

TED ANKARA COLLEGE FOUNDATION HIGH SCHOOL

International Baccalaureate

ENVIRONMENTAL SYSTEMS AND SOCIETIES

“Does the time of *Rattus Norvegicus* to complete a test labyrinth is affected by the presence of 95 dB noise they have been exposed for 30 minutes?”

Introduction:

In this experiment I'm planning to focus on the effect of noise pollution on the problem solving ability of humans. I believe that it is a global issue and it is all around the world since there are many constructions near schools and workplaces including the city I live in and the school I go and people have concentrating problems and sometimes need to use medicine for that issue. Also it disturbs the human being and cause an adverse effect on the mental and psychological well being. I believe that this experiment, the results and data that I will gather will be helpful for many people in schools and work places that suffer inefficient working and concentrating ability, decrease in working capacity. It might as well be helpful enough to decrease medicine usage for that issue.

The experiment that I'm planning to practise to find a solution to that global issue will be explained on the following parts.

Noise is a sound, especially one that is loud, unpleasant or that causes disturbance.

Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms. According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is. Exposure for more than 8 hours to constant noise beyond 85 dB may be hazardous.

According to The World Health Organisation harms of sound pollution can be investigated in seven sub-branches:

- 1- Hearing impairment
- 2- Interference with spoken communication
- 3- Sleep disturbances
- 4- Cardiovascular disturbances

- 5- Disturbances in mental health
- 6- Impaired task performance
- 7- Negative social behavior and annoyed reactions

Impaired task performance effect of noise pollution will be worked on in this experiment by taking a labyrinth as a task and observing the times for the subjects to complete that task by finishing the labyrinth.

While experimenting, *Rattus Norvegicus* will be used as subjects to observe the time of finishing the test labyrinth right after exposure to 95 dB of noise for 30 minutes.

Research Question:

Does the time of *Rattus Norvegicus* (Lab Rat) to complete a test labyrinth is affected by the presence of noise pollution they have been exposed for 30 minutes?

Hypothesis:

The time for completing the labyrinth will increase when the *Rattus Noevigicus* subjects are exposed to the noise pollution.

Variables:

Independent Variable: Presence and absence of 30 minutes of 95 dB noise

Dependent Variable: Time to complete the labyrinth, made by the experimenter.

Controlled Variables:

Temperature

Method: By the usage of the air conditioner in the lab that the experiment take place, temperature can be kept the same during all preparation and experiment.

Justification: If the temperature isn't constant then the physical activities of the rats will not be the same since their blood circulation wouldn't be nearly the same due to their body temperature and there would be a lot of inaccuracies in the data

Note: The subjects shouldn't be kept in cold, they should be kept in room temperature, 25 degrees celcius.

Kind of the Rats

Method: Working with the subjects that are the same species, *Rattus Noevegicus*

Justification: Different species of rats, even if they are from the same familia, would have different abilities in different fields since they have different physical appearance.

Age of the rats

Method: By experimenting with the subjects that all were born in two days, the age group of the subjects are kept constant.

Justification: Rats from different age groups would have different physical activity and body and the data would seriously affected by the age factor

Gender of the Rats

Method: By experimenting with the subjects that have the same gender (female) and controlling their gender by looking at their breeding organs.

Justification: If the gender of the rats are not the same, precision and accuracy in the data and the calculations cannot be obtained and the error would be high since as told before the problem solving ability and learning capacities vary between genders.

Uncontrolled Variable 1: Sizes of the rats.

Since the subjects are living organisms their sizes may differ from each other even though the species, gender and the ages are the same.

Uncontrolled Variable 2: Nutrients that the rats get until taken fort his experiment.

Since they haven't been taken before they were born but just before the experiments, their daily nutrition can't be controlled.

Method Development:

Since the rats are used as models of humans in many scientific experiments and studies and completing the test labyrinth is some sort of a problem that should be solved for them. Also they are easy to keep, take care of before the experiment and gather data with. So that is why *Rattus Norvegicus* is chosen to be used as subjects in this experiment. Also the experiment will be done in two trials and data set of two, both for independent group that is exposed to noise and the control group that is not exposed. There are some factors that would affect the data and calculations and result in huge amounts of error, so these factors should be applied to prevent systematic errors and inaccuracies among the data. The rats that are used should be female since they have a higher capacity for problem solving and learning according to the researches of California State University. Also young rats that are 6 months old are used to increase mobility and energy of the rats. The rats that are 6 months old are considered as grown ups according to the studies made by Laboratory of Enzimology and Experimental Carcinogenesis, Faculty of Medical Sciences, State University of Campinas - UNICAMP, Campinas, SP, Brazil. Since the problem solving ability will be determined through the time for completing the labyrinth, mobility of the subjects have a significant role for the experiment. All of the rats should be kept in one cage since they are type of animals that live in packs, large groups. So that they wouldn't feel stressed and the stress factor won't affect the time for them to complete the labyrinth.

