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EDITOR'S INTRODUCTION

During the summer break an opportunity to go back and reread past issues of the *Wagner College Forum for Undergraduate Research* presented itself. Although many of the articles are not in our respective fields, we can honestly state that they represent fine scholarship and are enjoyable to read. Hence, we would like to extend our sincere thanks to all who contributed to the success of the first three volumes. For those of you new to this publication, a section containing an index to past papers and abstracts can be found at the end of this edition.

The Wagner Forum for Undergraduate Research, now in its third year, is an interdisciplinary journal which provides an arena where students can publish their research. Papers are reviewed with respect to their intellectual merit and scope of contribution to a given field. To enhance readability the journal is typically subdivided into three sections entitled *The Natural Sciences*, *The Social Sciences* and *Critical Essays*. The first of these two sections are limited to papers and abstracts dealing with scientific investigations (experimental and theoretical). The third section is reserved for speculative papers based on the scholarly review and critical examination of previous works.

As has become a tradition, the abstracts of papers and posters presented at the Eastern Colleges Science Conference have been reprinted and placed in a special section. The conference, which was held in Riverdale, N.Y. on April 2-3, is the largest undergraduate research conference in the United States. Wagner College has, in recent years, played a major role and been recognized for the outstanding work contributed by its students and the faculty who supervised their research. Congratulations to all who have created an environment conducive to the pursuit of knowledge and the exploration of new ideas.

Gregory Falabella and Richard Brower, Editors

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Section I: Eastern Colleges Science Conference

Synthesis and In Vitro Analysis of Iron (III)-Based MRI Contrast Agents[1]

Dawn Pothier (Chemistry) and Dr. Nicholas Richardson (Chemistry)

MRI tumor detection by traditional contrast agents has proven difficult due to rapid excretion from the blood pool. However, a contrast agent that can reversibly bind to a macromolecule in the blood, such as human serum albumin (HSA), will remain in the blood pool for a longer amount of time. In addition, macromolecular binding can decrease spin-lattice relaxation times(T1) due to the Proton Relaxation Effect (PRE), allowing for enhanced differentiation between vascularized and non-vascularized tissue, and improved detection of tumors. A homologous series of ligands, all candidates for HAS binding, was synthesized and coordinated to iron(III). The relaxivities of the iron(III) complexes in water and HAS solutions were determined by use of a 20 MHz minispec.

A Study of Pendulum Oscillation

Victoria M. Lynch (Physics) and Dr. Otto Raths (Physics)

Since the time of Galileo, the periodic motion of the pendulum has fascinated physicists. Our paper presents period measurement data for a 2-meter and a 13-meter pendulum, the longest ever constructed at Wagner College. Using period data, precise statistical values of the acceleration due to gravity (g) were calculated and will be presented.

Complex Ice Accretions on Aircraft Wings

Nicolas Rada (Physics) and Dr. Gregory Falabella (Physics)

Last year the disastrous effects of ice accumulation on aircraft were explored through an experimental approach. A generic icing horn carved out of soap was employed. In actuality the shape of the ice formation varies considerably depending on ambient conditions and flight parameters. As a result, a comprehensive study involving several different ice accretion shapes was undertaken. Creating durable facsimiles of many different ice accretion shapes necessitated the development of a new procedure. It entailed using a digital 3-D model to produce a mold in which melted soap reinforced with glue is poured and frozen overnight. Preliminary data is encouraging and indicates that loss of lift is most severe when the ice juts from the surface at a sharp angle.

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[1] Recipient of Excellent Quality Presentation Award

Getting the Message Across: A Growing Demand for "Good" Codes in the Information Age[2]

Carolyn Palinkas[3] (Mathematics)

To ensure that data is transmitted accurately and efficiently over noisy channels, one must implement "good codes" – codes that reveal unaltered messages, once decoded. In this study, "good codes" are created using functions that operate like matrices over algebraic structures known as near-fields. Several forms of these codes are established and implemented, with the number of parameters varying. Systematically, a comparative analysis is conducted on the "matrix-like" functions using the programs GAP4 (Groups, Algorithms and Programming) and SONATA (Systems of Near-rings and their Applications). Current results in the area are minimal, and the findings of this study may be used to advance these results and to help prove new theorems showing the existence of inverses of "matrix-like" functions over near-fields.

Preferences for Same-Sex Shoaling in Zebrafish (Danio Rerio)

Janette Lebron[4] (Biology)

The zebrafish (Danio rerio) is a model organism in genetics and development. However, little is known of its normal behavior. We quantified zebrafish shoaling by comparing time spent by test fish near stimulus fish to time spent near an empty compartment at the opposite end of a narrow tank. Only visual cues were available. Test fish spent significantly more time near stimulus fish than near the empty compartment, in both same-sex and opposite-sex pairings. In both males ($p<0.025$) and females ($p<0.05$), shoaling was significantly more frequent in same-sex than in opposite-sex pairings. We have confirmed this preference for members of the same sex by giving fish a choice between groups of males and females. However, our experiments took place in the afternoon, while zebrafish spawn in early morning.

[2] Recipient of Excellent Quality Presentation Award
[3] Research performed under the direction of Dr. Mark Farag (Mathematics)
[4] Research performed under the direction of Dr. Brian Palestis (Biology)

Reversing Emotional Eating by Use of a Relaxation Technique

Lindsay B. Halperin (Psychology) and Dr. Laurence J. Nolan (Psychology)

Studies have demonstrated that inducing stress in an experimental setting can cause emotional eaters to consume larger quantities of food. Studies conducted on stress management have indicated that certain relaxation methods including listening to music can lower stress. In this study, we attempted to reduce stress-induced eating in emotional eaters in the laboratory by playing a classical music selection after a stressful activity and before food was presented. Meal size in this group was compared to two no-relaxation control groups: one which was provided with food immediately after the stressful activity and another which was given food after a delay comparable to the time taken to play the music.

Improving the Calorimeter Cup

Anna Arkhipova (Physics), Jared Jax (Physics),
Michelle Bingham (English) and Dr. Gregory Falabella (Physics)

The calorimeter cup, used to measure heat transfer, is an important piece of equipment in many areas of the physical sciences. Our laboratory experience has indicated that the design of the standard model used in many undergraduate laboratories is flawed and leads to significant inaccuracies. Despite its double wall, heat escapes (or enters) from the surroundings. The current research is an attempt to improve the design without adding to its cost. Through experimentation we discovered that free convection cycles in the top portion below the cap are responsible for most of the heat loss. To alleviate the problem the cap was modified. Preliminary findings suggest that the new design, although subtle, is a substantial improvement.

Stigma Against Mental Illness[5]

Kara Edgren (Psychology) and Dr. Amy Eshleman (Psychology)

"The mentally ill are disliked to a surprising degree" (Farina, 1971). Mental illness carries a deeply discrediting social stigma. The present study explores acceptance of these stigmatizing beliefs among college students and psychiatric patients. Participants

[5] Recipient of Excellent Quality Presentation Award

completed the Mental Illness Stigma Scale twice. College students completed the questionnaire from their own perspective, then from the imagined perspective of someone with a mental illness. Psychiatric patients completed the questionnaire from their own perspective, then from the perspective of someone without mental illness. Results reveal the prevalence of stigma expressed by each group and subtle prejudice expressed by college students. We test the hypothesis that psychiatric patients assume those without mental illness hold greater stigmatizing beliefs than is admitted by the college student sample.

