The Effect of Magnetic Fields on Danio Rerio Embryos

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Abstract:

Human generated magnetic fields are a relatively new thing. We now have large aluminum wires that run coast to coast carrying 155,000 to 765,000 volts on average (Reference 6). As more technology and electricity comes into our lives, the more we learn about the increasing rates of children being born prematurely or with developmental issues. It seems that these rates could correlate with each other. Tests on chicken embryos involving magnetic fields seem to show a negative effect on the development even if minor (Reference 3). With this experiment, zebrafish embryos were put into a magnetic field that is powerful enough to reset a hard drive to see if these embryos are in danger from magnetic fields in everyday circumstances. Based on the results, it seems that the magnetic field did cause some embryos to die but it is worth noting that some of the dishes were perfectly fine under the same intensity. Further research and a larger sample size is required to find out why this is the case. The Southern and Northern sides of the magnet both had an effect on the embryos survival .

Introduction:

There are forces pulling all around us. Gravity keeps everything the same relative distance away when acting alone, even if the mass is different from particle to particle (Figure 3). Magnetic forces don't pull the same way. The charge determines how much force and to what direction the particle will accelerate. This means that a highly negatively charged particle like oxygen will be affected much differently than positively charged hydrogen (Figure 2). It therefore only seems reasonable that some type of damage would take place to an embryo if the molecules are being ripped in different directions. Electrical forces are essential within cells. Photosynthesis, cellular respiration, and nerve impulses rely on electrical signaling. Having a strong background magnetic field affects those particles by changing the direction they move in, making them move in circles (Figure 1). Cellular respiration for example requires oxygen to accept the electron from cytochrome A_3. If that oxygen ion is displaced because of a magnetic field, the organism would fail to resperate and die. It is important to note that an electrical current did NOT running through the fish embryos. These embryos were within a strong magnetic field that is put out by a large "C" magnet. Although no field like that would be found in an every day event, MRI machines use extremely strong magnetic fields and have been a point of controversy in regards if they negatively affect the unborn. It can be assumed that magnetic fields that are weaker than the ones tested will have less of an effect on an organism. I hypothesize that there will be no statistically significant result from this experiment. The magnet has been extremely close to human cells and there has been no provable damage seen that could be caused by the magnet. To see if the magnet can cause cause damage, the embryos will be observed for deformities and the number alive each day tested will be counted. If there are not significant differences between the control and the magnetic embryos (in the realm of mortality rates and deformities) then it could be assumed there is no effect.

Materials:

1 large C magnet

Incubator

Labeler Tape

2 incubators (kept at least 10 feet apart)

40 zebrafish embryos

3 holed trays

Labeler tape

A non ferrous material to keep the trays in place

An EMF detector

Embryo liquid (200mg/L instant ocean solution)

Safety:

The magnet can and will attach to anything and everything that is ferrous. It will pull the object and the magnet together and could cause damage to anything caught in the middle of the contact points. The magnet can also break easily and could shard. Precautions were made to kept the magnet a safe distance from anything it could stick to.

Procedure:

1. Fill the individual trays in the stated order (NOTE: According to the figure 5)

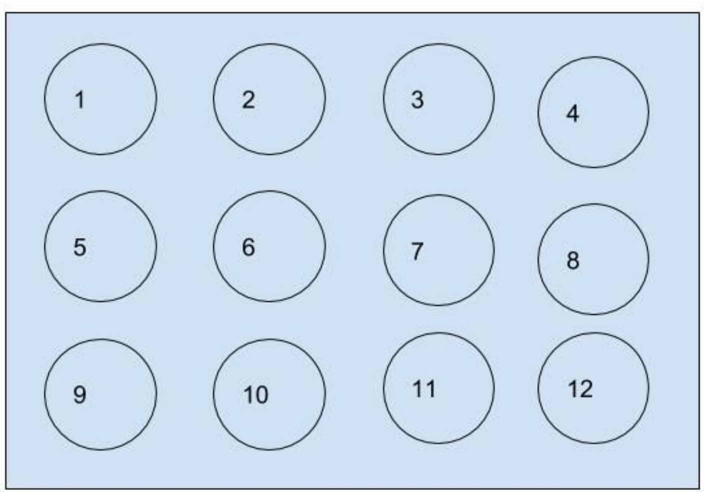


Figure 5

    a. Tray one (5 embryos in 5,6,7,8) Label 5 as red, 6 as middle red, 7 as middle blue, and 8 as blue
    b. Tray two (5 embryos in 5 and 8) Label 5 as far red and 8 as far blue

