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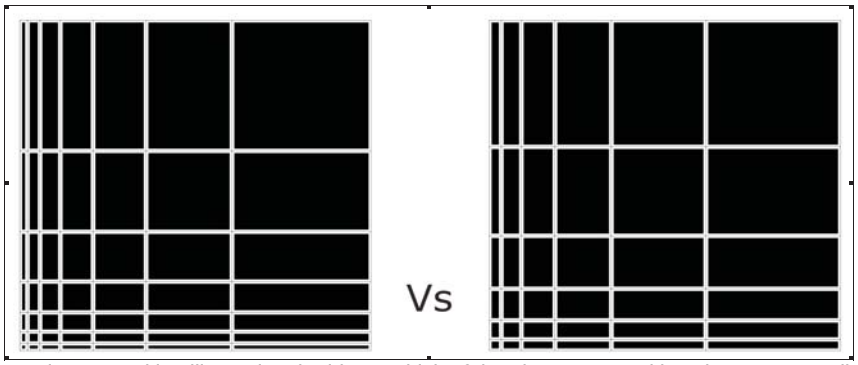
Paper, Artworks: **A Web-based Survey to Evaluate the Aesthetic Impact of the Golden Ratio**

Abstract:

The Golden Ratio is often regarded as the carrier of a strong aesthetic value in the Art World. The aim of this project is to put this attribute to the test, with a particular focus on whether the Golden Ratio can be regarded as a key factor for a superior compositional order in computer-generated abstract art.

Compositional algorithms have been conceived with inspiration from the systems of ordering and composition employed in the De Stijl movement [1], and coded by means of Processing.js, a Web-based version of Processing, an open-source programming language originally developed at MIT Media Lab [2].

The basic idea is to produce variants of algorithmic compositions in 2D and 3D space, some of which based on the Golden Ratio, presented on a page of a website. Viewers, unaware of the tested hypothesis, are asked to select and vote their aesthetically preferred item on the sole basis of their visual experience. Thus, a database of choices is built up, providing information with which the aesthetic impact of the Golden Ratio can be verified.



A sample composition illustrating the idea: Which of the above compositions is more appealing?

Tests with similar aims have already performed in the past [3], but this Web-based proposal widens the context of the participants to include at least six countries in four different continents, which can possibly shed some light on interesting differences in aesthetic perception throughout the world.

Topic: Art

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References:
[1] Michael White, "*De Stijl and Dutch Modernism*", Manchester University Press, Manchester, 2003
[2] http://processingjs.org
[3] Phil A Russell, "*Testing the aesthetic significance of the golden-section rectangle*", Perception 29(12), 1413–1422, 2000

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A Web-based Survey to Evaluate the Aesthetic Impact of the Golden Ratio

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Abstract

This work tackles the long-standing issue of verifying whether the golden ratio has a significant impact on aesthetic experiences. We propose a web-based experiment with generative abstract art to overcome the limitations of previous proposals, which have always been carried out with a limited amount of participants not constituting a representative sample of the population, and either with too varied artworks that have possibly distracted the viewers from the ratio issue, or with too scant rectangle-shaped cut-outs.

1. Introduction

The golden ratio is often regarded as the carrier of a strong aesthetic value in the Art World. The aim of this project is to put this attribute to the test, with a particular focus on whether the golden ratio can be regarded as a key factor for a superior compositional order in computer-generated abstract art.
Compositional algorithms have been conceived with a loose inspiration from the systems of ordering and composition employed in the De Stijl movement [1], and coded by means of Processing, an open-source programming language originally developed at MIT Media Lab [2].
The basic idea is to produce variants of algorithmic compositions, some of which based on the golden ratio, presented on a page of a website. Viewers, unaware of the tested hypothesis, are asked to select and vote their aesthetically preferred item on the sole basis of their visual experience. Thus, a database of choices is built up, providing information with which the aesthetic impact of the golden ratio can be verified.
This work is organized as follows: Section 2 illustrates other proposals in the literature that have tackled the enterprise of testing the impact of the golden ratio on the aesthetic experience of observers; Section 3 provides details on the generative algorithms that have been employed to create the designs for the experiment; Section 4 illustrates the set-up of the survey and the Web-based procedures; Section 5 presents and discusses the results of the experiment; finally, Section 6 concludes and traces the guidelines for future work.

