An analysis of beauty as it is related to the ratio 1:1.618

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Period. 3

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Introduction

Have you ever stopped and looked around at the world around you? Have you ever looked at birds flying around, the bees buzzing happily through the air, seashells on the beach, and thought that they were beautiful? Have you ever wondered why they are beautiful, how they are beautiful? These are the questions this study hopes to address.

Two ratios/algorithms form the backbone of what many people all around the world see as beauty. These two ratios/algorithms are the Golden ratio and the Fibonacci numbers; both of which are related to each other. The Fibonacci numbers are found by adding the two preceding numbers together to find the next number in the string. An example of this is 0, 1, 1, 2, 3, 5, 8, 13, Etc. The Golden ratio is 1:1.618; and coincidentally when this ratio is applied multiple times on a line, each number is 1.618 times larger than before, the results are shockingly similar to the Fibonacci numbers. Therefore, many scientists have accepted these two systems as interrelated. Despite popular belief, the golden ratio is not a rational number (a number that has some definite end). In fact, the Golden Ratio goes on into infinity, but is commonly rounded to be 1:1.618.

The ratio 1:1.618 is found all around us in nature. One of the most common places in nature where the ratio 1:1.618 is found is in seashells. Many people collect seashells because of their beauty and decorative value. In fact, seashells contain mathematically based patterns that are perceived as beautiful by the human brain. In nearly every seashell there is an unmistakable spiral. This spiral follows the pattern of the Fibonacci numbers almost exactly. (Hence the seashell follows the Golden Ratio, since the two are interrelated.) This same spiral can be seen in many other living and nonliving structures such as the inner ear of humans, some hydra species and even our home, Milky Way Galaxy. In addition to this, many other animals display the ratio 1:1.618 in other areas. For example, in humans the segments of the human finger and the upper, above the waist, and lower body, below the waist, are in the ratio of 1:1.618.

The ratio 1:1.618 is not only seen in nature, but also in many human creations such as art and architecture. Since recorded human history, people have wondered and pondered the beauty of the world around us. They wondered why it was beautiful, how it was beautiful and how can you measure beauty. The ancient Greeks are created for being the first to give a definitive answer to the mystery of beauty. The Greeks discovered the ratio 1:1.618. The Greeks used this ratio in
nearly everything they ever made (1, 3). Greek painting, mosaics, sculptures even pottery, all contained this ratio. The Greeks thought this ratio to be perfect and that is was close to divine. (1, 2, 5, 6, 11) One of the most notable structures the Ancient Greeks built was the Pantheon. This structure displays the ratio 1:1.618 in nearly all of it dimensions. (1, 7)

Even before the Greeks other cultures experimented with the Golden ratio and other ratio oriented art and architectural forms. Among the first known cultures do have the mathematics capable of doing this were the ancient Egyptians. Egyptian mathematics originated with their religious need to be connected with the stars and the more practical use of knowing when to plant crops. (1, 3, 8) The later Egyptians also developed some of the key aspects of geometry, such as the Theorem of Pythagoreans. This Theorem and its derived theorems helped later cultures develop the use of ratios in triangles or pyramids. An example of this is in the Pyramids of Gaza, which seem to show a definite mastery or architecture, with emphasize on mathematics. (1, 3)

The Greek mathematician Eudemus is thought to be the father of proportions, as we know them today. Though he didn’t develop proportions per say, he did come up with many of the theorems that govern proportions. Proportions are the building blocks of ratios, and without them many more complex ratios could not be created. His work is also later built upon to later develop Algebra and geometry. (1, 3, 9, 11)

The ratio of 1:1.618 even shows up in more modern art as well. M.C. Escher a well-known artist and mathematician also used this ratio heavily in his work. (5, 12) Even today the golden ratio is found nearly everywhere we look. It is present in many credit cards, televisions, doors, and automobiles. In fact, many makeup application style, and hair styles that beauty stylist use, enhance the bodies and faces ratios to or near 1:1.618. In fact, some common hairstyles such as some styles of braids have a ratio close to that of the golden ratio. (2, 5, 10, 11) Some scientists even claim that the golden ratio is present in music. In fact, it has been shown that some famous composers such as Mozart and Beethoven used the golden ratio in their music. (9) However, it is not known whether this is simply a coincidence or if these musical geniuses used this as apart of a system to make their music more appealing to the human ear. (8, 9)

