

The background of the cover is a low-angle photograph of corn plants. The silhouettes of the stalks and leaves are dark against a lighter, overcast sky. The plants are scattered across the frame, with some stalks reaching towards the top and others leaning at various angles. The overall mood is quiet and contemplative.

L U C E R N A

HONORS UNDERGRADUATE JOURNAL
The University of Missouri-Kansas City

V o l u m e T w o I s s u e O n e

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A N o t e f r o m t h e E d i t o r

Facing you now is the second installment of *Lucerna*, an interdisciplinary academic honors journal for the University of Missouri-Kansas City. First, great thanks are extended to the UMKC Student Government Association for aide in funding this important journal, and to Dean Karen Vorst of the College of Arts & Sciences who is a pillar of support for building quality undergraduate educations. Thanks also goes to the Office of the Provost, who has supported the Honors Program and all our various initiatives. Furthermore, many thanks are needed for the previous *Lucerna* staff all the readers, editors, and advisors who from nothing but an idea and will constructed a fantastic manuscript and an important outlet for excellence in UMKC academia. Last, thanks to everyone who submitted their work; it is for you that this production continues.

In the following pages you will find a wealth of ideas and discussions, spanning a variety of studies. Questions and conclusions abound. These questions and the inherent desire for knowledge they represent are the lifeblood of any academic enterprise. It is no surprise, then, that through many hours of laborious selection, the following essays have lit the path before them to find their resting places here inside of these covers. From stem cells, to friendship, to the environment, to theatre, art, and conceptual math, here before you are the culminations of minds and academic prose for this past fall and winter semesters. Yet do not think that these essays were the only ones written; these few represent only a portion of the light that fills our university. Let this journal be but a lantern by which you may gaze into a world of thought, curiosity and a yearning to wonder.

Jacob Westen,
2008 *Lucerna* Editor-In-Chief

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Sam Butler Hunziker

(Department of Mathematics)

George Berkeley's Mathematical Philosophy And The Calculus

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Berkeley's Life

As noted by Ronald Calinger (Calinger 1982), George Berkeley was born (1685) in County Kilkenny, Ireland; but, because of his ancestry, always considered himself an Englishman. Young Berkeley was enrolled in Kilkenny College (1696) and later Trinity College (1700) where he earned his Bachelor and Masters of Arts in 1704 and 1707 respectively. By 1710, Berkeley was ordained an Anglican priest and was lecturing at Trinity College on divinity, Greek and Hebrew. Throughout his years as a teacher and later an administrator, Berkeley wrote many influential philosophical texts, the most notable of which are *An Essay towards a New Theory of Vision* (hereafter referred to as *Theory*) and *Of the Principles of Human Knowledge* (hereafter referred to as *Principles*). In 1728 Berkeley married and shortly thereafter sailed for America where he and his new family resided in Rhode Island where he began a study group and set afoot the American philosophical movement with Samuel Johnson. While in the states, he wrote *Alciphron: or, the Minute Philosopher* (1732) and began, the subject of this essay, *The Analyst; or, A Discourse Addressed to an Infidel Mathematician* (hereafter referred to as *The Analyst*) which wouldn't be published until he moved back to England. The Berkeley family returned to England in 1734, the same year in which he was consecrated Anglican Bishop of Cloyne in Dublin and in which he published *The Analyst*. Together with his wife and six children, Berkeley lived in Cloyne until 1752 when

he went to live in Oxford until his death the next year, 1753.

Berkeley's Mathematical Beliefs / Writings

The Analyst was not the first work of Berkeley's to consider mathematics and its falsities. Berkeley became interested in mathematics while still at Trinity College and this attraction appears in many of his greatest texts. In particular, Berkeley's *Principles* contains ten pages regarding mathematics and its principles. Therein, he makes an argument regarding infinity, which we will consider in more detail for it relates greatly to *The Analyst* and its arguments.

Within *Principles*, Berkeley proceeds to discuss the "infinite divisibility of finite extension." To imagine the notion of extension, he asks the reader in *Theory* to envision a line free from any distinguishing characteristics no color, shape, magnitude, nor lack thereof; this he states is perfectly incomprehensible. However in *Principles*, he discusses finite extension, such as lines and shapes, and how the human mind might conceive of this idea given the fact that,

though [infinite divisibility of finite extension], is not expressly laid down either as an axiom or theorem... [it is] thought to have so inseparable and essential a connexion with the principles and demonstrations in Geometry that mathematicians never admit it into doubt, or make the least question of it (Berkeley 1901).

Berkeley believes that any idea, if not explicitly perceived by the human mind or senses is not possible and should not provide a base for science. In the remainder of *Principles*, he eventually reasons that, "when we say that a line is *infinitely divisible*, we mean (if we mean anything) *a line which is infinitely great*" thus,

upon a thorough examination it will be found that in any instance it is necessary to make use of or conceive infinitesimal parts of finite lines... nay, it will be evident this is never done, it being impossible (Berkeley 1901).

So, Berkeley does not believe in any aspect of infinity whether infinitely large or infinitely small, even saying that geometry is illegitimate if that science bases all understanding on the concept of infinity. This idea will be expressed more thoroughly in *The Analyst* as Berkeley's main backlash at the theoretical basis of the infinitesimal / differential calculus.

Newton's Mathematical Beliefs / Writings

Sir Isaac Newton was a gifted youngster, able to teach himself Euclid's *Elements* and other legendary mathematical texts, and he excelled quickly, taking a keen interest in infinite sums. It was through these infinite sums that the Englishman developed his theories of infinitesimals, which he referred to as "fluxions". These fluxions were the basis for Newton's calculus. Fluxional notation is most fully discussed in Newton's published posthumous works (Newton 1737), where he defines fluents and fluxions.

Now those quantities which I consider as gradually and indefinitely increasing, I shall hereafter call *Fluents*, or Flowing Quantities, and shall represent them by the final letters of the alphabet v, x, y, and z ... And the velocities by which every Fluent is increased by its generating motion (which I may call *Fluxions*, or simply Velocities, or Celerities,) I shall represent by the same letters pointed thus, y, x, y, and z; ... (1737)

Fluents can be thought of as functions of time and their fluxions as derivatives of the fluents with respect to time.

Fluents and their fluxions, as demonstrated, were defined in terms of the natural world flowing quantities such as water and their velocities which Newton was so interested in describing. It was due to their connections with the physical world that some pure mathematicians of the time struggled to comprehend Newton's definitions, and his notation was easily confused, leaving people to sometimes wonder if the small spot above a variable was to represent it as a fluxion or a stray pen mark. Nevertheless, his calculus of

fluents and fluxions was taught in English schools for years.

Leibniz's Mathematical Beliefs / Writings

The mathematical beliefs of Leibniz were not widely known to the mathematical community, because like Berkeley, Leibniz was primarily a philosopher and his texts in philosophy were more widely read. Though mathematics was not his primary subject, Leibniz proved he was a brilliant mathematician by developing a simple system for naming and using infinitesimals.

Leibniz's calculus was based upon the idea of a difference of two values. Thus, his infinitesimals were referred to as differentials. Basically, as the difference between two values becomes less and less, as the two values become closer and closer, that difference tends toward a single value which he expressed as an infinitesimally small difference. This idea can also be thought of as a differential change in a quantity; using his notation, a differential change in the quantity x would be expressed as dx .

This simple, unique notation is now seen as much easier to deal with, and the idea of the difference is much more mathematically oriented and clear than that of Newton's fluxions. For this reason, calculus classes across the world are now taught using Leibniz's notation.

Calculus Controversies

Calculus was founded amongst two primary controversies. First was the debate regarding the true 'inventor' of the calculus. While Newton was the most prominent mathematician and physicist of his time, Leibniz (like Berkeley) grew a reputation as a brilliant philosopher. This led many people of the time, including the Royal Society (a very influential, independent scientific academy in England), to initially believe Newton when he claimed to be the creator of the calculus. The Royal Society gave credit to Newton for developing the calculus and decreed that Leibniz was influenced by his correspondence with Newton in developing his version of the calculus. This decree stood for many years until recently, when the Royal Society withdrew it. More recent research has shown that Leibniz's ideas regarding

the calculus were printed by John Craig in 1685, while Newton's *Principia* and his notions of fluxions were not published until 1693 as a part of John Wallis's *Algebra* (Smith 1956, p.627).

Introduction to *The Analyst*

The second major debate regarding the 'early' calculus lies in the impreciseness of the calculus' foundations. Bernhard Nieuwentijt (Child 1920, p.145) wrote early criticisms of the concept of the infinitely small. He believed that neither Newton nor Leibniz had sufficiently defined the art of infinitesimals. One of his main arguments directed toward Leibniz included the lack of a distinction between zero and an infinitely small difference. As Nieuwentijt before him, Berkeley also lashed out at the foundations of Leibniz's infinitesimal calculus as well as Newton's fluxional calculus in his 1734 treatise *The Analyst*. Towards the beginning of *The Analyst*, Berkeley makes the statement:

It hath been an old remark that Geometry is an excellent Logic. And it must be owned, that when the Definitions are clear; when the Postulata cannot be refused, nor the Axioms denied; ... there is acquired a habit of reasoning, close and exact and methodical: which habit strengthens and sharpens the Mind, and being transferred to other Subjects, is of general use in the inquiry after Truth. But how far this is the case of our Geometrical Analysts, it may be worth while to consider (Berkeley 1901).

Berkeley claims that the founding principles of the calculus are ambiguous and, while possibly on the right track, must be revised in order to obtain the exactness of the ancients in their geometrical proofs. Though not a mathematician, Berkeley made very relevant comments pertaining directly to the calculus of Leibniz and Newton and caused these systems to be revised and grounded more certainly by specific definitions.

The 'infidel mathematician' of *The Analyst*'s title is most likely the renowned astronomer, Sir Edmund Halley who was the financier of Newton's *Principia*. Halley also contributed

to *Principia*, proving himself a very clever mathematician. However, he is considered an "infidel" by Berkeley because he "persuaded a mutual friend that the doctrines of Christianity were inconceivable" (Katz 1998). In the first sentence of *The Analyst*, Berkeley discusses his knowledge of Halley's proficiency in mathematics, but states that Halley and

too many more of the like Character are known to make such undue Authority, to the misleading of unwary Persons in matters of the highest Concernment, and whereof your mathematical Knowledge can by no means qualify you to be a competent Judge (Berkeley 1901).

He then proceeds to explain the object of his essay,

I shall claim the privilege of a Free-Thinker; and take the Liberty to inquire into the Object, Principles, and Method of Demonstration admitted by the Mathematicians of the present Age, with the same freedom that you presume to treat the Principles and Mysteries of Religion (Berkeley 1901).

Berkeley essentially claims that mathematicians of the time blindly follow the thoughts and ideas of a select few on the basis of faith, just as Christians follow God on the basis of faith. However he claims, the foundation on which the ideas of the mathematician's faith lie is unstable and in need of repair.

Berkeley demonstrates his knowledge of fluxions by examining their definitions and pointing out a few questionable arguments, the most notable of which is that "the Velocities of the Velocities, the second, third, fourth, and fifth Velocities, &c. exceed, if I mistake not, all Humane Understanding."

The Analyst Explication

Below appear excerpts from *The Analyst* with my short introductions and explications. My comments will be

in a smaller font within brackets so as to distinguish them from Berkeley's text which will be in 'normal' font. Also, the arguments of Berkeley begin with a proof in the manner of either Newton or Leibniz after which is Berkeley's revised proof of the same statement. These initial proofs are quoted from Berkeley's text, not the original text of its author.

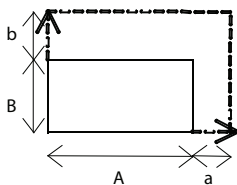
Newton's Rectangle Problem

The following proof can be found as Case I in Newton's famous *Principia*, Book II, Lemma II. In his rebuttal of Newton's proof, Berkeley demonstrates the ease of his own solutions and the simplicity of his own mathematical ideas.

Original Newtonian Proof [Repeated by Berkeley]

Suppose the Product or Rectangle AB increased by continual Motion: and that the momentaneous Increments of the Sides A and B are a and b . When the Sides A and B were deficient, or lesser by one half of their Moments, the Rectangle was: $A - \frac{1}{2}a \times B - \frac{1}{2}b$, $[(A - \frac{1}{2}a)(B - \frac{1}{2}b)]$ i. e., $AB - \frac{1}{2}aB - \frac{1}{2}bA + \frac{1}{4}ab$. And as soon as the Sides A and B are increased by the other two halves of their Moments, the Rectangle becomes: $[(A + \frac{1}{2}a)(B + \frac{1}{2}b)]$ or $AB + \frac{1}{2}aB + \frac{1}{2}bA + \frac{1}{4}ab$.

From the latter Rectangle subduct [subtract] the former, and the remaining Difference will be $aB + bA$. Therefore the Increment of the Rectangle generated by the entire Increments a and b is $aB + bA$. *Q.E.D.*



Berkeley's Rebuttal

But it is plain that the direct and true Method to obtain the Moment or Increment of the Rectangle AB , is to take the Sides as increased by their whole Increments, and so multiply them together, $A + a$ by $B + b$, the Product whereof $AB + aB + bA + ab$ is the augmented Rectangle; whence if we subduct AB , the Remainder $aB + bA + ab$ will be the true Increment of the Rectangle, exceeding that which was obtained by the former illegitimate and indirect Method by the Quantity ab . And this holds universally be the Quantities a and b what they will, big or little, Finite or Infinitesimal, Increments, Moments, or Velocities. Nor will it avail to say that ab is a Quantity exceeding small: Since we are told that *in rebus mathematicis errores quàm minimi non sunt contemnendi* [For errors, however small, are not to be neglected in Mathematics. This phrase is found in the introduction to Newton's *Quadrature of the Curve*.]

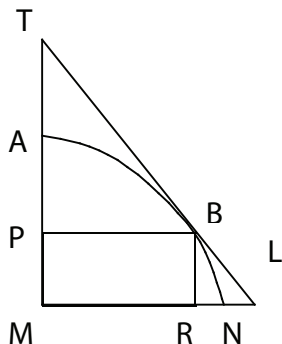
Triangle Problem

There were many ideas held as common knowledge by mathematicians of the time. In fact, this is one of Berkeley's complaints of mathematics as he mentioned the "men who pretend to believe no further than they can see." By this he makes reference to an earlier comment stating that many mathematicians when confronted with a greater mind will accept the ideas of this person without thinking about these ideas for themselves. This greater mind he refers to is Newton; however the following problem represents a commonly held belief in which Berkeley finds fault.

Original Problem [Repeated by Berkeley]

In order therefore to clear up this Point, we will suppose for instance that a Tangent is to be drawn to a Parabola, and examine the progress of this Affair, as it is performed by infinitesimal Differences.

Let AB be a Curve, the Abscisse [x-axis] $AP = x$, the Ordinate [y-axis] $PB = y$, the Difference of the Abscisse $PM = dx$, the Difference of the Ordinate $RN = dy$. Now by supposing the Curve to be a Polygon [the curve is assumed to be a polygon with infinitely many sides, each of which is of infinitely small length], and consequently BN , the Increment or Difference of the Curve [one side of the polygon], to be a straight Line coincident with the Tangent [TL], and the differential Triangle BRN to be similar to the triangle TPB



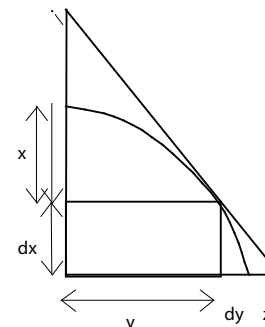
Berkeley's Illustration

[Now, according to the picture, triangle TPB is clearly not similar to BRN . In fact BRN is not even a triangle and triangle TPB clearly is similar to triangle BRL . This point Berkeley objects to as well, but allow me to clarify the reasoning behind Newton's proof. Remember, the text refers to a differential triangle BRN and we have assumed the curve to be part of a polygon with a side coincident (a member of) the line tangent to the curve. Thus at point B , the curve ABN is supposed to be a straight line (side of the polygon) of infinitesimal length which is equal to the line TL at point B ; so on the infinitesimal scale, triangle BRN is indeed similar to triangle TPB .]

the Subtangent [the projection of the tangent upon the x-axis] PT is found a fourth Proportional to $RN : RB : PB$: that is to $dy : dx : y$. Hence the Subtangent will be

$$\frac{y \cdot dx}{dy}$$

[in modern notation, $\frac{RN}{RB} = \frac{PB}{PT}$, $\frac{dy}{dx} = \frac{y}{\text{sub tangent}}$, and subtangent = $\frac{y \cdot dx}{dy}$].



Clarifying Illustration

Berkeley's Rebuttal

But herein there is an error arising from the aforementioned false supposition [remember, Newton supposes the curve to be a polygon], whence the value of PT comes out greater than the Truth [as will be demonstrated]: for in reality it is not the Triangle RNB but RLB which is similar to PBT , and therefore (instead of RN) RL should have been the first term of the Proportion, i. e. $RN + NL$, i. e. $dy + z$: whence the true expression for the Subtangent should have been $\frac{y \cdot dx}{dy + z}$.

There was therefore an error of defect in making dy the divisor [the *first* error]: which error was equal to z , i. e. NL the Line comprehended between the Curve and the Tangent. Now by the nature of the Curve $yy = px$ [because the curve is supposed to be a parabola], supposing p to be the Parameter [a constant], whence by the rule of Differences [Leibniz] $2y \cdot dy = p \cdot dx$ and $dy = \frac{p \cdot dx}{2y}$.

[The Rule of Differences simply means taking the derivative; thus, by applying $\frac{d}{dy}$ to each side of our original equation, $yy = px$, we obtain $2y = p \cdot \frac{dx}{dy}$, where $2y$ is the (modern) derivative of y^2 with respect to y . Algebra then takes us to the stated conclusion.]

But if you multiply $y + dy$ by itself, and retain the whole Product without rejecting the Square of the Difference, it will then come out, by substituting the augmented Quantities in the Equation of the Curve:

$$dy = \frac{p \cdot dx}{2y} - \frac{dy \cdot dy}{2y}$$

[So, by finding the moment of each side of the equation for the curve as above with Newton's rectangle problem $(y + dy)^2 = p(x + dx)$. Now through algebra, $y^2 + 2ydy + (dy)^2 = px + pdx$ and since $y^2 = px$, $2ydy + (dy)^2 = pdx$, $2ydy = pdx - (dy)^2$, and $dy = \frac{pdx - (dy)^2}{2y}$]

There was therefore an error of excess [the *second* error] in making

$$dy = \frac{p \cdot dx}{2y},$$

which followed from the erroneous Rule of Differences. And the measure of this second error is:

$$\frac{dy \cdot dy}{2y}$$

[Berkeley will describe his procedure for this final conclusion shortly]. Therefore the two errors being equal and contrary destroy each other; the first error of defect being corrected by a second error of excess.

If you had committed only one error, you would not have come at a true Solution of the Problem. But by virtue of a twofold mistake you arrive, though not at Science, yet at Truth. For Science it cannot be called, when you proceed blindfold, and arrive at the Truth not knowing how or by what means. To demonstrate that z is equal to ,

$$\frac{dy \cdot dy}{2y}$$

let BR or dx be m and RN or dy be n . By the thirty-third Proposition of the first Book of the Conics of Apollonius, and from similar Triangles, as $2x$ to y so is m to $n + z = \frac{my}{2x}$.

Likewise from the Nature of the Parabola $yy + 2yn + nn = xp + mp$ [$(y + dy)^2 = p(x + dx)$], and $2yn + nn = mp$

[found by substituting from the equation $y^2 = px$, expressed earlier as the equation for the curve ABN]: wherefore

$$\frac{2yn + nn}{p} = m$$

and because $yy = px$, will be equal to x . Therefore substituting these values instead of m and x we shall have

$$n + z = \frac{my}{2x} = \frac{2yyp + ynp}{2yyp}$$

i. e. $n + z = \frac{2ny + nn}{2y}$: which being reduced gives $z = \frac{nn}{2y} = \frac{dy \cdot dy}{2y}$

Q.E.D.

Response to *The Analyst*

After *The Analyst's* publication, responses began pouring in to the local papers and publishing companies. Many people took offence to Berkeley's suggestion that members of the mathematical community followed Newton in blind faith and did not verify his conclusions for themselves. Many of these rebuttals did not fully answer the questions posed by Berkeley and in the end showed that the writers did not even comprehend Berkeley's propositions.

None of the papers trying to refute the claims of Berkeley made any great jumps in the theory of calculus except Benjamin Robin's *Discourse Concerning the Nature and Certainty of Sir Isaac Newton's Method of Fluxions and of Prime and Ultimate Ratios* in 1735 and Colin Maclaurin's *Treatise of Fluxions* in 1742. Maclaurin spent more time developing his thoughts and created a very intricate view of and argument for fluxions.

Maclaurin took offence to Berkeley's claim of infidelity even taking it as a personal insult, thinking Berkeley charged all mathematicians with infidelity. His *Treatise of Fluxions* aimed "to show that 'infinitesimals' in the arguments of Newton can always be replaced by finite quantities" (Katz 1998). Maclaurin made a great effort to take the ideas of fluxions (he was a fan of Newton's calculus) and define them with great rigor in the manner of "the ancients" like in Euclid's *Elements* or Apollonius' *Conics*. Many of his proofs entailed single and double *reductio ad absurdum*. This proof style involves assuming a 'false' statement to be true, then by the usual methods of proof generating a

contradictory statement. Many dislike Maclaurin's proofs, but his work is the first correct method of proving calculus and was the first step toward a rigorous derivation of the calculus.

Validity of *The Analyst*

Berkeley does not criticize the conclusions drawn by the great mathematicians who developed the calculus, but as he states repeatedly, merely criticizes the method by which the conclusions were obtained. These methods appear to be a little suspect, but did they really require such a strong criticism? Consider Newton's rectangle problem. Berkeley provides a logical and more straightforward derivation of the moment of a rectangle and the only difference between his and Newton's answers is the product ab (deficient in Newton's). Since this product is so small, Newton treated it as negligible. Berkeley did not believe in neglecting any amount for the very fact that it is a real amount; therefore its absence creates a real error. Today when calculus is taught, one of the first topics (missing from these early developers) is the idea of a "limit," which is how this difference between these arguments can be settled.

