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EFFECT OF CHRONIC ADMINISTRATION OF LEAD (Pb) ON SOCIAL BEHAVIOUR OF MALE ALBINO RATS

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ABSTRACT

This study was designed to investigate the effect of chronic administration of lead (Pb) on social behaviour of male albino rats. 12 male rats with body weight ranging from 172-209 grams were randomly selected for the experiment. The rats were divided into two groups with 6 rats constituting each group. The groups are saline (control) group and lead (Pb) (experimental) group. The lead (Pb) administered was given orally at 10mg/kg of body weight. In the study social behaviour (grooming $p<.05$, sniffing of air $p<.05$, and face washing $p<.05$) was significantly affected by the treatment of lead (Pb). This result showed that the ingestion of lead (Pb) has some significant negative influence on social behaviour. . It was suggested that government and other concerned agencies should address how to control the ingestion of lead in areas reported to have its "epidemic" especially in Nigeria.

Keywords: Lead (Pb), Social behaviour, Rats

INTRODUCTION

Outbreak of Lead (Pb) epidemic in the Northern part of Nigeria is no more news. The British Broadcasting Corporation (BBC) on 5th October, 2010, announced that at least 400 children have died from lead poisoning in Northern Nigeria. Ever since then, death and other health problems due to this toxic substance have been on the increase. For example, in their study on lead exposure in children living in a smelter community in Northern Mexico, Rubion-Andrade, et al., (2011) found that due to chronic exposure to lead (Pb), the majority of the children needed combined interventions including "environmental, medical, and pharmacological" (p.2). Lead (Pb) is also reported to cause multiple effects from mild to debilitating and death in both human beings and animals. Pokras & Kneeland, ((2009), reported that lead (Pb) have multiple effects on all organs of the body over the lifespan, among them "abdominal cramps, anemia, ataxia, stunted growth and infertility in both genders" (p.2) as well as renal impairment, hypertension, miscarriages, stillbirth and cognitive deficiencies in children," (p.6); due to its effects on the central nervous system. Similar results on cognitive functioning and a decline in IQ level were reported earlier by Lanphear et al., (2005). Another study by Garza, Vega and Soto (2006) reported behavioural problems "including aggressiveness and impulsiveness" (p.62) among others. Other studies (Haefliger, et al., 2009; & Pilsner, et al., 2009) have reported an increase in mortality due to lead poisoning.

Lead (Pb) is one of the most toxic heavy metals and a widespread natural and occupational environmental pollutant. Its toxicity in humans and experimental animals has been well documented and widely reported (Pokras & Kneeland, 2009; Garza, Vega & Soto, 2006; Danadefi, Rozati, Banu, Rao & Grover, 2003; Choudhury & Mudipalli, 2008; Wang, Zhou, Yang, & Wang, 2011; & Thayer, Heindel, Butcher, & Gallo, 2012) . Lead is a bluish-white lustrous metal, very soft, highly malleable, ductile, and a relatively poor conductor of

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electricity which has been put to many applications that are used by humans over the years. It is very resistant to corrosion but tarnishes upon exposure to air. Lead fulfils no essential function in the human body, it can merely do harm after uptake from food, air or water. Several studies (Burger and Gochfeld, 2005; Liu et al., 2003; Jolly, Pabello, Bolivar & Lawrence, 2012; Cory-Slechta, 2008; Toscano & Guilarte, 2005) have reported several health and social problems in all the systems of the organism. It can cause several unwanted effects such as damage to the bones, kidneys, cardiovascular dysfunction (White, 2007), hearing loss, tooth decay (Lanphear, 2005), cataracts (Pokras & Kneeland, 2008) among others. Furthermore, exposure to lead (Pb) has been linked to poor functioning of the central nervous system as well as learning and behavioural difficulties. According to Pokras and Kneeland (2009), "lead is an element and a metal. It is soft, has low melting point, a high density and is found naturally in a variety of minerals" (p.2).