2. Related work and motivation

A number of tests with a similar aim have already performed in the past. Let us quickly present some of these experiments and point out the procedural differences with our approach to shed light on our contribution to the existing body of work.
Ajluni et al. have conducted an on-site survey, exposing 105 adult female subjects to specific paintings in two museums in Paris [3]. The artworks used in the experiments were divided in three pairs of paintings, one pair at the Museé d'Orsay and two at the Centre Pompidou. Each pair was composed by one painting containing the golden ratio (the test painting), and another without such feature (the control painting). The test and control paintings were by different artists, and they were chosen on the basis of the researchers' judgment on similarities in artistic style, and also on their relative distance within the museum, to enable the test subjects to compare them quickly. The results turned out to yield little significance, and no support to the hypothesis that the golden ration makes a difference in the aesthetic experience was found.
The effort of the authors has been undoubtedly valuable, but let us shed some light on the critical parts of this experiment that, in our opinion, may even undermine the scientific character of these negative results.
Let us take a look at one of the three pairs that have been used in the survey, more precisely, George Seurat's Le Cirque (Figure 1) and Paul Signac's Femme à l'ombrelle (Figure 2), both in the Museé d'Orsay. The former was the test painting featuring several parts fitting the golden ratio, whereas the latter was the control painting.

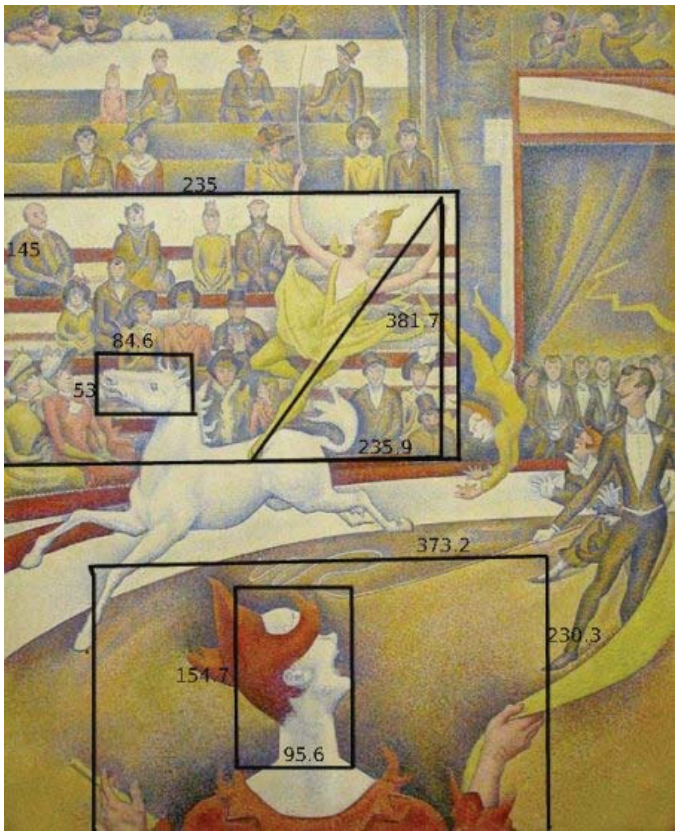

Figure 1: "Le Cirque" by Georges Seurat (1891) with golden ratio highlights by Ajluni et al. [3].

Figure 2: "Femme à l'ombrelle" by Paul Signac (1893).

According to the authors, the control painting was selected on the basis of similarity, to allow only for the mathematical accuracy of the composition to be tested during the survey. In other words, the artistic style, the color palette and the use of human figures had to be consistent between the artworks in each pair.
We are compelled to point out that the similarity between these two paintings are not enough to ensure that the only feature under test was the golden ratio factor which, according to the tested hypothesis, was to give Seurat's work an edge over Signac's. We can determine at least three factors that differentiate the two artworks other than the golden ratio: color intensity, composition with respect to the human body, and realism in depicting facial expressions. Signac's work (Figure 2) is characterized by intense colors, in strong contrast with each other: our eyes are particularly focused on the significant difference between the umbrella's orange and the dress' green, and between such green and the skirt's violet; Seurat's work (Figure 1), on the other hand, presents a much milder palette, and even very different colors next to each other like the performers' yellow and the curtains' blue do not lead to a strong contrast because the areas for each color are much smaller and they tend to blend if observed from a usual museum visitor's distance. Signac's work is clearly focused on a single womanly figure from up close and her face is depicted with a significant amount of realism, as shown by the shadows around her eyes, whereas Seurat's painting features a number of persons from a distance, and their facial features are only sketched and linear, like in a graphical illustration. The fact that both painters