The subjects that are in the independent group which will be exposed, will stay for 30 minutes with the presence of 95 dB of noise. According to the World Health Organisation 95 dB of sound is taken as noise pollution but it can only be harmful to the organism if exposed for 8 hours or more. So 30 minutes of exposure to noise

pollution is effective enough and minimal time to observe the difference in completing time.

As the labyrinth, model cardboard will be used. The reason that model cardboard is chosen as the main material of the labyrinth is that model cardboard is strong and durable to liquids, in case the rats urinate in the labyrinth. Also the model cardboard is not so heavy and easy to carry, since the labyrinth is prepared before the experiment and in case it is needed to be carried to the place where the experiment will take place. Beside the advantages of the model cardboard there is a disadvantage. The model cardboard is not so easy to cut, even though exacto knife is used, one stroke is not enough to cut the cardboard throughly and a few strokes are needed. And the shape and plan of the labyrinth is inspired by the labyrinths used by the Hampton Court maze and prepared according to the models of it.

Materials:

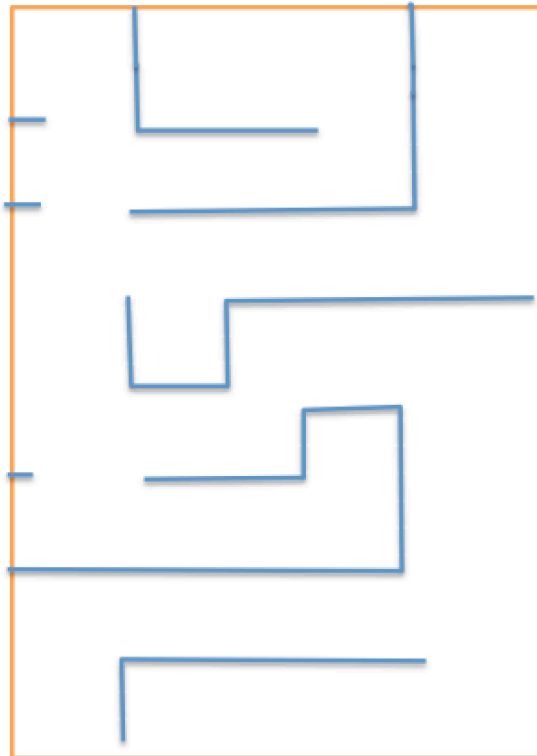
Material	Size	Quantity	Uncertainty
Laboratory Rats	-	20	-
Iphone Chronometer	-	1	± 0.2 s (human reflex time)
Model Cardboard	70x100 cm	3	-
Bose Mini Soundlink	-	1	-
Exacto Knife	15 cm	1	-
Hot Glue Gun		1	-
Silicon Cover (0.5 cm)	90x110 cm	1	-
Glue Gun Sticks	30 cm	6	

Table 1: Materials

A- Preparing the base of the labyrinth

B- Making the labyrinth

Finish



Since the rats are bigger than mice, the width of the tunnels in the labyrinth should be at least 15 cm for the rats to move around the labyrinth freely and without feeling like captured. If they feel like they are captured it will be hard to expect accurate results and obtain them easily since stress is a factor that affects their way of thinking and actions.

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Materials for the Labyrinth:

For both the base and the walls of the labyrinth model cardboard that was in size 70x100 cm is used.

Risk: Since a few strong strokes are needed to cut the model cardboard it can be a little dangerous, and also exacto knife is a very sharp material so wearing safety gloves are recommended.

Another material that was used is a silicon cover that is 0.3 cm thick and with the size of 90x110 cm. The reason that the cover is used is to protect the rats in the labyrinth. Since they are animals that climb, they could have climbed the walls of the labyrinth, got hurt, even fall and have significant injuries. To prevent that, the silicone is cut to the size of 80x100 cm and made air holes that have the radius of 0.3 cm. In every 25 cm²s (5x5 cm) for the subjects to breathe normally and act without feeling stresses under the conditions of the labyrinth.