According to Henry Akpan, the Nigerian health ministry's chief epidemiologist, there were reported cases of abdominal pains with vomiting, nausea and convulsions among the people living in this area. This makes us deduce that for a substance to have the capacity to alter the health of an individual to such an extent, it is potent enough to affect a wide range of human behaviour. It is well documented that the end result of lead (Pb) exposure is, in most cases is death, but there is definitely an interval of time between when the affected species is exposed to lead (Pb) and the time of death. This, therefore, allows us time to observe and gain insight as to the fact that during this period, the behaviour may be changing progressively, hence, the justification of this study to explore the effect of lead (Pb) on social behaviour.

It was also noted previously that lead (Pb) has some effects on the brain so it is likely that those who are chronically in contact with lead (Pb) may ultimately show cognitive related difficulties such as learning disabilities, mental retardation, and deficient coping skills in social settings among others. The link between lead (Pb) and social behaviour, such as face washing, self-grooming, sniffing of air and standing aggression, is well documented. However, contemporary studies have not delved so much on this aspect. Though these aspects of social behaviour have been researched on human beings, not many studies have been carried out in relation to the effect of lead (Pb) on the social behaviour of other species. Several studies (Pokras & Kneeland, 2009; Bagchi, & Preuss 2005; Liu, et al. 2003; Cory-Schlechta, 2008) have reported a correlation between lead (Pb) and various aspects of human behaviour such as violent and criminal behaviour, homicide, and aggression. Another study by Garza, Rosario, and Soto (2006) has also reported a correlation between lead poisoning and attention deficit in infants, and criminal behaviour and schizophrenia in adults. Several studies in Pokras and Kneeland (2009) reported "delinquent, antisocial behaviour, and aggressive behaviour in humans" (p.6), while some have documented aggressive behaviours in dogs and cats. Similar to earlier studies by Arnvig et al. (1980) and Venkatakrishna-Bhatt (1985), Oshomah (2006), explored the effects of lead (Pb) on various aspects of human behaviour such as cognitive dysfunction, violent and criminal behaviour, homicide, aggression, and body weight.

It is to this end that this study will go further to explore social behaviour in relation to lead (Pb) exposure in order to deduce human behaviour under extreme circumstances. The effect of this heavy metal on such performance can however not be measured as it will be unethical to use human participants in such a study. The effects of this heavy metal on behaviors that require the use of legs and hands such as standing, grooming, washing of the face, learning abilities in rats can be studied then the results be generalized to humans. Thus, if lead has either positive or negative effects on social behaviours in rats it might be safe to generalize to humans and assume that it will exert the same effect on social behaviour and other performance task in humans. The purpose of this study was, therefore, to find out if lead (Pb) will inhibit or enhance social behaviour. It also aims to know if the chronic administration of lead will have a positive or negative effect on the social behaviour of albino rats.

LITERATURE REVIEW

Many of the work found in literature on the effect of lead (Pb) on the human body in general focused mainly on children. The fact that children are the most vulnerable population when it comes to the effects of lead (Pb) on the central nervous system was explained in a study by Lanphear et al., (2005) on the effects of low level lead poisoning (<10 µg/dL) on cognitive functioning in children and infants. They found that IQ declined 7.4 points as average blood lead concentrations increased from 1 µg/dL to 10 µg/dL, and then declined 4.6 points for every 10 µg/dL increase after that.

In a research carried out by Kršiak and Borgesová (1972) aimed at establishing the effect of lead (Pb) on behaviour of pairs of rats, it was discovered that, lead (Pb) decreased all social activities in the treated rats even in the lower dose of 1.2 g/kg which hardly affected ataxia. Some of the social activities (face washing, social grooming, self grooming and all social acts involving walking) were reduced quite selectively. However, both social and non-social activities involving upright movement (mounting, aggressive posture, boxing and rearing) were reduced which may have been due to impaired motor function. Some social activities (e.g. defensive postures) may have been reduced because appropriate provoking activities (aggressive postures) in the untreated partners were decreased.

Beatty et al., (1982) researched on the psychomotor stimulants, social deprivation and play in juvenile rats in the experiment where the rats were treated with d-amphetamine (0.125–1 mg/kg) or methylphenidate (0.5–4 mg/kg). The caused dose-dependent decreases in play fighting in juvenile rats which were independent of sex and strain. Although brief social isolation profoundly increased play fighting, qualitatively similar drug effects on play were observed in socially housed and isolated animals. By contrast, at the highest doses tested both amphetamine and methylphenidate increased social investigation, but only if the rats were socially isolated. Stimulation of catecholamine systems is evidently incompatible with the expression of playful behaviour. The effect of chemicals (drugs) on social maintenance behaviour was also reported by several studies in Pokras and Keeland (2009) who reported aggressive behaviour in songbirds and rodents with elevations in blood levels.