Newton (as indicated above) thought of the "momentaneous increment" of the rectangle as being squeezed between the two values of $A - \frac{1}{2}a \times B - \frac{1}{2}b$ and $A + \frac{1}{2}a \times B + \frac{1}{2}b$. Today we might say: "the limit of $A \pm \frac{1}{2}a$ as a approaches 0 is A ", (similarly for B), which is what Newton lacked in his definitions. But the rectangle problem shows that he had an idea of what needed to be done, albeit without the proper vocabulary or tools to complete a rigorous definition.

Now, with the idea of a limit having been determined, were Berkeley's analysis and treatise still necessary? We will never know of course, but it is my belief that the calculus as we know it would have advanced less quickly and taken longer to attain a solid foundation if Berkeley had not published his objections. Though his main objection was with the idea of infinity and not the mathematics in general, he caused an uproar in the mathematical community of the time and helped to lead the way toward a fully-developed theory of infinitesimals, differentials, and hence, the calculus.

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Lucian Connole

(Department of Theater)

Surveying Designs for *Auntie Mame*



Creating a good stage design begins with deep understanding. This starts with truly knowing the play. The text is the greatest piece of research a designer has. In it are all the clues necessary to discovering character, setting, idea, and style. While it is the starting point, outside sources ultimately provide the depth and substance of a design. It is a designer's understanding of history, geography, culture, and human nature coupled with his or her own creativity that makes for an excellent work of stage art. If the text of a play is the soul of a design, then through the outside research the body takes form.

For the play *Auntie Mame* – a relatively campy comedy written in the 1956 – I read the text several times before beginning the design process. How many times a designer will delve into a play depends on the play and the designer, but multiple readings are standard. Along with the initial readings one must discuss the text with other designers. A remarkable thing about theatre is that it requires the audience. The collective perception of a play gives theatre its lasting viability and impact. The benefit of this to the designer is that in collaboration with other artists and peers, one grasps many of the most colorful and critical aspects of a play. Other people's criticism and opinion are a vital form of research that, while difficult to document, cannot be overlooked. In the process of designing *Auntie Mame*, I was fortunate to work alongside several other highly talented artists working on their own designs for the same show. The classroom laboratory provided us the opportunity to express our ideas, discuss our opinions, and thus glean invaluable insight that

would otherwise have been very difficult to access individually.

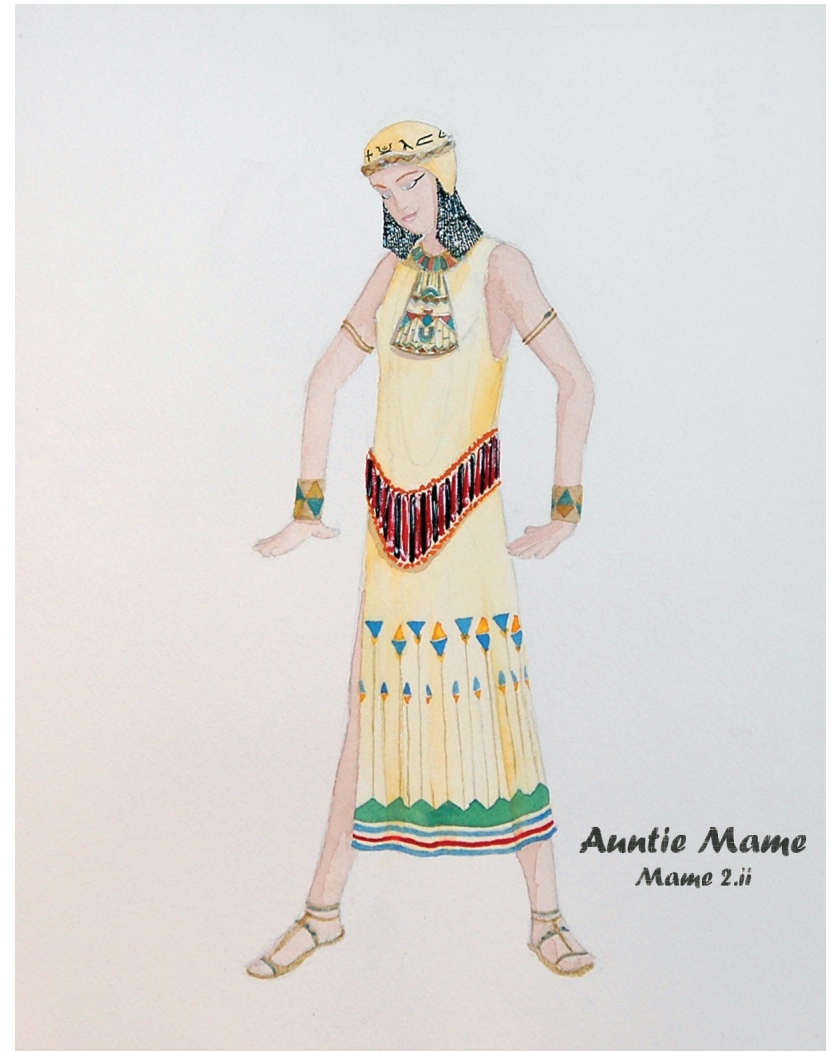
Out of the readings and discussions of the play came the parameters for the design which could then be filled in by the breath of documented research. *Auntie Mame* takes place in New York City, in the 1920s, 1930s, and minimally in the 1940s, so it was in that direction where I focused my scrutiny. Documentation on the culture, style, and history of these decades gave me the skeleton of my design. I then fleshed out this information by steeping my mind in relevant imagery. I absorbed photojournalism, works of art, architecture, and anything that I could see pertaining to those years. The extensive contact with pertinent visual research gives a designer the ability to accurately grasp the sensibilities of the milieu he hopes to represent. It is a mystery what will resonate with a designer in regards to a particular play. When a period is familiar and recognition of its particular nuances becomes natural, almost anything provides inspiration. So long as it truly harks back to that particular period's style, it can inform a design choice.

The books I used gave me a sense of the culture and the style of the time period I was researching. *The American Heritage History of the 20's and 30's* and *The Restless Decade – John Gutmann's Photographs of the Thirties* provided me a window into the world of those years – showing me people, places, and attitudes that gave me a greater understanding of the play. Also useful were books that informed my decisions in regard to color choices. I particularly emphasized the use of color in his design project. Especially helpful were *Authentic Art Deco Patterns in Full Color* and *Color Source Book*. These books documented palettes and patterns that either directly stemmed from the time periods in question or were useful as inspiration for unique design choices. For decisions of style and garment silhouette, I used multiple sources. Books such as *The Complete Costume History* and websites like *The Costumer's Manifesto* gave me a starting point for creating accurate costumes.

Also useful were websites that specialize in art and art history, photography, people, places – all things that can be used to inform design choices. The prodigious amount of information available on the Internet is, however, a double-edged sword. While there are vast resources available online, accuracy must always

be taken into consideration. For this reason it is paramount that thorough and reliable research be done prior to and in conjunction with Internet research. Again, once the subject matter is firmly grasped, almost anything can become useful to a designer.

The important thing to note about all research for Stage Design is that it must relate back to the script or it is ultimately of no use. All the choices I made can be traced back to my understanding and interpretation of the text. The way a character dresses, from her hairstyle to the clasps on her shoes, stems from words the playwright penned. As a designer, my job is to honor those words and to give them life through my own creativity in union with determined research.





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The Necessary and Sufficient Conditions for Friendship

In *The Nichomachean Ethics*, Aristotle distinguishes between three kinds of friendship: friendship of pleasure, of utility, and of virtue. Of these three, he claims that friendship based on virtue is the truest or most complete form. Thus, to learn what true friendship is in Aristotle's view, one must first learn how he defined virtue, since the former is dependent on the latter. In this essay I will argue that what Aristotle says about friendship is true, however, his ethical framework ultimately falls short of accounting for why this is true. Something more is needed. I will then offer a possible solution that might better explain why virtuous friendship is the most complete. And finally, I will attempt to deal with some possible objections to this solution.

II. The Most Rational Friendship

Since Aristotle's definition of true friendship is dependent on his definition of virtue, it is best to begin with a brief overview of what he said about virtue. Aristotle's ethical framework is an "end" based framework. He claimed that for every action there is some end or goal in mind which he called the good. Accordingly, there is a hierarchy of ends, with most ends falling under the umbrella of higher master ends or higher goods. For example, marksmanship can be an art in itself, but it can also be a means to military strategy. In turn, military strategy is a means to victory; victory is a means to national security, and so forth. However, Aristotle claimed that not everything can be a means to an end because that would require an infinite

regress of ends, which would make our actions meaningless and futile. So, he posits the existence of an end, "which we desire for its own sake, an end which determines all our other desires" (qtd. in Johnson 2007 p.62). This end would be the final end and also the Supreme Good at which all our actions and choices aim. Aristotle believes the supreme good is happiness, but to leave it at that would be, as he puts it, "trite." He takes it further and claims the best way to define the highest good is to ascertain the "proper function" of humankind. He asks:

Are we then to suppose that, while the carpenter and the shoemaker have definite functions or businesses belonging to them, man as such has none, and is not designed by nature to fulfill any function? Must we not rather assume that, just as the eye, the hand, the foot and each of the various members of the body manifestly has a certain function of its own, so a human being also has a certain function over and above all the functions of his particular members? What then precisely can this function be? (p.12, Book I, vii, 11)

Aristotle reasons that the proper function of humankind cannot be simply to exist, since that is no different from plants. Nor can it be merely sensory perception or impulse because that is no different than animals. He concludes that the proper function of humankind is the "active exercise of the rational faculty" (p.13, Book I, vii, 13). Reason is what sets us apart from all other living things. It is our characteristic activity. *The Stanford Encyclopedia of Philosophy* defines Aristotle's position on virtue as,

...the state that makes a human being good and makes him perform his function well. His function (his *ergon* or characteristic activity), Aristotle says,...is rational activity, so when we perform rational activity well, we are good (virtuous) human beings and live well (we are happy). [However] Scholars disagree about what kind of rational activity Aristotle means (Homiak 2003).

Whatever the disagreements, we can summarize Aristotle's argument thus far:

1. There is a supreme good at which all our actions and desires aim.
2. The proper function of humankind must be the supreme good.
3. The active exercise of the rational faculty is the proper function of humankind.
4. Therefore, the active exercise of the rational faculty is the supreme good at which all our actions and desires aim.

In the Aristotelian framework, a good shoemaker is not one who makes a shoe every once in a while, or makes poorly constructed shoes that fall apart. No, a good shoemaker is one who consistently makes high quality shoes. *He excels at his particular function.* Likewise, a good human is one who excels at his particular function of being a rational creature. The good person is consistently exercising his rational faculty and actively living in accordance with rational principle. This is our function according to Aristotle and this is the basic premise of his ethical argument. Later, in *The Nichomachean Ethics*, he offers the Doctrine of the Mean, which describes in detail what the good person will look like, how he will act under certain circumstances, and what kind of relationships he will have. That brings us to our main concern. Aristotle said, "The perfect form of friendship is that between the good, and those who resemble each other in virtue" (p.208, Book VIII, iii, 5). So, let us examine what he said about virtuous friendships. Aristotle criticizes friendships that are not based on virtue as being base or vulgar.

A friendship based on utility dissolves as soon as its profit ceases; for the friends did not love each other, but what they got out of each other. Friendships therefore based on pleasure and on utility can exist

between two bad men, [or] between one bad man and one good...But clearly only good men can be friends for what they are in themselves; since bad men do not take pleasure in each other, save as they get some advantage from each other (p.210, Book VIII, iv, 2).

Aristotle goes on to explain that a good and virtuous person will do good to his friend for his friend's sake, and not his own. There is a selflessness to the disposition of the virtuous, as opposed to the selfishness of the non-virtuous. And when this selfless goodwill is reciprocated between two individuals, it is a complete and true friendship. If one party is selfish, then the relationship is not mutual and it falls short of a complete friendship. Aristotle's view corroborates our common experience and intuition. It seems to make perfect sense until we go back and remember that he defined the supreme good as the "active exercise of the rational faculty." It is here where a couple of problems present themselves.

First, if the ultimate aim for a human is to actively exercise his rational faculty, then it does not require him to do it in a virtuous way. He could excel at calculating how to use people. He could excel at being manipulative in his relationships, as unfortunately many people do. He could even be rationally cruel; "artistically cruel" as it has been put. In other words, being virtuous is not a necessary condition for being rational. However, this may be unfair to Aristotle. Perhaps he didn't say that at all, and I've got it backwards. One could argue that Aristotle did not say that virtue is a necessary condition for being rational, but instead he argued the opposite that rationality is a necessary condition for behaving virtuously. That claim is controversial, as will be shown later, but I will concede it for now and respond with the following: In an end based framework, there is nothing beyond the final end. If my above summary of Aristotle's argument is correct, then the final end for Aristotle is the active exercise of the rational faculty; that is the supreme good. But a sufficient condition is beyond the necessary condition. If necessary condition Y is also the final end and supreme good, then there is nothing obligating us to go beyond that to the sufficient condition X. Let me offer

an illustration. Being in Kansas City, Missouri is a necessary condition for being on the UMKC campus. Being at UMKC is sufficient for saying you are in Kansas City. However, if your final destination or end goal is to merely get to Kansas City, then there is nothing that guarantees or obligates you to go beyond that into the UMKC campus. Likewise, if active rationality (as the necessary condition) is the final end, then there is nothing that guarantees or obligates a person to go beyond that and behave virtuously. But perhaps I am still being unfair to Aristotle by not taking into consideration his detailed description of the virtuous person, as outlined in the *Doctrine of the Mean*. To that I would simply argue that the Mean does not follow necessarily from his premises that lay the foundation for the supreme good. One could rationalize being a coward just as easily, maybe more easily, than being courageous. But that is a whole other argument in itself. The point I am making is that even though virtually everything Aristotle says about friendship is correct in my opinion, his ethical framework, which is an integral part of his argument, does not fully support it. This creates problems for Aristotle when he begins to talk about virtuous friends being selfless and loving the other for their own sake. There is nothing about rationality that compels a person to go beyond the end of rationality and become selfless. Are there not friendships in which we are dreadfully fair with our companions; not sacrificing one moment of unearned time, one bit of undeserved energy, not giving any credit where it isn't due? These kinds of friendships are common – perhaps the most common. And what is unreasonable about them? Nothing. They are perfectly rational and fair, yet there is no self-sacrifice. One can achieve the supreme good of actively exercising one's rational faculty and still never be selfless, which is necessary to achieve complete friendship. Reason is blind and pitiless. There is nothing about reason itself that causes us to love.

The second problem for Aristotle is that the person who is actively rational may never achieve true intimacy. Aristotle writes, “It is not possible to have many friends in the full meaning of the word friendship, any more than it is to be in love with many people at once... for perfect friendship you must get to know a man thoroughly, and become intimate with him, which

is a very difficult thing to do” (p.212, Book VIII, vi, 2). Aristotle correctly points out the difficulty of achieving true friendship, that is, intimacy. But what Aristotle doesn't account for is this: for a person to achieve true intimacy he must often do things that some would see as completely irrational! He must forgive when his friend does not deserve it. He must take the risk of making himself vulnerable. He must have courage. He must have faith. This is why it is so difficult to be truly intimate with people. And to compound this difficulty, for complete friendship to be achieved, these things must be reciprocated. *Both* people must forgive, *both* must make themselves vulnerable, *both* must have courage, *both* must have faith. It is truly hard to be intimate! Some may see Aristotle's picture of the virtuous man as one who is perfectly temperate, reasonable, and moderate. And while these qualities can be guards against vice and wrongdoing, they can also be obstacles for what is required to truly love. The great missionary preacher Oswald Chambers (1935) once wrote, “If human love does not carry a man beyond himself, it is not love. If love is always discreet, always wise, always sensible and calculating, never carried beyond itself, it is not love at all. It may be affection, it may be warmth of feeling, but it has not the true nature of love in it” (p.52). And so it is true, real friendship requires real intimacy; real intimacy requires real love; and real love often requires what some see as irrational. Reason can often prevent us from taking that risk.

Now there is a disagreement as to what counts as being rational and this is the controversy that I spoke of earlier. While some see taking the risk of making oneself vulnerable as irrational, others may see it as perfectly rational and thus the claim that rationality is a necessary condition for behaving virtuously is confirmed for them. For example, one may reason that what is lost by failing to make oneself vulnerable and open to intimacy, is greater than what one gains by not taking the risk. In other words, rationality can tell us that it is more beneficial in the end to take the risk of making oneself vulnerable. But beneficial for whom? For oneself. Notice the selfish logic that is intrinsic to rationality. Any attempt to show that self-sacrifice is somehow rational will always employ some form of self-interest, which seems contrary to the very idea of “self-sacrifice.” This

kind of reasoning seems to go against what Aristotle said is characteristic of virtuous friendship, in which each party loves the other for their sake and not his own. But this argument would involve an in-depth exploration of duty, altruism, etc. which would greatly exceed the length and purpose of this essay. My only point for bringing it up is to show that *Aristotle's claim that rationality is a necessary condition for behaving virtuously is controversial at best*. There is an entire tradition that argues that many virtuous acts are completely irrational. A lot of people see love as an irrational endeavor. There may indeed be good reasons to love, but that does not necessarily make love rational. Thus far, we have seen that there can be nothing beyond the final end. The final end (and supreme good), for Aristotle, is the active exercise of the rational faculty. Also, a sufficient condition is "beyond" the necessary condition. If rationality is a necessary condition for behaving virtuously, and rationality is the final end, then one has no need to go beyond rationality and behave virtuously. Furthermore, the claim that rationality is a necessary condition for virtuous behavior is controversial at best because there are many virtuous acts that could be argued are completely irrational. Ultimately, Aristotle's ethical framework falls short as a foundation for explaining why virtuous friendships are the most complete. Something more is needed.

III. The Proper Function of Humankind

Aristotle was correct to assert that friendships based on utility and pleasure are not true friendships, and it is only friendships based on virtue that achieve real intimacy. But something more is needed to explain why this is true and fill in the gaps of Aristotle's argument. Let us go back once again to what Aristotle said about the supreme good. He attempted to define the supreme good by ascertaining the proper function of humankind, which he said must be a function that is "over and beyond all the functions" of a human's particular members. He then concluded that living in accordance with reason is the proper function of humankind. But isn't reason a function of one of our members – the mind? So then reason is not over and beyond all of our other functions. It is simply a function which

distinguishes humans from the rest. Perhaps there is a different function which humans are designed for. Maybe the active exercise of the rational faculty is not the final end, but a means to something else – the true final end. Allow me to offer one possible answer which is quite simple: real friendship is based on a virtue where intimacy itself is the supreme good and the final end. *The Oxford English Dictionary* defines the word "intimate" as "inmost, most inward, deep seated; hence, pertaining to or connected with the inmost nature or fundamental character of a thing; essential; intrinsic." Perhaps it is this goal – to be "connected with the inmost nature" of something or someone – that is our deepest psychological desire, as well as our "proper function." When that desire is directed at an entity with the capacity for the same desire (i.e. a human being), is when intimacy can reach its fullest and most glorious form. Maybe intimacy, not rationality, is the "end which determines all our other desires." If intimacy is an end in itself, then reason is merely a tool to assist in achieving that end. In turn, emotion would also be a tool since true intimacy cannot exist without it. Therefore, a friendship in which both parties' goal is true intimacy will be the most complete friendship. When intimacy is the shared goal, everything else falls in line. Both parties will do what is required to achieve that goal: they will forgive, and they will allow themselves to be forgiven; they will take risks, and they will allow risks to be taken on their behalf; they will be courageous, and they will be vulnerable; they will be rational, and they will have faith. In this view, friendships based on utility and pleasure, while sometimes rational, can never achieve true intimacy because the goal of the parties involved is not intimacy, but something else. Their motives are not virtuous. It is only friendships where the motive of each party is virtuous – that is, concerned with intimacy – where they attain true friendship. This ethical framework, in which intimacy is the supreme good, may correct the deficiencies of Aristotle's framework and corroborate multiple aspects of the human experience. First, if the ultimate aim for a human is to achieve intimacy, then it requires him to do it in a virtuous way; that is, it requires him to be selfless. Selflessness, or goodwill as some might call it, is a necessary condition for intimacy to occur. Aristotle points

out that friendship is not an emotion, but a fixed disposition (p.212, Book VIII, v, 5). It is a voluntary activity in which we strive for intimacy. This requires us to have a disposition of general goodwill. Aristotle remarks, “Goodwill is inoperative friendship, which when it continues and reaches the point of intimacy may become friendship proper. Goodwill seems therefore to be the beginning of friendship, just as the pleasure of the eye is the beginning of love” (p.240, Book IX, v, 3). One cannot be truly intimate without having goodwill; just as one cannot have romantic love without first having some level of attraction. To put it in the terms of logic, we could say, “If intimacy, then goodwill.” Intimacy is sufficient for saying there is goodwill. Goodwill is a necessary condition for intimacy. Our experience confirms this truth. The people I know who have the most successfully intimate relationships, are also the kindest and most deep hearted people I know. And in turn, the people I know that lack goodwill the most; that are the cruelest and meanest people I can think of, are quite definitely the loneliest. Their lives are completely void of intimacy. They have not achieved it even with their spouse or children.

