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## Methods in Visual Mathematics: Reductionism in Researching Mathematical Principles in Art

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# Methods in Visual Mathematics: Reductionism in Researching Mathematical Principles in Art

## **Cover Page Note**

I would like to thank Professor Mary C. Boyes for her support and guidance in the process of this research.

## Introduction

People traditionally rely on visual arts as an effective communicator and medium of self-expression for when words fail to convey abstract concepts that are component to higher-level cognition. Thera Mjaaland, anthropologist and professional photographer, writes, “art is capable of negotiating conceptual gaps caused by a dichotomized epistemology” (393). In essence, she asserts that art helps relate different modes of thinking by illustrating the abstract and difficult to grasp—privileging the communicative skill of an image over that of text. Within this method of communication is a collection of works acknowledged by public consensus to be of an elevated status or value. The art world is deeply invested in the potential outcome of a discovery of cogent sources of aesthetic experience and the implications a “solution” of aesthetic appeal has for an evolving definition of art. However, researchers who endeavor to identify what precise elements make a work of fine art pleasing ultimately stumble into a pattern of reductionist thinking. In particular, those who analyze fine art in order to establish what mathematical principles may be responsible for a work’s enduring popularity use methods that institute confirmation bias. This type of reductionist analysis, while philosophically relevant, yields misleading conclusions about the sources of an artwork’s fame.

## Common Mathematic Principles Applied to Aesthetics

“Visual mathematics” refers to the connections and similarities between scientific and artistic endeavors and aesthetics based on mathematic patterning, as defined by professor of mathematics, Michele Emmer, in his article “Art and Visual Mathematics” from the journal *Leonardo*. This category of investigation falls within the field of experimental aesthetics, in which researchers attempt to uncover truths about the experience of pleasure as related to any number of selected attributes. Mathematics is a point of interest, as artists borrow a number of mathematical methods as guidance systems to organize their work. Symmetry, as described by Hector Sabelli and Atoor Lawandow in “Asymmetry, Symmetry, and Beauty,” is beautiful for the order it creates, but that asymmetry is what allows for the appreciation of this order, declaring, “opposites play a major role in creative evolution, artistic creativity, and beauty” (1621). Balance, in general, is a foundational principle emphasized in the artistic method as necessary for the creation of appealing art.

Maurits C. Escher is a notable example of the application of balance as a guiding method of organization for hugely successful results. He is best known for “the use of interlocking figures that fill a space and blur the distinction between object and background” (Marmor and Wagenaar 357). Artistic

sensibilities allowed him to expand upon traditional tessellating patterns of repeated geometric forms and create complex images with the same interlocking capacity. His *Sky and Water* shows a metamorphosis of interlocking figures in which black birds on a white sky morph into white fish in a black sea—organized along a basic two-part balance of equal black and white regions. The art world praises Escher for unique skills as he, while not a mathematician, uses techniques that permit masterful exploration of illusion. Mathematical perspective, calculated using vanishing points and concrete rules to create the illusion of depth, is a technique Escher manipulates that lends to a believability to otherwise impossible attributes of his work—including water running uphill, endless staircases, and three-dimensional forms that could not exist. In the work of other artists, perspective can be equally compelling. The emergence of perspective usage in the Renaissance generated considerable excitement as artists confronted viewers with unprecedented naturalism in the depiction of depth. Anecdotes reference the awe associated with wall murals and the sensation that one could walk straight into Raphael's *School of Athens* and interact with the famous figures depicted. It is for this reason that perspective is one of the most notably obvious contributions of mathematics to the arts.

Describing perspective implies the usage of Euclidean geometry, which features the familiar forms of straight lines, cubes, spheres, and others. However, as Patrick A. Heelan proposes about the work of Vincent Van Gogh, Euclidean geometry is not the only method to render three-dimensional space in two dimensions. Heelan asserts the distortions in the work of Van Gogh are not the result of inattention to proper mathematical perspective or shifting eye line, but rather a use of binocular perspective based on consistencies in rendering and the nature of binocular vision. The curvilinear tableaus depicted in Van Gogh's work display a fishbowl effect that is a known result of perceiving with both eyes open rather than closing one in order to flatten an image to represent it on a flat surface. Van Gogh's representation of space is truer to the three-dimensional world, but is less common than traditional Euclidean perspective. However, non-Euclidean perspective is a reminder that there are alternative, less popularized ways in which to represent space that, for Van Gogh at least, yield pleasing results.