   c. Tray three (5 embryos in 1 and 12) Label 1 as control 1 and 12 as control 2

2. Tray 3 is the control and will goes in incubator 2, it is important that both incubators should be set at 28 Celcius
3. The magnet is to be placed in the in incubator 1, the trays are to go parallel underneath is so that the “red” side is on the left and the “blue” side is on the right. The magnet sides should be labeled respectively.
4. The C magnet is to be placed directly on tray 1, tray 2 should be placed 5 inches underneath the magnet, directly under tray 3. (Image 1)
5. Place the trays in their respective spots in the incubator and make sure the temperature is 28 C.
6. Check everyday for the number of embryos living and record all deformities at the same time of day for 3 days.

Data:

Controls: Temperature, Time checked, Number of embryos, Distance from the magnets.

Independent Variable: Magnetic field added to embryos

Dependent Variable: Number or deformities and deaths.

Control magnetic field: .9 μT (The background magnetic field created by the earth's core)

Strong red and blue: 200 μT

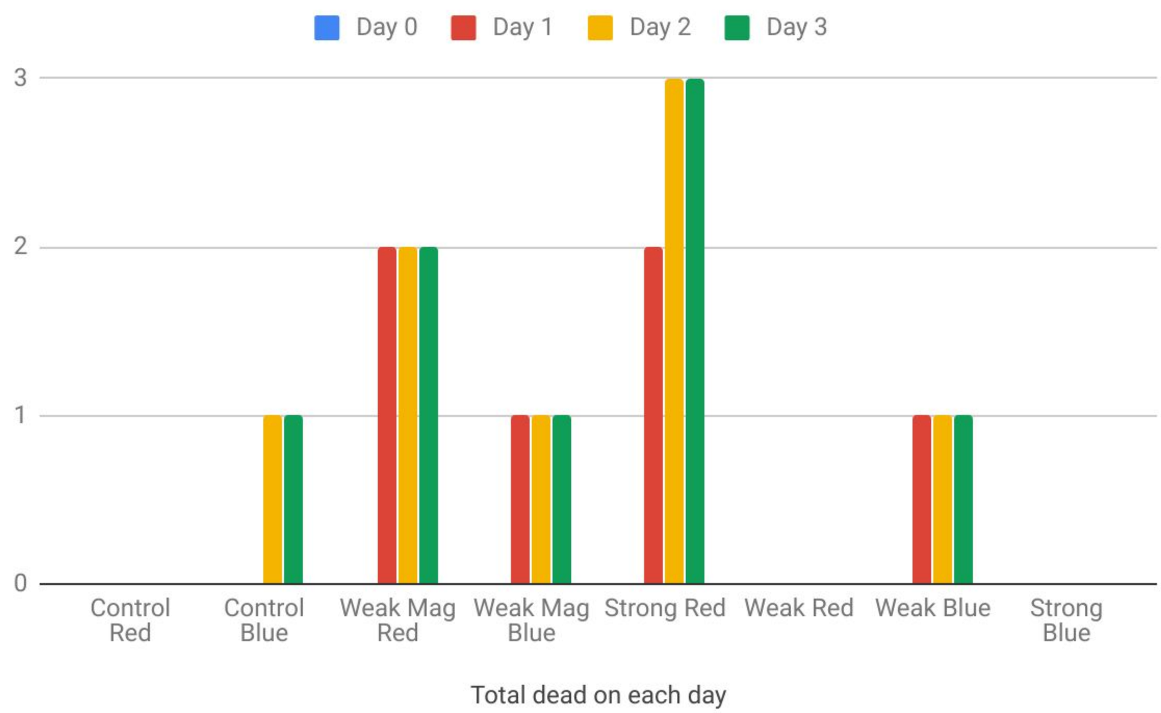
Middle red and blue: 195 μT

Weak red and blue: 120 μT

Dead	Control 1	Control 2	Weak Red	Weak Blue	Strong Red	Mid Red	Mid Blue	Strong Blue
Day 0	0	0	0	0	0	0	0	0
Day 1	0	0	2	1	2	0	1	0
Day 2	0	1	2	1	3	0	1	0
Day 3	0	1	2	1	3	0	1	0
Living day 3	5	4	3	4	2	5	4	5

Note: Middle blue had a deformity. Figure 4

Figure 5 is an example of healthy embryos also taken on day 3.



