rotating rod after ECT is a sign that the motor coordination (sensorimotor) functions of the brain was not significantly affected by the shock. Conversely, if the animal drops before or during spinning, it means the ECT had significantly affected the rats sensorimotor.

Procedures: after navigation test was completed, the rat was transferred into the rotarod machine. The rat was carefully placed and allowed to balance on the rod of the machine. A time piece was started immediately with the machine rotating. The rotarod was rotated at the speed of 53 rpm for a period of 5 minutes. The time taken for the animal to remain on the rod or fall to the ground was noted and recorded. Rats that remained on the rod after 5 minutes of rotation were recorded as "COMPLETE (CT)" whereas those that fell before the 5 minutes were recorded as "INCOMPLETE (IT)".

Hand Gripping Test Procedures

Principle: Rats ability to grip an object is a skills displayed in their every days' life. The will to skilfully manipulate objects around the environment only occurs when appropriate force is developed toward the size of the object to be gripped. Gripping is a function of the upper limbs and proportional to the amount of force produced through the hand. Gripping further expresses the amount of strengths produced by the articulation of muscles and bones of the hand under conscious neurological efforts.

Procedure: a mouse was introduce into the hand gripping box. There in the box, the two upper limbs of the mouse was placed to hold a hand gripping metal located at the superior aspect of the box. With the aid of the hand, support was provided to the rat till both fore limbs of the rats was able to firmly grip the metallic device. Time piece was started immediately the rat gripped the device and timed for a period of 5 minutes. Procedures where rats did not fall within 5 minutes was recorded as "COMPLETE (CT)" whereas those were the rats fell off the metal before the 5 minutes is complete was recorded as "INCOMPLETE (IT)".

Inverted Screen Test Procedures

Principle: the principle of the test relied on the fact that trained (pre-exposed) rats in their normal neurological conditions would hold firm or climb the gauze wire in the inverted position in the inverted screen. Conversely, rats whose brain had been traumatized via seizure is expected to show some deficits after ECT administration.

Procedures: with the aid of the hand as support, the rat was placed at an inverted position (up-side-down) at the superior aspect of the inverted screen box. The 4 limbs (2 fore- and 2 hind-) were made to firmly grip the wire gauze positioned superior to the rat. Immediately the rat was gripped to the wire gauze, a time piece was started and within 5 minutes, a session was

completed. Rats the completed their session while still holding the inverted screen wire were recorded as "COMPLETE (CT)" while those that fell off before the 5 minutes is completed was recorded as "INCOMPLETE (IT)".

Beam Walking

Principle: effective beam walking demonstrate an act of active motor coordination. Rats with impaired sensorimotor system following a seizure or lesion of the brain will certainly be unable to walk along the beam.

Procedure: after the inverted screen test was concluded, the rats (each, in succession) were placed on a 1 meter beam and at the origin. The time piece of 5 minutes was started immediately. The time taken for the mouse to move from the origin of the beam to the end was observed and recorded. Animals that could not move within the set 5 minutes was recorded as "INCOMPLETE (IT)" while those that moved and completed their task within the set 5 minutes was recorded as "COMPLETE (CT)". The procedure was repeated for other mice in other groups in succession.

Rats' Sacrifice Procedures

Apparatus: Normal saline (Buffer), Dissecting set, Dessicator, Chlorofoam, Dissecting Board, Cotton Wool, Ethanol, Surgical Blade and Scissors.

Procedures: the rat was placed in a dessicator for 2 minutes. With the aid of a pitting needle and a pair of scissors, the calvaria skin of the head was cut-off, followed by the skull bone opened. The brain was excised from its skull bone/socket and placed in a petri-dish containing water to wash off the blood. Thereafter, the brain was weighed on an Electronic weighing balance to extract 0.1g (100mg). The equipment was sterilised using ethanol after sacrifice with good housekeeping ensured.

Method of Data Analysis

The study utilized both Descriptive Statistics and Post Hoc Tests. The descriptive statistics was used to derive Means (x) and Standard Error of Means (SEM) for all variables including sensorimotor, cognimotor function and lipid peroxidation while Post Hoc analysed multiple comparisons of the various groups with the control. Result figures are expressed in mean ± SEM with n = 5. * represent values that are statistically significant upon comparison with the control. The mean difference is significant when less than 0.05 level ($\rho < 0.05$). All data obtained from the study was analysed using Statistical Package for Social Sciences (SPSS) version 22.0.