One Parameter Approximation of the Brachistochrome (Minimum Time) Problem

Brittany T. Corn (Physics/Mathematics),
Cho S. Kim (Computer Science) and Dr. Otto Raths (Physics)

In 1697, Jean Bernouli addressed a problem that was instrumental to the formulation of the Calculus of Variations: What is the frictionless path joining two points such that a mass will slide from upper to lower point in minimum time? Our paper presents various one-parameter models, which demonstrate other paths, which produce shorter time than the shortest path.

Cloning and Expression of the HSV-1 Gene US9

Nicole D. Hosmer (Biology) and Dr. Geoffrey Church (Biology)

Herpes simplex virus (HSV) can infect the mouth and the genitals and can recur over a person's lifetime. Treatment of herpes is dependent upon further research into virus assembly. We have focused on the role the US9 protein might play in this assembly process. In order to study this protein we have isolated the US9 gene from viral genomic DNA via PCR, the gene was then cloned into the expression vector pGEX-KG. Following transformation into E.coli , expression of the US9 protein was induced in an effort to begin looking for binding partners. This poster explains the details of the cloning procedure and the justification for choosing US9 as a structural protein of interest.

Phenotypic Expression is the Ultimate Proof of Genotypic Makeup

Janette Lebron[6] (Biology)

Special X chromosome rearrangements called attached-X (X^X) in Drosophila melanogaster forces the male fly to transfer his X chromosome to his F1 sons (patroclinous inheritance). This allows for inducing X chromosome mutations in the parental male that can be scored (lethals/phenotypic changes) in the F1 males. The gametes from the attached X^XY female will be X^X and Y and from the male X and Y. All the males carrying X lethals will die (1:1 ratio of males to females is offset), but newly induced observable phenotypes (eye color, body color and wing shape) are expressed in the male. X-ray and neutron beam induced X chromosomal mutations will be investigated in the F1 male Drosophila. The significance of this method is that it gives an effective way of scoring recessive mutations (that affect genes on X chromosome) in a diploid system the same way as in a haploid system.

Deep Aquifer Water, an Alternative Source of Drinking Water for Arsenic Affected Bangladesh

Sarah T. Alauddin (Chemistry), Alyssa Kenyon (Chemistry)
and Dr. Mohammad Alauddin (Chemistry)

Bangladesh, a developing country with a population of about 130 million people, is in desperate need of drinking water at permissible level of arsenic. About 97% of the population depends on shallow aquifer (40-100ft depth) water as their principle source of drinking water which is highly contaminated with arsenic. In our laboratory, we have analyzed over 120 water samples from deep aquifers (600 ft or more depth) for arsenic (As), boron (B), lead (Pb) and cadmium (Cd) by graphite-furnace atomic absorption spectroscopy method. While the water samples meet the WHO guideline value for As, Pb and Cd, some samples have B at a level higher than the WHO permissible value. The detection limits for As is 0.50 mg/l, for Pb and Cd are 1.00 mg/l and for B it is 0.05 mg/l. The method validation was checked by parallel analysis of National Institute of Standards and Technology (NIST) reference water. The deep aquifer water promises as a short term solution for arsenic affected Bangladesh population.

[6] Research performed under the direction of Dr. Ammini Moorthy (Biology)

Eating Behavior of Meal Plan and Non-Meal Plan Students in Single- and Multiple-Item Laboratory Meals

Kristen L. Fisher (Psychology) and Dr. Laurence J. Nolan (Psychology)

In the laboratory, participants eat more in a multiple-item meal than in a single item meal. There is also evidence that first semester college students gain weight on all-you-can-eat buffet meal plans. No long term studies of the effect of dietary variety on meal size have been conducted. We hypothesized that students exposed to high dietary variety may not respond to multiple item meals in the laboratory in the same way as other students. Thus, we compared the meal size of meal plan students regularly exposed to a high variety cafeteria to that of non-meal plan students provided with both multiple-item and single-item meals in the laboratory on nonconsecutive days.

The Implications of Priming on the Attitudes of College Students Experiencing Theatrical AIDS Education

Carolyn D. Tudisco[7] (Psychology)

The present study tests the effectiveness of theatre in AIDS education. Further, it proposes that a simple priming exercise reinforces education and increases empathy towards characters with AIDS. Scenes from an AIDS-related play were produced. Participants were randomly assigned to complete one of two priming questionnaires (focusing on AIDS or a control). Following the performance, all participants reported attitudes toward people with AIDS. The hypothesis predicted that participants who received the AIDS-related prime would hold more positive attitudes toward people with AIDS than would the group with the control prime. A third group reported attitudes toward people with AIDS without attending the theatrical performance. This group was predicted to express the greatest amount of stigma against people with AIDS.

[7] Research performed under the direction of Dr. Amy Eshleman (Psychology)

Section II:
The Natural Sciences

Getting the Message Across: A Growing Demand for "Good" Codes in the Information Age

Carolyn Palinkas[1] (Mathematics)

In this study, "good codes" are created using functions that operate like matrices upon $\mathbf{M}_2(N)$ over a chosen N, where N is an algebraic structure known as a near-field and $\mathbf{M}_2(N)$ is a 2×2 matrix near-ring over N. Several forms of codes are established and implemented, with the number of parameters varying. A frequency analysis shows that as the number of parameters increases, the letter frequencies in the ciphertext become more uniform, supporting the idea that the codes become more difficult to break.

I. Introduction and Background

With the Internet being used as a major form of communication and as a business enterprise, and with new-found national defense issues emerging, the United States of America is redefining the Information Age. Each day millions of people communicate on the Internet by sending e-mails and by voicing their opinions on message boards. People can even type messages to each other by using their cellular phones. Online businesses are thriving because customers have become more comfortable with sending private information over computers due to secure coding methods. Since September 11, the nation has been perfecting its ways of transmitting and securing military information.

There are seemingly countless examples of information exchanges in our world today. For each exchange, we must condense our data by encoding it using sequences of numbers. It is only in this way that our messages can be sent through channels to their destinations.

All types of communication channels contain some degree of noise - interference caused by neighboring channels, electric impulses, deterioration of equipment, etc. The problem is that the noise often interferes with data transmission [1]. With such an abundance of data being passed back and forth through these noisy channels, how can we be sure that our encoded messages have been accurately and efficiently transmitted to our recipients? When transmitting our data, we must use "good" codes - codes that reveal unaltered messages, once decoded. "Good" codes are easily implemented and inverted, and are sometimes able to detect and correct errors as well. Since we are immersed in the Information Age, there is a growing demand for these "good" codes in our society. With new technological advances constantly being made, there is a need for better coding

[1] Research performed under the direction of Dr. Mark Farag (Mathematics)

methods. Many "good" codes have already been created, but it is pertinent that we continue to make advances in coding theory so that each message that is sent can sail smoothly across the vast, bumpy sea of information. In this study, "good" codes are formulated by encoding and decoding messages using functions that operate like matrices over algebraic structures known as near-fields.

II. Near-fields

Definition 2.1. *A nonempty set R is said to be a left near-ring if in R if there are two operations + and · such that:*

(a) a, b ∈ R implies that a + b ∈ R.

(b) (a + b) + c = a + (b + c) for a, b, c ∈ R.

(c) There exists an element 0 ∈ R such that a + 0 = a for every a ∈ R.