If intimacy is the final end at which all our actions aim, then rationality is a means, or guide, to get us there. This would make Aristotle’s claim that rationality is a necessary condition for behaving virtuously more convincing. If intimacy is the end goal and virtuous behavior is necessary to achieve that goal, and being rational is necessary for behaving virtuously, then all of these things are achieved as a means to intimacy. To recall my earlier illustration, if the sufficient condition of getting to the UMKC campus is the end goal, then getting to the necessary condition of arriving in Kansas City is not enough. One is required to keep going until one gets to UMKC. Similarly, if the sufficient condition of virtuous behavior (intimacy) is the end goal, then merely achieving the necessary condition of being rational is not enough. One is required to go beyond. This brings clarity to the issue of selflessness. One can achieve rationality while still being selfish, but one cannot achieve intimacy while practicing selfishness. Intimacy requires a mutual giving of oneself to the other; a kind of submission or surrender that cannot happen if one person is selfishly holding

back. In his book *Humanity*, Jonathon Glover writes, “The deeper levels of relationships are denied to people who hold large parts of themselves back... to give yourself means that part of you belongs to the person you care for” (p.24). This is so true. The problem is that we have many selfish reasons for holding ourselves back. Many of them are rationalizations of self-defense. We fear being hurt. We fear being found out. So, we abandon intimacy and instead seek a cheap replacement—a perversion—something to give us the illusion of intimacy without any of its risks. We make friendships with people that will ask us what we’re doing this weekend, but would never ask us if we are happy in life. We maintain relationships with people we can laugh with, but would never feel comfortable crying in front of. We seek companions that will throw themselves at us physically, but deny us emotionally. We want friends that will never ask us hard questions; never tell us that we are doing wrong, or that we are hurting ourselves. We keep friends that we know will not call us out from hiding, because they are hiding themselves. Selfishness prevents intimacy. We would do well to remember the words that C.S. Lewis penned in *The Four Loves*

To love at all is to be vulnerable. Love anything and your heart will certainly be wrung and possibly broken. If you want to make sure of keeping it intact, you must give your heart to no one... Wrap it carefully around with hobbies and little luxuries... lock it up safe in the casket or coffin of your selfishness. But in that casket—safe, dark, motionless, airless—it will change. It will not be broken; it will become unbreakable, impenetrable, irredeemable... The only place outside heaven where you can be perfectly safe from all the dangers of love is hell! (121)

I am uncertain as to whether or not Lewis would agree with my intimacy-based framework. But his point is well taken. Love achieves intimacy, which is connection with the innermost nature of someone, but selfishness achieves the opposite. It separates us from the innermost nature of someone. It fractures relationships. So long as we are living selfishly and fearfully, we will be closed off from even the possibility of intimacy and left

in a state of isolation. Rationality, as the final end, cannot save us from this. But intimacy, as the final end, makes clear the path.

The second problem of Aristotle's is also corrected. As stated earlier, the perfectly rational person may never achieve true intimacy because it may be true that some virtuous actions, including love, are in fact irrational. But if intimacy is the final end and the aim of a person, then this controversy does not really matter. It makes no difference whether certain virtuous actions are actually rational or not because the ultimate end is not to be rational, but to be intimate. Of course someone could misinterpret this and take it to the extreme of believing that being rational does not matter at all and we can dive head first into any relationship that we want, so long as intimacy is our goal. This view is completely absurd. And unfortunately, there are many people that hold to it. They seem genuine and charismatic on the surface, but a closer look reveals a long trail of destruction behind them; people they have consumed and hurt all in the name of passion and intimacy. Hopefully no one will go away from this essay thinking I have argued for that. My argument is not that rationality is completely useless or does not matter at all. I have simply argued that it cannot be the final end. It may very well be the case that rationality is a necessary condition for behaving virtuously. I do not know. But rationality cannot be the final end, because then there is no need to go beyond it and we end up missing out on all the beauty of virtue and the wonderful risk of being open to intimacy. In the end, we would miss out on what I believe is our very purpose – the proper function of humankind.

Finally, I want to point out that the virtuous person, as I have defined it, is quite likely to achieve true intimacy. The first reason is because, in the framework I have outlined, to live virtuously means to strive for intimacy. The virtuous person will do what is necessary to cultivate and maintain real friendships. The only possible thing that could keep them from this is failing to find someone who is equally dedicated to striving for intimacy. That is the risk involved in it – there are no guarantees. But that brings me to the second reason: a virtuous person will seek equally virtuous friends. The person that strives for real intimacy will not waiste her time

with those that wish to play games, to be dishonest, or to just “have a little fun.” That does not mean the virtuous person will be closed off to everyone who falls short of this standard. As I explained earlier, the virtuous person must have a general disposition of goodwill and can have any given number of lesser friendships. However, she will reserve her most intimate and closest friendships for those who are equally virtuous.

IV. Answering Objections

Now that I have outlined an ethical framework in which intimacy is the supreme good, and have shown how this framework could possibly correct Aristotle's flaws and corroborate the human experience, I will attempt to answer some objections that could be raised against it. Someone might say: *Your framework based on intimacy ultimately results in more friendships of utility because you are essentially suggesting that we use one another as a means to an end – the end being intimacy.* Technically this objection could hold, but practically it doesn't work. This objection attempts to portray my argument as trivializing humans as a means to something else. But my argument does not do that. In a strict and literal sense, yes I am suggesting we use each other as a means to intimacy. However, the way in which I am suggesting we use each other is wholly different than any other kind of utilitarian framework. There is a way in which someone can use an object as a means to an end that cheapens the value of the object – to use it as *merely* a means to an end. And there is a way in which someone can use an object as a means to an end that bolsters the value of that object, that cultivates the health of that object, and that helps to fulfill the purpose of that object. Let me offer an illustration. If someone wanted to build the perfect house, it would involve them using wood as a means. However, they would not buy the cheapest wood available. They would not clumsily place the wood in position, or cut it without measuring first. No, they would seek out the highest quality wood. They would treat it to make it stronger and bring out the natural beauty of its grain. They would use the precision of a surgeon when measuring and cutting and they would place the wood

in its position in the most careful matter – all for the end of building the perfect house. Similarly, to “use” someone as a means to intimacy is not to cheapen them, but to exhort them. When the goal is intimacy, a person will seek out a friend of the highest character; of the utmost integrity. They will treat this person in a way that makes them stronger and brings out their natural beauty. And they will be mindful in caring for this person’s heart. Using someone as a means to intimacy does not cheapen that person at all. It helps to fulfill their very purpose and requires a disposition of selfless goodwill.

Your framework is too psychological. All this talk of such vague concepts of intimacy and love are too abstract. My framework is no more psychological than Aristotle’s. I basically use his entire framework, the only difference being that I substitute intimacy in place of reason as the proper function of humankind. I defined the term “intimate” as thoroughly as possible. Ultimately, any argument that speculates the end that “determines all our other desires” will be psychological to some extent.

How can you say that intimacy is the proper function of humankind? Isn’t that teleological? Much of Aristotle’s views are teleological. I am using what Aristotle said as a foundation for my argument. If humankind does have a proper function, then my argument provides good evidence that the function of humankind is more likely to be intimacy, rather than rationality.

If intimacy is the supreme good, then wouldn’t breaking off a friendship be the most evil thing you could do? This, in my opinion, is the most powerful objection to my argument. To answer it, I will refer to Aristotle. He says that in a case of extreme moral decline of a friend, one is justified in breaking off the friendship. But as long as there is capability of reform, we should continue to pursue him and help him morally. Ultimately, says Aristotle, “if one cannot restore him, one gives him up” (p.237, Book IX, iii, 3). It could be argued, in a case like this, that it is not the morally good person that broke off the friendship, but the one who became evil and selfish. It is they who turned away. The morally good friend simply let him go.

In conclusion, intimate friendship seems to be a painfully organic thing. It cannot be quantified or charted. It does not

fit into the peg of rationality. It always has a way of slipping through and evading any of our attempts to fully understand it intellectually. It is possible to use our rational faculty as a guide as we gain more experience in choosing friends. It can also help in the challenge of achieving intimacy with those whom we did not choose, such as our relatives. But in the end, the endeavors of love, intimacy, and friendship remain a beautiful mystery. I believe Aristotle had a lot of insight into relationships and much can be learned from his writings. He was correct that virtue is a form of activity – an art. Perhaps, for most of us, the gaps between the necessary and sufficient conditions for friendship lie not in our knowledge, but in the application of that knowledge.

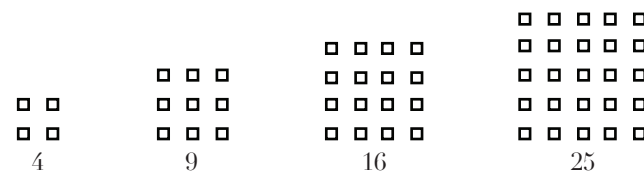
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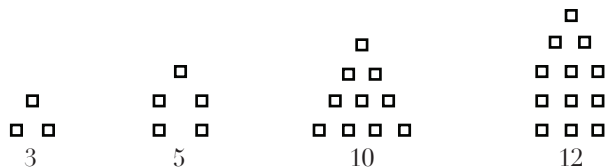
Polygonal Numbers

In mathematics we use square numbers often. In elementary school we memorize the squares of the natural numbers 1 through 10, and later use them to find the radius of a circle whose area is 9π , or to figure out that $\sqrt{75} = \sqrt{25 \cdot 3} = 5\sqrt{3}$. So we become fairly comfortable with square numbers. We may even have seen that they can be drawn as actual squares.



Square numbers, however, are not the only numbers that form geometric shapes. Numbers can also be triangular, pentagonal, or hexagonal, etc. These numbers that can be represented in geometric form, or polygonal numbers, have interested people for millennia, being traced back to the time of Pythagoras and the Pythagorean school (c. 572 - 497 B.C.) (Heath 1921, vol.I, p.67). It's easy to see how people who probably represented numbers in a strictly visual way, as quantities of pebbles in the sand, or dots arranged in a geometric pattern, could classify numbers as triangular, square, or pentagonal, etc., according to the shapes that were created by the arrangement of the objects (Burton 2003, p.90; Heath 1921, vol.I, p.76). For example, if we visualize the numbers 3, 5, 10, and 12, we see that the numbers 3 and 10 can be

arranged to form equilateral triangles, while 5 and 12 make equilateral pentagons. Thus, 3 and 10 are examples of triangular numbers, while 5 and 12 are examples of pentagonal numbers.

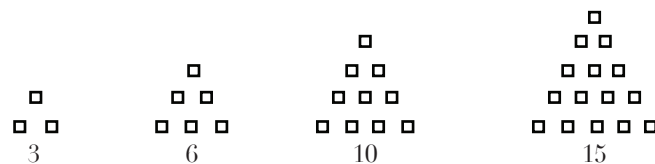


The triangular number $1 + 2 + 3 + 4 = 10$ was especially important to the Pythagoreans it was the symbol on which they swore their oaths. Called the “tetractys” or “holy fourfoldness,” it stood for the “four elements: fire, water, air, and earth” (Burton 2003, p. 187).

About 600 years after Pythagoras, two students of Pythagorean number philosophy, Nicomachus of Gerasa (c. 100 A.D.) and Theon of Smyrna (c. 130 A.D.), each included discussions of polygonal numbers in their collections of writings related to Plato’s basic curriculum (Heath 1910, p.2; Katz 1998, p.171). Nicomachus’ discussion of polygonal numbers is contained in his *Introduction to Arithmetic*, book II, chapters VII - XVIII. Theon’s discussion is in the section on Arithmetic in his book *Mathematics Useful for Understanding Plato*. Our introduction to the properties of polygonal numbers will be guided by the writings of these two men.

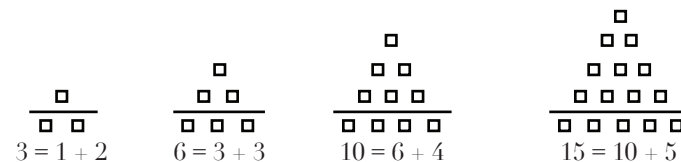
An Introduction to the Properties of Polygonal Numbers

We begin with a look at the triangular numbers. Nicomachus tells us in chapter VIII, book II of his *Introduction to Arithmetic* that “a triangular number is one which, when it is analyzed into units, shapes into triangular form the equilateral placement of its parts in a plane” (meaning that a triangular number can always be made to form an equilateral triangle when it is visualized using objects arranged in a plane). Examples of this are 3, 6, 10, and 15.



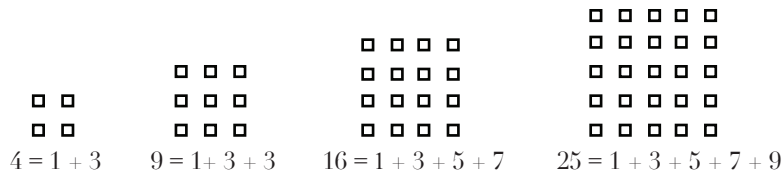
Looking at the diagrams, we see that each new triangular number is obtained from the previous number by adding another row containing one more small square than the previous row had. Thus, the number added each time increases by one, and so we also notice that the triangular numbers are formed from successive additions of the natural numbers, beginning with 1.

Theon uses the term “gnomon” to describe the numbers that are added to one polygonal number to get the next, and he notes that the gnomons of triangular numbers have a special property; “the sides of any triangle always have as many units as are contained in the last gnomon added to it” [Theon 1979, Arith.XXIII].

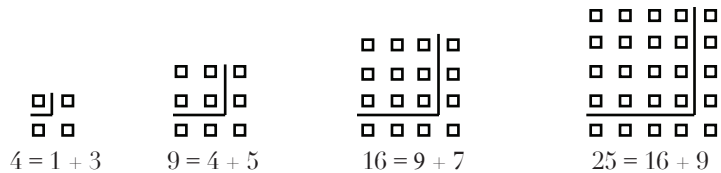


It is interesting to note that both Nicomachus and Theon call the number 1 a “potentially triangular number”. While it was common for the ancients to consider the number 1 (or unity) not to be a number in itself, but rather that which measures other things, to Theon of Smyrna the number 1 is considered the “Mystical Monad” -- “much more than the quantified unit: it is comparable to God and is the seed or seminal essence of everything which exists.” Theon tells us that 1 “is not a triangle in fact... but in power, for in being as the seed of all numbers, unity also possesses the faculty of engendering the triangle. When it is added to the number 2, it gives birth to the triangle...[Theon 1979, Arith.XXIII].

Squares can also be a result of adding numbers together. The square numbers are formed when, instead of adding up every natural number in succession, we add up just the odd numbers.

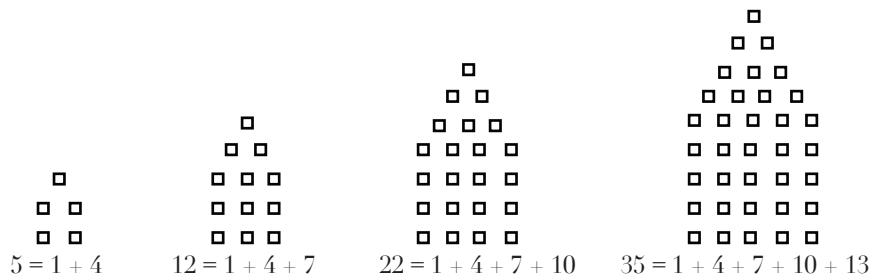


The gnomons that enlarge the squares are usually added around the outside of the previous square in an L-shape.

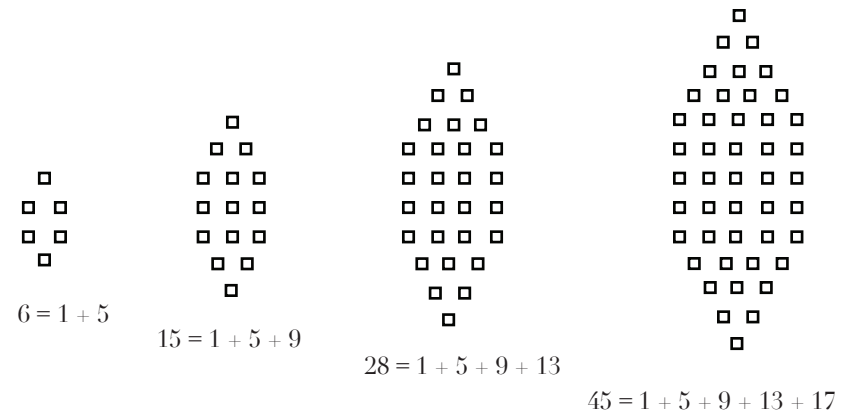


In chapter IX, book II of his *Introduction*, Nicomachus notices that for square numbers, “the side of each consists of as many units as there are numbers taken into the sum to produce it” (for example, $1 + 3 + 5 + 7 + 9$ is the sum of five terms, and the number 25 has 5 units on a side). He later comments that this is true for all the polygonal numbers. Theon observes that the squares are alternately odd and even [9, Arith.XX], an interesting result of adding up odd numbers.

To get the pentagonal numbers, we add up every third number in the sequence of natural numbers,

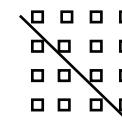


and for the hexagonal numbers we add up every fourth number.



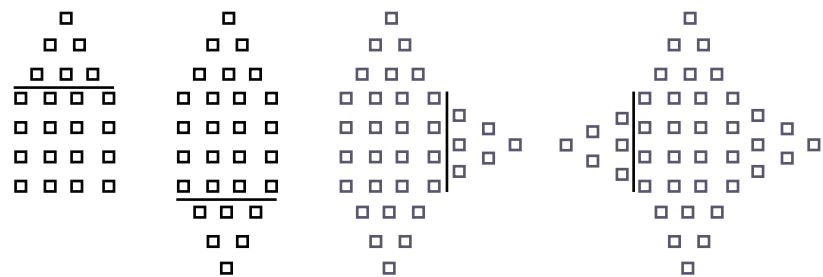
So in general, in order to form the triangular numbers, we added up successive natural numbers, for the square numbers we added had a difference of two, for the pentagonal numbers we added numbers with a difference of three, and so on, always starting with 1. Theon states this in section XXVII, “Thus generally in all the polygons, in removing two units from the number of angles, one will have the quantity by which the numbers serving to form the polygon must increase” (triangular numbers have a difference of $3 - 2 = 1$, squares have a difference of $4 - 2 = 2$, pentagonal numbers have a difference of $5 - 2 = 3$, etc.).

But it isn’t necessary to go all the way back to the natural numbers, beginning with 1, to form the polygonal numbers. We can use the triangular numbers as “building blocks” too. Another way to get a square number is to add two consecutive triangular numbers together. In fact, Theon tells us that the sum of two consecutive triangular numbers always equals the square number whose side is the same as the side of the larger of the two triangles [9, Arith.XXVIII].



Nicomachus then extends this concept to another method for the formation of polygonal numbers in general. He notes that a “triangle joined with the next square makes a pentagon,” and

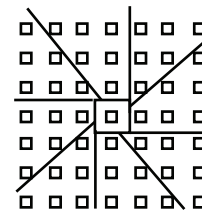
that the same is true for adding triangles to pentagons to produce hexagons, “and so on to infinity” (Nicomachus 1926, II.12).



He organizes this information in a table in which each new polygon is formed by adding the polygon immediately above it to the triangle in the previous column (Nicomachus 1926, II.12). For example, the hexagonal number 15 is created from the addition of the 12 above it, and the triangular number 3 at the top of the previous column.

Triangles	1	3	6	10	15	21	28	36	45	55
Squares	1	4	9	16	25	36	49	64	81	100
Pentagonals	1	5	12	22	35	51	70	92	117	145
Hexagonals	1	6	15	28	45	66	91	120	153	190
Heptagonals	1	7	18	34	55	81	112	148	189	235

One more way to obtain square numbers is found in the writings of Plutarch, a contemporary of Nicomachus of Gerasa and Theon of Smyrna. In his Platonic Questions, question V paragraph 2, he states that multiplying 8 times any triangular number and adding 1 results in a square.



Diophantus Extends the Study of Polygonal Numbers With His Treatise *On Polygonal Numbers*

Now that we’ve looked at the basic properties of polygonal numbers we are ready to explore a more proof-oriented approach to the study of polygonal numbers, as found in the writings of Diophantus. Although Diophantus is especially known for his more famous work, the *Arithmetica*, he also wrote about polygonal numbers.

About 150 years after Nicomachus and Theon, Diophantus (c. 250 A. D.) wrote his treatise *On Polygonal Numbers*, in which he proved that the sum of any arithmetic sequence is a polygonal number. In the process of doing this he also proved a generalization of Plutarch’s proposition mentioned above, applying it not only to triangular numbers but to any polygonal number. Unlike Nicomachus of Gerasa and Theon of Smyrna, who present their statements without proof, Diophantus uses geometric proofs in which he represents the unknown numbers being discussed as lengths.

Unfortunately only a fragment of *On Polygonal Numbers* survives today. We focus our look at Diophantus’ work *On Polygonal Numbers* by studying the first and last complete proofs that are contained in the fragment we have today. The first proposition is a “preliminary,” which is later used in the last complete proof in the fragment, that the sum of any arithmetic sequence is a polygonal number. We begin with the first proof contained in the fragment.

The First Proof in the Existing Fragment of *On Polygonal Numbers* (Diophantus 1890, p. 298; Heath 1910, p. 247)

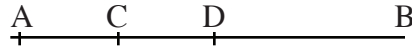
Diophantus says:

Given three numbers with a common difference, then 8 times the product of the greatest and middle, when added to the square of the least gives a square, the side of which is the sum of the greatest and twice the middle number.

[That is, given three numbers such that (greatest) - (middle) = (middle) - (least), then $8(\text{greatest})(\text{middle}) + (\text{least})^2 = (\text{greatest} + 2\text{middle})^2$.]

[Proof:]

Let the three numbers that lie an equal distance apart [that have a common difference] be AB, BC, BD. ^{*1}

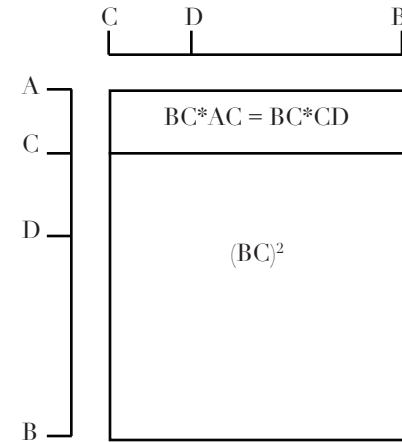


It will be shown that $8(AB \times BC) + (BD)^2 = (AB + 2BC)^2$.

By hypothesis, $AC = CD$, $AB = BC + CD$, and $BD = BC - CD$.

^{*1} The diagrams used in this paper to illustrate Diophantus' proofs are based on the diagrams that Sir Thomas Heath uses in his translation.

[Now, notice that $AB \times BC = (BC)^2 + BC \times CD$:



So, we have $8(AB \times BC) = 8(BC)^2 + 8(BC \times CD)$.