Results

Effect of non-lesion electrostimulation on sensorimotor activities (Rotarod, Hand Gripping, Inverted Screen and Beam walking abilities in rats)

Table 1: Rotarod Result

Groups	Week 1 Time (s)	Week2 Time (s)	Week3 Time (s)
Group 1 (Control)	185.16 ±4.42	184.94±2.30	98.26±45.78
Group2 (2mg Scop. + 5mA ECT)	300.00±0.00*	242.27±1.96*	257.00±1.00*
Group3 (3mA)	242.07±32.92	241.20±0.35	243.67±0.93*
Group4 (5mA)	203.33±18.61*	208.53±16.94*	220.53±19.75*
Group5 (0.3mg Aden + 5mA)	300.00±0.00*	300.00±0.00*	300.00±0.00*

Result figures are expressed in mean ± SEM. n = 5 and t = 300 seconds. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at less than 0.05 level. Source: Researcher's Analysis, 2021

Table 1 showed the statistical results obtained from Rotarod Experiment following administration of Electroconvulsive Therapy (ECT) which is a non-lesion electrostimulation on sensorimotor activities of albino rats of wisters strains. While group 1 was the negative (or Control) group, group 3 and 4 received low (3mA) and high (5mA) doses of the ECT respectively. More so, group 2 and 5 both ECT + Drugs Group. Group 2 received high doses (5mA) of ECT + Scopolamine while Group 5 received 5mA of ECT + Adenosine for a duration of 3 weeks. Here, week 1 is acute administration, week 2 is intermediate while week 3 is chronic.

Table 2 : Inverted Screen Test

Groups	Week 1 Time (s)	Week2 Time (s)	Week3 Time (s)
Group 1 (Control)	12.33±2.31	8.87±1.73	9.40±0.95
Group 2 (2mg Scop. + 5mA ECT)	13.73±0.07*	7.67±0.33*	8.98±0.31*
Group 3 (3mA)	9.81±1.02	7.33±1.27	8.10±0.76
Group 4 (5mA)	8.53±0.13	9.93±1.16*	10.07±1.51*
Group 5 (0.3mg Aden + 5mA)	12.73±1.33*	18.20±2.11*	16.80±0.58*

Result figures are expressed in mean ± SEM. n = 5 and t = 300 seconds. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level

This result in table 2 (C) display the relevance of the study on special motor coordination abilities such as inverted screen movement after administration of ECT. The table also compare the combined effect of ECT and known drugs (as Scopolamine and Adenosine) on such motor movement.

Effects of non-lesion electrostimulation on cognimotor activities (Passive Avoidance, Navigation Test and Barnes Maze Test)

Table 3: Passive Avoidance

Groups	Week1		Week2		Week3	
	Avoidance	Number	Avoidance	Number of	Avoidance	Number of

	Time (Sec)	of Shocks	Time (Sec)	Shocks	Time (Sec)	Shocks
Group 1 (Control)	1.91±0.51	2.60 ±0.50	2.91 ± 0.66	1.21 ± 0.42	2.38 ± 0.71	1.31 ± 0.46
Group2 (2mg Scop. + 5mA ECT)	2.70±0.30*	1.50 ±0.50	1.90±0.90*	0.30± 0.14*	2.10± 0.10	1.30 ± 0.30
Group3 (3mA)	1.70±0.34	1.82 ±0.38	2.90 ± 0.47	2.00 ± 1.00	2.10 ± 0.41	1.70 ± 0.34
Group4 (5mA)	2.30±0.68*	0.7 ±0.47*	2.10± 0.34*	1.70 ± 0.68	2.00 ± 0.00	1.10 ±0.41
Group5 (0.3mg Aden + 5mA)	2.51±0.37*	1.71 ±0.21	1.93±0.76*	0.52± 0.19*	2.31± 0.34	1.52 ± 0.22

Result figures are expressed as Mean ± SEM. n = 5 and t = 300 Seconds. * represent values that are statistically significant upon comparison with the control. The mean difference is significant at (ρ) < 0.05 level