(d) Given a ∈ R, there exists b ∈ R such that a + b = 0.

(e) a, b ∈ R implies that a · b ∈ R.

(f) a · (b · c) = (a · b) · c for a, b, c ∈ R.

(g) Left distributivity: a · (b + c) = (a · b) + (a · c) for a, b, c ∈ R.

A right near-ring would replace property (g) by the following property:

(g') Right distributivity: (a + b) · c = (a · c) + (b · c) for a, b, c ∈ R.

An example of a near-ring is $\mathbf{M}_0(\mathbf{Z}_3)$, the set of all zero-preserving maps on $\mathbf{Z}_3$, where $\mathbf{Z}_3$ is the cyclic group on three elements. Let $f, g \in \mathbf{M}_0(\mathbf{Z}_3)$, and define $f \circ g$ as $(f \circ g)(x) = f(g(x))$. Then, the right distributive law holds, making it a right near-ring.

Definition 2.2. *A near-ring R is said to be a field if all of the elements of R form an abelian group under + (addition in R), if the nonzero elements form a group under · (the product in R), and if both distributive laws hold.*

A familiar example of a field is the real numbers, because all of the elements in **R** form an abelian group under addition, and the nonzero elements of **R** form an abelian group under multiplication. Furthermore, both the left and right distributive laws hold.

In 1905, Dickson [3] showed that "one-sided distributive fields," or "near-fields" exist. Like fields, near-fields are sets with two operations. However, they differ in that they are missing one property of distributivity. Thus, they are either called "left" or "right" near-fields, depending upon which property of distributivity holds. This property makes codes involving near-fields more complex than codes involving fields, and inverse functions become more difficult to calculate. Near-fields were specifically chosen for this study, as opposed to near-rings, to ensure that the elements have multiplicative inverses.

Definition 2.3. *A near-ring R is said to be a near-field if the nonzero elements of R form a group (not necessarily abelian) under ·, the product in R.*

Thus, two properties need to be added to Definition 2.1 to obtain a near- field:

(h) T here exists an element $1 \in R$ *such that* $a \cdot 1 = 1 \cdot a$ *f or every* $a \in R$.

(i) F or each nonzero $a \in \boldsymbol{R}$, *there exists* $b \in \boldsymbol{R}$ *such that* $ab = ba = 1$.

The reader is referred to the following references for basic definitions and properties of near-rings and near-fields: [3], [8], [9].

III. Matrix-like Functions

Regular matrix multiplication fails to be associative using the elements of a near-field, since near-fields have only one property of distributivity. Therefore, a method that utilizes matrix-like functions must be implemented. Meldrum and van der Walt defined matrix-like functions in the following way:

Definition 3.1. ([6], p. 312) *Let n be an arbitrary natural number.If* $(R, +, \cdot)$ *is any left near-ring with identity* 1, R^n *is the direct sum of n copies of* $(R, +)$. *The element of* R^n *with* 1 *in the i-th place and* 0 *elsewhere is denoted by* ε_i. *The element of* R^n *with* 1 *in the j-th place and* 0 *elsewhere is denoted by* ε_j. *Let* ι_j *be the j-th coordinate injection function, so that* $\iota_j(1) = \varepsilon_i$, *and let* $\prod_j$ *be the j-th coordinate projection function, so that* $\prod_j(\varepsilon_j) = 1$. *Define* $n \times n$ *matrices as functions from* R^n *into* R^n.

Then, $f^r{}_{ij} : R^n \to R^n$ *is defined by:*

$f^r{}_{ij} := \iota_i f^r \prod_j$ *for* $1 \leq i, j \leq n$ *and all* $r \in R$.

In other words, $f^r{}_{ij}$ means to multiply the data in the *j-th* position by *r*, to insert the result into the *i-th* position, and to put a zero in all other positions.

Example 3.2. Let $i = 1, j = 2, r = a$: $(u, v) f^a{}_{12} = (va, 0)$.

The matrix-like functions can be used to perform the same operations as regular matrix multiplication over the ring of real numbers, **R**. The computer programs used for this study are GAP4 (Groups, Algorithms, and Programming) [4] and SONATA (Systems of Near-rings and their Applications) [5]. These programs use left near-fields, so the multiplication is always done on the left in this study.

For example, Let $A = \begin{pmatrix} 2 & 0 \\ 0 & 3 \end{pmatrix}$, and $M = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$.

Using regular matrix multiplication,

$$\begin{pmatrix} 3 \\ 4 \end{pmatrix} \begin{pmatrix} 2 & 0 \\ 0 & 3 \end{pmatrix} = \begin{pmatrix} 3(2) + 4(0) \\ 3(0) + 4(3) \end{pmatrix} = \begin{pmatrix} 6 \\ 12 \end{pmatrix}.$$

Using matrix-like functions, $(3,4)\, f^2{}_{11} = (3(2), 0) = (6, 0)$.

$(3,4)\, f^3{}_{22} = (0, 4(3)) = (0, 12)$.

$(3,4)\, g = (3,4)(f^2{}_{11} + f^3{}_{22}) = (3(2), 0) + (0, 4(3)) = (6, 0) + (0,12) = (6,12)$.

It can be seen that the matrix-like functions are analogous to elementary multiplication in standard Linear Algebra. The coding process for matrix-like functions is that a sender of a message uses a function g to encode a message (u, v). The recipient gets the encoded message (s, t) and uses the inverse function g^{-1} to decode the message.

IV. Two-, Three-, and Restricted Four-Parameter Cases

The matrix-like functions can be generalized for cases involving different numbers of parameters. Then, one may substitute any elements of a chosen near-field into the matrix, and for the message. When implementing the codes with the computer programs GAP4 [4] and SONATA [5], coding can be done efficiently.

Two-Parameter Case.

Lemma 4.1. *Let* $a, b \neq 0$.

Let $A = \begin{pmatrix} a & 0 \\ 0 & b \end{pmatrix}$, *and* $M = \begin{pmatrix} u \\ v \end{pmatrix}$.

Using regular matrix multiplication, $\begin{pmatrix} u \\ v \end{pmatrix} \begin{pmatrix} a & 0 \\ 0 & b \end{pmatrix} = \begin{pmatrix} ua \\ vb \end{pmatrix} = \begin{pmatrix} s \\ t \end{pmatrix}$.

Given the two-parameter function $g = (f^a{}_{11} + f^b{}_{22})$, the inverse function $g^{-1} = (f^{a^{-1}}{}_{11} + f^{b^{-1}}{}_{22})$.

Proof. $g = (u, v)\, (f^a{}_{11} + f^b{}_{22}) = (ua, vb) = (s, t)$. Then, the inverse function $(s, t)\, g^{-1} = (s, t)\, (f^{a^{-1}}{}_{11} + f^{b^{-1}}{}_{22}) = (ua, vb)\, (f^{a^{-1}}{}_{11} + f^{b^{-1}}{}_{22}) = (ua(a^{-1}), vb(b^{-1})) = (u, v)$.

Three-Parameter Case. By adding a third parameter, it is not simply right multiplication by an invertible element in the second position.

Lemma 4.2. *Let* $a, b, c \neq 0$.

Let $A = \begin{pmatrix} a & 0 \\ b & c \end{pmatrix}$, *and* $M = \begin{pmatrix} u \\ v \end{pmatrix}$.