used pointillism (i.e. a painting technique that uses dots of colour) is not enough to allow us to exclude the possibility that the above-mentioned differences between the two paintings may have influenced the judgment of the subjects. The issue in this test is the too rich variety of criteria the subjects can base their judgment upon.
Let us illustrate another test from the literature, affected by the opposite problem.
Dumitrescu presents an experiment carried out in a technical university for the discovery of the perfect proportion of rectangles, and the evaluation of the parameters that might influence the perception of such proportion [4]. The author interestingly decides not to show any golden rectangle in the experiment, but a variety of rectangles with 5 different length/height ratios: 1, 1.5, 2, 2.5, 3. Moreover, the length of rectangle would always be the larger size, so that the rectangles would be presented as horizontally oriented. The experimental procedures included some communication with the subject on the aim of the experiment and on the notion of the golden ration without revealing its actual value and then an evaluation on a qualitative scale from "totally bad proportionate" to "perfectly proportioned" of some rectangular colored cardboard cutouts (Figure 3).

Figure 3: cardboard rectangles used in Dimitrescu's experiment [4].

57 students took part in the experiment and it was observed that the highest mean score belonged to ratio 1.5, the nearest to the actual value of the golden ratio (1.618).
We argue that this test presents at least three shortcomings. Firstly, we do not have enough detailed report on the communication phase of the survey, but nonetheless we fear that the initial discussion may have had an influence on the subjects, by drawing their attention on the issue on proportions and making them more careful and biased toward an intermediate ratio. Secondly, it is arguable whether a small piece of colored cardboard can actually constitute an aesthetic experience. Finally, the age and the cultural background of the subjects, who were all students at the same technical university, seem to be too restricted to give the results a definitive significance.
It is very interesting to notice how Ajluni's and Dimitrescu's experiments are on opposite sides in several aspects: the former does not provide any explanation and is based on actual artworks, whereas the latter starts with an explanation phase and

focuses only on the pure geometrical form of rectangles. As shown in the following, our proposal lies in between, to avoid the issues that seem to be affecting these works.
A work that stands out in the literature is the experiment conducted by Russell in the Department of Psychology at the University of Aberdeen [5]. Two studies where conducted: the first one was similar to Ajluni's, based on paintings to be selected by a number of subjects, which did not yield any conclusive result, arguably because of the variety in shape, orientation, subject matter, and technique characterizing the artworks in the survey. The second experiment is undoubtedly more interesting, because it was based on a method of production, first proposed by Fechner, a pioneer in experimental psychology [6]. As illustrated by Russell, "subjects were required to produce the most pleasing rectangle under one of four between-subjects instruction conditions: 'horizontal rectangle', 'vertical rectangle', 'head-and-shoulders portrait painting', and 'landscape painting'." [5, p.1417] Although the results showed that the productions in the first two categories were somehow approximating the golden ratio, the last two yielded figures that left it out of the 95% confidence limits for their mean values. Moreover, the 176 participants were all students of the same class of Psychology, which cannot by any means be considered as a representative sample of the population. Finally, we cannot help questioning the rather mysterious concept of a "pleasing rectangle", although we are well aware that our proposal may be subject to the same criticism.
We aim at overcoming the main shortcomings of the proposals illustrated so far. Firstly, we place our experiments in the halfway between the scant aesthetic experience of a single rectangular shape and the distracting over-stimulation given by the variety of artworks from the past. As illustrated below, we do so by providing subjects with abstract compositions of rectangles based on a generative algorithm. Secondly, we overcome the numerical limitations of face-to-face experiments and intend to involve the biggest possible number of participants by setting up our experiments on a webpage able to reach any person in the world with a computer connected to the Internet.

3. Generative design for the experiment

The main idea is to present a subject with two very similar compositions, one comprised of rectangles characterized by the golden ratio. The ratio only intervenes in the production of the rectangles and not in their composition. The graphical style is loosely inspired from the paintings of the De Stijl movement.
The generative scripts were initially conceived in Processing [2] and successively translated into Java to guarantee a display of the composition independent from the browser in use.
Three different composition generators were created.
Generator #1 aims at generating simple, sparse, and mostly non-overlapping compositions. The rectangles have no fill colors and the background is white (Figure 4). The relevant script takes up a random range of numbers from the canvas' width and height to derive the respective x and y coordinates, which are checked against an array of previously declared points to avoid excessive overlaps, and then the composition is produced. The other image is built on the sole basis of the coordinates and the widths of the rectangles of the first composition, so that the only discriminating factor between the two compositions is the ratio of their rectangles.