Table 4 Barnes Maze

Groups	Week 1 Time (s)	Week2 Time (s)	Week3 Time (s)
Group 1 (Control)	156.53±19.81	79.33±1.41	110.49±48.11
Group2 (2mg Scop. + 5mA ECT)	108.33±34.24	29.67±18.47	164.40±24.54*
Group3 (3mA)	163.60±7.30	70.60±11.19	140.93±34.87
Group4 (5mA)	90.67±40.25	189.13±33.47*	199.20±23.70*
Group5 (0.3mg Aden + 5mA)	300.00±0.00*	300.00±0.00*	300.00±0.00*

Result figures are expressed in mean ± SEM. n = 5 and t = 300 seconds. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level

Table 5: Navigation Test

Groups	Week 1 Time (s)	Week2 Time (s)	Week3 Time (s)
Group 1 (Control)	244.13±23.27	197.27±21.26	262.20±25.29
Group2 (2mg Scop. + 5mA ECT)	275.07±31.84*	291.67±8.33*	293.07±6.93*
Group3 (3mA)	217.80±19.42	228.73±38.64	298.07±11.79*
Group4 (5mA)	228.13±25.59	260.20±33.41*	273.93±36.07*
Group5 (0.3mg Aden + 5mA)	300.00±0.00*	282.80±17.20*	289.96±10.04*

Result figures are expressed in mean ± SEM. n = 5 and t = 300 seconds. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level

Effect of low and high doses of ECT on sensorimotor, Cognimotor and Lipid Peroxidation

Table 6: Comparing Effect of Low and High Dose ECT on Sensorimotor Activities

Test	Week 1		Week 2		Week 3	
	Low (3mA)	High Dose (5mA)	Low (3mA)	High Dose (5mA)	Low (3mA)	High Dose (5mA)
Rotarod	242.07±32.92	203.33±18.61*	241.20±0.35	208.53±16.94*	243.67±0.93*	220.53±19.75*
Hand Gripping	9.67±2.32	7.73±1.16*	7.67±1.58	7.93±1.37*	8.00±1.00*	8.13±0.27*
Inverted Screen	9.81±1.02	8.53±0.13	7.33±1.27	9.93±1.16*	8.10±0.76	10.07±1.51*
Beam Walking	142.07± 32.92	203.03± 18.61	141.20± 0.35	208.53 ± 16.94	223.67± 0.93*	240.53± 19.75*

Result figures are expressed in mean ± SEM. n = 5 and t = 300 seconds. * represent values that are statistically significant upon comparison with the control. The mean difference is significant (ρ) at 0.05 level.

Table 7: Comparing Effect of Low and High Dose ECT on Cognimotor Activities

Test	Week 1		Week 2		Week 3	
	Low (3mA)	**High Dose (5mA)**	**Low (3mA)**	**High Dose (5mA)**	**Low (3mA)**	**High Dose (5mA)**
Passive Avoidance (Sec)	1.70±0.34	2.30±0.68*	2.90±0.47	2.10±0.34*	2.10 ± 0.41	2.00 ± 0.00
Barnes Maze (sec)	163.60±7.30	90.67±40.25	70.60±11.19	189.13±33.47*	140.93±34.87	199.20±23.70*
Navigation (Sec)	217.80±19.42	228.13±25.59	228.73±38.64	260.20±33.41*	298.07±11.79*	273.93±36.07*

Result figures are expressed in mean ± SEM. n = 5 and t = 300 seconds. * represent values that are statistically significant upon comparison with the control. The mean difference is significant at 0.05 level

Discussions

Sensorimotor activities entails all afferent, efferent transmissions and central integration and processing components required for muscle and joint articulations. The sensory signals integration begins at the spinal cord and moves posteriorly to the cerebellum and brainstem and finally to the somatosensory cortex for an effective motor coordination (8).