And since $8(AB \times BC) = 4[(BC)^2 + (BC \times CD)] + 4(BC)^2 + 4(BC \times CD)$,

thus $8(AB \times BC) = 4(AB \times BC) + 4(BC)^2 + 4(BC \times CD)$.

Adding $(BD)^2$ to both sides of the equation gives

$$8(AB \times BC) + (BD)^2 = 4(AB \times BC) + 4(BC)^2 + 4(BC \times CD) + (BD)^2,$$

[and from Euclid II.8 $4(BC \times CD) + (BD)^2 = (AB)^2$], ^{*1}

so we have $8(AB \times BC) + (BD)^2 = 4(AB \times BC) + 4(BC)^2 + (AB)^2$. {1}

^{*1} Euclid II.8 states that "If a straight line [BC] be cut at random, four times the rectangle contained by the whole and one of the segments [BC × CD] together with the square on the remaining segment [BD] is equal to the square described on the whole [BC] and the aforesaid segment as on the straight line" (Heath 1956, p. 389).

Draw $AE = BC$.



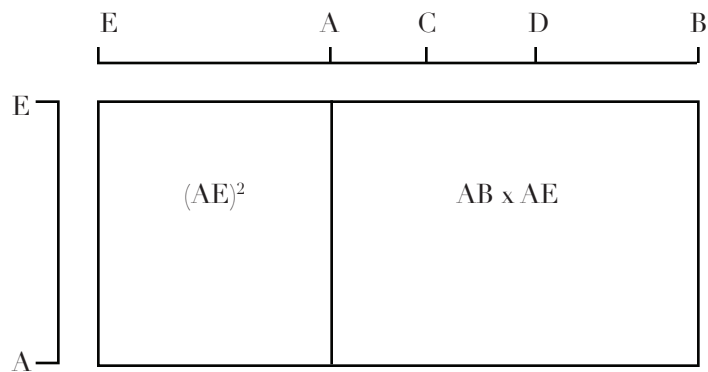
Now we focus on the $4(AB \times BC) + 4(BC)^2$, on the right side of this equation.

Since $AE = BC$, we get $4(AB \times BC) + 4(BC)^2 = 4(AB \times AE) + 4(AE)^2$.

$$\text{So } 8(AB \times BC) + (BD)^2 = 4(AB \times BC) + 4(BC)^2 + (AB)^2 \quad \{1\}$$

$$\text{becomes } 8(AB \times BC) + (BD)^2 = 4(AB \times AE) + 4(AE)^2 + (AB)^2. \quad \{2\}$$

[Notice that $(AB \times AE) + (AE)^2 = BE \times AE$.



$$\text{So } 8(AB \times BC) + (BD)^2 = \underbrace{4(AB \times AE) + 4(AE)^2}_{4(BE \times AE)} + (AB)^2. \quad \{2\}$$

$$\text{becomes } 8(AB \times BC) + (BD)^2 = \underbrace{4(BE \times AE) + (AB)^2}_{(BE + AE)^2}.$$

$$\text{Thus [by Euclid II.8] } 8(AB \times BC) + (BD)^2 = (BE + AE)^2. \quad \{3\}$$

Now, [since $AE = BC$, and A is between B and E], notice that

$$(BE) + AE = (AB + AE) + AE = AB + 2BC.$$

[So we have $8(AB \times BC) + (BD)^2 = (AB + 2BC)^2$, as desired.

Since AB, BC, and BD were the three numbers with common difference, we have that

$$8(\text{greatest})(\text{middle}) + (\text{least})^2 = (\text{greatest} + 2\text{middle})^2.]$$

Q.E.D.

Diophantus uses the above proposition in his proof that the sum of any arithmetic sequence is a polygonal number. In the next section we will explore this proof, which is the last complete proof in the fragment of *On Polygonal Numbers* (1890 p.307; Heath 1910, p.251).

Diophantus uses the following pieces of information as “preliminaries”:

i) The proposition proved above, that given three numbers with a common difference

[such that $(\text{greatest}) - (\text{middle}) = (\text{middle}) - (\text{least})$], we have $8(\text{greatest})(\text{middle}) + (\text{least})^2 = (\text{greatest} + 2\text{middle})^2$.

ii) His generalization of the proposition from Plutarch that given any number of terms of an arithmetic sequence beginning with 1, then

$$(\text{sum of all the terms})(8)(\text{common difference}) + (\text{common difference} - 2)^2 = [(\text{common difference})(2 \times \text{number of terms} - 1) + 2]^2.$$

iii) The first statement contained in the fragment of *On Polygonal Numbers*, that “all [natural] numbers from 3 upwards are polygonal numbers, containing as many angles as they have units. . .thus 3 is a triangular number, 4 a square number, 5 a pentagonal number, etc.”

iv) A definition of a polygonal number that he attributes to Hypsicles (c. 180 B.C.), which is essentially the same as what we stated earlier as a general rule for forming the triangular, square, and pentagonal numbers, etc. Hypsicles’ definition is, “If as many numbers as you please be set out at equal interval from 1, and the interval is 1, their sum is a triangular number; if the interval is 2, a square; if 3, a pentagonal; and generally the number of angles is greater by 2 than the interval” (Nicomachus 1926, p.246).

The Last Proof in the Existing Fragment of *On Polygonal Numbers* (Diophantus 1890 p.307; Heath 1910, p.251)

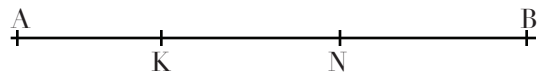
Diophantus says:
The above being premised, I say that if there be as many terms as we please in an arithmetic sequence, beginning with 1, the sum of the terms is polygonal.

[Proof:]

Let AB be any [natural] number [other than 1] that is a member of an arithmetic sequence that begins with 1.

[Say the arithmetic sequence is
 $1, 1 + (AB - 1), 1 + 2(AB - 1), \dots$]

Let AK = 1 unit, and KN = 2 units.



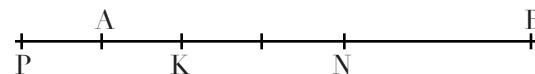
Applying Diophantus’ generalization of the proposition from Plutarch (ii above), that

$$\begin{aligned} &(\text{sum of all the terms})(8)(\text{common difference}) + (\text{common} \\ &\quad \text{difference} - 2)^2 = \\ &[(\text{common difference})(2 \times \text{number of terms} - 1) + 2]^2, \end{aligned}$$

[and noticing that $AB - 1 = BK =$ the common difference in this arithmetic sequence,] we have

$$\begin{aligned} &(\text{sum of terms}) \times 8(BK) + (BK)^2 = \\ &[(BK)(2 \times \text{number of terms} - 1) + 2]^2. \quad \{1\} \end{aligned}$$

Draw $AP = AK = 1$ unit.



This gives us $KP = 2$, and $KN = 2$,

and thus PB, BK, BN have a common difference
 $[PB - BK = BK - BN = 2]$.

So we can put PB, BK, and BN as “greatest,” “middle,” and “least,” respectively, into the equation stated in (i) above,

that $8(\text{greatest})(\text{middle}) + (\text{least})^2 = (\text{greatest} + \text{middle})^2$,

and we get $8(PB)(BK) + (BN)^2 = [PB + 2(BK)]^2. \quad \{2\}$

[Now Diophantus compares equations {1} and {2}. In order to make the right sides of the equations more similar he makes the following remark relating to equation {2}.]

Since $PB - PK = BK$, we have $PB + 2(BK) = PK + 3(BK) = 2 + 3(BK)$.

So equation {2} becomes $8(PB)(BK) + (BN)^2 = [3(BK) + 2]^2$.

Focusing on PB, we remember that $PB = 1 + AB$, so PB is the sum of the first two terms of the arithmetic sequence $1, 1 + (AB - 1), 1 + 2(AB - 1), \dots$

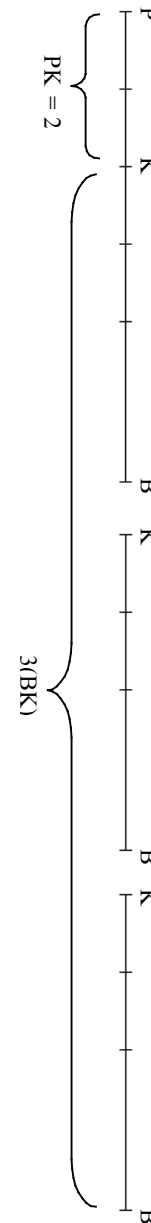
Thus, PB corresponds to the “(sum of terms)” in equation {1} when the number of terms is 2.

$$\text{So } (\text{sum of terms}) \times 8(BK) + (BN)^2 = [(BK)(2 \times \text{number of terms} - 1) + 2]^2 \{1\}$$

$$\text{becomes } (PB) \times 8(BK) + (BN)^2 = [(BK)(2 \times 2 - 1) + 2]^2$$

[PB is a polygonal number since AB is a natural number other than 1 (so at least 2), and $AP = 1$, so $PB \geq 3$, and by the fact stated in (iii) above that “all [natural] numbers from 3 upwards are polygonal numbers, containing as many angles as they have units.”]

Now, the number of angles in $PB =$ the number of units in PB
 $= BK + PK = BK + 2$
 $= (\text{common difference}) + 2$.



Therefore, since

- 1) PB is *any* polygonal number, and also the sum of the first two terms of any arithmetic sequence beginning with 1 [since AB is arbitrary],
- 2) and the sum of all the terms of the arithmetic progression is “subject to the same law” as PB [from the fact that PB corresponds to the (sum of terms) in equation {1} when the number of terms is 2],

we have that

the sum of all the terms of the arithmetic sequence must also be a polygonal number. And it must have the same number of angles as PB has [(common difference) + 2].

So we have shown that if there be as many terms as we please in an arithmetic sequence beginning with 1, the sum of the terms is polygonal.

Q.E.D.

five pentagonal numbers; and so on ad infinitum, for hexagons, heptagons, and any polygons whatever, the enunciation of this general and wonderful theorem being varied according to the number of angles. (p. 188)

The part of the theorem relating to squares was first proved by Lagrange in 1770, and the part relating to triangular numbers was proved by Gauss in 1801 (Burton 2003 p.93). Cauchy finally proved the theorem in its entirety in the 1800’s (Heath 1910 p.188).

Polygonal numbers continue to interest people even today. Researchers are exploring the study of polygonal numbers in the classroom as a way to introduce students to number theory (Abramovich, Fuji, & Wilson). And journals such as the *American Mathematical Monthly*, *The Joy of Mathematics*, and *Quantum* have recently published articles dealing with polygonal numbers. The authors of these articles are continuing the study of a subject that has interested people for over two millennia, and has included such famous mathematicians as the Pythagoreans, Nicomachus of Gerasa, Theon of Smyrna, Diophantus, Fermat, Lagrange, Gauss and Cauchy.

Recent Writings Concerning Polygonal Numbers

Polygonal numbers have continued to interest people throughout history. Fermat, Lagrange, Gauss, and Cauchy have all explored polygonal numbers. For example, over thirteen centuries after Diophantus, Pierre de Fermat (1601-1635) made this note in the margin of his copy of a translation of Diophantus’ writings (1890):

I have been the first to discover a most beautiful theorem of the greatest generality, namely this: Every [natural] number is either a triangular number or the sum of two or three triangular numbers; every [natural] number is a square or the sum of two, three, or four squares; every [natural] number is a pentagonal number or the sum of two, three, four, or

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The citations for the translations of the writings of Nicomachus of Gerasa and Theon of Smyrna appear in the body of this paper as follows: [8, II.18] refers to section 18 of book II of Nicomachus of Gerasa's *Introduction to Arithmetic* [9, Arith. XIII] refers to the 23rd section of the chapter on Arithmetic in Theon of Smyrna's *Mathematics Useful for Understanding Plato*.

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Determination of Magnesium Using EDTA

Abstract

This laboratory determined the magnesium content in unknown 2, and hardness of water for UMKC's tap water, Parkville water, and deionized water. The concentration of EDTA was 0.01000M used to titrate unknown 2. The concentration of the magnesium solution was determined to be $1.730 \cdot 10^{-3} \text{M}$ with a standard deviation of $3.082 \cdot 10^{-4}$ a standard error of the mean of $\pm 2.179 \cdot 10^{-4}$, and error limits of $\pm 9.371 \cdot 10^{-4}$ with 95% confidence. The hardness of UMKC tap water was 34.47mg/L, 20.20mg/L in Parkville, and 0.000 mg/L in deionized water.

The laboratory's purpose was to determine the magnesium content in unknown 2, and the hardness of water for the University of Missouri Kansas City's tap water, Parkville water, and deionized water. Hardness of water is determined by the presence of calcium ions and magnesium ions (1). According to NASQAN stations the predominant ion in Missouri is calcium (2). These metal ions come from dissolved minerals in aquifers and rivers. To measure the hardness of water requires a titration with a solution that will react in the same mole-to-mole ratio with both calcium ions and magnesium ions (2). The titration in this laboratory was done by using a standardized solution of ethylenediaminetetraacetic acid (EDTA) to titrate the four different solutions. EDTA was chosen as a titrant because it is a strong chelating agent. The word "chelate" is Greek for claw. The EDTA "clutches" the positive charges on metal ions. It has a unique chemical property that react with a large variety of metal

ions always in a one-EDTA (Y^{n-})-to-one metal ion (Me^{n+}) ratio. This forms a complex. EDTA has four hydrogens that can be lost (1).

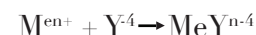
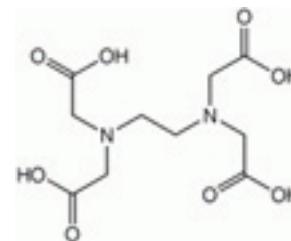


These four different oxidation states at different pH values. The EDTA used in this experiment was the hydrated form. The pH values control the relative concentration of H_4Y , H_3Y^- , H_2Y^{2-} , HY^{3-} , Y^{4-} . The molecular weight used in the calculations was the hydrated form of EDTA to account for the extra mass accumulated in a non-ideal environment. This decreased the possible margin of error, due to the presence of water, associated with partially hydrated forms.

The indicator used in this experiment was Eriochrome Black T. It was chosen because it also is a chelating agent. However, it has a lower affinity to the metal ions than EDTA. The weak bond is necessary in the indicator. If it had a strong affinity for the metal ions, then the EDTA would have to compete with the indicator. This would lead to error because there would be more ions present than the volume of the titrated EDTA would account for. Even though it weakly binds to metal ions and is easily kicked off by EDTA, only 2-3 drops of indicator were used to help reduce error.

Eriochrome Black T has one color when it is free in solution and a different color when it is bound to a metal ion and it can work at a variety of pH values. In an acidic solution the color change is from blue, as a free chelating agent, to orange when it is a ligand chelating agent. Between pH levels of 7-11, the color change is from red to blue. This change is more easily detected visually than red to orange. A basic pH was used in the experiment. EDTA can give up hydrogen ions that necessitate a buffer system to maintain a constant pH in the solution (3). The buffer used in this experiment was a mixture of ammonia and ammonium that had a pH of about 10.

Structure of EDTA



Materials and Methods

The glassware required for this experiment was 1000mL volumetric flask, three 250mL Erlenmeyer flasks, a 50ml burette, a 25mL, and a 50mL pipette. The chemicals needed were EDTA, the indicator Eriochrome Black T, the unknown 2 magnesium solution, an ammonia buffer solution, deionized water, UMKC tap water, and water from Parkville (3).

A 1000mL volumetric flask was cleaned with detergent and rinsed with deionized water. A 0.01M EDTA standard solution was prepared using hydrated EDTA. Approximately 3.7g were weighed on scale #4 in a weighing boat. This was washed with deionized water into the 1000mL volumetric flask. The original procedure called for a 250mL volumetric flask. It was changed so the solution had a smaller margin of error. The flask was filled half full with deionized water and swirled until the solid was dissolved. The solution was heated slightly for two minutes to aid in the dissolution of the EDTA. The flask was then filled to the calibration mark with deionized water and swirled (3).

Approximately 100mL of the unknown Mg^{2+} solution number 2 was put in a clean dry beaker and taken to the lab workstation. Three 25mL samples of unknown 2 were put in three 250mL Erlenmeyer flasks using a volumetric pipette. Two milliliters of the ammonia buffer solution and 8 drops of the indicator Eriochrome Black T were added to each sample. The solution became a deep magenta-red. The diluted EDTA solution was loaded into the burette and used to titrate the unknown solution until a blue endpoint (3).

A clean beaker was used to collect UMKC tap water. Triplicate samples of tap water were prepared. A 50mL pipette transferred the tap water to 250mL flasks to be tested for hardness. The buffer solution and indicator were added to the three samples. The solutions were titrated with EDTA until the blue endpoint was reached. The above steps were repeated with water from Parkville (3).

Deionized water was prepared as above with the buffer solution. However, when the indicator was added the solution immediately turned blue. No titration was necessary to reach the blue endpoint.

Results

The results showed the concentration of EDTA was 0.01000M that was used to titrate unknown 2. The concentration of the magnesium solution was determined to be $1.730 \times 10^{-3} \text{M}$. The hardness of tap water was 34.47mg/L, in Parkville water was 20.20mg/L and 0.000mg/L in deionized water. The standard deviation calculation $S = \sqrt{(\sum(x_i - \bar{x})^2 / n - 1)}$ produced a good standard deviation value, which means there is a large deal of accuracy to the measurement. The standard error of the mean $S_m = S / \sqrt{N}$ was also precise. The range for the 95% confidence level $\mu = \bar{x} \pm ts$ was good as well.

The parts per million calculations are milligrams per liter in metric units. The moles per liter were multiplied by the molecular weight. This yields grams per liter. The g/L are then multiplied by 1000 to give milligrams per liter. The ratio of mg/L and parts per million (ppm) is one to one.

$$\begin{aligned} \text{Mol/L} * \text{g/mol} &= \text{g/L} \\ \text{g/L} * 1000 &= \text{mg/L} \end{aligned}$$

Experimental Data: Hardness of Water

Scale #2

<u>Titration Data Mg²⁺</u>	<u>Trial 1</u>	<u>Trial 2</u>	<u>Trial 3</u>
Volume of unknown 2	25.00mL	25.00mL	25.00mL
Volume titrated	4.40mL	4.30mL	4.25mL
Concentration of Mg ²⁺	1.760×10^{-3}	1.720×10^{-3}	1.700×10^{-3}
Mean Concentration of Mg ²⁺		1.730×10^{-3}	
Mass of EDTA		3.7225g	
Concentration of EDTA		0.01000M	
Standard deviation [Mg ²⁺]		$\pm 3.082 \times 10^{-4}$	
Standard Error of the Mean		$\pm 2.179 \times 10^{-4}$	
Error Limits (95% CL)		$\pm 9.371 \times 10^{-4}$	
<u>Titration Data Tap Water</u>	<u>Trial 1</u>	<u>Trial 2</u>	<u>Trial 3</u>
Volume of Tap Water	50.00mL	50.00mL	50.00mL
Volume titrated	4.30mL	4.20mL	4.30mL
Concentration of ions	$8.600 \times 10^{-4} \text{M}$	$8.400 \times 10^{-4} \text{M}$	$8.400 \times 10^{-4} \text{M}$
Mean Concentration of ions		$8.500 \times 10^{-4} \text{M}$	
Hardness of water		34.47mg/L	
<u>Titration Data Parkville Water</u>	<u>Trial 1</u>	<u>Trial 2</u>	<u>Trial 3</u>
Volume of Parkville Water	50.00mL	50.00mL	50.00mL
Volume titrated	5.05mL	5.20mL	4.85mL
Concentration of ions	$1.010 \times 10^{-3} \text{M}$	$1.040 \times 10^{-3} \text{M}$	$9.700 \times 10^{-4} \text{M}$
Mean Concentration of ions		$1.010 \times 10^{-3} \text{M}$	
Hardness of water		20.20mg/L	
<u>Titration Data Deionized Water</u>	<u>Trial 1</u>	<u>Trial 2</u>	<u>Trial 3</u>
Hardness of water	0.000mg/L	0.000mg/L	0.000mg/L

Calculations

Concentration of EDTA

$$\begin{aligned} \text{Mass of sample} / \text{Molecular Weight of EDTA} / \text{1L} &= \text{moles of EDTA} \\ 3.7225 / 372.240 \text{g/mol} &= 0.01000\text{M} \end{aligned}$$

Concentration of ions

$$\begin{aligned} \text{Volume titrated} * \text{concentration of EDTA} &= \text{moles of EDTA} \\ \text{Moles of EDTA} &= \text{moles of metal ions} \\ \text{Moles of metal ions} / \text{volume} &= \text{concentration of ions} \\ 0.00440 \text{ L} * 0.01000\text{M EDTA} &= 0.004400 \text{ moles EDTA} = \text{moles of metal ions} \\ 0.004400 \text{mol} / 0.02500 \text{ L} &= 0.001760 \text{ M} \end{aligned}$$

Standard Deviation

$$\begin{aligned} &(\text{sum of } (x_i - \bar{x})^2 / \text{number} - 1)^{1/2} \\ &((0.00176 - 0.00173)^2 + (0.00172 - 0.00173)^2 + (0.00170 - 0.00173)^2 / 3 - 1)^{1/2} \\ &= 0.00173 \pm 3.082 \times 10^{-4} \end{aligned}$$

Standard Error of the Mean

$$S_m = S / \sqrt{N-1}$$
$$\text{Concentration of Mg}^{2+} = \pm 3.082 \cdot 10^{-4} / \sqrt{3-1} = 0.00173 \pm 2.179 \cdot 10^{-4}$$

Error Limits

$$\mu = X \text{ average} \pm ts / \sqrt{N} \quad t = 4.30 \quad (95\% \text{ CL})$$
$$0.00173 \pm (4.30 \cdot 3.082 \cdot 10^{-4}) / \sqrt{3-1} = 0.00173 \pm 9.371 \cdot 10^{-4}$$

Hardness of Water

$$\text{Number of moles per liter} \cdot \text{MW} \cdot 1000 = \text{mg/L}$$
$$0.00085 \text{M} \cdot 40.08 \text{g/mol} = 34.47 \text{mg/L}$$

Discussion

The unknown 2 had the highest concentration of metal ions of $1.730 \cdot 10^{-3} \text{M}$ compared UMKC tap water, which was greater than the concentration found in Parkville water. The deionized water had an ion concentration of zero. This is not surprising because deionized water has had all of the ions removed. This includes magnesium and calcium ions that constitute water hardness.