Perhaps the most notorious mathematical principle used in art, the Golden Section is surrounded by mystery and misconception. Historically, artists and designers distinguish the Golden Section as a superior guiding principle for visual aesthetics. Its integration need not be strictly intentional and measured, rather, according to the article "A Review of the Use of Symmetry, the Golden Section and Dynamic Symmetry in Contemporary Art" from Harold J. McWhinnie of the University of Maryland, "...many believe that the Golden Section is a natural and intuitive system of proportion often used without recourse to its strict geometric diagram" (242).

In contrast to the assumption that the Golden Section is an ubiquitous solution for visual aesthetics, John G. Benjafield, former professor of psychology at Brock University, asserts in his article “The Golden Section and American Psychology, 1892-1938” that “applications of the golden section may not always be methodologically sound” (67). He lists consensus from more recent empirical investigations into the value of the Golden Section that suggests its reputation glorifies and exaggerates its power as an aesthetic device. Susan T. Davis and John C. Jahnke discuss in “Unity and the Golden Section: Rules for Aesthetic Choice” the unexpected results of an experiment in which they discover “there was little preference for figures divided in the ratio of the golden section” (271), but, rather, a noted interest in divisions in the unity ratio. However, the researchers elect to suggest that there is not a strong enough difference in preference to highlight either ratio as superior.

The influence of time on attitudes toward the Golden Section is further emphasized when, in “Fechner’s Aesthetics Revisited,” Flip Phillips, J. Farley Norman, and Amanda M. Beers examine the research of Gustav Fechner and conclude his results are limited by subjectivity in his methods. Experimentation in the article showed no marked preference for the Golden Section—indicating assumptions of the merit of the ratio are dated. Even Frans Boselie and Emanuel Leeuwenberg, supporters of the appeal of the Golden Section, admit in the same paragraph that they argue for the pleasant nature of the ratio, “we do not make a special claim for the golden section” (24) in their 1985 study entitled “Birkhoff Revisited: Beauty as a Function of Effect and Means.”

A more recent addition to the palette of visual mathematics that has reached a degree of celebrity similar to the Golden Section is the fractal. Fractals, as defined by Benoit Mandelbrot, the father of fractal geometry, “are geometric shapes that are equally complex in their details as in their overall form” (22). He asserts that fractal geometry has evolved into its own category of art, as well as a component of understanding visual stimulation. Christoph Redies, Jens Hasenstein, and Joachim Denzler propose in the article “Fractal-like image statistics in visual art: similarity to natural scenes” published in the journal *Spatial Vision*, that the visual system with which humans develop art is based on natural scenes, which are fractal in nature. Thus, they conclude complexity is a significant component of the creation of pleasing images—echoing Berlyne’s earlier supposition in “Creativity and Exploration” that “‘perceptual curiosity’ is apt to result from exposure to novel, surprising, highly complex, or ambiguous stimulus patterns,” that is, interest is generated by these sources (30).

In examining the merit of stimulation as the cause of interest and fame, and complexity as the cause of stimulation, Alex Forsythe and Noel Sheehy, both psychologists with an interest in visual processing, declare “...interest is maintained at medium levels of complexity and that viewers will tolerate this

level of stimulation for longer periods of time” (507) in their 2011 article, “Is it not beautiful?” They relate the appropriate degree of complexity to nature. In fact, the greatest mathematical principles found in art—from symmetry, to particular ratios, to fractal images, to even Euclidean geometry—strike Hector Sabelli and Atoor Lawandow in their article “Asymmetry, Symmetry, and Beauty” as having an unquestionable resonance with natural scenes. They assert, “artistic archetypes portray fundamental patterns of nature” (1594), and suggest much like Redies, Hasenstein, and Denzler, that humans intuitively operate in a nature-based visual system that allows natural geometric principles to manifest in works of beauty—an innate understanding that Berlyne proposes in 1966 “exists before learning has time to mould perception” (30).

In contrast to the assertion that inclusion of natural elements like the fractal is a subconscious visual aesthetic, the research team of R. P. Taylor, R. Guzman, T. P. Martin, G. D. R. Hall, A. P. Micolich, D. Jonas, B. C. Scannell, M. S. Fairbanks, and C. A. Marlow discuss in their article “Authenticating Pollock paintings using fractal geometry” the role of the artist and intentionality in production of pleasing work with the presence of fractal elements. They describe the reaction to the identification of fractals in Pollock’s work with the arguments that “some art scholars interpreted these achievements in terms of remarkable artistic talent, while others proposed that fractals arise from the specific pouring technique developed by Pollock” (696). The empirical data provided from their experiment strongly supports intentional use of technique to create specific results by the artist, suggesting production of pleasing images with natural geometric elements can be achieved on a conscious level. Essentially, the incorporation of those mathematical principles considered valid and pleasing is a conscious stylistic decision of the artist in an effort to produce a successful work of art—however, they gloss over the implications of presence of mathematical principles due to accident rather than design, and offer no conclusion about validity in that respect.