Sensorimotor evaluation which measures motor coordination ability of the brain during strenuous or brain-based tasking activities (9) was evaluated using Rotarod, Hand Gripping, Inverted Screen and Beam Walking activities in 25 albino rats of wisters strain. The tests was aimed at determining possible effects of non-lesion electrostimulation on motor coordinating function of the brain. The rats were grouped into 5 with 5 rats each per group. Group 1 was the Control (Negative) and received on normal water and feeds. Group 2 to 4 were the experimental

groups with Group 2 receiving 2mg Scopolamine + 5mA ECT, Group 3 were administered 3mA ECT only while Group 4 received 5mA ECT. Group 5 received 5mA ECT with 0.3mg Adenosine injection. All administration and evaluation was for a period of 3 weeks. Results obtained in week 1 was recorded as acute, week 2 intermediate and week 3 recorded as chronic administration

Table 7 all presents result analysis for Rotarod, Hand Gripping, Inverted Screen and Beam Walking respectively which are markers or subcomponents of sensorimotor activities.

Result obtained for rotarod test as contained in Table 1 showed that Group 2 (300.00±0.00*), 4 (203.33±18.61*) and 5 (300.00±0.00*) produced significant ($p < 0.05$) effect on rotarod sensorimotor activities in week 1 (acute Phase) of experimental procedures whereas Group 3 with 3mA ECT did not produce any significant effect on the rat. Week 2 also showed similar result as week 1 with Group 2 (242.27±1.96*), 4 (208.53±16.94*) and 5 (300.00±0.00*) in week 2 having significant effects on rotarod sensorimotor as against Group 3 (241.20±0.35). This result suggests that low doses of ECT may not produce any significantly effect on rotarod sensorimotor activities as compared with higher doses or when combined with scopolamine. Week 3 being chronic administration had all experimental groups producing significant results on rotarod sensorimotor activities. The result obtained for the third week especially with the inclusion of the Group 3 (243.67±0.93*) being significant suggests that chronic administration of ECT affected motor coordination with particular reference to rotarod activities.

This finding affirm earlier reports by (10) who stated that ECS demonstrates hyperactivities in dose-dependent manner in sensorimotor function with possibilities of increasing hyperactivities on chronic administrations. It however negates those of Fan et al., (11) who exonerated the ECT from any possible side effects on sensorimotor functions in the brain and concluded that ECT being an efficient therapy for major depressive disorder has no side effect. This result also disagree with Olorunfemi *et al*., (12) who believed ECT is safe and has no negative side effects on sensorimotor functions.

Table 2 presents result for inverted screen tests among the 5 groups. Inverted screen measures sensorimotor strength, endurance and possible navigation in upside-down position and general motor coordination abilities in an experimental rat (13). While Group 1 being the Control had 12.33±2.31, 8.87±1.73 and 9.40±0.95 for week 1, Week 2 and Week 3 respectively, results of other groups (experimental groups) were compared with it to check for possible significant difference. Group 2 which received 2mg Scopolamine and 5mA ECT had 13.73±0.07* in week1, 7.67±0.33* in Week 2, and 8.98±0.31* in Week 3. Group 3 which received 3mA ECT only had 9.81±1.02 in week 1, 7.33±1.27 in week 2, 8.10±0.76 in week 3. Group 4 with 5mA ECT only produced 8.53±0.13 in Week 1, 9.93±1.16* in Week 2, 10.07±1.51* in Week 3. Lastly, Group 5 which received 0.3mg Adenosine Injection + 5mA of ECT produced 12.73±1.33* in Week 1, 18.20±2.11* in Week 2 and 16.80±0.58* in Week 3. From the result, Group 2 (2mg Scop. + 5mA ECT) and Group 5 (0.3mg Aden + 5mA) are both "drugs + ECT groups" produced significant effects in the mice. For Group 2, the mice were unable to perform their routine task in inverted screen activities from the first to the third week of administration. This condition is

presumably be adduced to the presence of scopolamine. The drugs is an antimuscarinic substance that blocks activities of acetylcholine in the brain (Buhot, *et al*., (14) which in turn disrupt memory acquisition, retention and learning of new tasks. The outcome of this result also affirm reports by Williams *et al*. (15) who stated that when scopolamine is used on receptor antagonist of muscarine, hyoscine was found to induce temporary memory lose or cognitive defects.

Like in Group 2, Group 5 also produced significant effects on the mice ability to holdup to inverted screen positions. This result was contrary to popular expectations as the presence of adenosine being a tranquilizer should have calm the mice nervousness or reverse the effect of the seizure; however outcome of the result showed that the mice were unable to function in inverted positions. This findings affirmed reports by Barraco *et al (16*) whom in their work "central effects of adenosine analogs on locomotor activities in mice and antagonism of caffeine" stated that adenosine was responsible for lowering locomotor sensorimotor from the brain.