Data Analysis:

An average of .5 embryos died in the control dishes under an unchanged environment.

Chi Square Probability of result:

Weak Mag Red: 11%

Weak Mag Blue: 65%

Strong Red: 1%

Weak Red: 65%*

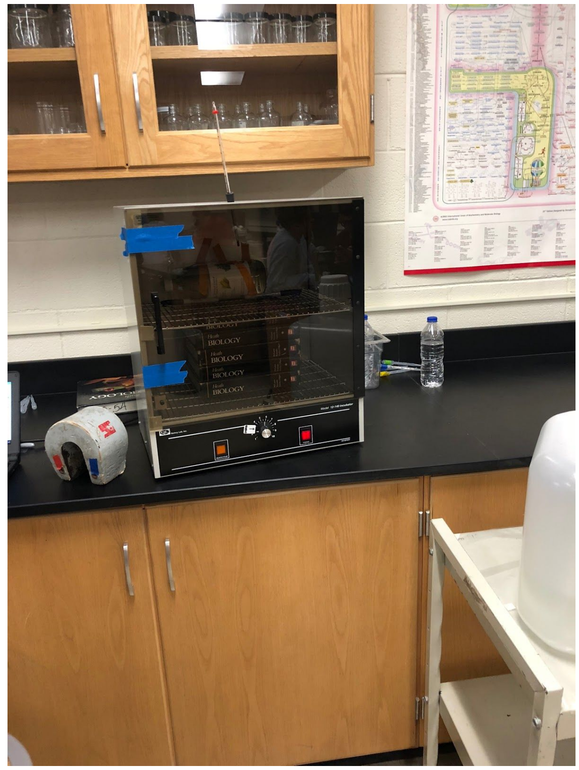
Weak Blue: 65%

Strong Blue: 65%*

* In these dishes, none of the embryos died but the control showed an average of .5 dead per plate as expected.

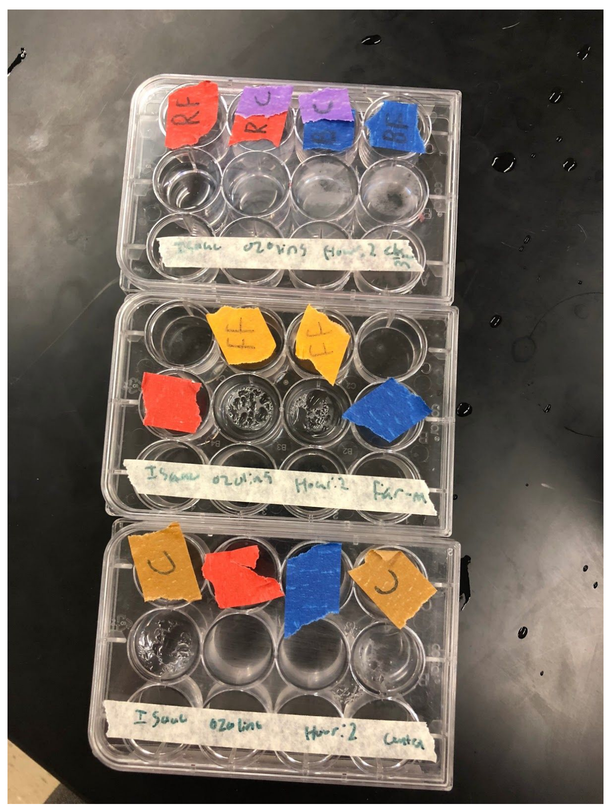
The chi Square test was used to compare the control to each individual dish. The lower the percentage, the more likely that the independent variable had an effect. A high percentage means that the independent variable likely had a small to no effect. One degree of freedom was used for every dish as they were individually compared to the control. The chart on the previous page shows the total number of dead embryos in every dish. It's important to note that every single embryo (except one) that died within in any of the magnetic fields died before the first checkin while the one that died in the control dish died between day 1 and day 2. It could be that some of the embryos were genetically destined to survive or die within the field that they were placed in. Further experimentation would be required to test that hypothesis however. Statistically, these results show that the magnetic field is affecting the development of the zebrafish embryos. There is only a one percent chance that the dish labeled strong red could have that outcome and not be affected by the magnetic field. The data shows a correlation between a higher magnetic field and a higher death rate.