Using regular matrix multiplication, $\begin{pmatrix} u \\ v \end{pmatrix} \begin{pmatrix} a & 0 \\ b & c \end{pmatrix} = \begin{pmatrix} ua \\ ub + vc \end{pmatrix} = \begin{pmatrix} s \\ t \end{pmatrix}$.

Given the two-parameter function $g = (f^{a}{}_{11} + f^{b}{}_{21} + f^{c}{}_{22})$, *the inverse function* $g^{-1} = (h_3 \circ h_2 \circ h_1)$, *where* $h_1 = f^{1}{}_{22} + f^{a\text{^-}1}{}_{11}$, $h_2 = f^{1}{}_{11} + f^{1}{}_{22} + f^{-b}{}_{21}$, *and* $h_3 = f^{1}{}_{11} + f^{c\text{^-}1}{}_{22}$.

Proof. $(u, v)g = (u, v)\,(f^{a}{}_{11} + f^{b}{}_{21} + f^{c}{}_{22}) = (ua, ub + vc) = (s, t)$.

Then, the inverse function $(s, t)g^{-1} = (h_3 \circ h_2 \circ h_1)$

$= (s, t)\,(h_3 \circ h_2 \circ h_1)$

$= (ua, ub + vc)\,(h_3 \circ h_2 \circ h_1)$.

$(ua, ub + vc)\,h_1 = (ua(a^{-1}), ub + vc) = (u, ub + vc)$

$(u, ub + vc)\,h_2 = (u, ub + vc - ub) = (u, vc)$

$(u, vc)\,h_3 = (u, vc(c^{-1})) = (u, v)$.

Restricted Four-Parameter Case.

Lemma 4.3. *Let* $a, b, c, d \neq 0$.

Further, suppose that a, b, d *are in* $\mathbf{C}(N) := [\alpha \in N$ *such that* $\alpha \cdot \beta = \beta \cdot \alpha$ *for all* $\beta \in N]$, *known as the center (set of all commutative elements).*

Let $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$, *and* $M = \begin{pmatrix} u \\ v \end{pmatrix}$.

Using regular matrix multiplication, $\begin{pmatrix} u \\ v \end{pmatrix} \begin{pmatrix} a & b \\ c & d \end{pmatrix} = \begin{pmatrix} ua + vb \\ uc + vd \end{pmatrix} = \begin{pmatrix} s \\ t \end{pmatrix}$.

Let $\Delta = (ab^{-1}) - (ucd^{-1}) \neq 0$. *Given the four-parameter function* $g = (f^{a}{}_{11} + f^{b}{}_{12} + f^{c}{}_{21} + f^{d}{}_{22})$, *the inverse function* $g^{-1} = (h_6 \circ h_5 \circ h_4 \circ h_3 \circ h_2 \circ h_1)$, *where* $h_1 = f^{1}{}_{11} + f^{d\text{^-}1}{}_{22}$, $h_2 = f^{1}{}_{11} + f^{-b}{}_{12} + f^{1}{}_{22}$, *and* $h_3 = f^{a\text{^-}1}{}_{11} + f^{1}{}_{22}$, $h_4 = f^{ab\text{^-}1}{}_{11} + f^{1}{}_{22}$, $h_5 = f^{\Delta\text{-}1}{}_{11} + f^{1}{}_{22}$, $h_6 = f^{1}{}_{11} + f^{1}{}_{22} + f^{-cd\text{^-}1}{}_{21}$.

Proof. $(u, v)g = (u, v)\,(f^{a}{}_{11} + f^{b}{}_{12} + f^{c}{}_{21} + f^{d}{}_{22}) = (ua + vb, uc + vd) = (s, t)$.

Then, the inverse function $(s, t)g^{-1} = (h_6 \circ h_5 \circ h_4 \circ h_3 \circ h_2 \circ h_1)$

$= (s, t)\ (h_6 \circ h_5 \circ h_4 \circ h_3 \circ h_2 \circ h_1)$

$= (ua + vb, uc + vd)\ (h_6 \circ h_5 \circ h_4 \circ h_3 \circ h_2 \circ h_1)$.

Since d is in $\mathbf{C}(N)$, it follows that d^{-1} is in $\mathbf{C}(N)$, and that d^{-1} can be distributed on the right.

$(ua + vb, uc + vd)h_1 = (ua + vb, (uc + vd)(d^{-1})) = (ua + vb, uc(d^{-1}) + vd(d^{-1}))$
$= (ua + vb, ucd^{-1} + v)$.

Similarly, since b is in $\mathbf{C}(N)$, it can be distributed on the right.

$(ua + vb, ucd^{-1} + v)h_2 = (ua + vb + (ucd^{-1} + v)(-b), ucd^{-1} + v) = (ua + vb - ucd^{-1}b$
$- vb, ucd^{-1} + v) = (ua - ucd^{-1}b, ucd^{-1} + v)$.

Since a is in $\mathbf{C}(N)$, it follows that a^{-1} is in $\mathbf{C}(N)$, and that a^{-1} can be distributed on the right.

$(ua - ucd^{-1}b, ucd^{-1} + v)h_3 = ((ua - ucd^{-1}b)(a^{-1}), ucd^{-1} + v) = (ua(a^{-1}) - ucd^{-1}b(a^{-1}),$
$ucd^{-1} + v) = (u - ucd^{-1}ba^{-1}, ucd^{-1} + v)$.

Since b is in $\mathbf{C}(N)$, it follows that b^{-1} is in $\mathbf{C}(N)$. Also, a is in $\mathbf{C}(N)$, so ab^{-1} can be distributed on the right.

$(u - ucd^{-1}ba^{-1}, ucd^{-1} + v)h_4 = ((u - ucd^{-1}ba^{-1})(ab^{-1}), ucd^{-1} + v) = (u(ab^{-1}) -$
$(ucd^{-1}ba^{-1})(ab^{-1})), ucd^{-1} + v) = (u(ab^{-1}) - (ucd^{-1}), ucd^{-1} + v)$.

$(u(ab^{-1}) - (ucd^{-1}), ucd^{-1} + v)h_5 = (u(\Delta), ucd^{-1} + v)h_5 = (u(\Delta)(\Delta^{-1}), ucd^{-1} + v) =$
$(u, ucd^{-1} + v)$.

$(u, ucd^{-1} + v)h_6 = (u, ucd^{-1} + v - (ucd^{-1})) - (u, v)$.

V. Frequency Analysis

Because certain letters occur more frequently than others in the English language, a code-breaker can use this information to analyze ciphertext. A frequency analysis of the letters can be done on the ciphertext in an attempt to break the code and to reveal the plaintext message. For example, in a simple monoalphabetic substitution cipher, if the letter 'q' occurs more frequently in the ciphertext message, a code-breaker may suspect that 'q' is actually one of the frequently occurring letters, such as 'e.'

An example of a cipher that uses regular matrix multiplication is the Hill Cipher. The Hill Cipher is a cipher that takes blocks of size n and enciphers these blocks into other blocks of size n. One must choose an integer n and create an n x n matrix A

whose entries are integers mod 26. The plaintext message must be rewritten as a series of row vectors. To encrypt, one would multiply the vector by the matrix and reduce mod 26. In order to decrypt, one must calculate the inverse of the matrix and multiply it by the ciphertext row vectors [1]. A ciphertext-only cryptanalysis of a Hill Cipher is considerably more difficult than for a monoalphabetic substitution. If the underlying plaintext is English, then the characteristic letter frequencies are obscured [7]. A frequency analysis was done on this study's two-, three-, and restricted four-parameter cases to determine if the characteristic letter frequencies become obscured after a plaintext message is encoded with these codes.