Cognimotor activities focuses on spatial memory and learning abilities. In other to determine possible effects of non-lesion electrostimulation on spatial memory and learning in mice, passive avoidance, Navigation and Barnes Maze tests were all explored after administration of electroconvulsive therapy and the drugs on the mice as determined by their groups. During the tests, all procedures were timed for 300 seconds which is equivalent to 5 minutes as completion time. Time taken to complete each task were recorded with statistical analysis displayed in the above tables. Passive Avoidance Test also known as Inhibitory Avoidance Test is a fear based test that demonstrates spatial learning and memory and used as a component of cognimotor investigations by Bernhard and Helmut (16). The footshocks induced on the mice at the dark compartment of the ECT machine caused a rapid withdrawals of the rats from the dark compartment. The phenomenon demonstrated presented us a clearer picture in the understanding of rats's spatial learning, short-term memory attenuation and long-term memory. The avoidance here also showed us how mice develops habituation towards harmful scenario. Memory cognimotor performance are positively correlated with the latency to escape; the better the recollection, the greater the latency (17, 18). At this point, some group learned and remembered the noxious nature of the black compartment, while others did not learned neither remembered that the black compartment was harmful.

Table 3 presents results for Passive Avoidance investigation. Results from this table are in two sub-variables which are the measurement of avoidance time and that of number of foot shocks received in 3 minutes for each of the 3 weeks. Results from the experimental groups are compared with the control group for significant statistical differences. For the control, avoidance is 1.91±0.51 sec while number of Shock is 2.60 ±0.50 for week 1. Similarly, week also recorded avoidance as 2.91 ± 0.66 at 1.21 ± 0.42 number of footshocks while Week 3 had 2.38 ± 0.71 avoidance at 1.31 ± 0.46 shocks. From this table, only group 3 (3mA ECT) stood out to be different without producing any significant effects on the group; Group 3 week 1 had 1.70±0.34 avoidance time and 1.82 ±0.38 number of shocks, week 2 had 2.90 ± 0.47 avoidance time with 2.00 ± 1.00 number of shocks. At week 3, 1.70 ± 0.34 shocks produced 2.10 ± 0.41 avoidance. This result did not produce any significant effect on the mice passive avoidance cognimotor. That is to say, the mice having received the shocks, escaped from the black compartment of the

passive avoidance box to the white and refuse to return to the black anymore. That means the mice learned of the eminent danger in the black compartment and refuse to return there. This also imply that their memories were not affected by the effects of the 3mA ECT. The withdrawal response habituated is believed to be due to the low threshold of 3mA ECT electro-stimulation received by the group. The low dose could not significantly alter neural activities including spatial memory and learning. Again, even at week 3 being for chronic administration, the shock did not also produced any significant effect on the mice avoidance response. This therefore suggests that low dose electro-stimulation does not produce any significant effect on passive avoidance cognimotor. This also implies that the low dose did not affect the rat's spatial memory with reference to withdrawal response from the effect of electrocution. This discovery affirmed (17, 16) whom in their separate study report maintained that Memory cognimotor performance will be positively correlated with the latency to escape in a dose-dependent manner. This findings also agree in part with (19) who argued and came up with the conclusion that ECT could not significantly impair spatial memory. Navya, *et al*., (19) however did not expatiate on possible outcome of the high dose ECT on spatial memory and learning.

Still on table 4, similar results were obtained for group 2 (2mg Scop. + 5mA ECT), 4(5mA) and 5 (0.3mg Aden + 5mA). At week 1, the 3 groups showed significant statistics for avoidance except for number of shocks; however, only group 4 was significant for shocks in the entire week 1. In week 2, both avoidance and number of shocks were significant for Group 2 (2mg Scop. + 5mA ECT), Group 4 (5mA) and Group 5 (0.3mg Aden + 5mA). This mean, the mice having received the shocks in the dark compartment escaped immediately to the bright compartment and within a short period of time (less than 5 minutes) returned again to the dark compartment despite the danger of shock contained there and received another shock again. Such negative return (response) towards a noxious scenario is a sign of memory impairment. It shows that the mice's spatial memories to recall the noxious scenario within the short time of 1-5 minutes (as the case may be) was being distorted by the effects of the high dose ECT + Drugs. At this point, agitation was high in the mice after receiving the high doses and could not settle for calmness. This finding is in tandem with Krishnamurth *et al*., (20) who their stated that ECT produces more impairments than even the antidepressant agent (dothiepin) whose memory impairment effects had already been established. This findings however negated reports by (Ushakova *et al*., (21) whom both claimed that ECT was safe.