One and only one of the compositions randomly pick the golden ratio, whereas the rectangles in the other are characterized by ratio 2.1.

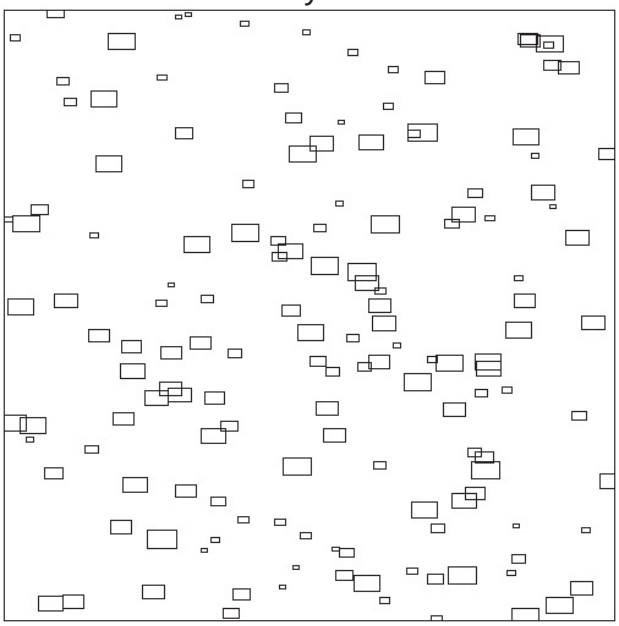

Figure 4: a composition by Generator #1 (variant with golden ratio).

Generator #2 adds a color filling the rectangles, each of which is assigned a random alpha value that determines its transparency. The script does not check their positions against previously defined points, so the chances for overlap are increased (Figure 5).

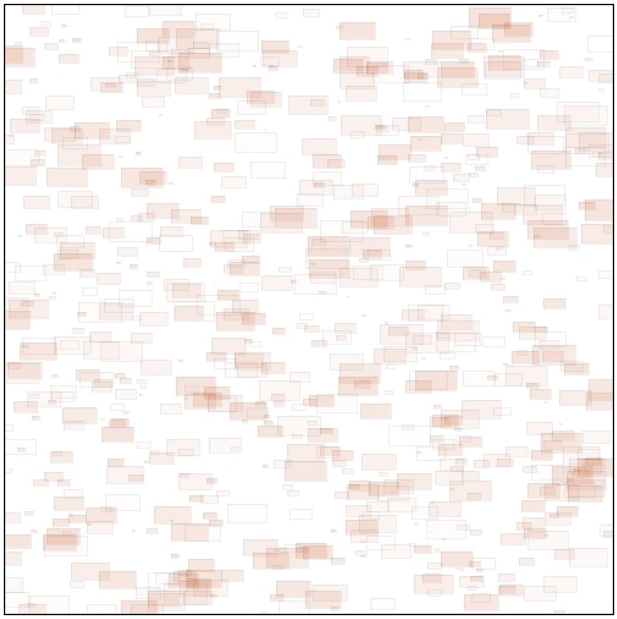

Figure 5: a composition by Generator #2 (variant without golden ratio).

Generator #3 creates larger overlapping rectangles. Variety is increased by an additional loop of rectangle generation. The first loop generates larger rectangles with a set of darker alpha values over a yellow background, whereas the second loop creates a background filling with smaller yellow rectangles with varying alpha values and a denser set of population points (Figure 6).

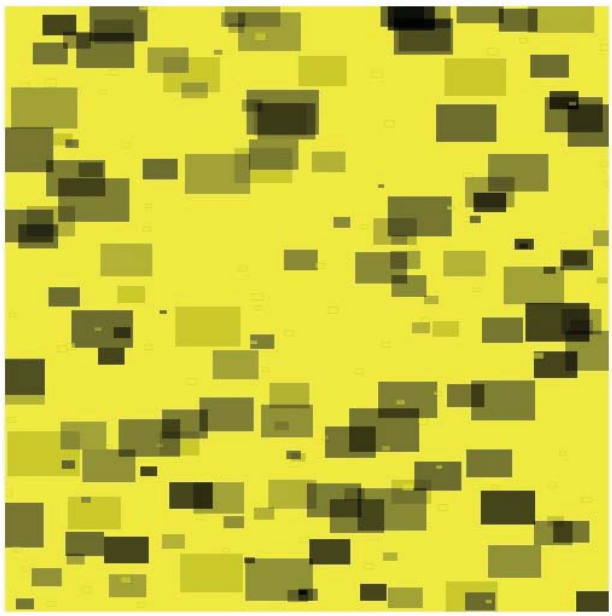

Figure 6: a composition by Generator #3 (variant with golden ratio).