Kansas City has some of the best water in the Nation. The water quality in Kansas City was ranked third out of 100 American cities tested in March 2007 (4). It regularly exceeds the EPA's regulation standards of 180 containments, and tests for over 300 in more than 300,000 tests annually (4). Hard water can potentially cause a problem of calcium buildup in pipes and faucets. However, soft water can increase the salt concentration in a person's diet causing problems for individuals with high blood pressure.

UMKC's water was 34.47mg/L , which is moderately soft. Parkville tap water was 20.20mg/L , which is considered soft. It was surprising that Parkville's water was soft. Parkville is only a mile from the water treatment plant and borders the Missouri River. I expected that Parkville's water would be hard because the city is on the bank of the Missouri River which runs through limestone bedrock, and is full of metal which dissolved to make hard water. The water was probably freshly treated therefore reducing the number of ions in the water.

The University's water was harder than Parkville's water.

It is possible that the water came from an aquifer, which could account for the differences observed in the two tap water samples if they were from different sources. An underground aquifer would have a higher concentration of metal ions than a surface body of water such as a river. Aquifers are large underground water reservoirs that formed during the last glacial recession. The largest in North America is the Ogallala Aquifer that covers the central United States including Colorado, Nebraska, Kansas, and Oklahoma (2). It is heavily relied upon for irrigation of crops and as a municipal water source. Its volume has been decreasing rapidly because of the heavy usage.

It is likely that Kansas City uses the Missouri River for water instead of aquifers. The state line separates the use of aquifers versus the river. On the Kansas side of Kansas City the Ogallala aquifer is used and can be seen by the high concentration of metal ions in the water. On the Missouri side there is a steep drop in ion concentration indicating that the Missouri river is used (2). Kansas City sits at the bottom of the Missouri River basin, which has the water runoff of seven northern states. This provides easily accessible freshwater

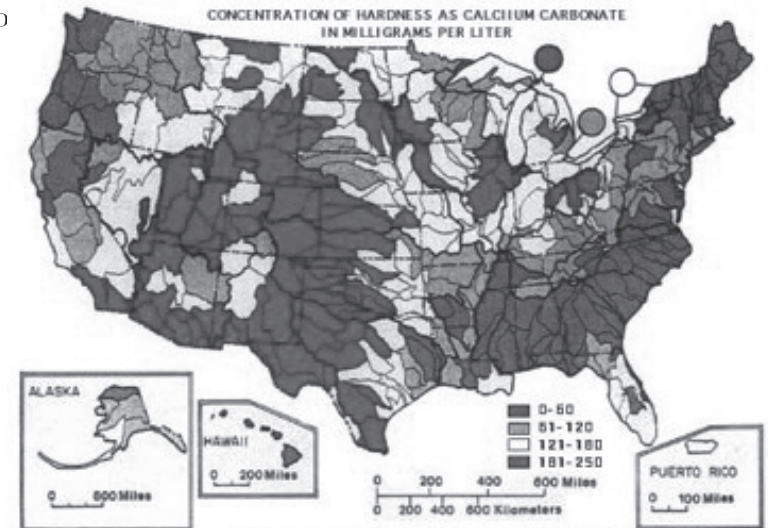


Figure 5.—Mean hardness as calcium carbonate at NASQAN stations during 1975 water year. Map at bottom is colored to show station data representing flow from the accounting unit.

<http://www.water-research.net/images/hardwatermap1.jpg>

Possible errors in this experiment included carbon dioxide dissolving in the water during the experiment, which would have made the solution softer. The indicator worked by binding as a chelating agent to the metal ions in the same way as EDTA. It was possible that not all the indicator was kicked off of the metal ions during titration. This would have made the concentration of metal ions lower than the true value. Titration error was another possibility.

The chemical used in the laboratory for testing the concentration of metal ions, EDTA, is a widely used chemical in the industrial world. When food is tinned or canned some of the metal from the container will dissolve into the food. This causes an unpleasant metallic taste. To avoid metal-flavored food while keeping an economic container, EDTA is employed to bind to metal ions so that they are not reactive, and thus not tasted. EDTA is not harmful when digested in small quantities and can be found in cans of Coke as well as much of the food that Americans eat. It is listed as an ingredient on the nutrition label of the foods that contain it. EDTA is also used as an alternative treatment to heavy metal poisoning of leads, cadmium, and zinc. It tightly binds to the metals in the bloodstream, becomes unreactive and is excreted out of the body (5).

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Aristotle on Friendship

In the age of the Internet, we seek friendship in ways never imagined in the time of Aristotle. Is it possible that two people connected only by digital signals and the urge to kill ogres could ever really be virtuous friends? First I will explore what Aristotle describes and defines as the lesser friendships of utility and pleasure, and continue on to the good or virtuous friendships. Then I will discuss the possibility of such friendships existing over the Internet, and conclude with my answer to the question above.

For a relationship to be considered a friendship, “men must feel goodwill for each other...be aware of each other’s goodwill, and the cause of their goodwill must be one of the lovable qualities...” (Aristotle 1996, p. 206). The lovable qualities are that which are “lovable, and that... is either what is good, or pleasant, or useful” (p. 206). “Nothing is more characteristic of friends than that they seek each other’s society: poor men desire their friends’ assistance, and even the most prosperous wish for their companionship... but it is impossible for men to spend their time together unless they give each other pleasure, or have common tastes” (p. 211). To be more specific, Aristotle adds a qualification to his definition above: “the feeling of goodwill must be known to its object” (p. 207). Friendships “...require time and intimacy... and so you cannot admit him to friendship or really be friends, before each has shown the other that he is worthy of friendship and has won his confidence” (p. 209). By qualifying this requirement as such, Aristotle eliminates the possibility of unintended or

one-sided friendship, where an individual A is “friends” with another individual B, despite the fact that B has no intention of being so with A. Also, even if A feels that he and B are friends, it is not an active friendship unless B is equally engaged in the friendship. “[P]ersons who wish another good for his own sake, if the feeling is not reciprocated, are merely said to feel goodwill for him: only when mutual is such goodwill termed friendship” (p. 207). Friendships are thus further limited to relationships in which two people are reciprocally sharing active goodwill, which is taken a step further to remove the possibility of friendship with inanimate objects: “the term Friendship is not applied to love for inanimate objects, since here there is no return of affection, and also no wish for the good of the object” (p. 207).

Aristotle also distinguishes the possibility of two people who could be friends because of their goodwill status, but are not so because neither has initiated an active friendship:

For a man often feels goodwill towards persons whom he has never seen, but whom he believes to be good or useful, and one of these persons may also entertain the same feeling towards him. Here then we have a case of two people mutually well-disposed, whom nevertheless we cannot speak of as friends, because they are not aware of each other’s regard (p. 207).

Of the two non-virtuous species of friendship, utility is the least similar to the virtuous relationship:

Friends of this kind do not indeed frequent each other’s company much, for in some cases they are not even pleasing to each other, and therefore have no use for friendly intercourse unless they are mutually profitable; since their pleasure in each other goes no further than their expectations of advantage (p. 208).

Due to their shallow, and sometimes tumultuous nature, friendships of utility operate more like exploitation, whereas a virtuous friendship resembles a cooperative effort: “the friends associate with each other for profit,

and so each always wants more, and thinks he is getting less than his due... and the one who is doing a service can never supply all that the one receiving it wants” (p. 224).

Virtuous friendships are based on a shared like-character; while friendships of utility “[seem] most frequently to spring from opposites, for instance a friendship between a poor man and a rich one, or between an ignorant man and a learned; for a person desiring something which he happens to lack will give something else in return for it” (p. 216). Aristotle also recognizes and highlights the possibility of an accidental “attraction between opposites... what they actually desire is the mean between them” (p. 216), as opposed to a motivated search for oppositely minded individuals.

Friendships based on utility, in which each participant uses the other’s resources out of convenience, run their course as change occurs within the resources or motives shared between the two. Friendships of pleasure, however, are less subject to changing resources and more so to emotion. “[The] young are prone to fall in love, as love is chiefly guided by emotion, and grounded on pleasure; hence they form attachments quickly and give them up quickly” (p.208). Friendships of utility change based on what each friend has, while friendships of pleasure change based upon what each friend wants. “[The] things that please them change as their age alters; hence they both form friendships and drop them quickly, since their affections alter with what gives them pleasure, and the tastes of youth change quickly” (p. 208).

Pleasant friendships require two people to actually enjoy one another’s company, “for that is how they get the enjoyment of their friendship” (Aristotle 208). Even those who need no assistance materially need someone to share their fortune with.

[Those] blessed with great prosperity have no need of useful friends, but do need pleasant ones, since they desire some society; and though they may put up with what is unpleasant for a short time, no one would stand it continually... and therefore the rich seek for friends who will be pleasant (p. 213).

If the prosperous do not need useful friends in the traditional sense of sharing resources, isn’t it true that they need pleasant friends as a matter of utility? Aristotle qualifies pleasant friendships as requiring “enjoying each other’s company” (Aristotle 223), and utility friendships “in some cases they are not even pleasing to each other” (p. 208).

Nor again are complaints likely to occur between friends whose motive is pleasure either; for if they enjoy each other’s company, both alike get what they wish for; and indeed it would seem ridiculous to find fault with somebody for not being agreeable to you, when you need not associate with him if you do not want to do so (p.223).

The goal of those who seek a friendship which is perfect, balanced, and of the “good” seek what Aristotle refers to as a virtuous friendship.

“The perfect form of friendship is that between the good, and those who resemble each other in virtue. For these friends wish each alike the other’s good in respect of their goodness, and they are good in themselves; but it is those who wish the good of their friends for their friend’s sake who are friends in the fullest sense, since they love each other for themselves and not accidentally” (pp. 208-209).

Aristotle defines a friend as “one who wishes and promotes by action, the real or apparent good of another for the other’s sake... [and] one who wishes the existence and preservation of his friend for the friend’s sake” (p. 238). A virtuous friendship begins at friendly relations, but requires more to be considered a friendship. “People who enter into friendly relations quickly have the wish to be friends, but cannot really be friends without... knowing each other to be [worthy of friendship]; the wish to be friends is a quick growth, but friendship it is not” (Aristotle 209).

“Also for perfect friendship you must get to know a

man thoroughly, and become intimate with him, which is a very difficult thing to do. But it is possible to like a number of persons for their utility and pleasantness, for useful and pleasant people are plentiful, and the benefits they confer can be enjoyed at once” (p. 212).

Another requirement of a virtuous relationship is that good men be exclusively involved: “only good men can be friends for what they are in themselves; since bad men do not take pleasure in each other, save as they get some advantage from each other” (p. 210). Thus are the necessary conditions for a virtuous friendship, but how does Aristotle describe such a friendship?

“The society of each other is the most desirable thing there is. For friendship is essentially a partnership. And a man stands in the same relation to a friend as to himself, but ... the consciousness of his friend’s existence... [is also a good]; but this consciousness is actualized by intercourse; hence friends naturally desire each other’s society. And whatever pursuit it is that constitutes existence for a man or that makes his life worth living, he desires to share that pursuit with his friends” (p. 251).

Unlike in a friendship of pleasure or utility, “in a friendship based on virtue, each party is eager to benefit the other” and “no complaints nor quarrels can arise, since nobody is angry with one who loves him and benefits him” (p. 223). Between the men, “the absolutely good and pleasant are the chief objects of affection” (p. 209).

Further, “such friendships are of course rare, because such men are few, and such friendship is naturally permanent, since it combines in itself all the attributes that friends ought to possess” (p. 209). “Hence the friendship of these lasts as long as they continue to be good; and virtue is a permanent quality” (p. 209).

To differentiate further between the lesser friendships and the virtuous, “these two secondary forms of friendship are not very likely to coincide: men do not make friends with each other both for utility and pleasure at the same time, since accidental

qualities are rarely found in combination” (p. 211). Thus, he has differentiated between the random and rare combination of friendship of pleasure and utility which is not shared between good men, such as if two bad men used one another’s resources to more effectively act badly, while at the same time genuinely enjoying each other’s company, this rare combination of pleasure and utility does not a virtuous friendship make, since they are not possibly “slow to believe anybody’s word about a friend who he has himself tried and tested for many years, and with them there is mutual confidence, the incapacity ever to do each other wrong” (p. 210), as both are bad men and cannot be trusted.

“Thus the friendship of inferior people is evil, for they take part together in inferior pursuits, and by becoming like each other are made positively evil. But the friendship of good is good, and grows with their intercourse. And they seem actually to become better by putting their friendship into practice, and because they correct each other’s faults, for each takes the impress from the other of those traits in him that give him pleasure...” (p. 251).

Finally, friendships are necessary for happiness. “[It] seems strange that if we attribute all good things to the happy man we should not assign him friends, which we consider the greatest of external goods” (p. 246).

Aristotle realized that a friendship based on pleasure, especially between children, can appear similar to virtuous friendship. He addresses this issue as such:

“Of these two inferior kinds of friendship, the one that more closely resembles true friendship is that based on pleasure, in which the same benefit is conferred by both parties, and they enjoy each other’s company, or have common tastes; as is the case of friendships of young people. For in these there is more generosity of feeling, whereas the friendship of utility is a thing for sordid souls” (p. 213).

To prevent confusion about the difference between

goodwill and friendship, I will now highlight some differentiations made in book nine. “Goodwill appears to be an element of friendly feeling, but it is not the same thing as friendship; for it can be felt towards strangers, and it can be unknown to its object, whereas friendship cannot” (Aristotle 240). This clarification harkens back to the requirements of friendship being intentionally shared in both directions by two parties, neither of which can be an inanimate object. “Well-wishers are not necessarily friends: they merely desire the good of those whose well-wishers they are, and would not actively assist them to attain it, not be put to any trouble on their behalf” (p. 240). I believe what he should have written was “and [perhaps] would not assist them to attain it, [perhaps] not be put to any trouble on their behalf,” as even wishing well and putting themselves through a bit of trouble, or helping one to attain good, does not necessarily constitute friendship assuming the one who is wished well doesn’t return the attention or effort.

Two further points on goodwill I would like to highlight are:

“Hence, extending the meaning of the term friendship we may say that goodwill is inoperative friendship, which when it continues and reaches the point of intimacy may become friendship proper not the sort of friendship whose motive is utility or pleasure, for these do not arouse goodwill” (p. 241).

By defining goodwill as inoperative friendship, he is essentially calling goodwill the stem cell or perhaps the diving board of friendship, whereas you must either have present the “stem cell” of goodwill from which friendship will grow, or you must climb onto the “diving board” of goodwill before taking the leap towards friendship. Each metaphor has its own value; stem cells illustrate an open beginning, and the diving board represents the figurative “leap” required to enter friendship. Finally, by asserting that, generally, “true goodwill is aroused by some kind of excellence or moral goodness: it springs up when one person thinks another beautiful or brave or the like...” (p. 241), Aristotle addresses the age-old problem of attention-getting. I, for example, might make great friends with Herm Edwards,

coach of the Kansas City Chiefs, given our similar characters, but sending him a letter and asking him to be my friend will very likely end without result. I have to get his attention, and arouse his goodwill with an excellent display. Perhaps by approaching Mr. Edwards at a restaurant and displaying a depth of football knowledge rarely seen by a normal fan, I have at least demonstrated my deservingness of his goodwill. I at least got a picture to commemorate the event.

Turning now to the problem of the Internet relationship, and whether or not such a pairing of two individuals connected only by electronic pulses of 1 and 0 could ever grow into a true virtuous friendship. Aristotle limits virtuous relationships, and as such arguably prevents such friendships from existing online, without human-to-human contact.

...friends when in each other’s company derive pleasure from and confer benefits on each other; whereas friends who are asleep or parted are not actively friendly, yet have the disposition to be so. For separation does not destroy friendship absolutely, though it prevents its active exercise. If however the absence be prolonged, it seems to cause the friendly feeling itself to be forgotten... (p. 211).

As with pen pals, or two great friends of virtue separated by miles, email communication cannot prevent the loss of active exercise. To share words, ideas and goodwill over any medium other than face-to-face communication can cause the loss of friendly feeling described above. All is not lost however, as in the case of online games, where friends actively participate in team work to complete an objective, all the while able to communicate in real time and witness almost firsthand the actions of the other; it is possible yet that friendship can continue in earnest.

Another serious limitation put down by Aristotle is on the number of friends possible:

“It is not possible to have many friends in the full meaning of the word friendship, any more

than it is to be in love with many people at once ... and it is not easy for the same person to like a number of people at once, nor indeed perhaps can good men be found in large numbers” (p. 212).

Whether the issue of online friendships is limited to people known only online, and never met in person or not, to keep intimately close to many people is a difficult chore. It has seemed in my personal experience that I can sustain up to three deep friendships at a time, while having loose friendships and sharing general goodwill with a nearly limitless number at the same time. When one friend is online less often, if the time I normally spend talking or playing with them is taken up by playing or talking with someone not normally considered my friend, in time the new friend can bump the old friend out of their place of honor, until the first friend makes it a point to reclaim that position. To distinguish this action from simply exchanging friends of utility, I point out that there is no malice in placing one above the other, in fact there is never a specific action of even thinking of one over the other, one simply begins to fit into my life better than the other, and when the first fits better again, he or she resumes where we left off to begin with.

Finally, I would like to address two issues of disparity between friends: “...when a wide disparity arises between two friends in point of virtue or vice, or of wealth, or anything else; they no longer remain nor expect to remain friends...when one becomes very remote from the other, as God is remote from man, it can continue no longer.” (p. 215). My experience is that internet friendships have an advantage over personal friendships in that destructive behaviors such as alcohol abuse have less effect. While I do not condone self-destructive behavior, it is easier for both parties to ignore when not face to face with the issue, as we would be if personal friends. The negative to this is that it is easy for one to completely misrepresent themselves online, which brings me to my final point on the possibility of virtual virtuous friendships.

Many would argue that friendships can be formed over instant messaging programs, such as AIM, where, much like a telephone conversation, two people communicate directly and

in real time. To dissolve this idea, I point to SmarterChild, a user who appears and discusses anything like a regular AIM user. SmarterChild is a “bot,” a computer controlled automated messenger, who can interact based on context clues and hold a conversation with a user, never letting on that the person is in fact, talking to a computer. While “bots” in online games obviously lack human characteristics of play and communication, text-based AIM bots are as human as any user when communicating via text chat. Aristotle requires that friendship occur between two humans, “the term Friendship is not applied to love for inanimate objects, since here there is no return of affection, and also no wish for the good of the object” (p. 207). Thus, because the only way to truly verify that this person you have never met is human is to indeed meet them in person, it is impossible to have a virtuous friendship via AIM or other instant messaging services without having met the person prior. Internet gaming is another matter entirely.

“Suppose one friend to have remained the same while the other has improved, and become greatly the superior in virtue: ought the latter to keep up the friendship?” (p. 238). Aristotle answers that “without [enjoying each other’s company] intercourse and therefore friendship are... impossible” (p. 238). While intercourse is more possible in online gaming than in general Internet activity, the inherent nature of the gaming society online is what distinguishes the relationships formed there as utilitarian and not virtuous.

I look to my great friend in real life, who plays such games online as Kornja. He had what appeared to be a quite close relationship with many members of his guild in World of Warcraft, where he and 39 of his closest friends would join to fight together. He was close friends with three or four members, and friendly to the rest, but in time as the best members of the group got better at the game, a chasm began to form between the top 5 players (Kornja included) and the other 35 members. Unwilling to cut ties with his friends in the lower segment, Kornja stayed with the group despite the other four greats threatening to leave. When the four best left, Kornja realized that his two friends in the top four were only his friends when he could help them achieve victory, and were perfectly willing to leave

him behind. "...differences between friends most frequently arise when the nature of their friendship is not what they think it is" (p. 237). Despite his loyalty, the guild collapsed beneath him as other less skillful players attempted to fill the power vacuum left by their departed leadership, and now, months later, Kornja has lost contact with all of his Warcraft friends. Luckily, his new-found free time has allowed him to reconnect with the real world, and build better friendships with real people. It seems the only true virtuous friendships exist in reality, as it is impossible to realize another's intentions online. Many of the requirements for friendship, such as shared experience, shared character, and goodwill are perfectly possible online, but because you can never be sure that both parties share in the matter similarly, as is required, Internet friendships remain utilitarian or for pleasure, as Kornja has learned. Luckily for Kornja, he has my friendship in reality... until he finds out I'm only using him for his bulldogs.

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The Question of the Homoerotic in Thomas Eakins' *The Swimming Hole*



Fig. 1, Thomas Eakins, *The Swimming Hole*, c. 1883-85. Oil on Panel.

In 1885 Thomas Eakins painted *The Swimming Hole* (Fig. 1) for one of his colleagues at the Pennsylvania Academy of Fine Arts where Eakins himself was an instructor. The painting depicts six naked men, accompanied by a red setter, in a pyramidal arrangement. The men are gathered on a rocky pier overlooking a lake outside of Eakins' hometown of Philadelphia. The clear water brilliantly reflects the scene of the convening men above, and the lake is set amid the dark foliage beyond the water's edge. Eakins accentuates the swimmers' bodies with his use of stark lighting, creating a sharp contrast between their flesh and their surroundings. The men in the

scene dive, sunbathe, and swim on a sunny day in the man-made reservoir of Dove Lake on Mill Creek. The central group of five men convenes on a pier, with each man seemingly in his own world. In fact, no one in the scene seems to acknowledge the presence of the others, except for the lone swimmer in the lower right corner, identified as Eakins. Watching the scene from his place in the water, Eakins is the only participant who seems aware of the activity in the foreground and the only man who may know exactly what is happening before us.