Cutler and Mackintosh (1975) studied the effects of delta-9-tetrahydrocannabinol on social behaviour in the laboratory mouse and rat. The results suggested that, in both species, immobility was increased and non-social activity reduced after injections of 5 mg/kg of delta-9-tetrahydrocannabinol. Flight was increased in treated mice but not in treated rats. Aggression was not significantly altered in either species. Thus, in the mouse, the qualitative behavioural effects of delta-9-tetrahydrocannabinol were similar to those previously reported for crude cannabis resin. Comparison of the dose-response data indicated that some other constituents of cannabis may reduce the flight reaction from delta-9-tetrahydrocannabinol although not interfering with immobility. Immobility reduces frequency of social interaction needed for stimulation of the body which may eventually lead to the death of the organism.

In their research on the effects of lead (Pb) in the laboratory mouse development and social behaviour after lifelong administration of a small dose of lead (Pb) acetate in drinking fluid, Donald, Cutler, Moore, Bradley (1989) found that the behaviour of the treated offspring in social encounters was shown by ethological procedures to differ from that of controls. The

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most consistent change after treatment with lead was enhancement of social and sexual investigation. This was seen in females at 26-27 weeks when encountering male partners, in isolated males at 32-33 weeks encountering female partners, and in group-housed males and females in single first sex encounters at 17-18 weeks. At 17-18 weeks, the duration of this behaviour was increased in treated females in the first 3 minutes and in treated males in the final 5 minutes of the 20 minutes period of observation. Behavioural changes in juvenile mice at 6-7 weeks occurred only during the final 5 of the 20 minutes observation. At 3- 4 weeks only a marginal difference in behaviour was detectable in the treated females. Overall the behavioural effects of lead differed between males and females and between juveniles. . In a more recent study by Jolly, Pabello, Bolivar, and Lawrence (2012) on the effects of lead (Pb) on behavioural performance and gene expression in mice, the findings show that while the female mice's exploratory behaviour decreased, the male mice developed more selective aggressive behaviour.

Akano (2001) investigated the effect of acute administration of caffeine and nicotine on the social behaviour of male albino rats. He discovered that caffeine did not have a significant effect while nicotine had a significant effect on all the behaviours measured except face washing. Also in a study carried out by. Salinas et al., (2002)to determine the effect of lead (Pb) and spatial ability vs. cued open field performance in male Fischer rats who received chronic exposure to either water containing 250 ppm lead (Pb) or tap water. The results that while lead did not appear to significantly affect motor activity during the habituation phase, lead-exposed spatially trained rats exhibited superior acquisition and performance of the food-rewarded task compared to their controls and their cue-trained lead-exposed counterparts. Furthermore, by the last day of training, lead significantly reduced the relative amount of time spent on the periphery of the maze in spatially and cued-trained rats. All these are evidence of how chemical compounds such as drugs and lead could influence general behaviour, including social behaviour negatively.

The current study hypothesizes that:

1. Rats treated with lead (Pb) will significantly exhibit less self grooming behaviour than rats treated with saline.
2. Rats treated with lead (Pb) will significantly exhibit sniffing of air than rats treated with saline.
3. Rats treated with lead (Pb) will significantly exhibit less face washing behaviour than rats treated with saline.

METHODOLOGY

Subjects

Twelve (12) albino rats with body weight ranging from 172 to 209gms at the onset of the experiment were used in the experiment. Rats were without any previous history of heavy metal ingestion. They were first housed together in white cages measuring 38cm by 25cm by 18cm obtained from a renowned plastic company. There were two cages that housed six rats each.

Design

The experimental/control group, randomized subject design was employed. The subjects were matched according to body weight with the view of ensuring that subjects with bigger body weight are not grouped together.