B- Making the labyrinth

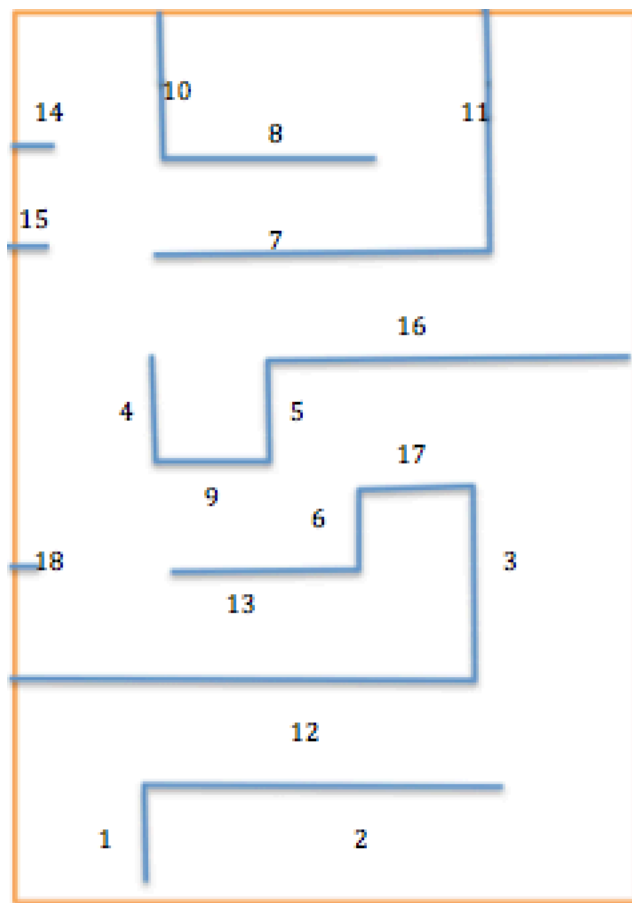
- 1- 5 strips that are 14x100 cm are cut from the 2 of the modeling cardboard using the exacto knife.
- 2- The silicon sheet that has the sizes of 90x110 cm is cut to the size of 80x100 cm to be put on the top of the labyrinth that is 70x100 cm.
- 3- The strips are cut to the following sizes:
 - 1-14x14 cm
 - 2-43x14 cm
 - 3-29x14 cm
 - 4-14x14 cm
 - 5-11,5x14 cm

- 6-20x14 cm
- 7-34x14 cm
- 8-10x14 cm
- 9-13x14 cm
- 10-14x14 cm
- 11-35x14 cm
- 12-55x14 cm
- 13-20x14 cm
- 14-7,5x14 cm
- 15-7,5x14 cm
- 16- 4 x14 cm
- 17-10x14 cm
- 18- 7.5x14 cm

- 4- Numbers of the pieces are written on the pieces.
- 5- Sides of the base cardboard are covered by sticking the cardboard sticks with the hot glue gun.

For the short edges (50 cm) two strips that are 14x50 cm are used.
For the long edges (70 cm) two strips that are 14x70 cm are used.
- 6- With the hot glue gun pieces are stucked to their numbers on the base of the labyrinth. And also stick the edges of the labyrinth with the pieces that are cut in the 5. step. And the right places for each piece to stick on will be clearly shown in the next part (sticking the pieces to their places part)

Sticking the Pieces to their Places:



After the labyrinth is fully ready and the hot glue is fully dried the silicone cover that has air holes in every 5 cm's should be put on top of the labyrinth.

Method:

- 1- First subject should be taken from its cage and at the same time with its feet touch to the base of the labyrinth the timer should be started.
- 2- The timer should be stopped when the subject gets to the finish point and the subjects should be put back to another cage where the subjects that have completed the labyrinth will be put in.
- 3- Steps 2 and 3 should be repeated for both the control group and independent group of the first trial.
- 4- The data should be noted down.

- 5-** Before moving on with the second trial there must be 1 hour break. 20 minutes for the subjects to rest and 30 minutes for the subjects to forget the way to the exit and to expose the independent group to 95 dB noise from the Bose Mini Soundlink speaker in another room.