## Survey Methods and Data Collection

To identify a relationship, if any, between inclusion of mathematical principles and patterns and enduring fame of art, a brief, informal survey is conducted where examples of work are “read” for selected techniques. The investigation is limited to portrait-style paintings from the Western Art context to control the format of analysis. To determine fame, lists were amassed of the images found on repeated Google searches of “famous art,” “popular art,” “most famous artwork,” and other similar queries. These were also compared to the compiled list of top items on several poster sites that do art print reproductions, including a look at Amazon.com to see lists of “items often purchased together” to get a sense of

works of similar fame. The final list consists of Leonardo da Vinci's *Mona Lisa*, Johannes Vermeer's *Girl with a Pearl Earring*, Vincent Van Gogh's *Self Portrait with a Palette*, Edvard Munch's *The Scream*, Henri Matisse's *Green Stripe*, and Raphael's *Bindo Altoviti*. While these images come from a number of periods and are painted in different styles, they are all generally accepted as portraits with a similar degree of fame. The titles are not always familiar, but the images, when experimentally shared with a sample of peers, are immediately recognized without hesitation.

The initial step was to uncover research already conducted that argues for the presence of mathematic principles in any of these works. There is a high volume of unverified speculation about the golden section being present in the *Mona Lisa* in the form of the golden rectangle organizing the arrangement of features and her posture. However, the majority of these selected works are essentially untouched by visual mathematics scholars when compared to the fascination with fractal images in Hokusai's prints and Pollock's paint spattering. It is possible that the nature of the selected works bars such interest—they are not at the forefront of some brand-new movement or stylistic shift that involves use of a new technique, and are often left to a more specialized group of scholars who are interested in the particular painting rather than a trending attribute that unites famous works.

For reference, the *Mona Lisa* is considered prior to the application of the survey analysis, as it is undeniably the most famous of the group and could reveal problems in the survey questions.

What reads most strongly from this work is the symmetry of the features even though the body is turned at a three-quarter angle. The piece is segmented into ratios of thirds—a classically accepted compositional decision to create balance. There is also a sense of perspective created by the atmosphere placed behind the figure to create the illusion of distance. In keeping with Renaissance perceptions of composition, the figure fits within triangular or pyramidal shapes.

Some claim the Golden Section is the source of the *Mona Lisa's* enduring appeal. After generating a template of a Golden Rectangle (a rectangle formed with sides that properly display the Golden Section with a dividing line) and aligning it several ways overtop the image, a problem that will plague the entire survey emerges: the ratio fits. In fact, it fits in several places, in several directions, in several alignments. The ratio, when scaled, will fit sensibly most anywhere over the image. It stands to reason, logically, that it is not hard for the head and shoulder to align just so, and the nose and chin to align similarly.

However, when this proportion can be generated over the image of the *Mona Lisa* and several of the other paintings surveyed, the question emerges of whether this intentional use of a successful design element or the ability of the researcher to place a rather simple rectangle in an asymmetrical ratio division

over the work in a sensible manner that allows it to fit. This question was recorded for later consideration, and the rest of the survey was conducted in a format of visual observation, measurement with a ruler and a Golden Rectangle template, and magnifying tools on the computer to zoom and analyze fractal imagery present in accordance with a guiding research questionnaire.

Presented is the questionnaire used for evaluation of the images at the time of the survey, with the applicable terminology defined in italics:

1. Is this a famous portrait? *“Fame” determined if the portrait appears in top frequencies of repeated search samplings on the Internet.*
  - a. Yes
  - b. No
  
2. Which direction is the face of the figure turned? *Directions taken from the viewer’s perspective.*
  - a. Mostly left
  - b. Mostly right
  - c. Mostly to center
  - d. Away/other
  
3. Which direction does the front of the body face? *Directions taken from viewer’s perspective.*
  - a. Mostly left
  - b. Mostly right
  - c. Mostly to center
  - d. Away/other
  
4. Where is the gaze of the figure? *“Gaze” taken to mean the direction the eyes face—whether or not they appear centrally focused forward where the viewer would be positioned.*
  - a. Mostly at the viewer
  - b. Mostly not at the viewer
  
5. What type of balance is present? *Balance determined by two attributes: for symmetry, the figure would be placed centrally, and a rough line drawn vertically through the center would show similar masses of light and dark on either side. Asymmetry would not meet these conditions.*
  - a. Symmetrical
  - b. Asymmetrical

6. Is the composition triangular? *Triangular composition established by three directional lines drawn around the edges of the figure—in a triangular composition, these lines are determined to intersect in such a manner as to approximate a triangle.*