Lastly, week 3 Week 3 represents chronic administration for both non-lesion electrostimulation and the drugs groups but was surprisingly insignificant for all experimental groups. For example Group 2 had 2.10± 0.10 avoidance at 1.30 ± 0.30 shocks. Group 3 had 2.10 ± 0.41 avoidance at 1.70 ± 0.34 shocks; Group 4 also recorded 2.00 ± 0.00 avoidance at 1.10 ±0.41 shock while Group 5 recorded 2.31± 0.34 avoidance at 1.52 ± 0.22 shocks for group 3. At the third week, results in table 4 (A) showed that at further stimulations, the mice gained consciousness from their euphoria and distorted spatial memory and became tranquilized. As a result, the mice received the shocks and immediately ran to the bright compartments and remained there. This suggests that having received multiple stimulations over a long period of time (chronic) the rats' spatial memory and learning become restored. This also implies that at chroninc administration,

the ECT was no longer significant in creating seizure and memory distortion, however, there appear to be restoration of memory cognimotor. The mice were observed to have recovered from the effect of the seizure in the 3rd week even when administration was still ongoing. The actual physiologic mechanism responsible for this phenomenon is unclear and so further studies are required to unmask the neurological phenomenon. This finding therefore showed that previous reports by (Ushakova *et al*., (21); Navya, *et al*., (19) and others on the safety of ECT on memory and learning was limited. Their studies did not include the effect of the process at the onset of treatment (acute), intermediate and chronic phase but however jumped to conclude its effects on the final outcome. Findings from this study had also negated the conclusion drawn by Krishnamurth *et al*., (20) on the safety of ECT on spatial memory where they asserted that electroconvulsive therapy and antidepressant agents are both known to impair learning and spatial memory.

Table 4 presents results obtained for Barnes Maze test. Like in other tables, results gotten for experimental groups were compared with those gotten for the control at each week for the 3 weeks duration. Group 1 here had 156.53±19.81 for week 1, 79.33±1.41 at week 2 and 110.49±48.11 at week 3. Group 2 (2mg Scop. + 5mA ECT) when compared with the Control did not show any significant effect at Week 1 (108.33±34.24), Week2 (29.67±18.47) and Week 3 (164.40±24.54*). This suggests that the mice having received the administration were still able to locate the hole into the dark box for week 1 & 2. It is not clear why despite the high dose ECT and Scopolamine, the mice were still able to find their way into the save box. However, following observation from this study, the insignificant values recorded could be due to the fact that the 7 holes on the Barnes Maze round top were not far apart from one another. As a result, the mice easily locate the save holes into the box even under the high dose ECT + 2mg Scopolamine. Nevertheless, Week 3 Group2 later became significant. Thus resilience sustained in week 1 and 2 could not last to Week 3. This also implies that long time (chronic) administration of ECT + Scopolamine (which may *ab initio* not be significant) may causes seizure that affects spatial memory. In other words, long time administration of non-lesion electrostimulation could be devastating on learning and collateral memory impairments.

Another fact to prove the significant effect of chronic administration on spatial memory, Group 4 (5mA) also showed significant increasing effect from week 2 (189.13±33.47*) to Week 3 (199.20±23.70*) whereas Week1 (90.67±40.25) was not significant. Group 3 (3mA) also shared similar outcome as Group 2 except that group 3 only had its Week 3 (170.60±11.19*) to be significant. Result from this week 3 further showed that the mice were still able to find their way into the save dark box even under the influence of the seizure induced by the 3mA ECT. Result of this findings in group 3 could be due to the low dose ECT (3mA) which implies that low dose ECT was not significant in the causation of seizure which could lead to amnesia.