Consider the following plaintext message:

> I THINK 'TASTE' IS A SOCIAL CONCEPT AND NOT AN ARTISTIC ONE. I'M WILLING TO SHOW GOOD TASTE, IF I CAN, IN SOMEBODY ELSE'S LIVING ROOM, BUT OUR READING LIFE IS TOO SHORT FOR A WRITER TO BE IN ANY WAY POLITE. SINCE HIS WORDS ENTER INTO ANOTHER'S BRAIN IN SILENCE AND INTIMACY, HE SHOULD BE AS HONEST AS WE ARE WITH OURSELVES [7].

A frequency analysis on the plaintext was conducted to see how often each letter occurred in the text (see Appendix I). Punctuation and natural word divisions were not considered. It can be seen that some letters, such as the vowels, naturally occur more often.

In a preliminary study, a near-field of size 9 was chosen. Then, the elements of the near-field were written in pairs for a total of 81 pairs, by the Multiplication Principle. An extra element was added to the plaintext so that there was an even number of characters, since the characters were placed in pairs. The extra element chosen was n0, which represents the character '?'. An alphabet was created by assigning each pair to a specific character. However, it can be seen that this is a substitution cipher, with a one-to-one correspondence of pairs to elements.

Next, a near-field of size 49 was chosen. An alphabet was defined by assigning each element of the near-field to a specific character. Characters included letters, numbers, and symbols (see Appendix N). In this case the letters were chosen in a systematic way, which makes the code vulnerable. To make the code more secure, a random number generator can be used to assign the elements of the near-field to the characters. A Microsoft Visual C++ program was written to transform the characters into integers that represent the elements of the near-field (see Appendices 1 and 2). The elements were then placed in pairs and encoded. There is no longer a correspondence between numbers and elements, because the ciphertext of a character changes depending upon where it is positioned. Programs were created in GAP4 and SONATA to test the two-, three-, and restricted four-parameter cases (see Appendices C-H). The resulting

ciphertext numbers were then counted manually, and frequency values were recorded for the corresponding characters. A Microsoft Visual C++ program may also be created for this part of the problem to make the calculations more efficient.

The two-parameter case is not much better than a substitution cipher. For example, consider the string "function" using the alphabet defined in Appendix N. Let $a = n3$, $b = n5$. Then, $(n6, n21) = (f, u) \rightarrow (n6 * n3, n21 * n5) = (n21, n20) = (u, j)$. Similarly,

$(n14, n3) = (n, c) \rightarrow (n2, n21) = (b, u)$,

$(n20, n9) = (t, i) \rightarrow (n9, n5) = (i, e)$,

$(n15, n14) = (o, n) \rightarrow (n6, n20) = (f, t)$.

Because an element may appear in the first or second position of a pair and it is being multiplied by one other element, the case contains two substitution ciphers - one for the first position and one for the second position of a pair. It can be seen that in the second pair, *n* corresponds to *b* in the ciphertext, but *n* corresponds to *t* in the last pair.

The graph is therefore not noticeably more uniform than the plaintext message (see Appendix J). There is some improvement in the three-parameter case, since a substitution cipher is only being used in the second position of a pair. For example, consider the string "function" using the alphabet defined in Appendix N. Let $a = n3$, $b = n5$, $c = n8$. Then, $(n6, n21) = (f, u) \rightarrow (n6 * n3, n6 * n5 + n21 * n8) = (n21, n28) = (u, 1)$. Similarly,

$(n14, n3) = (n, c) \rightarrow (n2, n22) = (b, v)$,

$(n20, n9) = (t, i) \rightarrow (n9, n35) = (i, 8)$,

$(n15, n14) = (o, n) \rightarrow (n6, n24) = (f, x)$.

It can be seen that the ciphertext does not change in the first position of the pairs, since the same operation is being performed as in the two-parameter case. The spread of the graph is larger, but there is still a section of high peaks on the lefthand side of the graph. (see Appendix K).

The restricted four-parameter case shows some improvement in the tightness of the band of the graph. The reason for this improvement is that neither position is a simple substitution cipher (see Appendix L). It can be seen that the peaks are higher on the righthand side for this case than they were for the three-parameter case. For example, consider the string "function" using the alphabet defined in Appendix N. Let $a = n1$, $b = n21$, $c = n5$, and $d = n21$, where $a, b, d \in \mathbf{C}(N)$. Then, $(n6, n21) = (f, u) \rightarrow (n6* n1+ n21*n21, n6 *n5 + n21 *n21) = (n10, n13) = (j, m)$. Similarly,

$(n14, n3) = (n, c) \rightarrow (n40, n1) = (@, a)$,
$(n20, n9) = (t, i) \rightarrow (n5, n19) = (e, s)$,
$(n15, n14) = (o, n) \rightarrow (n35, n5) = (8, e)$.

An unrestricted four-parameter case was studied, and there was considerable improvement in the uniformity of the letter frequencies (see Appendix M). By using different elements for *a*, *b*, *c* and *d* for this case, there was a noticeable difference in the graphs. Therefore, it can be seen that the choice of elements plays a large role in the uniformity of the characteristic frequencies. One should use the computer programs to test different elements until he or she can obtain the most uniform graph. However, the inverse function of the unrestricted case was not determined, so it has not been verified that the code can actually be implemented.

VI. Conclusion

Codes can be created using functions that operate like matrices upon $\mathbf{M}_2(N)$ over a chosen near-field, *N*. It can be seen that as the number of parameters increases for these codes, the frequencies of characters in the ciphertext become more uniform. These results give evidence that the codes become more difficult to break as the number of parameters increases. It would be satisfying to compute the complete characterization of an unrestricted four-parameter case for further study, so that one does not have to rely on certain elements being in the center of a chosen *N*. These codes are in fact "good" codes. The codes are easy to implement and invert by using the programs. Further study can be done to show if these codes can detect and correct errors as well. The computational results of this study may be used to advance current findings in the area and to help prove new theorems showing the existence of inverses of "matrix-like" functions over near-fields.