- a. Yes
- b. No

7. Is the composition aligned in thirds? *A composition deemed to be aligned in thirds displays three masses of tone/hue that appear roughly equal from visual examination.*

- a. Yes
- b. No

8. What perspective is apparent? *Perspective determined with a ruler to establish horizon line, and continue all visible identifying lines into space to note where they converge. A non-Euclidean perspective is identified by warped and rounded identifying lines.*

- a. Euclidean
- b. non-Euclidean
- c. Undefined/inconclusive

9. Can the Golden Section apply anywhere? *Golden Section deemed to apply if a Golden Rectangle template will fit vertically or horizontally in a sensible fashion to align with features or landmarks of the painting.*

- a. Yes
- b. No

10. Can the Golden Section apply to the face, specifically? *Golden Section deemed to apply to the face if a Golden Rectangle template, scaled to size, will fit vertically or horizontally in a sensible fashion to align with facial features.*

- a. Yes
- b. No

11. Are fractal patterns detected without visual aid? *Fractal patterns refer to noticeable repetition of similar forms to create larger forms of a similar type.*

- a. Yes
- b. No

12. Are fractal patterns detected under any intensity of zoom? *Fractal patterns under zoom refer to noticeable mimicry of larger forms detected on a smaller scale within the work.*

- a. Yes
- b. No

13. What other factors are unique to the work that could offer other explanations for the appeal of this piece? *Other factors include attributes of the work that are not mathematically informed.*

The raw results of questions 1-12 are placed in a table. Question 13 is answered in the consequent discussion:

<i>Mona Lisa</i>		<i>Girl with a Pearl Earring</i>		<i>Portrait with a Palette</i>		<i>The Scream</i>		<i>Green Stripe</i>		<i>Bindo Altoviti</i>	
1	a	1	a	1	a	1	a	1	a	1	a
2	c	2	a	2	a	2	c	2	c	2	b
3	a	3	d	3	a	3	c	3	b	3	d
4	a	4	a	4	b	4	b	4	b	4	a
5	a	5	b	5	b	5	b	5	a	5	b
6	a	6	a	6	a	6	b	6	a	6	a
7	a	7	b	7	a	7	b	7	a	7	a
8	a	8	a	8	b	8	a	8	a	8	a
9	a	9	b	9	b	9	b	9	a	9	a
10	a	10	b	10	b	10	b	10	a	10	a
11	b	11	b	11	a	11	a	11	a	11	b
12	b	12	b	12	a	12	a	12	a	12	b

### Discussion of Survey Results

The *Mona Lisa*, regardless of history, is unique in this collection for the fine artistry of skin and cloth textures. The use of an atmospheric, defined background also distinguishes this work from the empty negative space shown in all other works except for *The Scream*.

Vermeer's *Girl with a Pearl Earring* stands out for the greatest figural asymmetry of this set, and the presence of an intense light source against an extremely dark background. This is also apparent to a lesser degree in Raphael's *Bindo Altoviti*. The *Bindo Altoviti* also presents a body most clearly turned away from the viewer, with the highest degree of realism in rendering apparent in details such as the texture and fall of the hair.

In contrast to these three "classical" pieces, the paint application of Van Gogh, Matisse, and Munch is vastly different. Impasto painting techniques of thick, viscous paint likely applied with a palette knife or large brush are apparent. The discordant colors, particularly in *Green Stripe*, stand out glaringly against more demure and delicate classical hues. Van Gogh's warped perspective and fractal, repetitive brush strokes is particularly striking, as is the dream-like logic of the least representational selection, *The Scream*.

Adhering to Berlyne's notion that complexity is a significant component of preference, as he proposes in his 1966 article, "Curiosity and Exploration," it would seem undeniable that a work from this latter group should be the most popular. In his study, he notes, "the subject spends more time looking at the 'more complex' than at the 'less complex' of a pair" (28). Therefore, the content, coloring, and paint application of these works, along with survey results that show they feature a higher instance of fractal complexity and less rigidly classical figure placement, indicate they should be more desirable than the other half of the survey set.

However, the *Mona Lisa* is the unchallenged leader of this group concerning fame, but lacks support by any mathematical principles or measurements of complexity. Thus, the apparent conclusion is that no single mathematical principle can be the true source of fame. Other possible explanatory factors exist—it is not only the *Mona Lisa* subject to rumor, scrutiny, and mystique. Many of these works and other famous pieces experience this treatment—whether this contributes to a rise to fame or is the result of achieving fame is a separate concern.