Group 5 (0.3mg Aden + 5mA) were extremely significant and having the same result (300.00±0.00*) for the 3 consecutive weeks. That means none of the mice were able to move an inch, perform any coordinated task neither find their way through the hole into the black save box in the maze. This result suggests that the adenosine could have produced an effect that over

tranquilized the mice under seizures, and apparently the reason significant number of the mice were unable to perform any task after receiving the 5mA ECT and 0.3mg Adenosine.

It is worthy of note that while other researchers had continue to argue the safety prophylaxis of non-lesion electrostimulation, none had been able to explain the significant effect/difference between acute and chronic administration of non-lesion electrostimulation could cause cognimotor functions. This study had not only showed the effect of ECT on memory but also presented variations between short and long term ECT administration and possible significantly effects on spatial memory, learning and other brain-based skills. For example, (Krishnamurth *et al*., (20); Erin *et al*., (2017) only explained that electroconvulsive therapy and antidepressant agents are both known to impair learning and spatial memory but did not state how long such administration could produce the said memory impairments as claimed.

Table 5 presents result obtained for navigation experiment. Navigation Test simply explained the ability of the mice to remember their usual route (pathways) they often move (meander) through to the exit point. Being able to remember such complex route and navigate through after receiving electrostimulation and drugs will be a sign of stable mental alertness and whereas any mice is unable to, it will signify memory loss and cognimotor impairment. Group 1 being the control group at week 1 had 244.13±23.27, Week 2 had 197.27±21.26 and Week 3 produced 262.20±25.29 as results which are here used for comparison. Group 2 (2mg Scop. + 5mA ECT) and Group 5 (0.3mg Aden + 5mA) produced significant effects on the 3 weeks as shown in Week 1 (275.07±31.84*), Week 2 (291.67±8.33*) and Week 3 (293.07±6.93*) for Group2 and 300.00±0.00* for Week 1, 282.80±17.20* for Week 2 and 289.96±10.04* for Week 3 Group 5. This implies that mice in this group having received the doses of the 5mA ECT and 2mg Scopolamine were unable to locate trace their pathway out of the navigation box. This also mean the administration significantly affected the mice spatial memory from week 1 of experiment to Week 3. This could be due to the high level of seizure induced by the combination of high dose (5mA) ECT and 2mg Scopolamine. Findings from this result affirms earlier reports by van-Buel, *et al*., (2017) who expressed fears for possible side effects including amnesia for the use of electrostimulation in the therapeutics of various neurological disorders; but negated reports by Ushakova *et al*., (21) who asserted that ECT was safe and converse to what others were saying. (21) in their conclusion did not however narrowed the declaration to spatial memory, learning among other cognimotor brain based skills.

Group 4 (5mA ECT) only became significant from week 2 (260.20±33.41*) to 3 (273.93±36.07*). Week 1 (228.13±25.59) was not significant. This result showed that high dose ECT become more destructive on cognimotor as time goes on with administration. Finding from this result therefore provides that chronic administration of only ECT would significantly aid memory attenuation and damaging consequences on learning and other cognimotor skills as time of administration proceeds. In table 5 shows the comparative difference between low and high doses of electroconvulsive therapy of non-lesion electrostimulation on the mice sensorimotor system. This comparison explains effective doses of the ECT therapeutics that significantly induce seizure such that motor coordination of sensory perception are being affected.

Rotarod week 1 had 242.07±32.92 for low dose and 203.33±18.61* for high doses; Week 2 was also 208.53±16.94* for low dose and 243.67±0.93* for high doses. From this result, it showed that the high dose produced significant ($\rho < 0.05$) seizure which in turn affected motor coordination, nervousness and muscular fatigue. As a result, the mice were unable to locate the hole into the save box. This therefore imply that high dose (5mA) of ECT significantly induced seizure which affected their rotarod performance in the sensorimotor system. Rotarod Week 3 however differ from week 1 and 2. At week 3, both low dose (243.67±0.93*) and high dose (220.53±19.75*) became significant. This finding again suggested that low dose (3mA) of ECT which were earlier not significant at week 1 and 2 became significant as administration progressed into the 3rd week. On Hand gripping, similar result attained in rotarod was also recorded in hand gripping test. The variance between the high and low dose are just same as rotarod. That is to say, everything already explained on rotarod about the significant difference between low and high dose ECT also apply in hand gripping tests. This therefore mean that if a previously insignificant low dose of ECT extend further over a long period of time, could become significant as administration becomes chronic. In other words, low dose administration of ECT may significantly affect rotarod if administered for longer duration; but at short duration, it may not significantly affect rotarod. This therefore become important reference especially in long term (chronic) treatment of some neurological disorders as schizophrenia, catatonia, depression *et al*.