VII. Literature Cited

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Appendix A: Microsoft Visual C++ Program to Change Plaintext Message Characters into Numerical Values that Correspond to Elements of a Near-Field of Size 49

```
#include <iostream>
using std::cout;
using std::cin;
#include<string>

struct values
{
	char *v;
};

typedef struct values val;

int main()
{
	// Declaration
	char Plaintext[500];

	int i=0;
	val Output[500];

	for (i=0; i<500; i++)
		Output[i].v=NULL;

	// Input the data
	cout<<"Enter your text data: ";
	cin.getline(Plaintext,500);

	i=0;

	// Computations
	while(Plaintext[i]!='\0')
	{
```

```
switch(Plaintext[i])
{
        case '?':
        Output[i].v = "0";
        break;
        case 'a':
        Output[i].v = "1";
        break;
        case 'b':
        Output[i].v = "2";
        break;
        case 'c':
        Output[i].v = "3";
        break;
        case 'd':
        Output[i].v = "4";
        break;
        case 'e':
        Output[i].v = "5";
        break;
        case 'f':
        Output[i].v = "6";
        break;
        case 'g':
        Output[i].v = "7";
        break;
        case 'h':
        Output[i].v = "8";
        break;
        case 'i':
        Output[i].v = "9";
        break;
        case 'j':
        Output[i].v = "10";
```

```
break;
case 'k':
Output[i].v = "11";
break;
case 'l':
Output[i].v = "12";
break;
case'm':
Output[i].v = "13";
break;
case 'n':
Output[i].v = "14";
break;
case 'o':
Output[i].v = "15";
break;
case 'p':
Output[i].v = "16";
break;
case 'q':
Output[i].v = "17";
break;
case 'r':
Output[i].v = "18";
break;
case 's':
Output[i].v = "19";
break;
case 't':
Output[i].v = "20";
break;
case 'u':
Output[i].v = "21";
break;
```

```
case 'v':
Output[i].v = "22";
break;
case 'w':
Output[i].v = "23";
break;
case 'x':
Output[i].v = "24";
break;
case 'y':
Output[i].v = "25";
break;
case 'z':
Output[i].v = "26";
break;
case '0':
Output[i].v = "27";
break;
case '1':
Output[i].v = "28";
break;
case '2':
Output[i].v = "29";
break;
case '3':
Output[i].v = "30";
break;
case '4':
Output[i].v = "31";
break;
case '5':
Output[i].v = "32";
break;
case '6':
```

```
Output[i].v = "33";
break;
case '7':
Output[i].v = "34";
break;
case '8':
Output[i].v = "35";
break;
case '9':
Output[i].v = "36";
break;
case '.':
Output[i].v = "37";
break;
case ',':
Output[i].v = "38";
break;
case '!':
Output[i].v = "39";
break;
case '@':
Output[i].v = "40";
break;
case '#':
Output[i].v = "41";
break;
case '$':
Output[i].v = "42";
break;
case '%':
Output[i].v = "43";
break;
case '^':
Output[i].v = "44";
```

```
        break;
        case '&':
        Output[i].v = "45";
        break;
        case '*':
        Output[i].v = "46";
        break;
        case '(':
        Output[i].v = "47";
        break;
        case ')':
        Output[i].v = "48";
        break;
        case ' ':
        Output[i].v = " ";
        break;

        default:
        cout<<"Error.\n";
        break;
}
        i++;
}

// Output the data
cout<<"Output: \n";
cout<<"[";
        for(i=0; i<strlen(Plaintext); i++)
{
        if (Output[i].v != " ")
        {
                cout<<Output[i].v;
                if (Output[i+1].v != NULL)
```

```
                cout << ", ";
            }
        }
        cout<<"]\n";
        return 0;
}
```

Appendix B: Sample Input/Output of Appendix A

Enter your text data: i think taste is a social concept and not an artistic one im willing to show good taste if i can in somebody elses living room but our reading life is too short for a writer to be in any way polite since his words enter into anothers brain in silence and intimacy he should be as honest as we are with ourselves

Output:
[9, 20, 8, 9, 14, 11, 20, 1, 19, 20, 5, 9, 19, 1, 19, 15, 3, 9, 1, 12, 3, 15, 14, 3, 5, 16, 20, 1, 14, 4, 14, 15, 20, 1, 14, 1, 18, 20, 9, 19, 20, 9, 3, 15, 14, 5, 9, 13, 23, 9, 12, 12, 9, 14, 7, 20, 15, 19, 8, 15, 23, 7, 15, 15, 4, 20, 1, 19, 20, 5, 9, 6, 9, 3, 1, 14, 9, 14, 19, 15, 13, 5, 2, 15, 4, 25, 5, 12, 19, 5, 19, 12, 9, 22, 9, 14, 7, 18, 15, 15, 13, 2, 21, 20, 15, 21, 18, 18, 5, 1, 4, 9, 14, 7, 12, 9, 6, 5, 9, 19, 20, 15, 15, 19, 8, 15, 18, 20, 6, 15, 18, 1, 23, 18, 9, 20, 5, 18, 20, 15, 2, 5, 9, 14, 1, 14, 25, 23, 1, 25, 16, 15, 12, 9, 20, 5, 19, 9, 14, 3, 5, 8, 9, 19, 23, 15, 18, 4, 19, 5, 14, 20, 5, 18, 9, 14, 20, 15, 1, 14, 15, 20, 8, 5, 18, 19, 2, 18, 1, 9, 14, 9, 14, 19, 9, 12, 5, 14, 3, 5, 1, 14 , 4, 9, 14, 20, 9, 13, 1, 3, 25, 8, 5, 19, 8, 15, 21, 12, 4, 2, 5, 1, 19, 8, 15, 14, 5, 19, 20, 1, 19, 23, 5, 1, 18, 5, 23, 9, 20, 8, 15, 21, 18, 19, 5, 12, 22, 5, 19]

Appendix C: GAP Code For the Two-Parameter Case

```
RequirePackage("sonata");

str:=[9, 20, 8, 9, 14, 11, 20, 1, 19, 20, 5, 9, 19, 1, 19, 15, 3, 9, 1, 12, 3, 15, 14, 3, 5, 16, 20,
1, 14, 4, 14, 15, 20, 1, 14, 1, 18, 20, 9, 19, 20, 9, 3, 15, 14, 5, 9, 13, 23, 9, 12, 12, 9, 14, 7,
```

```
20, 15, 19, 8, 15, 23, 7, 15, 15, 4, 20, 1,19, 20, 5, 9, 6, 9, 3, 1, 14, 9, 14, 19, 15, 13, 5, 2,
15, 4, 25, 5, 12, 19, 5,19, 12, 9, 22, 9, 14, 7, 18, 15, 15, 13, 2, 21, 20, 15, 21, 18, 18, 5, 1,
4, 9, 14, 7, 12, 9, 6, 5, 9, 19, 20, 15, 15, 19, 8, 15, 18, 20, 6, 15, 18, 1, 23, 18,9, 20, 5, 18,
20, 15, 2, 5, 9, 14, 1, 14, 25, 23, 1, 25, 16, 15, 12, 9, 20, 5, 19, 9, 14, 3, 5, 8, 9, 19, 23, 15,
18, 4, 19, 5, 14, 20, 5, 18, 9, 14, 20, 15, 1, 14, 15, 20, 8, 5, 18, 19, 2, 18, 1, 9, 14, 9, 14,
19, 9, 12, 5, 14, 3, 5, 1, 14, 4, 9, 14, 20, 9, 13, 1, 3, 25, 8, 5, 19, 8, 15, 21, 12, 4, 2, 5, 1,
19, 8, 15, 14, 5, 19, 20, 1, 19, 23, 5, 1, 18, 5, 23, 9, 20, 8, 15, 21, 18, 19, 5, 12, 22, 5, 19,
0];

H:=ExceptionalNearFields(49);
N1:=H[1];
NN:=AsList(N1);
I:=Filtered(N1,a->ForAll(N1,x->a*x=x and x*a=x));
i:=I[1];
a:=NN[4];
b:=NN[6];
AINVERSE:=Filtered(NN,x->a*x=i and x*a=i);
ainv:=AINVERSE[1];
BINVERSE:=Filtered(NN,x->b*x=i and x*b=i);
binv:=BINVERSE[1];

k:=1;
outlist:=[];

while k<= Length(str)-1 do
> s:=str[k]*a; t:=str[k+1]*b;
> for i in [1..49] do
> if(s=NN[i]) then u:=i-1;
fi;
> if(t=NN[i]) then v:=i-1;
> fi;
```

```
> od;
Append(outlist,[u]);
Append(outlist,[v]);
> k:=k+2;
> od;

outlist;
```