Even in a condensed format, this survey shows the basic problems for research into aesthetics. From the collected data, it could be said that a composition based on thirds is the ultimate avenue to achieve fame, but this would be limited by the sample taken and would be a misguided conclusion. It would be just as simple to create a template for a ratio different from the Golden Section, apply it, and conclude that must be the source of the portrait's desirability. Much of the scholarly research on this topic follows a similar trend of reductionism through methods—in identifying components of success, but claiming these attributes as the source rather than pieces to a larger puzzle of explanation.

## Examination of Research Methods in Visual Aesthetics

Methods of data collection in art are subjective because this field requires consideration of opinions of participants that go beyond objective collection. Researchers rely on several categories of collection that are limited in scope due to the qualitative nature of art description. Tension exists between old research with older methods and emerging research with moderately improved methods that contradicts long-standing conclusions.

According to psychologist John G. Benjafield in “The Golden Section and American Psychology,” the guidelines for experimental aesthetics are those established by Gustav Fechner, “including the *method of choice* (subjects choose the most pleasing from a series of forms), the *method of production* (subjects produce the form most pleasing to them), and the *method of use* (establish the most popular forms commonly employed)” (53). However, in “Fechner’s Aesthetics Revisited” from the research team of Flip Philips, J. Farley Norman, and Amanda M. Beers, the investigation of experiments using Fechner’s methods reveals flaws. Each method type has obstacles. The most limited method the researchers noted was the method of choice because it limits the options of the subjects to only those forms selected by the researchers—this allowed Fechner’s research to be biased toward the preference of the Golden Section.

The method of production also demonstrates flaws in that enculturation plays a role in what images a participant is likely to produce. For example, in Western societies in which the historical popularity of the Golden Section is particularly significant, the reproduction of an approximation of the ratio is a cultural predisposition. This misinformation carries over into the method of use. The usage of a particular form is easily based on hype and rumor—for example, the use of the Golden Section in architecture or advertising that builds off assumptions, true or not, of its value.

The method of use is further limited by the sample size or selection of the researchers. In this instance, confirmation bias runs rampant, as all conclusions may be based on a subjective array of data. Note this rings true for the survey presented; any conclusions are drawn from data selected by a researcher—and the appearance of the Golden Section and other attributes within the works relies on a researcher’s judgment.

In essence, Philips, Norman, and Beers find fault in all current methods of evaluation, and declare, “one of the ongoing fundamental problems in empirical aesthetics is the definition and discovery of appropriate metrics that can be used to evaluate artwork” (264). Susan T. Davis and John C. Jahnke also highlight “the fundamental issue of the appropriateness of any particular method for the measurement of aesthetic preference” (273), and go so far as to question not only all research conducted with current methods, but also the ethics of attempting to

quantify beauty at all—echoed in the assertion of Philips, Norman, and Beers that “much of the problem with applying a metric to beauty comes from the simultaneous interplay of the denotative and, more significantly, the connotative properties of artwork” (269). The amount of subjectivity and room for error and interpretation in qualitative research leads to tentative acceptance of arguments based upon the resulting data.

A major obstacle to qualitative research, particularly in reference to the visual arts, which relies on participant discussion of opinion, is an inability to isolate and evaluate objective variables. The viewer is the ultimate judge of a work, and does not necessarily base this opinion on a reasonable and identifiable checklist of predetermined aspects. A significant real-life manifestation of this process is the evaluation of student work by art teachers. Susan Orr’s article “‘Being an artist you kind of, I mean, you get used to excellence’: Identity, Values, and Fine Art Assessment Practices” examines a study of the methods by which art professors assess student work, and she concludes that professors draw from “their experiences as ex art students, their identity as artists, their own artistic practices, their conceptualization of the arts arena” (37) and so forth. Thus, there is no solution present even in academia for the evaluation of a work’s quality, much less a measure of popularity.

Indeed, the strongest efforts to objectively isolate and measure aesthetic pleasure gradually fade under pressure from later research. Frans Boselie and Emanuel Leeuwenberg contend “beauty is a function of two opposing factors...the mathematician Birkhoff...defined an aesthetic measure (M), to which order elements (O) contributed positively and complexity elements (C) negatively,” (1) resulting in a metric for aesthetics proposed by Birkhoff in 1933 of the form  $M=O/C$ . This “aesthetic measure” is a stand-by in the field of experimental aesthetics, but, much like the Golden Section, faces adversity from later research that questions the validity of its application. Boselie and Leeuwenberg later note, “[Birkhoff] did not carry out any research into the actual aesthetic judgments of people himself, but his formula has been tested by others in many experiments” (2), and these tests generally may display a correlation, but “the coefficients were mostly disappointingly low” (3). Frieder Nake’s “Information Aesthetics: An heroic experiment” also briefly questions Birkhoff’s metric for evaluation, declaring, “We must keep in mind that this was an objective measure that said nothing about the subjective judgment by a given observer” (4). Nake argues for a distinction between “measure” and “value”—that is, reserving “measure” for those things that can align with an objective numeric scale, and using “value” to describe a measure of the subjective relation between viewer and art object. Operating with these assumptions, the “measure” of a painting’s visual worth can be separated from the “value” placed upon it by society—for example, a “value” that would generate fame.