Over the last sixty years, Thomas Eakins' work has been revisited and interpreted as having homoerotic and homosexual undertones. Many of these arguments stem from the analysis of *The Swimming Hole*. Most scholars addressing, or in some instances avoiding, this subject present their arguments in somewhat of a selective manner, often addressing only aspects of the artist's life and career that best fit their own arguments. In order to begin to understand the conscious and unconscious elements of Eakins' work, it is important to know something about the controversial life of the artist. Throughout Thomas Eakins' career, he often challenged the prudery of Victorian propriety. He stood out often as a problematic figure in both his personal and artistic life. His insistence on using the nude model in his classes at the Pennsylvania Academy of Fine Arts would eventually lead to his forced resignation (Goodrich, 1982, p.25). The famed "loin cloth scandal" was the last straw in Eakins' academic career, filled with sexual harassment accusations and controversies over his common ritual of disrobing before his students and badgering them to do the same¹ (Goodrich, 1982, p. 24). To understand Eakins' feelings about the nude, we must look at his background and training in art and how in his academic career in America, he was seldom allowed to study from the naked body.

Born in 1844 in Pennsylvania, Thomas was the eldest of four in an upper-middle class family. His father Benjamin was an accomplished teacher and later made his wealth as a land owner, supporting Thomas through most of his career (Goodrich, 1982, p.7). His father went so far as to let Thomas

¹ In 1886 when using a male model with female students Eakins removed the model's loin cloth to show the students the genitalia in relation to the pelvic girdle.

live in the old family house, where he paid for his room and board, a gesture that always seemed to leave Thomas on the anxious side. After high school he studied at the Pennsylvania Academy of Fine Arts in 1861, while simultaneously studying anatomy at the Jefferson Medical College. In the American academies of Eakins' time the nude model was scarcely used. The students instead studied the human body from reproductions of sculptures from classical antiquity. On the rare occasions when the students were allowed to study from a naked model, it was required that the models wear masks to conceal their faces and identities (Goodrich, 1982, p.8). Upon graduation from the Academy, Eakins, under pressure from his father, headed to Paris and entered the Ecole des Beaux-Arts, where he began studying under Jean-Léon Gérôme in September, 1866 (Goodrich, 1982, p. 10). During his time in Paris, Eakins was able to study the unmasked naked body free of guilt. While in Paris he attended the Salons and was disenchanted with the French academy's treatment of the female nude. In a letter home to his father Eakins writes;

I can conceive of few circumstances wherein I would paint a naked woman, but if I did I would not mutilate her for double the money. She is the most beautiful thing there is except a naked man, but I never saw one exhibited. It would be a godsend to see a fine man painted in a studio with bare walls...I hate affectation (Homer, 2002, p.36).

The mutilation Eakins was describing was how the academy recast the display of nudity through the omission of the woman's genitalia and body hair. Being a strict realist Eakins believed this "castration" created a lie that was made more offensive by an allegorical veil that excused the painting and exhibition of nude women.

After some time in Spain studying the Spanish naturalists and developing a love for the works of Velazquez, Eakins returned to America in 1870. When the Pennsylvania Academy of the Fine Arts opened its new building in 1876, Eakins signed on as a professor teaching courses in life drawing and painting (Goodrich, 1982, p.20). His interest in anatomy and



Fig. 2. Studies of locomotion, in collaboration with Edward Muybridge.

science is reflected in his anatomical lectures at the Pennsylvania Academy, wherein his students took part in dissections as Eakins had when he was a student. Being a man of science, he also developed an intense interest in photography, and he worked with Edward Muybridge in photographing the naked body in studies of locomotion (Fig. 2) (Goodrich, 1982, p.21). After accepting the position at the Academy, Eakins used nude models as the basis of his teachings (Goodrich, 1982, p.19). He believed the study from the naked body was a critical component in art education and that the American academies and Victorian society were wrong to deny their future artists. Using male and female models in coed classes was considered outrageous as much by his colleagues as by the more conservative public. Rumors and exaggerations of exploits among models, students and himself in class led to accusations of sodomy² and his nude photographs of his ventures with students led to an ultimatum that called for his forced resignation in 1886 (Doyle, 2006, p.25).

In the year prior to his resignation, Eakins was approached by Edward Coates a committee member and art collector, about the commission of a painting. The result of this commission was *The Swimming Hole*, originally entitled *Swimming* by Eakins (Adams, 2005, p.306). The painting's original title, *Swimming*, and Eakins being the only figure actually swimming may suggest this image is about Eakins and his experience. In any case, the image expresses Eakins' feelings about manhood and masculinity generating many different explanations about what this male nakedness was meant to signify and whether the artist was aware of it or not. Having some knowledge of the artist's training and academic practices, the circumstances under which *The Swimming Hole* was painted must be examined in order to

analyze the extent of the sexual undercurrents in this painting.

In preparing *The Swimming Hole*, Eakins made several photographic studies of his friends and students, whom he used as models in the painting. Some of the photographs were taken at the dilapidated pier at Dove Lake where the painting is set (Berger, 2000, p.92). Some of the more provocative photographs were taken in the area around Dove Lake where Eakins photographed the men wrestling, playing tug of war and engaged in other outdoor activities in the nearby woods (figs. 3-8). These photographic studies become troublesome for some scholars attempting to decode Eakins' work. The photographs have been interpreted by various researchers as transcending the boundary of study and crossing into the realm of exhibitionism and voyeurism, saturated with latent homosexual desires. The "horseplay scenes" that show the men engaged in various hands-on activities have been read as coupling images in which Eakins, or someone else, has paired up the men in each image (Adams, 2005, p.315-318).

In the photographs at the scene of the painting the men interact and engage one another; this involvement with each other is also evident in his preliminary oil sketch (fig.9). Yet in the final painting of the *Swimming Hole* the figures no longer seem to interact or even look at each other, except for Eakins watching from the corner. For whatever reason, Eakins' photograph and oil studies of the men, not only aware of one another but physically interacting with each other, were abandoned. In the end, the image is of the men disengaged, if not unaware of each other's presence, that is, except for Eakins alone in the water.



Fig. 3. Photo study at Dove Lake for *The Swimming Hole*, 1883.



Fig. 4., Photo study at Dove Lake for *The Swimming Hole*, 1883.



Fig. 5. *Seven Males, Nude, Two Boxing at Center*, 1883



Fig. 6. Photo study at Dove Lake for the *Swimming Hole*, 1883.



Fig. 7. *Six Males, Nude, Wrestling*, 1883.



Fig. 8. *Males Nudes in a Seated Tug-of-War*, 1883.



Fig. 9. Oil Study for *The Swimming Hole*, 1883.

The painting shows all the male figures with no trace of clothing and yet, for whatever reason, Eakins has not painted any genitals. The central figure atop the pier becomes androgynous, if not more effeminate in posture, and the protrusion of the figure's buttocks is the focal point of the painting. The men

that populate the composition would have been identifiable by the painting's main viewing audience at the Academy for which it was intended (Berger, 2000, p.92). However, Eakins included photographs of some of his subjects alongside the painting when he exhibited it, negating the idea of his sitters' ambiguity and androgyny (Adams, 2005, p.321). Sexual readings into *The Swimming Hole* also stem from its unusual reception and the name changes it has undergone. The painting was commissioned by Edward Coates, a colleague of Eakins and a member of the Academy's Board of Directors. Coates had wanted a painting he could later dedicate to the school as a symbol of the caliber of artists the Academy would produce. However when presented with Eakins' final painting, Coates reluctantly accepted it only to later ask if Eakins would exchange it for an alternate work (Adams, 2005, p.323). Coates rejected the painting on the grounds of it being too aggressive in its display of naked men. The easily identifiable men – Eakins and his students from the Academy – further complicated matters for Coates. Coates probably feared that the other patrons at the Academy would associate him with Eakins' interest in the nude and the same conflicts that led to Eakins' expulsion from the academy less than a year after painting this image (Berger, 2000, p.90; Doyle, 2006, p.15). However, sources do not show any indication that the problematic elements of Eakins' work in his own time were centered on notions of homosexuality among his contemporaries.

Scholars interested in trying to decipher any homoerotic content or undertones in Eakins' work today face a number of problems. For a long time there was a lack of critical analysis of the place of homoeroticism in his work, until the last thirty years when scholars used psychoanalytical tools in decoding elements of Eakins' work as having homoerotic meanings. Whitney Davis uses a Freudian perspective to discuss the sexual nature of Eakins' creative processes for *The Swimming Hole*. Davis believes that the suppression of Eakins' homosexuality is a hidden subject of his preparatory photographs and paintings (Davis, 1994, p.301-341). Davis and other researchers draw on Eakins' friendship with Walt Whitman, an open homosexual and admirer of Eakins' work, as an indicator of his sexuality. During Eakins' and Whitman's friendship, Eakins had photographed

Whitman with his younger male companion William Duckett, as well as painted one of many portraits of Whitman (figs.10, 11) (Homer, 2002, p.213). However, all sources discussing the nature of Whitman and Eakins' relationship define their friendship as one of mutual respect and admiration for one another's work and character. Jennifer Doyle asserts in *Sex Objects* that Eakins should be placed at the beginning of a homosexual visual tradition in American Art, linking his work to the portraits of Robert Mapplethorpe, and to the films and photographs of Andy Warhol (Doyle, 2006, p.22). Comparing Eakins nude photographs to Robert Mapplethorpe's naked African-American men and Andy Warhol's genital Polaroids, Doyle believes the link to be self evident. Doyle goes on to state that the spirit of play in the photographs for *The Swimming Hole* was direct inspiration for the homoerotic films *Lonesome Cowboy* and *My Hustler*, also by Andy Warhol (Doyle, 2006, p.22). This is problematic in that Doyle's argument looks back from the present. Eakins in all likelihood was not attempting to establish this visual tradition nor was he aware that he was taking part in the creation of one. The correlations that Warhol and Mapplethorpe may draw from Eakins' work were strictly by the former's study of the latter.

Eakins and his images of nudity become more complicated when we consider again how Eakins does not show any genitals in his final painting of *The Swimming Hole*. The resulting androgynous figures can be seen throughout his work and only further confuse matters when we consider the letter to his father stating his distaste for French castration of the female nude. In his 1883 painting *Arcadia* (fig. 12), we again are presented with naked figures, all of whom conceal their gender. The middle and right figures are both males, while the seated figure to the right is female.

We know their gender and identity because the setting is Eakins' sister's farm and the models were his niece and nephew, as well as one of his students (figs. 13, 14, 15) (Homer, 2002, p.146). Ironically, Eakins concealed the genders of the figures and yet depicted the boys with pipes. The pipes can be read as the phallic instrument often attributed to the Arcadian god Pan, associated with eroticism, echoed by the title *Arcadia*.



Fig. 10. Walt Whitman and Bill Duckett, 1886.

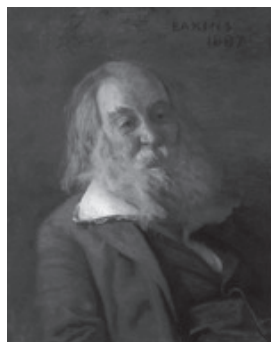


Fig. 11. Thomas Eakins, *Walt Whitman*, 1887-88.



Fig. 12. Thomas Eakins, *Arcadia*, 1883.

The androgynous body is shown in several of Eakins' nude photographic studies for this image, as well as others done in and out of his studio. One particular image is of the artist himself in a feminine, Odalisque-like pose in which Eakins' gender is not discernable (fig. 16). Henry Adams makes note of Eakins becoming the androgynous other in his photograph of himself. These images of the castrated androgynous figures, both male and female, seem to only further blur the sexual connotations in Eakins' work.

The profusion of issues surrounding gender and sexual identity in Eakins' work only grows more complicated when we consider any one of his individual works in relation to others as I discussed above. Eakins scholars, early on and up until the present, remain sharply divided as to the meanings and underlying subjects of his work. Doyle and Davis, among others, still explore the homoerotic nature of Eakins' work arguing in Davis' case, that Eakins' paintings are "not not homosexual" (Adams, 2005, p.310). Davis believes that while Eakins' paintings and photographs may not convey any direct indicators of homosexuality, one cannot deny that there are elements of Eakins' work with latent homosexual undertones. Davis employs Freudian psychoanalysis and points to Whitman and Eakins' relationship as the basis of his theory. He argues that Eakins was drawn to Whitman's character as a great exhibitionist and, more significantly, as an open homosexual (Johns, 1983, p.145).



Fig. 13. Photographic male study for *Arcadia*.



Fig. 14. Photographic male study for *Arcadia*.



Fig. 15. Photographic male study for *Arcadia*.



Fig. 16. Thomas Eakins nude, 1883.

Whitman, for Eakins, was the unconscious complement to Eakins' suppressed desires that Davis sees emulated in *The Swimming Hole* (Davis, 1994, p.309). The desires appear overtly in the preparatory images with the "coupled" pairs of boys that Eakins had staged in his photographs. The final painting marks a heavy revision and omissions when compared to the photographs and oil study's sentiments and acts as a visual marker to Eakins' suppression of his homosexual desires (Davis, 1994, p.328). In opposition to theories such as those put forth by Davis, there remains a large scholarly group that rejects ideas of homosexual or homoerotic tendencies in Eakins' work. Eakins' major biographers beginning with the pioneer of Eakins' biography, Lloyd Goodrich, and the contemporary scholars William Innes Homer and Martin Berger define Eakins' work with terms like "homo-social" to describe this painting. The homosocial reading of *The Swimming Hole* stems from the argument that the image is a celebration of the bonds between student and teacher and manhood and masculinity (Berger, 2000, p.96-98). Lloyd Goodrich is quick to dismiss any gay tendencies and addresses the men's naked interactions: "Eakins was always entirely natural about nudity, and preferred bathing without the benefit of bathing suits" (Goodrich, 1982, p.23).

The contemporary scholars opposed to the theories of homoeroticism in Eakins' paintings and photographs argue that these images are reflective of the artist's meditations on manhood, meant to convey an inspiring image of the modern man in Eakins' time. Berger and others maintain that the painting was to celebrate the success of local men while being an image that confirms the personal ties to the patron Coates (Adams, 2005, p.113; Berger, 2000, p.92). The setting of Dove Lake was a known manmade reservoir created by a local industrialist for his copper mine. The lake, created for the use of a nearby copper mill, both fulfilled the factories industrial requirements while intentionally creating a recreational area for local boating and swimming. According to Berger, the success of American industry thus led to the creation of the lake and afforded new opportunities for men to indulge in more leisurely activities. The connection becomes intimate to the patron who made his wealth in industrial speculation which permitted his

patronage of art and Eakins (Berger, 2000, p.92). For Berger, *The Swimming Hole* addresses gender through a promotion of masculinity that is affirmed in Eakins through his students' dedication to their professor. The students stand at the edge of the pier and on the metaphorical edge of success and manhood before joining their mentor in the lake. This sentiment is shared by William Innes Homer, who in protest against homosexual allegations describes *The Swimming Hole* as a: relaxing moment of male companionship away from the cares, and the women of the city. The young men, and Eakins himself, are free to frolic in the nude. The painting expresses Eakins' own relaxed openness about the human body exposed fully and without embarrassment...there is no evidence that Eakins was gay, but he encouraged a closeness among his male students and young artist friends that recalls the kind of bonding enjoyed in the Whitman circle (Homer, 2002, p. 116).

Homer's view is a traditional one that is shared by many of the scholars who believe that Eakins' paintings were realistic images that celebrated a growing cult of the masculine in the forefront of the gilded age. Everyone seems to define the motivations at play in *The Swimming Hole* in a slightly different manner. There are some scholars who remain safely in the middle and cannot say one way or the other what exactly is going on in Thomas Eakins' paintings. It seems that most of these arguments are based on the omission and/or the embellishment of details that could disprove any one argument. I believe these different interpretations and often conflicting explanations are indications that there is something unexplainable beneath the surface of the artist's work. The question of Eakins' intentions or unconscious desires or fears that permeate these images is a question that, asked only so recently, is far from being answered. Most likely the sexual nature of the issues at play in Eakins' work was something not wholly known or understood to the artist himself. In any event, the continued work on the artist's amazing career and often troubled and controversial life puts us closer to understanding the complex nature of the work of one of America's greatest masters.

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- Fig. 16, Thomas Eakins nude, semireclining on couch, from rear, ca. 1883, Platinum Print, 5 3/8 x 7 1/4 inches, Pennsylvania Academy of the Fine Arts. Pbs.org; *Thomas Eakins: Scenes from Modern Life*, http://www.pbs.org/eakins/img_1884.htm. (accessed November 4, 2006).

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Sexual Predators, Civil Commitment Programs, and Sexual Predator Laws



Children are being abused at alarming rates in this country. Research has shown that 23% of adults have reported being sexually abused as a child. The National Center on Child Abuse Prevention Research reported that “in 1997 there were 223,650 reports of child sexual abuse received by child welfare agencies across the United States” (Levenson, 2003). These numbers don’t include the thousands of abuse cases that go unreported each year. Even in the case where the abuse is reported, many of the sexual abusers are never caught and/or prosecuted.

It is because of the growing number of victims that researchers have spent so much time researching the sexual abuser and all issues related to the sexual abuser. One of the most researched aspects of the sexual abuser is how the government is trying to treat these sexual predators and keep the communities safe from them, namely civil commitment programs and community notification. The researchers who have provided some of the most imperative research in this area of study include Jill Levenson with her meta-analysis “Policy Interventions Designed to Combat Sexual Violence: Community Notification and Civil Commitment” and her study “Sexual Predator Civil Commitment: A Comparison of Selected and Released Offenders”; Ron Langevin, Suzanne Curnoe, Paul Fedoroff, and Renee Bennet with their study “Lifetime Sex Offender Recidivism: A 25-year Follow-Up Study”; Wanda Kendall and Monit Cheung and their article “Sexually Violent Predators and Civil Commitment Laws”; John La Fond and Bruce Winnick with their literature review “Sex Offenders and the Law”;

Stephen Webster’s “Pathways to Sexual Offense Recidivism Following Treatment: An Examination of the Ward and Hudson Self-Regulation Model of Relapse”; James Seager, Debra Jellicoe, and Gurmeet Dhaliwal with their study “Refusers, Dropouts, and Completers: Measuring Sex Offender Treatment Efficacy”.

These authors, through their research, have helped to answer why sexual abusers abuse, how they abuse, what can be done to prevent them from abusing, what are predictors of abusing, and how is the government protecting society from these abusers. All of the researchers’ empirical findings are presented and these questions answered in this review. Jill Levenson did a thorough meta-analysis of the topics at hand and it is the format of that meta-analysis that will be used to lay out the issues in a logical format, to integrate the other researchers’ findings coherently together, and to integrate the other researchers’ findings to Levenson’s meta-analysis. The main issues of this literature review concern sexual predators, civil commitment programs, and laws regarding sexual abuse.

Jill Levenson’s Meta-Analysis of Sexual Offenders and Civil Commitment Programs

Jill Levenson’s meta-analysis on the topic of sexual violence is a key piece in studying sexual predators, civil commitment programs, and laws pertaining to sexual predators and civil commitment programs. The big area of research for Levenson is civil commitment programs and sexual predators. Civil commitment is recognized as “the process by which mentally ill individuals who are considered dangerous to themselves or others are detained in an inpatient facility and forced to receive mental health care” (Levenson, 2003). States were required to have civil commitment programs after the Sexually Violent Predator Statute was enacted in 1990 in response to a sexual predator with a 24-year history of murder and sexual assault who was released from a 10-year prison sentence and just two years later abducted, sexually abused, and killed a 7-year old boy. This statute requires that sexual predators be put into treatment programs after their prison sentences have been fulfilled. Another benchmark case for civil commitment programs is that of *Hendricks v. Kansas*. This case

“limited sex offender civil commitment to those individuals who have been convicted of a sexual crime and demonstrate (a) a mental abnormality or personality disorder that makes it difficult, if not impossible, for the person to control his sexual behavior and (b) a likelihood to commit future sexual offenses” (Levenson, 2003). More extensive discussion of the laws dealing with sexual offenders appears later in this literature review.

The question of who is a sexually violent predator is one of the sub-areas of research under civil commitment programs. The label of sexual predator in many states “applies specifically to sex offenders who target strangers or acquaintances with whom a relationship has been established primarily for the purpose of victimization, who have multiple victims, or who commit especially violent offenses” (Levenson, 2003). Most sexually violent predators have some kind of a mental abnormality or a personality disorder. It is because of these abnormalities and disorders that predators seek out young and impressionable children and gain their trust while meticulously planning their attack. When looking at the average number of victims of sexually violent predators, Levenson found that “the average number of victims for pedophiles who molested girls was 20; for pedophiles who preferred boys, the average number was over 100” (Levenson, 2003).

Next, Levenson looked at the goals of civil commitment. Although one of the main goals of civil commitment is rehabilitation of sexual offenders, punishment, isolation, and incapacitation are the primary goals. For a sexual offender to be admitted into a civil commitment program, they must go through an admittance process with multiple steps. First, the sexual offender needs a referral from the prison that released them. Second, trained professionals must evaluate them and if the offender is then deemed to be at high risk for being sexually violent, they are given a hearing. Finally, if at the trial there is probable cause to believe that the person is indeed sexually violent, they then enter the system.

There are, however many criticisms of civil commitment. Some critics argue that civil commitment programs are just another jail and another way to keep someone locked up for good. Other critics wonder if paraphilia, a diagnosis of many

sexual offenders, meets the American Psychiatric Association’s definition of a “mental illness” and therefore meeting the requirements for civil commitment programs. The problem, critics contend, is that “the term ‘mental abnormality’ has no scientific or clinical meaning, but rather represents only a ‘deviation from the norm’” (Levenson, 2003). This is just one of the many arguments in the ongoing debate of “mad v. bad” or “sick v. evil”.

Levenson then researches the costs of civil commitment programs. She finds that the costs of the programs are very high. To be more specific, “yearly costs for civil commitment programs are estimated to range from \$70,000 per client in Washington to \$103,000 in California” (Levenson, 2003). Release from the civil commitment programs does not occur nearly as much as admittance to the programs does; release is actually a rare occurrence. The cost of these programs continues to grow with each new client. There have been some alternatives to civil commitment programs mentioned. These include treatment while incarcerated and lifetime parole. These are both cost-cutting mechanisms and ways to reach many sexual offenders at one time.

Levenson finds pitfalls in the research of civil commitment programs when she is researching whether or not they are linked to offender recidivism. One pitfall was that there was no literature available on the subject. Another pitfall, she discovered, is that professionals’ ability to predict future dangerous behavior is questionable. Another area of concern is the lack of ability to evaluate whether or not a sexual offender is ready for release from the program. Levenson concludes her literature review emphasizing the point that, “perhaps the most pressing need is the importance of establishing empirical evidence that community notification and civil commitment achieve their goal of reducing sexual violence” (Levenson, 2003).