Appendix D: Sample Input/Output of Appendix C

```
gap> RequirePackage("sonata");
gap> $5, 12, 22, 5, 19, 0];
[ 9, 20, 8, 9, 14, 11, 20, 1, 19, 20, 5, 9, 19, 1, 19, 15, 3, 9, 1, 12, 3, 15, 14, 3, 5, 16, 20, 1,
14, 4, 14, 15, 20, 1, 14, 1, 18, 20, 9, 19, 20, 9, 3, 15, 14, 5, 9, 13, 23, 9, 12, 12, 9, 14, 7,
20, 15, 19, 8, 15, 23, 7, 15, 15, 4, 20, 1, 19, 20, 5, 9, 6, 9, 3, 1, 14, 9, 14, 19, 15, 13, 5, 2,
15, 4, 25, 5, 12, 19, 5, 19, 12, 9, 22, 9, 14, 7, 18, 15, 15, 13, 2, 21, 20, 15, 21, 18, 18, 5, 1,
4, 9, 14, 7, 12, 9, 6, 5, 9, 19, 20, 15, 15, 19, 8, 15, 18, 20, 6, 15, 18, 1, 23, 18, 9, 20, 5, 18,
20, 15, 2, 5, 9, 14, 1, 14, 25, 23, 1, 25, 16, 15, 12, 9, 20, 5, 19, 9, 14, 3, 5, 8, 9, 19, 23, 15,
18, 4, 19, 5, 14, 20, 5, 18, 9, 14, 20, 15, 1, 14, 15, 20, 8, 5, 18, 19, 2, 18, 1, 9, 14, 9, 14,
19, 9, 12, 5, 14, 3, 5, 1, 14, 4, 9, 14, 20, 9, 13, 1, 3, 25, 8, 5, 19, 8, 15, 21, 12, 4, 2, 5, 1,
19, 8, 15, 14, 5, 19, 20, 1, 19, 23, 5, 1, 18, 5, 23, 9, 20, 8, 15, 21, 18, 19, 5, 12, 22, 5, 19,
0]

gap> H:=ExceptionalNearFields(49);
[ ExplicitMultiplicationNearRing ( <pc group of size 49 with 2 generators> ,
multiplication ) ]
gap> N1:=H[1];
ExplicitMultiplicationNearRing ( <pc group of size 49 with 2 generators> , multiplication
)
gap> NN:=AsList(N1);
[ (<identity> of ...), (f1), (f2), (f1^2), (f1*f2), (f2^2), (f1^3), (f1^2*f2), (f1*f2^2), (f2^3),
(f1^4), (f1^3*f2), (f1^2*f2^2), (f1*f2^3), (f2^4), (f1^5), (f1^4*f2), (f1^3*f2^2),
(f1^2*f2^3), (f1*f2^4), (f2^5), (f1^6), (f1^5*f2), (f1^4*f2^2), (f1^3*f2^3), (f1^2*f2^4),
(f1*f2^5),
```

```
(f2^6), (f1^6*f2), (f1^5*f2^2), (f1^4*f2^3), (f1^3*f2^4), (f1^2*f2^5), (f1*f2^6),
(f1^6*f2^2), (f1^5*f2^3), (f1^4*f2^4), (f1^3*f2^5), (f1^2*f2^6), (f1^6*f2^3),
(f1^5*f2^4), (f1^4*f2^5), (f1^3*f2^6), (f1^6*f2^4), (f1^5*f2^5), (f1^4*f2^6),
(f1^6*f2^5), (f1^5*f2^6), (f1^6*f2^6) ]
gap> I:=Filtered(N1,a->ForAll(N1,x->a*x=x and x*a=x));
[ (f1) ]
gap> i:=I[1];
(f1)
gap> a:=NN[4];
(f1^2)
gap> b:=NN[6];
(f2^2)
gap> AINVERSE:=Filtered(NN,x->a*x=i and x*a=i);
[ (f1^4) ]
gap> ainv:=AINVERSE[1];
(f1^4)
gap> BINVERSE:=Filtered(NN,x->b*x=i and x*b=i);
[ (f2^5) ]
gap> binv:=BINVERSE[1];
(f2^5)
gap> k:=1;
1
gap> outlist:=[];
[  ]
gap> while k<= Length(str)-1 do
> > s:=str[k]*a; t:=str[k+1]*b;
> > for i in [1..49] do
> > if(s=NN[i]) then u:=i-1;
> fi;
> > if(t=NN[i]) then v:=i-1;
> > fi;
> > od;
> Append(outlist,[u]);
> Append(outlist,[v]);
```

> > k:=k+2;

> > od;

gap> outlist;

[10, 20, 3, 14, 0, 2, 15, 5, 6, 20, 6, 14, 6, 5, 6, 5, 21, 14, 3, 9, 21, 5, 0, 27, 6, 14, 15, 5, 0, 2, 0, 5, 15, 5, 0, 5, 1, 20, 10, 9, 15, 14, 21, 5, 0, 9, 10, 20, 10, 14, 6, 9, 10, 0, 0, 20, 3, 9, 3, 5, 10, 0, 3, 5, 1, 20, 3, 9, 15, 9, 10, 20, 10, 27, 3, 0, 10, 0, 6, 5, 15, 9, 10, 5, 1, 2, 6, 9, 6, 9, 6, 9, 10, 5, 10, 0, 0, 2, 3, 5, 15, 14, 0, 20, 3, 0, 1, 2, 6, 5, 1, 14, 0, 0, 6, 14, 15, 9, 10, 9, 15, 5, 3, 9, 3, 5, 1, 20, 15, 5, 1, 5, 10, 2, 10, 20, 6, 2, 15, 5, 10, 9, 10, 0, 3, 0, 1, 14, 3, 2, 10, 5, 6, 14, 15, 9, 6, 14, 0, 27, 6, 5, 10, 9, 10, 5, 1, 2, 6, 9, 0, 20, 6, 2, 10, 0, 15, 5, 3, 0, 3, 20, 3, 9, 1, 9, 10, 2, 3, 14, 0, 14, 0, 9, 10, 9, 6, 0, 21, 9, 3, 0, 1, 14, 0, 20, 10, 20, 3, 27, 1, 5, 6, 9, 3, 5, 0, 9, 1, 14, 6, 5, 6, 5, 3, 0, 6, 9, 15, 5, 6, 14, 6, 5, 1, 9, 10, 14, 15, 5, 3, 0, 1, 9, 6, 9, 3, 9, 6, 0]