Another odd place the golden ratio is seen is a person’s handwriting. In fact many of the letters with a vertical or horizontal bar in them are in the ratio of 1:1.618, with the bar dividing the two segments. Some letters this is known to appear in are: A, E, F, R, B, H, and P. (9) The most bizarre aspect of this is that it is done casually,
usually without the person realizing or even consciously knowing they are writing with the ratio 1:1.618. It seems that in someway people use this ratio quite naturally or instinctively through out their daily lives. This may be a reason why this ratio is seen so readily in art, architecture and crafts. (3, 4, 5, 8, 12)

Isn't it a little ironic, that all these different artist and cultures all seem to search for beauty in the same ratio? Many seemingly different “beautiful” things have this one ratio in common; could this be the missing link to beauty in the universe? These objects may all share this ratio but not be beautiful to every person. If an object truly has the golden rule of beauty, the majority should think that objects with that ratio are beautiful. (1, 3, 11) Since beauty is thought to be in the eye of the beholder, how could this one ratio be beautiful to everyone (1)? This study is meant to test if general groups of people really do find the golden ratio beautiful.
Method

Image Preparation:

To prepare the images for this experiment first find six images that hold the ratio of 1:1.618. The images used in the initial experiment can be seen below: (The author made the images of the Pantheon and Golden Triangle. The Coal Car image was a picture taken by the authors’ mother. The Golden Spiral was edited by the author from a preexisting template. The images of the Leaf and Insect are from 
http://www.beautyanalysis.com/mba_phithekeytobeauty_page.htm

Pantheon  Coal Car  Golden Spiral

Golden Triangle  Leaf  Insect

Each of the images above has the ratio 1:1.618, however all the ratios are found in different areas and aspects of the object. The ratio of 1:1.618 is found in the width to the height in the images of the sketch of the pantheon, and the Coal Car image. In the image of the Golden Spiral, the ratio of 1:1.618 is found in the size of the second largest portion to the largest portion of the Golden Spiral. In the image of the golden triangle, the ratio of 1:1.618 is found in the length of the base compared to that of the sides. In both the Leaf and the Insect the ratio of 1:1.618 is found in the segments of the life form. The caliper defines these segments.
The next step after finding the images is to edit the ratios of all the images and skew them. Each image should have four skews of it and the original image. This comes to a total of five images per object. These five images per object are referred to as a set of images. The skew ratio for all of the images in each set are 1:1.418, 1:1.518, 1:1.618 (the original image), 1:1.718 and 1:1.818. An example of this is shown below with the Golden Triangle Set.

The differences in the ratio of the base to the sides are clearly seen in all of the images of the set. To skew the pictures use paint shop pro or another program that is used for image editing and allows you to view the exact location of pixels. Then zoom in till the individual pixels are visible. Plot the exact points of the corners that form the ratio. Now find the distance between the points. (In the Golden Triangle set, the corners are the 3 angles points of the triangle.) Now multiply the length of the base by the ratio you wish the sides to be. The resulting number is the length the sides must be to fit into the ratio you multiplied the base by. Adjust the length of the sides to the number you received from the preceding equation. Repeat this for all four of the skew ratios for each set of images. An example is shown below with the ratio 1:1.418 on the Golden Triangle: (The images in this document are not to scale because the images used in my project vary from.)

\[
\begin{align*}
\text{Line AB=CB;} & \quad \text{Line AC=3} \\
AB & = AC \times 1.418 \\
AB & = 3 \times 1.418 \\
AB & = 4.254 \\
\text{Adjust the length of Lines AB and CB to 4.254}
\end{align*}
\]
Preparation of Image Display:

After the editing if the images is complete, attach the six sets of images on a piece of tag board with and adhesive device such as tape; with three sets of images per side, each set is allocated 1/6 of the total space of the tag board, with approximately 2 to 3 inches of space between sets. Label the sets 1 – 6 and each image in the set 1 – 5 for reference purposes. See example below:

![Sample Image Display](image_url)

Testing:

A data table was created containing the following fields: the test subjects name, age, sex, and which image they selected. Although name, sex and age are not necessary for analysis they were collected for reference purposes. The test subject stands in front of the tag board with approximately one foot between him/her and the board. I covered the board with the image sets on it with another piece of tag board measuring the same dimensions as the one with the images on it. I then stated to the person, “Chose the image from each set that you find the most visually appealing. Tell me the number of or point to this picture. There are six sets of images and you will have a maximum of twenty seconds per set to select the most visually appealing image. There will be no talking during the test. Ask any and all questions now.” After stating this I proceeded with timing and recording which image they found the most visually appealing. To display these sets of images I moved back the covering piece of tag board to display a set. I showed all the sets in a random order and changed the pattern of images occasionally, to ensure accurate results. To turn the boards over I ask the test subject to lift the board up while I place the cover sheet under the board and flip it over. I then flip both over and continue testing. I record all data in my lab notebook. After I have gone through all the sets I thank the test subject.
Analyzing:

In analyzing your results, tally your results; now look for any trends in the data of different sets or overall. After this is complete, your data should be graphed, showing and or demonstrating your data trends.