Other Researchers’ Findings on Sexual Predators and Civil Commitment Programs

Levenson’s meta-analysis of the issues at hand is thorough and extensive. However, even more studies have been done and even more articles written about sexual offenders, civil commitment programs, and laws concerning sexual offenders and civil commitment programs that are not included in her

literature review. A study of lifetime, sex-offender recidivism by Ron Langevin, a piece by Jill Levenson on sexual predators and civil commitment, and academic articles and analyses written by Wanda Kendall, Stephen Webster, James Seager, and John La Fond, allow us to study the issues at hand more extensively. The information obtained through these studies and articles is linked and formatted almost exactly as Levenson's meta-analysis.

One of the first questions addressed by Levenson that is also addressed by some of the previously mentioned authors is the issue of who is a sexually violent predator. Levenson goes into detail about who is considered to be a violent predator and what this label means. She does not, however, define sexual abuse in her review, which is key considering that sexual abuse is the behavior of these sexually violent predators. Kendall does offer a definition in her analysis and goes into further detail about who is a sexually violent predator. Kendall defines sexual abuse as "referring to an individual perpetrating a sexual act against another person who is non-consenting, unable to consent, or too young to consent. Such sexual behaviors range from verbal and sexual harassment to fondling genitalia, rape, and sadistic sexual acts" (Kendall & Cheung, 2004). Kendall also discovers that sexually violent predators are repetitive in their behavior. Offenders are considered to be predatory because they are always on the hunt for their next victims.

The next issue addressed is civil commitment programs. The main areas of concern for the civil commitment programs are their goals, the cost, impact, and effectiveness. La Fond writes that one of the goals of civil commitment programs is that offenders be treated and monitored in the communities where they live thus freeing up resources, namely financial resources, needed to help sexually abused children or those who are at risk for becoming abusers themselves. Kendall offers up goals of the civil commitment programs from two different perspectives, the public health view and the treatment point of view. Kendall writes, "[f]rom the public health point of view, incarcerating these criminals will protect the public from harm. From the treatment point of view, simultaneous prevention and treatment programs planned with support from legislation will prevent later abuse" (Kendall & Cheung, 2004).

The next sub-topic discussed is the cost of civil commitment programs. Kendall's research coincides with Levenson's in that they both have found that civil commitment programs are expensive. Levenson discusses the one-year cost per offender in the states of Washington and California, whereas Kendall discusses the 10-year cost of implementing a new policy in the state of Illinois and found that it would be \$1,007,719,300.

The next area discussed is prediction of sexual offense recidivism. Many of the authors find meaningful research to add to Levenson's extensive review in this area. Segar finds that some programs have linked treatment with reduced recidivism but that the efficacy of the treatment in reducing recidivism is still unknown. Webster discovers that Marlatt and Fordon are responsible for creating the first model of relapse prevention. Relapse, as Webster also learns, is a four-step process, "the occurrence of a high-risk situation for which there is no coping response; decreased self efficacy (accompanied by a positive outcome expectancy for the sexually abusive encounter); a lapse, which leads the individual to anticipate the positive effects of the sexually abusive encounter; and finally a relapse" (Webster, 2005).

On the topic of prediction, Ron Langevin, Suzanne Curnoe, Paul Fedoroff, and Renee Bennet's study, "Lifetime Sex Offender Recidivism: A 25-year Follow-Up Study", is a significant piece of research. They first acknowledge the problems that have occurred in other recidivism studies, mainly the varying results from different studies. Problems occur due to the multiple criteria that fit the definition of recidivism. These criteria include: 1) sex offense re-convictions and 2) any new charge or arrest for sexual offenses (this includes any type of new conviction, any type of new charge, parole violations, and/or court appearances). Researchers have used one or all of the criteria but no two researchers use the exact same when conducting research. Problems also occur because sex offenses can be plea-bargained down to a lesser charge and fly under the radar of researchers. Another problem occurs due to the fact that police charges may be deceiving. A perfect example is, "a single charge of sexual assault may represent years of abuse of a single victim, while multiple charges of sexual assault may involve a single victim on a single occasion" (Langevin, Curnoe, Fedoroff,

Bennet, 2004). Problems also occur because group composition and sample size may vary over time in recidivism studies. Lastly, problems occur with low reported rates and short follow-up time.

For this study, Langevin and his colleagues have 2,124 sexual offenders who had been seen for psychiatric assessment from 1966 to 1999. For the follow-up portion of the study only 351 men were available. The different groups of men were: incest offenders, genital exhibitionists, extra-familial child sexual abusers, sexually aggressive, courtship disorders, and sexually polymorphous men. The mean age of the group was 31.7 years old and most participants were high-school dropouts. It was also discovered that the vast majority of the offenders (96.9%) were Caucasian. Langevin compiled the detailed criminal histories of all the participants and divided them into five different types of charges:

- 1) Sexual offences, including sexual assault indecent assault, and sexual interference;
- 2) violent offences that were not indicated as sexual, such as common assault, wounding, and homicide;
- 3) substance-abuse related charges such as driving while ability impaired;
- 4) property offences such as break and enter;
- and 5) other procedural offences such as failure to comply with a court order (Langevin et al, 2004).

He also looks at time in prison, time on parole, number of convictions, and number of court appearances.

Next, Langevin shares his results. Of the 351 men used for this portion of the study, they would have a lifetime total of 2,961 convictions over the 25 years, 38.7% labeled as sex crimes. The offenders were in court a total of 2,193 times over the 25 years, 37.5% because of sex offenses. Langevin also discovers that “the majority of men had reoffended within five years at large, 68.6%...and 74.2% acknowledged offending without any legal involvement with the authorities” (Langevin et al, 2004). Extra-familial offenders against children and exhibitionists showed the highest recidivist rates, about 70%, however almost all reoffended if their undetected crimes would have been included in the results. Finally, “a total of 88.3% of offenders would have been considered sex offense recidivists if they had been caught” (Langevin et al, 2004). These results could vary due to the fact that, as mentioned before, many sexual offenders have their

charges plea-bargained down to lesser charges. After looking at the research, one could predict that the vast majority of sexual offenders, if given the opportunity, will recidivate. It is because of this fact that Langevin suggests that future research cover a time span of over five years for the findings to be more accurate.

Another area that Levenson discusses in her literature review is the impact of civil commitment programs on sexual offense recidivism. To shed more light on the topic, a study done by Levenson, “Sexual Predator Civil Commitment: A Comparison of Selected and Released Offenders”, is a valuable tool. The purpose of this study “is to investigate whether sex offenders who are selected for civil commitment are indeed more sexually dangerous than those who are not selected” (Levenson, 2004). Levenson hypothesizes that those selected for civil commitment would be more likely to have been diagnosed with a paraphilia or antisocial disorder as well as having higher risk assessment scores and other factors linked to recidivism. The sample for this study consists of 450 adult males who were competent sex offenders. Of the sample of men, “222 were child molesters with minor victims only, 115 rapists with adult victims only, 99 mixed who had adult and minor victims...the vast majority of participants had extra familial victims (92%)... and nearly half belonged to a racial or ethnic minority group” (Levenson, 2004). The participants of this study went through the civil commitment program selection process discussed earlier: they are interviewed, evaluated, the court has probable cause that they will recidivate, and then they are taken under custody. The evaluators use the Static-99, the Rapid Risk Assessment for Sex Offense Recidivism, the Minnesota Sex Offender Screening Tool, and the Psychopathy Checklist-Revised to assess the mental capacities of all sexual offenders who are part of this study. These evaluations also include criminal history, diagnosis, psychosocial information, and risk assessment.

The results of Levenson’s study show that the selected offenders score significantly higher on their evaluation tests. Levenson also discovers that selected offenders “had younger victims than released offenders, higher numbers of victims... had prior treatment failure, used a weapon in the commission of a sex offense, had a history of a variety of sex crimes, and had

reported experiencing childhood sexual abuse” (Levenson, 2004). Although the percentage is small, it is significant to note that 5% of the selected offenders said that they intended to commit more sex crimes if and when they were released whereas none in the release group did. Levenson found that her hypothesis is supported in that evaluators select the worst sexual offenders to place in the civil commitment programs and that those who are part of the selected group are more likely to be diagnosed paraphilic or antisocial than the released group. This study aids in trying to assess how successful the civil commitment programs are, however; more research needs to be done. This is why Levenson suggests that “more research from states with sexually violent predator commitment statutes is needed, and ultimately, the effectiveness of civil commitment should be measured by its impact on sex offense recidivism” (Levenson, 2004).

The last area of discussion when dealing with civil commitment programs is evaluating readiness for release from civil commitment. John La Fond and Bruce Winnick offer insight into this area of discussion with their article “Sex Offenders and the Law”. They conclude that when discussing sex-offender risk assessment, “experts can provide useful information in predicting whether specific sex offenders are likely to reoffend and points out that experts are better at identifying which offenders are dangerous than they are in determining when these offenders can be safely released into the community” (La Fond & Winnick, 1998). They also conclude that actuarial prediction is better than clinical prediction when looking at the approaches to risk assessment.

Sexual Predators and the Law

The third and final area of discussion by Levenson and all the other authors is sexual predators and the law. The laws have just recently started catching up with the problems created by sexual offenders. Although our system has come far, it is significant to note that 37% of sex offenders will return to the system again and again and that the vast majority of sex offenders in custody are not and may not be incarcerated. Kendall discovers through her research that there are four categories of civil commitment laws:

First, the sexual psychopathic model: which is an alternative to criminal prosecution and is based on the premise that sex offenders are “mad, not bad” and therefore need to be treated, cured, and released. Second, the post-conviction commitment: treatment of the offender ensues instead of sentencing and indefinite confinement of persons determined to be dangerous offenders. Third, the mental health commitment: offenders are not criminally prosecuted but are committed for mental health treatment. This law also recognizes that sex offenders may not be psychotic. Fourth, the post-prison commitment: the offender must complete involuntary civil commitment after imprisonment (Kendall & Cheung, 2004).

In the literature, high recidivism rates have been discussed extensively and a few questions arise. What has the government been doing to prevent sex offenders from recidivating and what is protecting the communities from the sexual predators? There are two benchmark cases that have addressed these questions, one of which was discussed earlier in the review. The first of the benchmark cases, as discussed in Levenson’s meta-analysis, deals with community notification and children who are victims of sexual abuse. The brutal rape and murder of Megan Kanaka by a sexual offender in her neighborhood led to “Megan’s Law” being passed by President Bill Clinton in 1996. This federal law “mandated all 50 states to develop requirements for convicted sex offenders to register with local law enforcement agencies and to notify communities when a sex offender lives in close proximity” (Levenson, 2003).

However, notification laws are the cause of many problems for communities. Notification may give the community a false sense of security because only convicted sexual offenders are forced to follow this law. The public does not take into consideration how many of the sexual predators are members of their own families, close family friends, or other non-convicted sexual offenders. Another flaw of community notification is geography. The laws of notification “are typically restricted to the geographical community in which the offender resides, offenders can easily seek victims in communities other than their own” (Levenson, 2003). These laws also have negative

effects on the offender and the offender's family and friends and can lead to verbal and physical abuse of the offender, their friends, and/or their family. Another problem with notification is that so much money is going to these notification programs that treatment and prevention programs have suffered monetarily. Studies also show that "38% of citizens reported increased anxiety due to notification and the lack of alternatives for dealing with sex offenders living in communities" (Levenson, 2003). The notification laws also add work for the already exhausted law enforcement agencies. One of the sub-areas of notification-law research was recidivism. Levenson discovered that recidivism rates might be lower than the public thinks but also goes on to acknowledge that so many sex crimes go unreported that recidivism statistics may not be all that accurate. Levenson concludes that there has been no research suggesting that the community notification laws actually benefit communities, are an effective strategy, or reduce recidivism.

Kansas v. Hendricks, the second benchmark case briefly discussed earlier, deals with civil commitment programs. This case made it necessary for sexual offenders to be diagnosed with a mental disorder to be put into a civil commitment program. Hendricks had a long history of child abuse and was a perfect candidate for the Sexually Violent Predator Act mentioned earlier. Hendricks motioned for the petition of confinement against him to be dismissed on the grounds that his Constitutional rights were being violated. Supreme Court Justice Clarence Thomas wrote for the majority, "The Kansas Act requires a finding of future dangerousness, and then links that finding to the existence of a 'mental abnormality' or 'personality disorder' that makes it difficult, if not impossible, for the person to control his dangerous behavior" (Levenson, 2003) for that person to be justifiably entered into a civil commitment program and Hendricks fit the requirements.

Since then, civil commitment programs have been required in all 50 states and 16 states have "passed civil commitment laws providing for the continuous confinement and treatment of sexually violent offenders" (Kendall & Cheung, 2004). However, just as Megan's Law and notification laws have their fair share of problems, so do the mandatory

civil commitment laws. The sex offenders' liberty comes into question when dealing with civil commitment programs. Critics believe that sexual offenders who have been punished to the fullest extent of the law should regain their liberty and be released back into society, not forced into further confinement and incarceration. There is also an issue when diagnosing someone as 'mentally ill'. La Fond and Winnick discover in their research that "the courts that have upheld sexual predator laws have not yet provided a thorough and useful account of legal mental illness... What type of impairment should qualify as a mental disorder that would justify involuntary civil commitment?" (La Fond & Winnick, 1998). So as one can see, the United States government has made great strides in dealing with sexual predators but much still needs to be done to fix the pitfalls of the laws that have been passed.

Conclusion

The research is extensive when it comes to sexual predators, civil commitment programs, and the law. The research has shown that sexual predators are usually diagnosed as mentally ill with some form of mental abnormality or personality disorder. Because of that fact that they are in need of treatment. Treatment can be found in the civil commitment programs that are mandated by all 50 states. Research has also shown that sexual predators have a high recidivism rate. Almost all sexual predators, if given ample opportunity, will recidivate and it is unlikely that the proper authorities will catch them. It is because of that fact that communities need protection from these predators. Laws requiring sexual predators to notify their communities of their presence are one way of protecting the community. However, as seen through the research, there are many problems with the treatment programs, notification policies, and the laws that have been established to help sexual predators with their illnesses and to keep the communities safe from their abuse. It is because of these problems that more research needs to be done on sexual predators, civil commitment programs, and the law. Research needs to be done to verify that treatment programs prevent sexual offenders from recidivating. There has been no empirical research done that

has verified that treatment programs are the direct cause of low recidivism rates in sexual offenders. More research needs to be done to figure out how community notification statutes effect the communities and if these effects are positive or negative. More research also needs to be done to find out if community notification laws are reaching their intended goals, namely protecting the community from convicted sexual abusers by preventing sexual abuse of members of the community. The research available on community notification has found that sexual predators still abuse even after notifying communities of their presence and that notifying laws even lure the communities into a false sense of security. Research has shown that studies done on sexual predators need to be done over longer time periods to get more accurate results. Sexual offenders have been shown to recidivate within the first five years of release from the civil commitment programs. The number only increases as time goes on. Most research done on recidivism has a time frame of five years or shorter. This excludes imperative information about the many sexual offenders who recidivate after five years or of the sexual offenders who continuously recidivate after the time frame allotted for the study.

More research needs to be done to find other ways of treating sexual offenders besides mandated civil commitment programs that may or may not effect recidivism rates. The research presented has shown many holes when it comes to studies done on sexual offenders, civil commitment programs, and the law. These holes lead to many questions but these next few in particular: 1) Are civil commitment programs the direct cause of lower recidivism rates of sexual offenders? 2) Are community notification programs reaching their intended goals? 3) What other programs can be implemented to better treat sexual predators?

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Stem Cell Research: What the Cell is the Controversy?

Humpty-Dumpty sat on a wall; Humpty-Dumpty had a great fall. All the king's horses and all the king's men couldn't put Humpty together again...but stem cells sure could. However, American eagerness to formulate generally uneducated opinions regarding sophisticated and complex issues such as stem cell research often scribes disaster for the minds behind the technology. This, when coupled with government willingness to pass legislation representing "the people" (however uninformed), leads to unnecessary restrictions on a powerful medical tool like stem cell advancement. Because American society as a whole including the government is ignorant on scientific matters such as stem cell research, only experts at the helms of privately funded corporations should make decisions regarding this issue. The federal government should lift its restrictions, thereby permitting the pursuit of both embryonic and adult stem cell research, and support current endeavors toward the collection of umbilical cord blood for research purposes, or the United States will fall further behind other nations.

By definition, "a stem cell is a non-differentiated cell that can divide and multiply in its undifferentiated state, but which can also give rise to more specialized differentiated cells" (Holm 494). Incredible controversy has arisen in the U.S. specifically over embryonic stem cell research. Human embryos contain "the most powerful stem cells," as these totipotent cells "have the potential of transforming to any type of cell" and therefore contain by far the most potential of the three types of stem cells—embryonic, adult, and umbilical cord blood cells

(Toh Keng Kiat 89). Robert Klein, head of the 2004 Proposition 71 campaign to fund stem cell research in California, stated that even as we wait for stem cells to be "perfected, they'll dispense potent medicine hope" (McManus 159). Unfortunately, we can never be certain of a "correct" answer when discussing ethical questions and morals; we can only do what is best for the majority. A majority of our population does stand to profit from stem cell research, and "helping many, many individuals is justification for taking a single cell [...] and using it to benefit more individuals" (McManus 170). However, stem cell research progress has been stalled in our nation since critics of the research President Bush included wield more power over science than the scientists themselves because of political, legal, and ethical debates freezing the progress of researchers.

Conservatives opposed to embryonic stem cell research favor a ban on the use of human embryos for research, arguing that "human beings in their earliest stages have the same right not to be killed that children and adults do" ("Stem" 12). These individuals base their beliefs on a literal interpretation of the Bible ("whatever you did [to] one of the least of these [...], you did [to] me"), with fears of organ farms and indestructible cloned armies fueling their crusade (Concordia, Matt. 25.40b). A prominent theory among naysayers is that of the classic slippery slope. Opponents to stem cell research fear "that allowing this would put us on a slippery slope towards reproductive cloning" (Holm 500). In the UK and "a number of other European countries," the "political reaction to the perceived slippery slope [...] is seen as a possible threat to the positive development of stem cell research," while being perceived by the U.S. government as a "possible tool to justify the prohibition of stem cell research [...] as part of a more comprehensive ban on all kinds of human cloning" (Holm 501). What challengers to stem cell research fail to recognize, however, is that "the potential to become something (or someone) is hardly the same as being something (or someone)" (qtd. in McManus 169). Jonathan D. Moreno, Kornfeld Professor and Director of the Center for Biomedical Ethics at the University of Virginia, summarizes the "standard argument" for the employment of "the hundreds of thousands" of unused embryos still in

fertility clinics: The embryos “could be freely donated, and they will never be implanted so will never be in a position to continue to develop” (Moreno 3). He also explains critics’ assertions that “there is in this argument a suppressed appeal to a notorious premise that these leftover embryos ‘will die anyway,’” somehow thereby associating “the feared massacre of human embryos in fertility clinics with a previous holocaust,” but an embryo becomes a human being and is given life in a mother’s womb, not in a test tube or Petri dish (Moreno 3).

On November 7 of last year (2006), Missouri voters passed Amendment 2, the Missouri Stem Cell Research and Cures Initiative, with support from 51.1 percent of the electorate (about 45,000 votes) despite the pronounced efforts of those opposed. One Lutheran church’s newsletter told the members of its congregation to vote against the amendment in the election, describing the wording of the initiative as “deceitful” and citing Proverbs 15:4 as a supporting verse: “The tongue that brings healing is a tree of life, but a deceitful tongue crushes the spirit” (St. Paul). In fact, the main arguments against Amendment 2 came from churches and specifically targeted the vocabulary of the initiative with regard to cloning and “ambiguous language about unborn human life (e.g. ‘the product of fertilization’),” stating it would “[open] the door for unlimited taxpayer funds to be used for the cloning and destruction of human embryos” (St. Paul). The Missouri Roundtable for Life called the cloning initiative “the boldest attempt ever to highjack the legitimate processes, procedures, and functions of representative government in Missouri,” further asserting that “its basic mechanism is a language structure [...] designed to defeat the casual reader by reversing reasonable inferences about the text in subsequent subsections” (St. Paul). The main point of interest in this particular pamphlet and countless other pieces of religious propaganda against the amendment is the lack of definition of the origin of life (when it begins, what is considered a “human being,” etc.) or a substantial argument against stem cell research itself, topics which many individuals debate. The difficulty lies not in stating one’s position but in defending that position with solid facts, which the church failed to do.

Along with substantial campaigns against the Missouri

Stem Cell Research and Cures Initiative came many proponents of this amendment, using scientific data and the experiences of others as support for their standing. Over 100 non-profit patient and medical groups supported a “yes” vote on Amendment 2, including the American Association for Cancer Research, American Diabetes Association, Christopher Reeve Foundation, Muscular Dystrophy Association, and Society for Women’s Health Research (Why). The medical conditions for which stem cells could provide cures “affect hundreds of thousands of Missourians including a child, parent, or grandparent in over half of all Missouri families” (Why). It is those hundreds of thousands of people in one state alone (not to mention the rest of the nation, the world, and the afflicted yet to come) that justify using tiny, non-human bunches of cells grown in tubes and dishes to assist in the discovery of cures for diseases inflicting pain and death on living, breathing, feeling human beings.