Alex Forsythe and Noel Sheehy explore the impact of fame on perceptions of work in their article “Is it not beautiful?” from the journal *Psychologist*, declaring, “When viewers are told about the authenticity of a painting, features previously ignored become ‘obvious’ to the viewer and this awareness has been linked with changes in neural activity in areas associated with expectancy memory and value systems” (505). Thus, the fame associated with a particular artist contributes to perceptions of greatness—the question raised is whether this perceived greatness is valid, given the tendency to ignore flaws when expectation is high. According to the research conducted, famed works from famed artists are held in higher esteem, whether or not they are higher quality in some way—confounding the understanding of what is “good” with what is “popular.” Additionally, the audience responds to not only the provided visual stimuli, but also subtext, meaning, and metaphor that do not relate to the use of physical technique.

As Michele Emmer states in his article, “Art and Visual Mathematics,” “creativity is much in vogue today: people look for it everywhere and, naturally, find it everywhere” (318). Essentially, a viewership will see only what it chooses to see as a component of the subjective nature of art as a generator of discussion. As Flip Phillips, J. Farley Norman, and Amanda M. Beers identify, a major obstacle to objective evaluation is the influence of connotative aspects of a work that may influence popularity in ways that are unpredictable and immeasurable. The suggestion of Susan T. Davis and John C. Jahnke, in the Department of Psychology at the University of Dayton, in the article “Unity and the Golden Section: Rules for Aesthetic Choice?” in reference to the Golden Section is that “a more profitable scheme for scientific analysis of aesthetic choice appears to lie less in some “magic” number and more in the domain of causal perceptual process” (275), calling for the erasure of isolationist practices and instead focusing on complex systems of perception.

### Obstacles to Producing Appropriate Metrics for Visual Aesthetics

A work of art lives and dies in the hands of the viewer and the perceptions of the audience triumph over the intent of the artist. For example, Patrick A. Heelan, professor of Philosophy at Georgetown University, discusses in “Toward a New Analysis of the Pictorial Space of Vincent Van Gogh” that “the assumption that [Van Gogh] was trying to represent a Euclidean space is incorrect” (484). However, a conditioned viewership perceives non-Euclidean geometry as flawed because of lifelong enculturation based entirely on the belief that the world operates under Euclidean geometry. Thus, the audience of Van Gogh’s work assumes fault rather than perceiving a different mode of seeing based on binocular vision. Even critics cannot be distanced from a degree of bias. In Harold J.

McWhinnie's "A Review of the Use of Symmetry, the Golden section, and Dynamic Symmetry in Contemporary Art," he finds "art critics favorably disposed toward dynamic symmetry see it as providing a firm conceptual basis; those prejudiced against it see it as a hindrance to the emotion and imagination of the artist" (245). Opinion and subjectivity, discouraged in other fields, is the core of art perception. As a result, somehow quantifying or establishing the roots of visual pleasure is an endeavor whose value is appreciated for the stimulating discourse generated until a time where appropriate metrics cease to elude researchers.

Researchers and artists alike have wondered from time immemorial why certain images compel the mind into attention and why other works fall by the wayside. Solutions have long been suggested and investigated, but currently there is no concrete conclusion available. In fact, research indicates no singular variable will provide the desired solution—for, as Siri Hustvedt contends in the article "Embodied Visions: What Does it Mean to Look at Art?" from *The Yale Review*, "despite the scientific zeal to atomize experience, to break it down into comprehensible bits and pieces, this approach often results in a frozen view of reality" (32).

Changing times also hinder the ability to describe experience. The current, Post-Modernist era of art is the ideal breeding ground for works that are interesting enough to elicit wild debate. The Post-Modernist principle that "everything is art" is perhaps the most controversial notion to hit the art world in history. On one side is a group that asserts that "art" can be found within any object—be it made by man, machine, or mother nature. This side asserts that any simple object has its own rules of governing and its own logic, and that is what makes it beautiful. The benefit associated with this belief is recognition of artistry typically considered as craft to be given credit for beauty. The other group determines that "art" comes with a degree of elitism out of necessity, to distinguish that which is worthy of the term from "common" objects. The distinction runs against the current societal atmosphere of equality in all aspects of life. It is difficult for this side of the debate to accept that a Van Gogh and the street sign on the corner should be held in the same esteem.