Magnet on Tray (Image 1)



The setup when closed (Image 2)

Open setup (Image 3)



Trays with respective places of embryos (Image 4)

Discussion:

The results of the experiment seemed to show that magnetic fields have a result on zebrafish embryos even if the effect is unpredictable. At the beginning of the experiment, the sides of the magnet were labeled with blue and red tape so that there was no bias in seeing if the north or south end of the magnet was affecting survival rates (Blue is north and Red is South). From the results gathered it can be concluded that both the south and north end of a magnet can damage zebrafish embryos. The experiment also tested how well zebrafish embryos can survive under differently intense magnetic fields. It is important to note that all of the embryos in the magnetic field with the exception of one died between day 0 and day 1. This could be because of the different resistance levels different organisms have under stressers. These results can be compared to how bacteria survive in the presence of an antibiotic. The weak die off instantly and the resistant survive and thrive on until their natural death date. The one embryo that died between day 1 and day 2 under the magnet could have been non viable from the start. There was a difference between the control and a few of the dishes under moderate to extreme EMF. The dish labeled strong red had three embryos die and based on a chi Square analysis there is only a one percent chance of that happening if the magnetic field had no effect. This leads to the conclusion that there is a measurable difference in the survival rate of embryos subjected to magnetic fields and those under regular circumstances. To support that conclusion, there was also only an 11% chance that the weak mag red dish would have the same mortality rates as the control if the magnetic field was not affecting the embryos. Note that this experiment used a limited sample size to test in an area with little other data. There was one sample per location therefore more testing with larger sample sizes must be done before there results can be seen as fact. One embryo did die within the control and that threw off the chi Square results when none of the zebrafish died in that particular dish. This experiment was done to get the ball rolling on further experimentation regarding magnetic fields. The palm of my hand was under 20 μT (microteslas) every hour this lab took to type up. Electronics are already accepted into everyday life and we as a race have no idea of the consequences. Smartphones could be like the lead cups that destroyed Rome (Reference 7). We simply do not know. More tests are needed in this field and this experiment should only be the beginning.

References:

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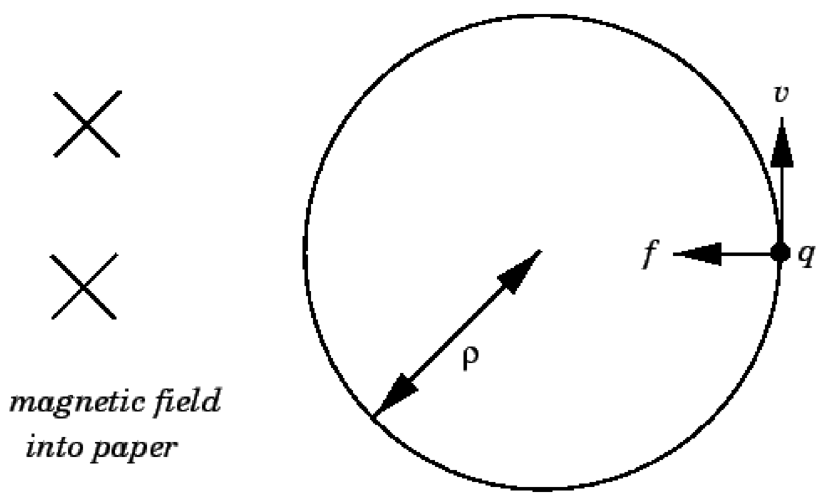