Results

Numerical Format:

**SET 1:**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Number of times selected</th>
<th>Percentage of times selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1.418</td>
<td>4</td>
<td>10.3%</td>
</tr>
<tr>
<td>1:1.518</td>
<td>5</td>
<td>12.8%</td>
</tr>
<tr>
<td>1:1.618</td>
<td>14</td>
<td>35.9%</td>
</tr>
<tr>
<td>1:1.718</td>
<td>9</td>
<td>23.1%</td>
</tr>
<tr>
<td>1:1.818</td>
<td>7</td>
<td>17.9%</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>100%</td>
</tr>
</tbody>
</table>

**SET 2:**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Number of times selected</th>
<th>Percentage of times selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1.418</td>
<td>3</td>
<td>7.9%</td>
</tr>
<tr>
<td>1:1.518</td>
<td>11</td>
<td>28.9%</td>
</tr>
<tr>
<td>1:1.618</td>
<td>4</td>
<td>10.5%</td>
</tr>
<tr>
<td>1:1.718</td>
<td>15</td>
<td>39.5%</td>
</tr>
<tr>
<td>1:1.818</td>
<td>5</td>
<td>13.2%</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>100%</td>
</tr>
</tbody>
</table>

**SET 3:**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Number of times selected</th>
<th>Percentage of times selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1.418</td>
<td>11</td>
<td>27.5%</td>
</tr>
<tr>
<td>1:1.518</td>
<td>8</td>
<td>20%</td>
</tr>
<tr>
<td>1:1.618</td>
<td>9</td>
<td>22.5%</td>
</tr>
<tr>
<td>1:1.718</td>
<td>5</td>
<td>12.5%</td>
</tr>
<tr>
<td>1:1.818</td>
<td>7</td>
<td>17.5%</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100%</td>
</tr>
</tbody>
</table>
**SET 4:**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Number of times selected</th>
<th>Percentage of times selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1.418</td>
<td>4</td>
<td>10.3%</td>
</tr>
<tr>
<td>1:1.518</td>
<td>10</td>
<td>25.6%</td>
</tr>
<tr>
<td>1:1.618</td>
<td>4</td>
<td>10.3%</td>
</tr>
<tr>
<td>1:1.718</td>
<td>6</td>
<td>15.4%</td>
</tr>
<tr>
<td>1:1.818</td>
<td>15</td>
<td>38.5%</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>100%</td>
</tr>
</tbody>
</table>

**SET 5:**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Number of times selected</th>
<th>Percentage of times selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1.418</td>
<td>14</td>
<td>35%</td>
</tr>
<tr>
<td>1:1.518</td>
<td>7</td>
<td>17.5%</td>
</tr>
<tr>
<td>1:1.618</td>
<td>7</td>
<td>17.5%</td>
</tr>
<tr>
<td>1:1.718</td>
<td>7</td>
<td>17.5%</td>
</tr>
<tr>
<td>1:1.818</td>
<td>5</td>
<td>12.5%</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100%</td>
</tr>
</tbody>
</table>

**SET 6:**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Number of times selected</th>
<th>Percentage of times selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1.418</td>
<td>14</td>
<td>35.9%</td>
</tr>
<tr>
<td>1:1.518</td>
<td>11</td>
<td>28.2%</td>
</tr>
<tr>
<td>1:1.618</td>
<td>6</td>
<td>15.4%</td>
</tr>
<tr>
<td>1:1.718</td>
<td>7</td>
<td>17.9%</td>
</tr>
<tr>
<td>1:1.818</td>
<td>1</td>
<td>2.6%</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>100%</td>
</tr>
</tbody>
</table>

(A test subject data was not used due to not completing the full length of an experiment. Another test subject failed to respond within the allocated 20-second time frame.)
Graphical Format:

- Green = 1:1.418
- Blue = 1:1.518
- Yellow = 1:1.618
- Cyan = 1:1.718
- Pink = 1:1.818

**SET 1**

- 1:1.818 (17.9%)
- 1:1.418 (10.3%)
- 1:1.518 (12.8%)
- 1:1.718 (23.1%)
- 1:1.618 (35.9%)