To add to the above, Inverted screen and Beam Walking Tests also showed similar outcome. Though in the first and second week, both low and high dose ECT did not produce any significant effect on both Inverted Screen and Beam Walking, however, at week 3, only high dose (5mA) ECT was significant (10.07±1.51*) for inverted screen test; this means low dose (3mA) did not produce any significant effect on inverted screen test throughout the 3 weeks experiment. For Beam Walking, there was no significant difference for both low and high dose in week 1 and 2. However, only week 3 became significant for both low and high doses. This outcome suggests that can be more effective with time. Again, this finding may be useful to individuals who often encounter small or major electrocutions (ambiguation) in the cause of their daily routines over a long period of time. Their motor coordination and sensory system should be required for further sensorimotor evaluations.

Table 6 compares effect of low and high dose ECT on cognimotor function. Data obtained for cognimotor markers includes passive avoidance, Barnes Maze and Navigation investigations performed over a period of 3 weeks. A group of the mice received low dose (3mA) while another received high dose (5mA). Due to the incessant electrocution often received by power transmission workers and those undergoing neurological disorders treatment therefore necessitate that we examine possible dose-dependent effect of ECT on spatial memory, learning and general cognimotor impairments. In table 4 (B), low dose (3mA) was not significant at week 1 (1.70±0.34), week 2 (2.90±0.47) and week 3 (2.10 ± 0.41) but high dose was significant for week 1 (2.30±0.68*) and week 2 (2.10±0.34*) for passive avoidance. This means that low dose of 3mA could not significantly distort special memory and thus the mice kept avoiding the dark chamber containing the shock after receiving the footshock.

Barnes Maze also had similar result as passive avoidance. From week 1 to week 3, low dose (3mA) did not significantly affect the mice special memory and learning. Even at 3rd week being chronic administration, low dose ECT did not significantly affect Barnes maze cognimotor. However, high dose (5mA) at week 2 (189.13±33.47*) and 3 (199.20±23.70*) significantly affected cognimotor. Low dose experiment using Barnes maze therefore suggest that only high dose would be effective as duration of administration increases (chronic). Navigation test result also on table (B) showed significant statistic for low dose only at week 3 (298.07±11.79*); the rest of week 1 (217.80±19.42) and 2 (228.73±38.64) were not significant. This result once again affirmed that low dose ECT administration over a long period of time could significantly distort spatial memory, plasticity of learning and general cognimotor functions. Navigation high dose was nearly similar with low dose. Whereas low dose was significant only at 3rd week, high dose became significant at 2nd to 3rd week. However, at week 1, both low (217.80±19.42) and high dose (228.13±25.59) did not significantly affected mental coordination. With this report, one thing becomes prominent, and that is the fact that cognimotor distortion become more severe when duration of ECT administration become chronic. This occurrence applies to both low and high dose administrations.

Conclusions

This study had not only showed the effect of ECT non-lesion electrostimulation on motor functions but also presented variations between short and long term ECT administration and possible significantly effects on spatial memory, learning and other brain-based skills. These findings shall therefore constitute important reference especially for long term (chronic) treatment of some neurological disorders as schizophrenia, catatonia, depression *et al* and particularly when using ECT non-lesion electrostimulation techniques as option. Following observations and results emanating from this carefully conducted study with implications on sensorimotor and cognimotor activities and lipid peroxidation, it become imperative to conclude that: Low dose electrostimulation did not significantly affect either of sensorimotor or cognimotor activities in the first 2 weeks, but upon chronic administration, it significantly affected both motor functions which implies that low dose ECT was time dependant.. High dose non-lesion electrostimulation was devastating on spatial learning with collateral memory attenuation, retrograde amnesia and general cognimotor and sensorimotor skills incapacitation. From the study, it become worthy to note that non-lesion electrostimulation using ECT significantly played the stressor role on brain electrochemistry while endogenous antioxidants metabolized in compensatory physiology could not significantly reverse the effect of ECT on both cognimotor and sensorimotor

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COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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