Figure 1

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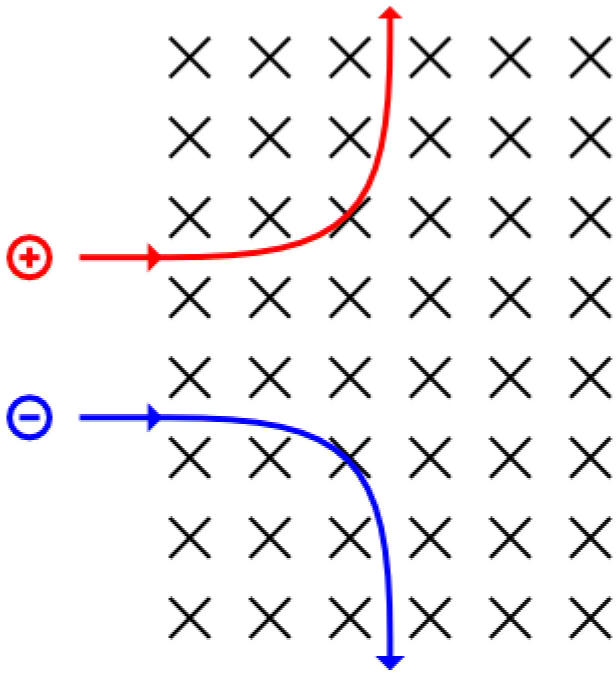

Figure 2:

Kurzon. “File:Path of Charged Particles in a Magnetic Field.png.” *Wikimedia*, 10 Apr. 2010, commons.wikimedia.org/wiki/File:Path_of_charged_particles_in_a_magnetic_field.png.

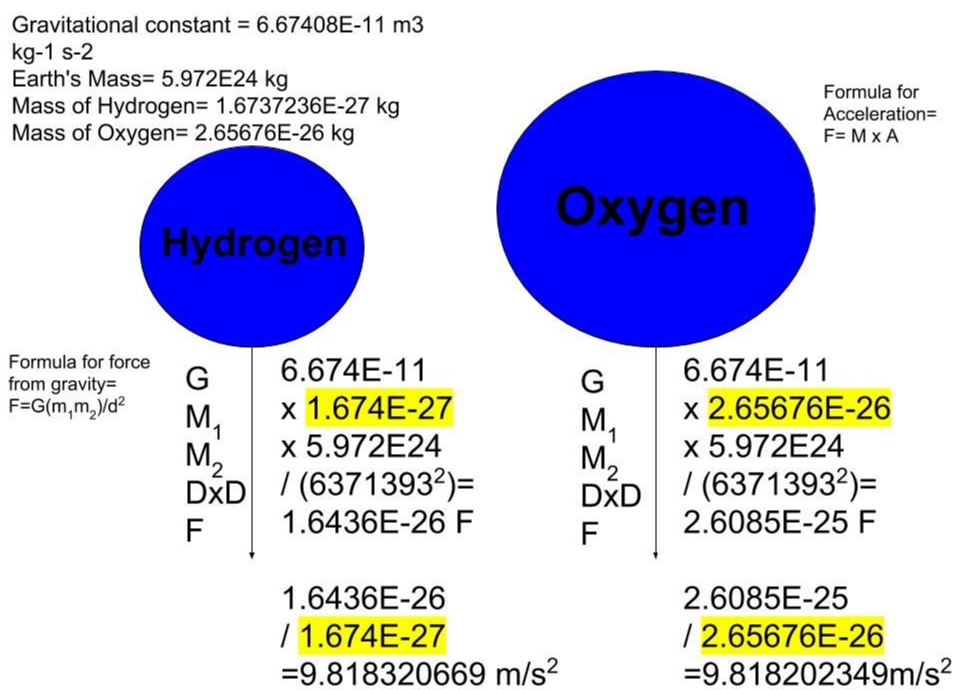

Figure 3 (Self Made)

Figure 4 (Self Taken on Day 3)

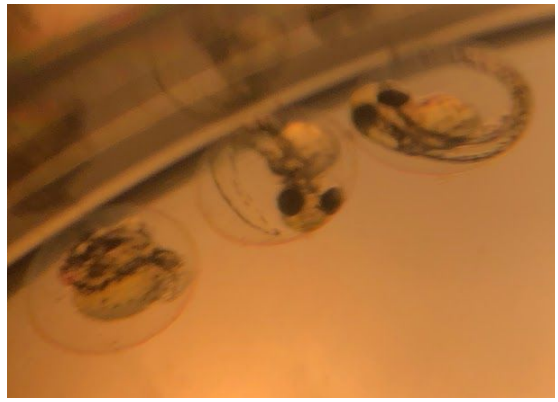

Figure 5 (Self Taken on Day 3)