The experience of pleasure fuels this debate—can items of work that are created to make a point about the "ugly" or "obscene" even be measured with the "beautiful" works in terms of pleasure? It appears that perhaps the assumption that pleasure and beauty are interchangeable terms further limits research in the experimental aesthetics arena. It may even be possible that the simplest explanation for fame relies on the cultural mood surrounding a piece, not the physical piece itself.

Art as the object of discussion is not a new development, but it has certainly evolved. Professor of Mathematics Education Tony Brown of

Manchester University explains discussion of art as “multi-layered debate with wide participation” (759), and contends that “contemporary art has long since moved on from notions of art objects being admired by independent observers” (763). Post-modernism forces a larger base of discourse—involving more individuals in a conversation with a work than ever before. Now, it is not about what a viewer sees of themselves reflected in a piece, but rather what truths a crowd is able to establish from a mutual interest in evaluating a work’s merit by the principle of “everything is art.” This sensation is described by Siri Hustvedt as “that excursion into you that is also I” (38) which speaks of the merit of shared experience—determining that “looking at visual art always involves a form of mirroring, which may be but is not necessarily conscious” (24).

### New Directions for Visual Aesthetics Research

The ability to process the intricacies of critical thinking where information must be evaluated, synthesized with the known, processed, and made personal for retention is an essential indicator of the level of cognition that man has achieved. A new era is emerging, with new technologies. As shown in this informal survey, a new resource is available to help the process of weeding out extraneous variables: the Internet. While the survey is limited in considering only those works selected by the researcher for observation, the method of selection shows an interesting new avenue. When employing the method of use in earlier eras, researchers were limited in scope by the knowledge they were able to amass from sources indicative of public consensus—and this data, even carefully collected, loses a degree of validity for each moment it is sitting under analysis, for the public mind can change in a moment.

However, the Internet erases this timer and limited scope: instantaneous results are available for any opinion desired. It is here that this informal survey proves valuable: while the results are ambiguous and appear to show only the problems of attempting to apply a metric to art, the success is in the sampling. Only recently is it possible to obtain a sample in such a manner—essentially asking the public via the World Wide Web what they would deem “famous” art. This is the key to weeding out variables: the search queries did not ask for the most beautiful, the most pleasing, or the most psychologically stimulating art—the searches asked for fame and popularity.

Dorothee M. Augustin, Johan Wagemans, and Claus-Christian Carbon identify in the 2012 “All is beautiful? Generality vs. specificity of word usage in visual aesthetics” published in *Acta Psychologica* that “A central problem in the literature on psychological aesthetics is a lack of precision in terminology regarding the description and measurement of aesthetic impressions” (187). Indeed, the same issue that renders a useless Internet search is the same issue that

can render a useless study: if the question is not right, the answers will be wrong. Much like the searches performed in this instance, the queries placed to experiment participants must carefully and specifically highlight the desired information. If aesthetics is ever to be treated with the same empirical respect as more concrete sciences, a similar if not greater degree of consideration must be given to how requests are phrased to subjects—in the same manner calculator commands would be thoughtfully composed and executed.

While it is unclear if it is mathematics or any of the highlighted mathematical principles are the root source of the fame of all of the observed works, an internet sampling method was indeed able to determine the works are actually considered famous by an overwhelming majority, which is a success in an unexpected form. Any researcher will contend that good results can only come from a good sample—and even from this small-scale survey it is apparent that the connectedness of the current web culture and prominence of social media presents an avenue for expressing the many opinions of many individuals in a convenient whole. This has the potential to illustrate the group cohesion and mirroring that are now an indispensable component of modern methods of experiencing art. Building from the notion that the Internet can function as a social thermometer—even hosting the website “What Does the Internet Think” to relate the general feelings being expressed about a topic at any given moment—it appears there is promise to move completely away from the limited bounds of the methods delineated by Fechner and challenged by Flip Philips, J. Farley Norman, and Amanda M. Beers because researchers can obtain a massive sample size with relative ease, and physically see the use of desired attributes.

The latest endeavors regarding experimental aesthetics would benefit from pursuing a way to utilize global connectivity as a component of defining newer, more accurate, and more streamlined metrics for the many facets of “beauty” that allow for a distinction between the objective “measure” of a work, and the work’s subjective “value.” As Berlyne asserts in “Psychological Aesthetics, Speculative and Scientific,” published in *Leonardo* one year after his death, there are two over-arching types of science. One “combines mathematics with empirical observation,” while the other, a more abstract notion, maintains “the study of human activities require[s] a ‘new science,’ in which there [is] more room for imagination, emotional sensitivity, and a study of historical and cultural context than would be appropriate when researching questions concerning inanimate matter” (56). With technological advances that turn culture and public opinion into quantifiable data, it is likely these two spheres of scientific thinking can meld more harmoniously in the coming era.