Jeff McCaffrey is a business major at the University of Missouri-Kansas City. He played football as a college freshman at the U.S. Air Force Academy when he was paralyzed in a car accident. Now in a wheelchair, he is “rallying students” and has helped found the Student Society for Stem Cell Research, UMKC chapter, the “first student-organized stem cell advocacy group in Missouri,” for the “cause that may have him walking again” (“UMKC”). The mission of the SSSCR is “to educate, advocate, and act on public policy affecting medical stem cell research” (“UMKC”). Similarly, retired Missouri U.S. Army veteran Colonel Stanley D. Brown remarked during the campaign for the Missouri Stem Cell Research and Cures Initiative, “When I talk with injured soldiers back from Iraq and Afghanistan, sometimes the only smile I receive is when I speak of the medical research being done to repair or replace damaged spinal cord nerves,” the same kind of treatment that could in the future help Jeff McCaffrey walk once again (Why). Matt LaVanchy, a fire fighter, also reasons in favor of stem cell research with the following: “Stem cells could provide cures for diseases like muscular dystrophy and new treatments for severe burn injuries that affect thousands of fire victims and fire fighters” (Why). They those suffering with muscular dystrophy, Alzheimer’s, sickle cell disease, ALS, lung diseases,

or diabetes; those who are paralyzed; burn victims; and so many more are the ones we think about when we think of stem cell research and all it has to offer (Why). The bundles of cells in a laboratory are not people; they are not even comparable.

The potential to develop into a life is hardly the same as a life itself, evidenced in the process of somatic cell nuclear transfer (SCNT), part of the “human research cloning protocols” of several acclaimed scientific teams from around the world (Hyun and Jung 34). In this procedure, the nucleus of an unfertilized human egg is replaced with the nucleus of an ordinary patient-specific human cell and used to “develop a blastocyst-stage embryo that is genetically identical to the patient cell donor” (McManus 158, Hyun and Jung 34). These altered human stem cells are then cloned (McManus 158). However, “like the stem cell [‘soup’] more generally, the idea of using the products [human blastocysts] of SCNT to generate lines of human embryonic stem cells has thrust a remarkably esoteric matter into the political scene” (Moreno 3). When broken down into its basic parts, however, the issue becomes uncomplicated and more black-and-white.

Fundamentally, this newest breakthrough clearly poses an unembellished challenge to the conservatives’ position that embryonic stem cell research ends human lives. With the explanation that “every human cell contains the genetic information to create a new human being, the old arguments for preserving ‘unique’ human embryos fade away” (Singer 40). Obviously, “if mere potentiality to develop into a human being is enough to make something morally human, [...] then every human cell has a special or inviolable moral status, a view that is patently absurd” (McManus 170). The opposition, however, argues that “the use of a neutral expression [somatic cell nuclear transfer] deliberately obfuscate[s] what [is] ‘really going on’” and accused the California Stem Cell Research Initiative sponsors of “deception,” though the name of the process does actually describe exactly what is “really going on” (Moreno 3). Debates on the power and philosophy of language should be left out of science. We have the abilities to think, learn, and create in order to use them, not sit idly on them.

Another goal of embryonic stem cell research has been to discover a method to make these stem cells created

through SCNT reproduce without differentiating and then direct their cellular development, thereby eliminating some of the hullabaloo surrounding the use of actual human embryos (Cohen 240). This could be achieved through therapeutic cloning, or stem cell expansion. SCNT is, after all, part of a broader area of study known as “human research cloning.” Lest we turn ghostly pale at the word “clone,” interim president and neuroscientist Zach W. Hall of the University of California, San Francisco School of Medicine assures us that “no, we’re [not cloning human beings]; we’re taking the cells out at a very, very early level of development and cloning cells” (Lehrman 40). When stem cells divide, they “create one copy of themselves (daughter cells), and start differentiating into specialized cells” (Toh Keng Kiat 92). Stem cell expansion would “create daughter cell after daughter cell without also differentiating” (Toh Keng Kiat 92). Nonetheless, additional ethical queries arise from the possible abuse of cloning’s extensive replication capabilities.

Here we make the distinction between “reproductive cloning (to make a baby that’s genetically identical to the donor), which almost no one favors, or therapeutic cloning (to isolate and harvest its stem cells) to advance the field of regenerative medicine” (McManus 158). We cannot prohibit all cloning “just because its therapeutic applications could be misused. Even Michael Jackson’s face doesn’t get plastic surgeons arrested” (McManus 169). In 1998 “researchers at the University of Wisconsin published a method for deriving and culturing human embryonic stem cells indefinitely,” making possible the creation of “stable human stem cell lines” and “[generating] (in principle) unlimited quantities of any particular embryonic stem cell” (Holm 494). The results of therapeutic cloning would be these stem cell lines, “something that is self-renewing, that you can perpetuate indefinitely,” though “researchers will need hundreds possibly thousands of lines to provide genetic matches for the entire population” (Bruck 13; McManus 161). Stem cell lines would allow for both the standardization of “research into human stem cells” and the creation of “reproducible stem cell therapies” (Holm 494). Today, however, only a few are in existence in the United States.

An inevitable consequence of the attempted development

of viable stem cell lines is the need for ova. Even for the process of somatic cell nuclear transfer, many unfertilized eggs are required, just as in more common and accepted fertility treatment procedures. The result of this need for ova is the “harvesting of multiple eggs,” achieved through ovarian stimulation, “an invasive and uncomfortable two-stage process requiring many clinic visits, multiple injections of hormones, and minor surgery,” at the end of which the “mature eggs are then collected [...] for use in in vitro fertilization or in research” (Beeson 574). This can be harmful to the women who undergo the process, which has led to an occasionally unenthusiastic conclusion.

A number of individuals fear that “egg harvesting” is becoming a serious problem and is “threatening [to] women’s health” (Beeson 573). Young women are “being asked to donate or sell their ova, not only for use in fertility clinics, but increasingly for non-clinical use in experimental cloning research” (Beeson 573). Egg collection for stem cell research is “being conducted in the context of an international race for dominance in and commercialization of the production of embryonic stem cells and related products,” which some do not judge to be a defensible rationale for the process considering the alleged threats to women’s health in egg harvesting practices (Beeson 573).

These individuals believe the “risks of egg harvesting [...] do not receive adequate attention” but are instead obscured by “a research climate marked by conflicts of interest; the misleading use of language to describe research goals; and a commercial push that may lead to the exploitation of young women” (Beeson 573). The “conflicts of interest” refer to the fact that “some physicians who harvest eggs are also involved in stem cell research,” a problem when “clinicians have an interest in obtaining their eggs” (Beeson 574). Some also feel that the emphasis in opposition to embryonic stem cell research should center less on “the moral status of the embryo” and more on “other important ethical issues raised by women’s health advocates,” such as egg harvesting. The fact of the matter is these women are going to make that exceedingly personal decision based on their own individual financial situations, beliefs, and wishes (Beeson 574). Those are variables for which no physician can account or alter independently of the woman willing to submit herself

to the procedure. For that reason, the risks of egg harvesting should not factor into the debate over stem cell research as long as women are receiving a full-disclosure risk-benefit analysis before undertaking such a commitment. These women are aiding in the development of therapies that may someday save their own lives. When much of the contentious work such as settling debates like this one is finished, scientists can continue progressing toward cures and treatments, uninterrupted.

However, scientists must first finish this litigious work before they can move forward with therapies, and government restrictions under President Bush’s plan are seriously inhibiting their progress. President Bush believes that embryonic stem cell research crosses a moral boundary, stating he “oppose[s] federal funding for stem cell research that involves destroying living human embryos” (“AASP”). In a feeble attempt at compromise, he announced his plan on August 9, 2001, limiting federal funding to 64 “genetically diverse” lines he claimed existed worldwide, created before the implementation of his policy (“AASP,” “Time” 11a). By 2004, many called for a reform of the President’s policy as reports concurred “the original number of embryonic stem cell lines deemed available for federal research in August 2001 had been overestimated and many of those cell lines were perhaps unsuitable for research,” all having been “tainted by animal products used to help them grow in the laboratory. They may be useless or even dangerous in treating humans, a study published in January’s *Nature Medicine* found” (“AASP,” “Time” 11a).

In addition, they are far from “genetically diverse,” most being from “people who tend to use in vitro clinics—the white, the infertile, the affluent” (McManus 161). While the affluent may at first be the only ones with the means to afford stem cell research treatments and therapies (and therefore be unaffected by the limited number of therapies with the potential to develop now), one must take into consideration the fact that these are more than cosmetic issues. As with many types of cancer, as treatments are more common and better understood for the often life-and-death diseases embryonic stem cell research can address, insurance and individuals will be able to pay for them. They could at the minimum be an option, but the President, in his patchy comprehension of the subject matter on which

he unhesitatingly adjudicated a conclusive verdict, has built an impenetrable Great Wall for American scientists, needlessly handcuffing them with an absence of utilizable stem cell lines.

Fortunately, embryonic stem cell research is not the only type of collection method available today; adult stem cells are a second alternative. These more “traditional” cells “are collected from the bone marrow and peripheral or circulating blood” of the person needing the treatment or transplant “so as to avoid rejection” (Toh Keng Kiat 89; Cohen 240). The chief advantage of adult stem cell research is the “diminished or minor ethical concerns expressed by most individuals,” but this merely masks greater worries of decreased possibilities for both the research and the nation (Cohen 240). Adult stem cells are much less versatile than embryonic; therefore, scientists are certain that “embryonic stem cells will have broader therapeutic applications” (Madden 34). Moreover, adult stem cells are “difficult to maintain [...] in long term culture,” further tapering their potential, yet even the narrow applications of adult stem cell research have made it valuable (Cohen 240). Nonetheless, embryonic stem cell research clearly stands to benefit a significantly larger group of people.

A third and relatively new means of stem cell collection is umbilical cord (or placenta) blood. When the baby is born, the doctor extracts the blood still present in the umbilical cord and placenta (Toh Keng Kiat 90). The blood is then “cryogenically stored for future use” (Toh Keng Kiat 90). Like adult stem cells, however, umbilical cord blood stem cells are “multipotent,” i.e., incapable of “[generating] all cell types” (Toh Keng Kiat 89). In addition, “the cost would be phenomenal” and its justification questionable “considering the very small proportion of placentas that would be used ultimately” (Cohen 240). Another disadvantage of cord blood stem cells is because of their relative primitiveness, “the engraftment process takes longer, leaving the patient receiving the transplantation at risk of infection for a longer period of time” (Toh Keng Kiat 91). This could prove fatal in certain cases, thereby defeating the total purpose of such a treatment.

One final problem with umbilical cord blood collection is the limited sample size, “usually barely enough for just one

treatment” (Toh Keng Kiat 92). Scientists are therefore searching for a way to increase sample size without altering the cells at all. They may have found their answer in the technology of Boston-based Cyomatrix LLC, whose “core technology is a unique, patented, three-dimensional cell growth bimetallic matrix called Cyomatrix, a proven platform for cell growth” (Toh Keng Kiat 92). The Cyomatrix material “looks and feels like bone marrow,” in which stem cells “normally reside and expand” and may be useful for enhancing “production of human T-cells, a critical component of the immune system” (Toh Keng Kiat 92). The abilities of the material have “implications in treatments for cancers, immune disorders, viral or bacterial infections, and other conditions that are today proving drug resistant” (Toh Keng Kiat 92). Still, adult stem cell and umbilical cord blood stem cell transplantation each present problems, but even with their disadvantages, as of mid-2003, 72 diseases, including leukemia and Hodgkin’s disease, were deemed treatable with them, which when compared to 45 in 2002 is a promising statistic (Toh Keng Kiat 90). Nevertheless, treatments developed from umbilical cord blood and adult stem cells compose less than half of the number of diseases embryonic stem cell research would address, among them various forms of cancer, diabetes, cardiovascular disease, rheumatoid arthritis, spinal cord injuries, autoimmune disease, allergies, and neurodegenerative diseases such as Parkinson’s and ALS (Bruck 21; “Disease” 787; Passier 11). First, however, the debate must be settled before we can use these technologies to their fullest potential.

The United States should not be willing to let a controversy such as the one presently enshrouding embryonic stem cell research stall our scientific progress, regardless of the limited benefits we are reaping from the two unrestricted collection methods. In the past, “it was [...] against the law to examine dead bodies to help our understanding of ourselves” (Cohen 240). Another obstacle comes with the fact that many Americans are unaware of the various stem cell collection techniques and the ensuing research, which often leads to tenuous scorn or dismissal of this developing medical tool. The phrase “stem cell research” has, in fact, become a false substitute for embryonic stem cell research because of the

extensive publicity allotted that particular specialty of the much broader field. The blame for this fundamental misattribution falls primarily on the scientific community, with the media and uninformed individuals also sharing part of the responsibility.

Our population is constantly inundated with scientific claims. With advertisements ranging from scientific-sounding shampoo billboards to the assertion that Cheerios are “good for your heart” and “can help lower your cholesterol,” members of the general public, typically devoid of any scientific training beyond high school biology, are “easy prey to the pseudoscientific” (Speed Weed 271). Once a declaration such as this presents itself, we are all too eager to scramble for the “guaranteed” product for weight loss, silky hair, or wrinkle-free skin, albeit without any definite comprehension of its actual capabilities. Perhaps the hope for an increased quality of life drives us toward current fads, or perhaps the mere intrigue of the unknown propels us closer to this “miracle” merchandise. In a study by the National Science Foundation, “fewer than half of American adults polled (47 percent) knew that the earth takes one year to orbit the sun,” yet Americans claim to be “all ears about science: 90 percent of respondents were moderately or very interested in new scientific discoveries” in a 2002 National Science Board survey (Robinson 68; Speed Weed 272). This proves a frightening statistic when juxtaposed with our real understanding of an area that supposedly intrigues us.

Many Americans find themselves in a familiar situation regarding scientific issues with a solid opinion but little background or knowledge of the science regarding the subject yet we value the opinions of the citizens in this nation, and we consider those when formulating policies, especially on controversial issues. In a nation where celebrity pet pampering and reality television shows have overtaken actual newsworthy information, scientists still depend upon society for their privileges (Quimby 163). With a discovery as momentous as that of somatic cell nuclear transfer, one would believe that it would be “front-page news” in American media, yet the coverage has not been quite up to par. Human nature causes us to have a difficult time admitting when we have fallen behind. We know we should have made the breakthrough first or at least be well on our

way. Popular media, with all its scandalous exposés, is in a way sheltered. Celebrities’ newest cosmetic surgeries often trump science because it clears both the reporter’s and the average person’s head with a healthy margin. We tend to brush science off as “boring” or “unimportant” until it affects us personally. We sometimes take advantage of the opportunities afforded us and leave it to someone else to educate us instead of “home-schooling” ourselves. In all actuality, “a true democracy cannot exist without a fully and accurately informed voting public” (Missouri). This illustrates the ironic ignorance of Americans, though not all accountability lies with the media and the public.

In addition to these individuals who neglect to take a step beyond popular media and inform themselves about topics ranging from potentially useless or even detrimental health supplements they are currently taking to pressing scientific issues like stem cell research, a weighty portion of the blame descends on scientists themselves. Undoubtedly, much more is at stake than the size of one’s thighs or a flawless complexion with respect to stem cell research. The final step of the scientific method is to report and share results, yet the experts often express timidity at making their findings known. In the United States, “scientists are still doing groundbreaking work with mouse stem cells, [...] reluctant to move to human cells, where the real scientific and commercial payoff lies,” mostly because of “lack of funds and the constant threat that such an approach could be banned” (Carey, “Stem Cell Wars”). This hesitation might also be a result of the plausible belief that the citizens have no desire to hear about the latest discoveries, or knowledge that their “cult of men in white coats” is “tolerated only on its best behavior” (Quimby 162). A minority of fanatics’ noisy opposition fuels their apprehension.

To quell both the animosity and the anxiety, the blinkered public must learn to put its faith in the well-educated men and women of science in our country and allow them to “call the shots” they are perfectly capable of calling regarding stem cell research. The value of our currency is based on faith; surely, we can trust highly intelligent individuals educated in our own schools and universities to make only the best decisions for us. Using history as a guide, no one voted when George Washington crossed the

Delaware, yet the situation ended as well as we had hoped. On a more modern note, the Food and Drug Administration does not ask people for their opinions when considering approval of a new prescription medication. We, in turn, take the word of this panel of learned and skilled authorities, for they are experts in their area. Stem cell researchers are no different concerning their focus than FDA specialists with regard to their business, but we habitually accept the latter's often far-reaching judgment without question. We should begin to show the scientific community in the discipline of stem cell research the same respect and allow them to make important decisions such as which avenues to chase with research and how best to turn their findings into cures and therapies for diseases.

Since we cannot hope to educate everyone fully on the matter, the debate will undoubtedly persist for years, especially in the most conservative portions of the United States. As with the creation versus evolution debate currently plaguing our nation, we will never satisfy both sides. Instead, we should recognize the right of the scientific community to "do its job" and pursue stem cell research; likewise, the public may exercise its right to refuse treatment. One potential consequence, however, would certainly be hypocrisy. While "not all conservative Christians attack science and reason while gorging on their fruits, [...] the fanatical fringe surely does" (McManus 161). Invariably, those that vehemently contest the research now will be some of the first to "take a ticket" as cures and therapies develop for debilitating diseases, particularly those that typically affect the elderly, when they or their loved ones are forced to choose between a double standard and death. By 2040, "an increasing proportion of the population in developed countries will be more than 75 years old and thinking about how their lives will end" (Singer 41). We must act now to aid these individuals in the near future.

Though the United States House of Representatives passed the Stem Cell Research Enhancement Act, legislation calling for "increasing federal support of embryonic stem cell research" on May 24, 2005, President Bush eventually vetoed it, keeping "the stem cell landscape for now [...] at status quo" ("AASP," "House" 5). To avoid this controversy over federal public funding of research the entire public does not support, private

corporations with scientific experts in stem cell research leading the way should finance the endeavor (though federal funds would certainly be advantageous). Currently, individual states and private companies head the field in America. A prominent paradigm is California, where citizens "voted to spend \$3 billion over ten years" in state funds in November 2004 with the passage of Proposition 71 (Carey, "Stem-Cell Also"). Connecticut, Illinois, and Maryland were quick to follow "with funding initiatives of their own" ("AASP"). Similarly, "New Jersey has dedicated \$11.5 million for its own stem cell institute, with another \$380 million in the works" (Lehrman 41). Also, the aforementioned Missouri Stem Cell Research and Cures Initiative passed recently. Some states, however, are either unable or unwilling to fund stem cell research institutions in their respective jurisdictions. This is where private resources enter the scene.

Stem cell research advocates need not to worry about lack of funding should the industry go entirely private, for a plethora of informed philanthropists would earnestly pour funds into such a cause. They fear that "state and federal threats to ban much of the research are hindering the pace of research in America" (Carey, "Stem-Cell Also"). Robert Klein himself donated \$2.6 million to the California Institute for Regenerative Medicine (Lehrman 40). Another example is the Harvard Stem Cell Institute, which "has raised \$30 million from foundations and private donors, and is creating its own stem-cell lines" (Carey, "Stem-Cell Also"). Andy Grove, the chairperson of Intel, gave the University of California, San Francisco, a \$5 million grant for the establishment of a Developmental and Stem Cell Biology Program (Gershon 929). The resources are indeed available, even and particularly in the private sector, but this does not atone for President Bush's lack of support for American scientists.

The President's discouragement for our men and women of science, evident in his restriction on federal funding for stem cell research, has caused an inopportune paucity of both scientists and funding in the United States. In Korea, for example, the estimates of annual spending on embryonic stem cell work are "more than \$100 million" (Carey, "Stem Cell Wars"). The Juvenile Diabetes Research Foundation "now gives two thirds of its grant money for embryonic stem cell research

to foreign scientists” (Carey, “Stem-Cell Also”). Most progress today comes from other nations as the United States struggles to stay “in the game,” let alone “the unchallenged lead” (Carey, “Stem-Cell Also”). In 1998, “nearly 60% of the papers in the field were written by U.S. scientists” (Carey, “Stem Cell Wars”). As of July 2006, “the percentage [was] below 30%” (Carey, “Stem Cell Wars”). Cloning expert Jose Cibelli, professor of animal biotechnology at Michigan State University, testifies that the bill “is like getting a foot in the door and trying to open it a little, when other countries are building huge gates” (qtd. in Carey, “Stem-Cell Also”). Because additional cures to those already in existence will undoubtedly take much time to develop, we must begin exponential progress immediately. Apparently, we are the only powerful nation with the “hang-up” on saving lives.

The field of stem cell research was “pioneered in the U.S. and American researchers were the first to create long-lived cultures of stem cells, [...] in 1998, and the scientific community immediately saw vast potential,” yet people are now leaving the world’s scientific superpower for treatment in countries like Korea, Britain, and Japan (Carey, “Stem-Cell Also”). The divergence is due in part to different religious beliefs. For example, “in Jewish and Islamic law, a developing embryo [does not] become human for forty days – well within the time frame in which embryos would be used for therapeutic research” (McManus 170). Certainly, this eliminates the controversy over embryonic stem cell research for some nations.

Another important distinction is a generally “more liberal and favorable research [environment] for the field” in countries such as the United Kingdom, Australia, China, India, Israel, Singapore, and Sweden (Gershon 928). Countries like Korea and Britain “explicitly allow the creation of new human embryos as a source of stem cells,” but this does not make them any less “decent” or moral (Carey, “Stem Cell Wars”). The U.S. slips to the back of the pack as “foreign labs [announce] a series of major breakthroughs, developments that move scientists a step closer to cures for a range of illnesses,” and the U.S. “could lose out on the eventual commercial applications to companies in [...] other countries that are rushing ahead with the research (Carey, “Stem-Cell Also”). Cibelli states, “We’re

really in the Dark Ages” (qtd. in Carey, “Stem-Cell Also”). We have the potential to become an even more outstanding nation because of technological and scientific advances such as this; we are the only ones holding ourselves back.

The controversy over stem cell research – specifically embryonic – is nothing short of disastrous, its effects comparable to a successful protest of the automobile. We rely heavily on our vehicles (many of which come from outside the U.S.). A boycott would be not only outrageous but also counterproductive, yet we are doing exactly that to stem cell researchers. “American ignorance is driving public affairs,” with the scientific community, the media, and blasé individuals to blame (Robinson 71). We live in a nation where abortion is a perfectly legal option in some states, yet we do not give our embryonic stem cell researchers a solid foundation on which to build cures, treatments, and therapies for diseases from which millions of Americans suffer. We only stand to gain from stem cell research. By lifting its restrictions, the federal government could demonstrate support for our scientists in their efforts to “catch up” to the rest of the world, whether publicly or privately funded. We, as citizens, should also back the exceptional minds behind the research, but we must first take a serious interest. Stem cell research could give Humpty-Dumpty another chance. To an America sick with illiberality, get well soon.

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