The independent variable was lead (Pb), which was administered at (10 micro gram/kg), while the dependent variables were social behaviour such as face washing, sniffing of air, self grooming. The rats were divided into two groups of six rats each. The first group, the experimental group, was administered with lead (Pb), while the second group, the control group was administered saline according to body weight of each subject. Data were then analysed using t-test for independent samples.

Lead (Pb) Concentration and Preparation

1ml of lead (Pb) was taken from 1000 part per million (ppm) stock solution of lead (Pb) and dissolved in 100ml standard volumetric flask. This solution resulted into a stock solution of 10 ppm. 1ml of the 10 part per million was taken and dissolved in 100mls of distilled water in a volumetric flask in 10mg. This was then administered to the rats in the experimental group per one (1) kilogram bodyweight.

Procedure

The rats were first housed in their cages for about five weeks to familiarize before the commencement of the experiment, and they had unlimited access to food and water. The experiment was in session for a period of 4 weeks and can be divided into three distinct stages. The pre treatment (baseline period) stage which lasted for 4 weeks was meant to provide insight into the social behaviours of the rats. The rats were then observed in a pair randomly selected for a trial period of 10 minutes. Each pair was entitled to 3 trials making a total of 30 minutes per duo.

The second stage was the treatment stage lasting for 2 weeks. At this stage, lead (Pb) and saline were administered with the oral cannula. Upon commencement of the experiment, the rats were treated according to their group (i.e. the experimental group was treated with lead (Pb) and the control group was treated with distilled water). Then there was a 30 minute wait for the lead (Pb) and distilled water to be properly and effectively ingested into the system before introducing food and water to the rats.

Then the rats were then taken in pairs (i.e. one from control and one from experimental) and introduced into a larger cage where the behaviour of each pair of rats was observed for a total of 10mins (trial period). Each rat from the experimental and control group was allowed three trials with each other but the selection was done in a random manner. Each rat was observed for a total time of 30minutes. The reason for the three trials was to control for extraneous variables.

The third stage was the post treatment stage when drug administration of lead (Pb) and saline had been withdrawn. The rats were then observed in pairs, each pair having been randomly selected for a trial period of 10 minutes. Each pair was also entitled to 3 trials making a total of 30 minutes per duo.

RESULTS

Hypothesis One:

Rats treated with lead (Pb) will significantly exhibit less self grooming behaviour than rats treated with saline. This was tested using t-test for the independent samples by comparing the self grooming behaviour between the experimental and saline (control) group. The result is shown in table 1 below.

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Table 1. Summary of T-test For Independent Samples Showing the Influence of Lead Administration on Self Grooming Behaviour

Group	*N*	$\overline{X}$	*S.D*	*df*	*T*	*P*
Experimental	6	9.66	5.89	10	5.135	P<.05
Control	6	14.66	6.75			

The result in table 1 indicates that lead administration significantly influences self grooming behaviour of rats at t= 5.135 (df, 10); P <.05. This result shows that the experimental group was (X = 9.66: SD = 5.89) and the control group was (X = 14.66: SD = 6.75). It is important to note that there was no significant difference in the self- grooming behaviour of the two groups in pre and post lead administration stages. Therefore, the stated hypothesis was confirmed in this study.

Hypothesis Two:

Rats treated with lead (Pb) will significantly exhibit more sniffing of air behaviour than rats treated with saline. Sniffing of air behaviour was tested with t-test for the independent samples and the result is presented on table 2 below.

Table 2. Summary of T-Test for Independent Samples Showing the Influence of Lead Administration on Sniffing Of Air Behaviour

Group	*N*	$\overline{X}$	*S.D*	*df*	*T*	*P*
Experimental	6	42.83	14.02	10	5.525	P<.05
Control	6	29.67	7.58			

The result on table 2 indicates that lead administration significantly influenced sniffing of air behaviour among albino rats at df (10); t = 5.525; P<.05. That is the experimental group (X = 42.83, SD= 14.02) and the control group (X = 29.67, SD = 7.58). This implies that the rats in the experimental group exhibited higher sniffing of air behaviour than those in the control group. Therefore, the tested hypothesis was confirmed.

Hypothesis Three:

Rats treated with lead (Pb) will significantly exhibit less face washing behaviour than rats treated with saline. Face washing behaviour was tested with t-test for the independent samples and the result is presented on table 3 below.