## Works Cited

- Augustin, Dorothee M., Johan Wagemans, and Claus-Christian Carbon. "All is beautiful? Generality vs. specificity of word usage in visual aesthetics." *Acta Psychologica*. 139.1 (2012): 187-201. Web. 07 August 2012.
- Benjafield, John G. "The Golden Section and American Psychology, 1892-1938." *Journal of the History of the Behavioral Sciences*. 46.1 (2010): 52-71. Web. 15 October 2011.
- Berlyne, D. E. "Curiosity and Exploration." *Science*. 153.3731 (1966): 25-33. Web. 07 August 2012.
- Berlyne, D. E. "Psychological Aesthetics, Speculative and Scientific." *Leonardo*. 10.1 (1977): 56-58. Web. 07 August 2012.
- Boselie, Frans & Emanuel Leeuwenberg. "Birkhoff Revisited: Beauty as a Function of Effect and Means." *The American Journal of Psychology*. 98.1 (1985): 1-39. Web. 07 August 2012.
- Brown, Tony. "The Art of Mathematics: Bedding down for a new era." *Educational Philosophy and Theory*, 39.7 (2007): n. pag. Web. 25 Sept. 2011.
- Davis, Susan T. & John C. Jahnke. "Unity and the Golden Section: Rules for Aesthetic Choice?" *The American Journal of Psychology*, 104.2 (1991): 257-277. Web. 01 October 2011.
- Emmer, Michele. "Art and Visual Mathematics." *Leonardo*. 27.3 (1994): 237-240. Web. 06 October 2011.
- Forsythe, Alex & Noel Sheehy. "Is it not beautiful?" *Psychologist*. 24.7 (2011): 504-507. Web. 16 Sept. 2011.
- Heelan, Patrick A. "Toward a New Analysis of the Pictorial Space of Vincent Van Gogh." *College Art Association*. 54.4 (1972): 478-492. Web. 08 October 2011.
- Hustvedt, Siri. "Embodied Visions: What Does it Mean to Look at a Work of Art?" *The Yale Review*. 98.4 (2010): 22-38. Web. 01 December 2011.
- Mandelbrot, Benoit B. "Fractals and an Art for the Sake of Science." *Leonardo: Supplemental Issue*. 2 (1989): 21-24. Web. 08 October 2011.
- Marmor, Michael F. & Willem A. Wagenaar. "Escher and the Ophthalmologist." *Survey of Ophthalmology*. 48.3 (2003): 356-362. Web. 01 October 2011.
- McWhinnie, Harold J. "A Review of the Use of Symmetry, the Golden Section and Dynamic Symmetry in Contemporary Art." *Leonardo*. 19.3 (1986): 241-245. Web. 05 October 2011.
- Mjaaland, Thera. "Evocative Encounters: An Exploration of Artistic Practice as a Visual Research Method." *Visual Anthropology*. 22 (2009): 393-411. Web. 21 November 2011.

- Nake, Frieder. "Information Aesthetics: An heroic experiment." *Journal of Mathematics and the Arts*. 6:2-3 (2012): 65-75. Web. 07 August 2012.
- Orr, Suan. "'Being an artist you kind of, I mean, you get used to excellence': Identity, Values, and Fine Art Assessment Practices." *iJade*. 30.1 (2011): 37-44. Web. 27 November 2011.
- Phillips, Flip, J. Farley Norman, and Amanda M. Beers. "Fechner's Aesthetics Revisited." *Seeing and Perceiving*. 23 (2010): 263-271. Web. 05 October 2011.
- Redies, Christoph, Jens Hasenstein, and Joachim Denzler. "Fractal-like image statistics in visual art: similarity to natural scenes." *Spatial Vision*. 21.1-2 (2007): 137-148. Web. 04 October 2011.
- Sabelli, Hector and Atoor Lawandow. "Asymmetry, Symmetry and Beauty." *Symmetry*. 2 (2010): 1592-1624. Web. 12 October 2011.
- Taylor, R. P., R. Guzman, T. P. Martin, G. D. R. Hall, A. P. Micolich, D. Jonas, B. C. Scannell, M. S. Fairbanks & C. A. Marlow. "Authenticating Pollock paintings using fractal geometry." *ScienceDirect*. 28.6 (2007): 695-702. Web. 26 September 2011.