Results, Analysis and Conclusion

Data:

Trial 1:

Number of the rats	Times of the group that is not exposed to the noise (s) (± 0.01 s)	Times of the group that is exposed to the noise (s) (± 0.01 s)
1	39.41	117.28
2	42.80	127.60
3	45.21	143.50
4	51.95	173.38
5	54.10	179.06
6	56.51	182.67
7	68.67	186.64
8	70.31	204.71
9	72.01	288.51
10	89.02	313.78

Table 2: First trials of both control and independent variable group (Arrenged in increasing order)

Trial 2:

Number of the Rats	Times of the group that is not exposed to the noise (s) (± 0.01 s)	Times of the group that is exposed to the noise (s) (± 0.01 s)
1	38.12	113.10
2	39.24	119.05
3	40.87	124.18
4	41.19	128.69
5	42.59	131.87
6	44.47	144.16
7	52.13	158.43
8	56.08	182.62
9	59.65	190.06
10	73.40	227.41

Table 3: Second trials of both control and independent group (Arranged in increasing order)

Note: The data for both the control and independent group are arranged in increasing order but not for the same subjects, because all the subjects that are worked with belonged to the same species, gender and age group so it was nearly impossible to understand which one was which after they are put back into their cages. They could have been labeled with numbers on their tails as the experts do while experimenting for such researches but for ethical reasons no mark should be on the rats and they should not be harmed.

Calculations:

In this step calculations will be made to make it easier to comment on the data that is gathered from the experiment in two trials with 20 subjects. The calculations would give the chance to evaluate the results and support or deny the hypothesis that is stated at the beginning.

Calculating the Mean Values for both Independent and Control Group:

How to calculate the mean?: First of all, all the data from the same group and trial will be summed up and the result will be divided to the data number in that group (in that case the result will be divided to 10 since there are 10 subjects in one group of one trial that take part in this experiment).

For example: Let A,B and C be the data and the mean should be calculated, first of all A,B and C should be summed up and then, divided by 3 since there are 3 of them. The following calculation must be done: $(\frac{A+B+C}{3})$

Example mean calculation (this calculation will be mad efor the control group of the first trial):

Step 1: All of the data from the control group of the first trial should be summed

$$38.12 + 39.24 + 40.87 + 41.19 + 42.59 + 44.47 + 52.13 + 56.08 + 59.65 \\ + 73.40 = 487.74$$

Step 2: The sum value will be divided by 10, since 10 is the data number fort he control group of the first trial.

$$\frac{487.74}{10} = 48.774 \cong 48.77$$

Mean (Trial 1, Control Group): $58,999 \cong 59$ s

Mean (Trial 1, Independent Group): $191,713 \cong 191.71$

Mean (Trial 2, Control Group): $48.774 \cong 48.77$ s

Mean (Trial 2, Independent Group): $151.957 \cong 151.96$

Also to be able to comment on the data better some other calculations should be made. Calculations such as standard deviation will be made and standard error will be calculated by using the standard deviation. Also t-test will be applied to see if the data is accurate.

First of all, descriptive statistics will be calculated via Excel Application.

Descriptive Statistics		<hr/>	
		<i>Group that is not exposed to the noise</i>	<i>Group that is Exposed to the noise</i>
Mean		53,8865	171,835
Standard Error		3,204212874	12,29223412
Standard Deviation		14,3296756	54,97254219
Count		20	20
Confidence Level			
(95,0%)		6,706494622	25,7279417

After the descriptive statistics are calculated, t-test is applied to both control group that is the group that is not exposed to the noise and the independent group which is the group that is exposed to the 95 dB noise for 30 minutes. Since there are no conditional difference between the trials that will make the data inaccurate, two trials will be used together while applying the t-test. The t-test works as assuming that the mean values of groups are the same according to the Null Hypothesis and if that hypothesis is rejected, they are not the same and this experiment's hypothesis is supported. So when the Null Hypothesis is rejected and the P value, the error value of the T-Test, is less than 5% ($P < 0.05$) then the data is accurate and the hypothesis is supported.

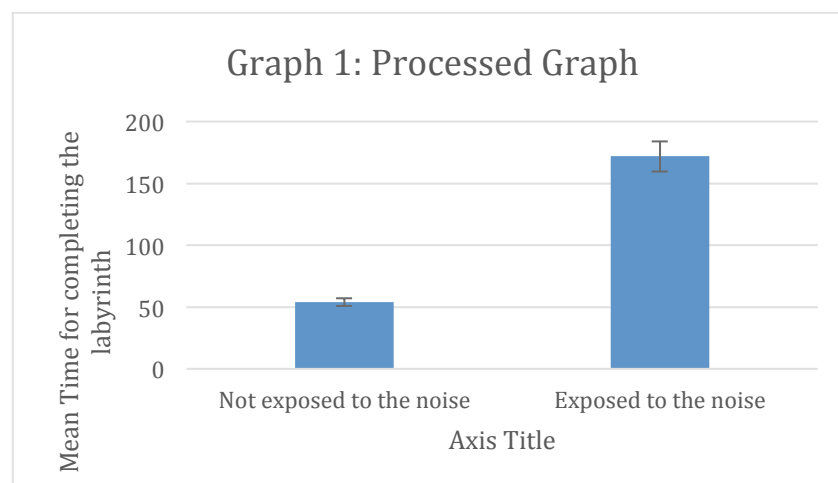
t-Test: Two-Sample Assuming Unequal Variances