4. Web application for the experiment

The online tester (OT) was developed in the form of a web application that does not require any specific software on the subjects' side but a common AJAX-enabled web browser. OT is fully Java-based with very ordinary requirements on the server side; it runs on Apache Tomcat application server and data are stored in a MySQL database.
The software architecture is flexible enough to enable us to integrate different image generators, each one based on a specific technology and a custom algorithm, and to freely embed them into binary questions, making OT a valuable support also for future web-based aesthetic experiments.
We have set up a website at cs.unibg.it/GenerativeTest to host OT. The interface guides the subject through the test. After a splash window, OT shows two compositions from Generator #1 next to each other: one with golden ratio rectangles, one without. Their positions (left or right) are randomly set. Each composition is accompanied on its upper side by a button that allows the subject to select it to express their preference (Figure 7). A click on any button immediately leads to the following pair, by Generator #2. The structure of this new page is identical to the previous one, and a click on any preference button leads to the last pair of compositions, by Generator #3. For each answer, not only OT stores the selection, but also the position of the selected image (i.e. left or right) to evaluate the impact of the presentation layout. After the last selection, the subject is offered the opportunity to retake the test with newly generated compositions, or to conclude the experiment, after which OT stores the subject's computer's IP address and its localization (the subject's country), obtained by querying a publicly available online service [7].

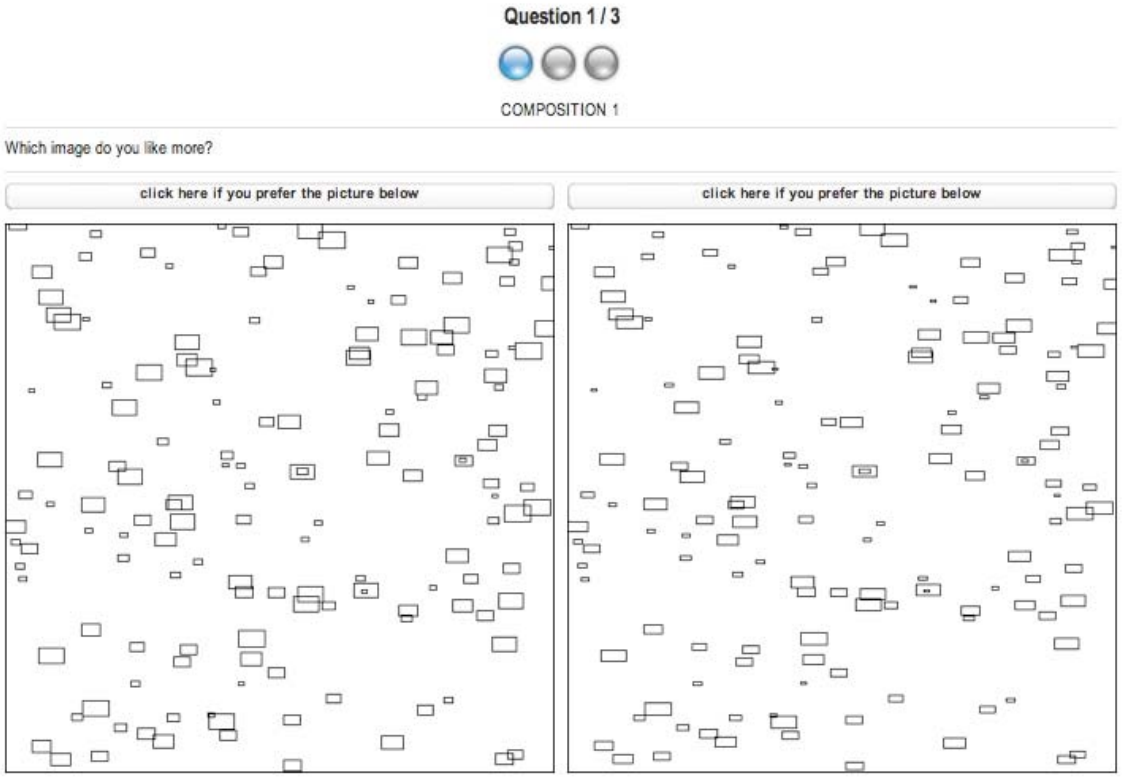

Figure 7: a screenshot of the Generative Test

5. Results of the survey

At the time of writing, 244 subjects from 20 different countries have taken the test (Figure 8). They were recruited via mass emails and social networks and blogs such as Facebook, Twitter, and Tumblr.
Two surprising results have emerged, which call for further work on OT to achieve more significance in our experiments.
Firstly, the three generators have produced significantly different outcomes:

- in the compositions from Generator #1, the golden variants have been selected 146 times (out of 244), with a p-value of 0.0013 (i.e. there's a probability of 0.13% to obtain these results in case people were choosing the compositions randomly);
- in the compositions from Generator #2, the golden variants have been selected 129 times (out of 244), with a p-value of 0.20, which shows that the result is much less significant than in the previous case;
- in the compositions from Generator #3, the golden variants are actually losing against the non-golden variants, which were selected 144 times (out of 244).

In other words, we are not allowed to draw any conclusion about the influence of the golden ratio, possibly because some other factor is affecting the subjects' choice. One hypothesis is that in the sparse compositions from Generator #1 the bigger dimensions of the golden-ratio rectangles provides a fuller and thus more appealing picture. Following this line of reasoning, we would be able to explain the failure of the compositions from Generator #3, which are comprised of larger rectangles and hence look more cluttered in the golden-ratio variants.

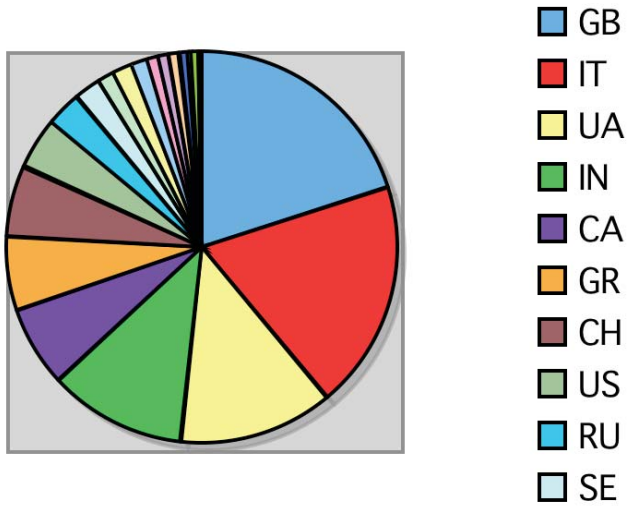

Figure 8: composition of subjects' countries (Nov. 2011)

Even more surprising was the result of the analysis on the position of the winning compositions: out of 732 tests, the composition on the right was selected 415 times, with a p-value of 0.000165. It is clear that the right-hand side plays a significant role that we cannot neglect in our future endeavors.

6. Conclusions and future work

This work was aiming at analyzing the influence of the golden ratio on aesthetic experiences, and intended to go beyond the results of previous experiments in the literature that were seen as too simplistic, in that they were based solely on rectangular cut-outs, and on face-to-face trials with a limited number of subjects. To tackle this issues, we have brought the experiment on the Internet in the form of a website, and created some abstract compositions. Our results so far seem to show us that we are still far from a conclusive result, in that with the proposed procedure we may have bumped into two new issues: ergonomic factors influencing web users, and the influence of compositional factors on their aesthetic experience.

Acknowledgments

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References

[1] Michael White, “De Stijl and Dutch Modernism”, Manchester University Press, Manchester, 2003

[2] http://www.processing.org

[3] Allison Ajluni, Cassandra Martin, and Ayesha Yalamarthy, "A Study on Adult

Female Human Perception of the Golden Ratio in Paintings using Psychological Survey", Art and Science in Paris, July 2010: The Golden Ratio, Art, and Human Perception, 2010

[4] Andrei Dumitrescu, "Experiment for the rediscovery of the perfect proportion of rectangle", Scientific Bulletin, Series A, Applied Mathematics and Physics 71(1), 2009

[5] Phil A Russell, "Testing the aesthetic significance of the golden-section rectangle", Perception 29(12), 1413–1422, 2000

[6] Gustav Theodor Fechner, "Zur experimentalen Aesthetik", Hirzel, 1871

[7] http://geoip.wtanaka.com