**SET 2**

- 1:1.818 (13.2%)
- 1:1.418 (7.9%)
- 1:1.518 (28.9%)
- 1:1.718 (39.5%)
- 1:1.618 (10.5%)

**SET 3**

- 1:1.818 (17.5%)
- 1:1.418 (27.5%)
- 1:1.718 (12.5%)
- 1:1.618 (22.5%)
- 1:1.518 (20.0%)
Discussion/Conclusion

The data collected revealed little about whether the people in general find the ratio of 1:1.618 beautiful. One of the only trends seemed to be that in Sets 3, 5 and 6 the ratio 1:1.418 was selected the most. In Set 3, 27.5% or 11 people out of the 40 people tested selected the ratio 1:1.418. In Set 5, 35% or 14 people out of the 40 people tested selected the ratio 1:1.418. In Set 6, 35.9% or 14 people out of the 39 people tested selected the ratio 1:1.418. Other than this minor point, the data reveals an almost random selection of images. From this, one can only conclude that the ratio 1:1.618 plays a small role in which image the test subject finds most visually appealing. In fact the ratio 1:1.618 was only selected the majority of the time in image Set 1. In Set 1, 35.9% or 14 people out of the 39 people tested selected the ratio 1:1.618.

Through directly observations of the test subjects in this experiment several discoveries were made. Among these are that the type of image and where the ratio is found in the image plays a role in how the test subject reacts to the images. Through this observation it appears that the test subjects are more objective with man-made or geometric objects such as the Pantheon or Golden Triangle image sets. This was clearly observed in the fact that many people quickly and accurately judged these Sets with no hesitation and no signs of confusion in which image is the most visually appealing. In fact the Set with the Pantheon image is Set 1, the only set in which the ratio 1:1.618 was selected most frequently. On the other hand, the test subjects were observed to be the least objective when judging the appeal of the biological structures, such as the Leaf and the Insect. This was observed in the fact that many test subjects were hesitant in selecting an image and in the fact that many test subjects either ran out of time on these Sets and were forced to pick an image immediately. This may have thrown off the accuracy of Sets 2, the set with the insect, and 5, the set with the leaf. Also, the limited overall test pool size limited the accuracy of the test.

It has come to my attention, through direct observations and the commentary given by test subjects, most notably Mr. Conrad, that the experiment is flawed. It is flawed because people react differently to different categories of objects and to where the ratio 1:1.618 is found in the object, and many different combinations of both of these variables were used in the image preparation. In all five different object categories and four different ratio locations were used. For this experiment to contain fewer variables and be more efficient the number of object categories and ratio locations should remain constant instead of
changing from set to set. Because of these inconstancies and the large number of variables present in the experiment, this data may not be accurate.
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    1997

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    1999

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    Christopher D. Green
    1995
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Personal Statement

In this experiment I learned and developed the basic skills necessary for any future research I decide to do, such as organization, punctuality, and report writing. Though my project was flawed in several ways, I believe this insight into the world of research will be helpful. In fact, I enjoy most parts of research such as getting to meet new people, learning about new Ideas and concepts. The only part of research I don’t like is compiling my data into a report and analyzing it. Despite this major pain my research project was fun to do, and I learned a lot about the dynamics and mathematics behind the Golden Selection and the Fibonacci Numbers; much of which went straight over my head.

While doing this experiment, I also learned many things that are completely unrelated to doing projects such as; if a woman looks like she is over 20, don’t ask her, her age; that a person’s mode and surroundings seem to effect there test taking aptitude and ability; if you approach a person in a dead serious manor, they will be scared away; if you approach a person in too light hearted a manor, they will take you and your experiment as a joke; a person’s impression of you will effect how they take your test/experiment; people like to ask questions; and that people will give you their opinion even if you don’t ask for it. I have also learned that the neater your data tables, the easier your data compilation will be when the time comes.

If I were to conduct a similar experiment in the future I would make several key changes to its design and execution. First and foremost I would have to develop a more concrete way of approaching people to use in my experiment, since the way you approach someone greatly effects there reliability as a test subject. I would also limit the categories of objects and to where the ratio 1:1.618 is found in the object to one object category and one location, because these variables seem to play a huge role in the test subjects’ perception of beauty. A full write up about this can be found at http://htpprints.yorku.ca/documents/docs/00/00/00/03/htp00000003-00/goldrev3.htm. Also, instead of testing ratios that I derived from the ratio 1:1.618, I would use unrelated ratios such as 1:1 or 1:2.7.

Overall, despite my experiment being flawed, I believe this was an interesting insight into the world of research that few members of our modern society are given the opportunity to have.