	<i>The group that is not exposed to the noise</i>	<i>The group that is exposed to the noise</i>
Mean	53,8865	171,835
Variance	205,3396029	3021,980395
Observations	20	20
Hypothesized Difference	Mean 0	
df	22	
t Stat	-	9,285096153
P(T<=t) one-tail		2,28656E-09
t Critical one-tail		1,717144374
P(T<=t) two-tail		4,57312E-09
t Critical two-tail		2,073873068

Since the hypothesis states that mean value of the group that is not exposed to the noise will be smaller than the mean of the group which is exposed to the noise, the hypothesis is one tailed. Hypothesis states that $\mu_1 < \mu_2$ where μ_1 is the mean of the group that was in absence of noise and μ_2 is the group that is in the presence of noise.

So the P value of the T-test is one tailed P value.

Also a bar graph for both groups will be drawn with the error bars to see the error amounts.



Errors and Uncertainties:

There can be a bit of uncertainty about the mean values since they are rounded to two decimal places (two digits after the whole number). Although the conditions were the same, the times for both groups of second trial are less than the first trial. The reason for that is even though how much time the subjects wait before the second trial there is a learning part. Also the error bars of the bar graph that has been drawn, show that the errors are not significant. As can be seen from the descriptive statistics table, the error for the control group that is not exposed to noise is 3,204212874 and for the independent group which is exposed to the noise the error is 12,29223412 which is more than the control group.

Conclusion:

After the exploration, the data have been gathered; mean, standard deviation and standard errors have been calculated; bar graph and error bars are drawn. Also the T-Test has been applied to the gathered data and P value came out to be **$2,28656 \cdot 10^{-9}$** .

Evaluation:

The experiment, data and the calculations fully supported the hypothesis that when exposed to 30 minutes of 95 dB noise, the problem solving ability decreases and slows down. Also in this experiment no injuries or harm came to the subject either physically or psychologically.

I had so much pleasure while both experimenting and calculating the necessities to be able to comment on the data and support or deny my hypothesis.

Also when the mean and standard deviation were calculated the results were satisfying and they showed that there were no significant errors and the data was accurate.

When the t-test is applied to the data the data came out to be accurate as well. As a part of the t-test, the Null hypothesis was stated which supports that the mean value of the group that is not exposed to noise will be the same with the mean value of the group. But with the t-test Null hypothesis is rejected and the one tailed hypothesis of the time for the group that is exposed will be more than the group that is not exposed. And since the P value for the t-test is came out to be $2,28656.10^{-9}$ and as a part of the t-test when P value is smaller than %5 (0.05) then the data is accurate. So in this exploration the P value of the t-test came out to be much more smaller than 0.05, so this shows that the data were accurate and had not significant error, also this states that the hypothesis is completely supported by fully rejecting the Null Hypothesis.

In conclusion, the hypothesis which is supported and included a global issue is proven to be true. As can be seen from the experiment and the supported hypothesis, since noise pollution severely affects the problem solving ability there shouldn't be noise pollution near schools and working places such as offices (at least not during weekdays or working hours) and with my supported hypothesis I will try to raise awareness on this topic starting by talking the school representatives of our school about the construction places around our school. And then I'm planning to extend this issue and results in every way I can.

Also in this experiment there were a few problems that can be solved by further studies, such as the stress that the subjects might had an effect on the results I got.

Applications:

After the experiment that I had made and the results I managed to get made me think of other applications that this experiment can be useful and be improved for further studies. As I mentioned in the conclusion part this study and my hypothesis that is

supported by the results can be used to raise awareness and finding solutions to this global issue. But also the method of mine came out be an effective method to use a labyrinth as a model of a problem, and I believe that this method with different variables such as stress effect, temperature effect and other variables on task performance can be studied in further scientific researches. For example complication of the labyrinth can be taken as an independent variable to work on how the stress amount affects problem solving ability with some other background research and can be bonded to another environmental issue.

And I think that this experiment can be improved due to some problems I had seen. In second trials rats seemed to learnt about the way to the exit after the first trial, so this aspect can be improved by using twice as many rats I used.

To sum up, there are many other implications that the method I used and the subjects I chose to work with can be applied to other studies as well to get other results on relevant global issues.

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