Table 3. Summary of T-test For Independent Samples Showing the Influence of Lead Administration on Face Washing Behaviour

Group	*N*	$\overline{X}$	*S.D*	*df*	*T*	*P*
Experimental	6	9.50	4.76	10	5.533	P<.05
Control	6	19.00	7.46			

The result on table 3 indicates that there was significant difference in face washing behaviour between the experimental and control groups of albino rats based on lead (Pb) administration at df (10); t = 5.533; P<.05. That is, the experimental group (X = 9.50, SD= 4.76) and the control group (X = 19.00, SD =7.46).

The result implies that the significant mean difference between the groups was as a result of lead administration to the experimental group since there was no significant difference in the face washing behaviour of the rats at both the pre-test and post-test periods. Therefore, lead administration did significantly affect face washing behaviour of the rats. Thus, the stated hypothesis was confirmed.

DISCUSSION AND CONCLUSION

The results have gone to show that generally Lead (Pb) intake by whatever method has significant negative influence on behaviour. The first hypothesis which predicted that rats treated with lead (Pb) will significantly exhibit less self grooming behaviour than rats treated with saline was confirmed. Indeed lead (Pb) reduced self grooming behaviour amongst rats that were treated with lead (Pb) compared with those that were not given lead (Pb).

This result supports findings of Kršiak and Borgesová (1972) who observed that lead (Pb) decreased all social activities in the treated rats even in the lower dose of 1.2 g/kg which hardly affected ataxia. Some of the social activities (face washing, social grooming, self grooming and all social acts involving walking) were reduced quite selectively. It is important to note the adverse effect of lead (Pb) on body physiology that reflects overt social behaviour such as observed in this study.

The second hypothesis which predicted that rats treated with lead (Pb) will significantly exhibit sniffing of air than rats treated with saline was confirmed. Indeed it was observed that rats treated with lead (Pb) exhibited sniffing of air behaviour significantly more than rats that were not given lead (Pb). This effect might be due to the fact that the toxic substance in lead (Pb) made the rats gasp for breathe more, confirming the constellation of symptoms in lead (Pb) poisoning as reported by Rubion-Andrade, et al., (2011) who discovered that lead (Pb) may increase the risk of cancer of the lungs and asthma among workers exposed to lead (Pb) over a period of time.

The third hypothesis predicted that rats treated with lead (Pb) will significantly exhibit less face washing behaviour than rats treated with saline were also confirmed. Indeed lead (Pb) significantly reduced the number of times the face washing behaviour was exhibited by the experimental group compared to those that were not giving lead (Pb).

The reduction in the frequency of face washing behaviour was observed during the experiment; as the days of the experiment increased so did the frequency of occurrences of the face washing behaviour reduce in the experimental group. This might be due to the fact that the accumulation of lead (Pb) was beginning to take effect as the days increased. Similar findings were reported in the study by Kršiak and Borgesová (1972) who observed that lead (Pb) decreased all social activities in the treated rats even in the lower dose of 1.2 g/kg which hardly affected ataxia.

From the findings of this study, it can then be concluded that continuous or chronic intake of lead (Pb) in whatever form exposes people to danger of anti-social behaviour that may eventually lead to death if not curtailed or effectively and properly managed. Though rats were used in the study because of ethical issues involved in the use of human beings in an experiment of this nature, the implications for human health and social behaviour cannot be ignored as there is room for extrapolation of results of these kinds to human species. This has implication for governments all over the world, Nigeria included to curtail further getting in contact with lead (Pb) so as to prevent mortality.

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RECOMMENDATIONS

In order to prevent or minimize the effect of lead (Pb) accumulation on individuals within the society the following is recommended:

1. People who are exposed to lead (Pb) on a daily basis should be warned of the physiological and behavioural effect lead (Pb) has on their body.
2. Campaign by government agencies against lead (Pb) based products should be energetic, especially in rural and semi-urban communities.
3. Companies that use heavy metals such as lead (Pb) should ensure that preventive measures such as nose guards and regular medical examinations are put in place so as to reduce the rate of inhalation of such heavy metals.
4. Picking things from the floor and putting in your mouth should be discouraged among little children by care givers.

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