Appendix E: GAP4 Code for the Three-Parameter Case

```
RequirePackage("sonata");

str:=[9, 20, 8, 9, 14, 11, 20, 1, 19, 20, 5, 9, 19, 1, 19, 15, 3, 9, 1, 12, 3, 15, 14, 3, 5, 16, 20,
1, 14, 4, 14, 15, 20, 1, 14, 1, 18, 20, 9, 19, 20, 9, 3, 15, 14, 5, 9, 13, 23, 9, 12, 12, 9, 14, 7,
20, 15, 19, 8, 15, 23, 7, 15, 15, 4, 20, 1,19, 20, 5, 9, 6, 9, 3, 1, 14, 9, 14, 19, 15, 13, 5, 2,
15, 4, 25, 5, 12, 19, 5, 19, 12, 9, 22, 9, 14, 7, 18, 15, 15, 13, 2, 21, 20, 15, 21, 18, 18, 5, 1,
4, 9, 14, 7, 12, 9, 6, 5, 9, 19, 20, 15, 15, 19, 8, 15, 18, 20, 6, 15, 18, 1, 23, 18,9, 20, 5, 18,
20, 15, 2, 5, 9, 14, 1, 14, 25, 23, 1, 25, 16, 15, 12, 9, 20, 5, 19, 9, 14, 3, 5, 8, 9, 19, 23, 15,
18, 4, 19, 5, 14, 20, 5, 18, 9, 14, 20, 15, 1, 14, 15, 20, 8, 5, 18, 19, 2, 18, 1, 9, 14, 9, 14,
19, 9, 12, 5, 14, 3, 5, 1, 14, 4, 9, 14, 20, 9, 13, 1, 3, 25, 8, 5, 19, 8, 15, 21, 12, 4, 2, 5, 1,
19, 8, 15, 14, 5, 19, 20, 1, 19, 23, 5, 1, 18, 5, 23, 9, 20, 8, 15, 21, 18, 19, 5, 12, 22, 5, 19,
0];

H:=ExceptionalNearFields(49);

N1:=H[1];

NN:=AsList(N1);

I:=Filtered(N1,a->ForAll(N1,x->a*x=x and x*a=x));
```

```
i:=I[1];
a:=NN[4];
b:=NN[6];
c:=NN[8];
AINVERSE:=Filtered(NN,x->a*x=i and x*a=i);
ainv:=AINVERSE[1];
BINVERSE:=Filtered(NN,x->b*x=i and x*b=i);
binv:=BINVERSE[1];
CINVERSE:=Filtered(NN,x->c*x=i and x*c=i);
cinv:=CINVERSE[1];

k:=1;
outlist:=[];

while k<= Length(str)-1 do
> s:=str[k]*a; t:=str[k]*b + str[k+1]*c;
> for i in [1..49] do
> if(s=NN[i]) then u:=i-1;
fi;
> if(t=NN[i]) then v:=i-1;
> fi;
> od;
Append(outlist,[u]);
Append(outlist,[v]);
> k:=k+2;
> od;
outlist;
```

Appendix F: Sample Input/Output of Appendix E

```
gap> RequirePackage("sonata");
gap> $5, 12, 22, 5, 19, 0];

[ 9, 20, 8, 9, 14, 11, 20, 1, 19, 20, 5, 9, 19, 1, 19, 15, 3, 9, 1, 12, 3, 15, 14, 3, 5, 16, 20, 1,
14, 4, 14, 15, 20, 1, 14, 1, 18, 20, 9, 19, 20, 9, 3, 15, 14, 5, 9, 13, 23, 9, 12, 12, 9, 14, 7,
20, 15, 19, 8, 15, 23, 7, 15, 15, 4, 20, 1, 19, 20, 5, 9, 6, 9, 3, 1, 14, 9, 14, 19, 15, 13, 5, 2,
15, 4, 25, 5, 12, 19, 5, 19, 12, 9, 22, 9, 14, 7, 18, 15, 15, 13, 2, 21, 20, 15, 21, 18, 18, 5, 1,
4, 9, 14, 7, 12, 9, 6, 5, 9, 19, 20, 15, 15, 19, 8, 15, 18, 20, 6, 15, 18, 1, 23, 18, 9, 20, 5, 18,
20, 15, 2, 5, 9, 14, 1, 14, 25, 23, 1, 25, 16, 15, 12, 9, 20, 5, 19, 9, 14, 3, 5, 8, 9, 19, 23, 15,
18, 4, 19, 5, 14, 20, 5, 18, 9, 14, 20, 15, 1, 14, 15, 20, 8, 5, 18, 19, 2, 18, 1, 9, 14, 9, 14,
19, 9, 12, 5, 14, 3, 5, 1, 14, 4, 9, 14, 20, 9, 13, 1, 3, 25, 8, 5, 19, 8, 15, 21, 12, 4, 2, 5, 1,
19, 8, 15, 14, 5, 19, 20, 1, 19, 23, 5, 1, 18, 5, 23, 9, 20, 8, 15, 21, 18, 19, 5, 12, 22, 5, 19, 0
]

gap> H:=ExceptionalNearFields(49);
[ ExplicitMultiplicationNearRing ( <pc group of size 49 with 2 generators> ,
multiplication ) ]
gap> N1:=H[1];
ExplicitMultiplicationNearRing ( <pc group of size 49 with 2 generators> , multiplication
)
gap> NN:=AsList(N1);
[ (<identity> of ...), (f1), (f2), (f1^2), (f1*f2), (f2^2), (f1^3), (f1^2*f2), (f1*f2^2), (f2^3),
(f1^4), (f1^3*f2), (f1^2*f2^2), (f1*f2^3), (f2^4), (f1^5), (f1^4*f2), (f1^3*f2^2),
(f1^2*f2^3), (f1*f2^4), (f2^5), (f1^6), (f1^5*f2), (f1^4*f2^2), (f1^3*f2^3), (f1^2*f2^4),
(f1*f2^5), (f2^6), (f1^6*f2), (f1^5*f2^2), (f1^4*f2^3), (f1^3*f2^4), (f1^2*f2^5),
(f1*f2^6), (f1^6*f2^2), (f1^5*f2^3), (f1^4*f2^4), (f1^3*f2^5), (f1^2*f2^6), (f1^6*f2^3),
(f1^5*f2^4), (f1^4*f2^5), (f1^3*f2^6), (f1^6*f2^4), (f1^5*f2^5), (f1^4*f2^6),
(f1^6*f2^5), (f1^5*f2^6), (f1^6*f2^6) ]
gap> I:=Filtered(N1,a->ForAll(N1,x->a*x=x and x*a=x));
[ (f1) ]
gap> i:=I[1];
(f1)
```

```
gap> a:=NN[4];
(f1^2)
gap> b:=NN[6];
(f2^2)
gap> c:=NN[8];
(f1^2*f2)
gap> AINVERSE:=Filtered(NN,x->a*x=i and x*a=i);
[ (f1^4) ]
gap> ainv:=AINVERSE[1];
(f1^4)
gap> BINVERSE:=Filtered(NN,x->b*x=i and x*b=i);
[ (f2^5) ]
gap> binv:=BINVERSE[1];
(f2^5)
gap> CINVERSE:=Filtered(NN,x->c*x=i and x*c=i);
[ (f1^5*f2^6) ]
gap> cinv:=CINVERSE[1];
(f1^5*f2^6)
gap> k:=1;
1
gap> outlist:=[];
[  ]
gap> while k<= Length(str)-1 do
> > s:=str[k]*a; t:=str[k]*b + str[k+1]*c;
> > for i in [1..49] do
> > if(s=NN[i]) then u:=i-1;
> fi;
> > if(t=NN[i]) then v:=i-1;
> > fi;
> > od;
> Append(outlist,[u]);
> Append(outlist,[v]);
> > k:=k+2;
> > od;
```

gap> outlist;

[10, 35, 3, 36, 0, 19, 15, 38, 6, 29, 6, 41, 6, 25, 6, 25, 21, 16, 3, 6, 21, 3, 0, 39, 6, 41, 15, 38, 0, 19, 0, 7, 15, 38, 0, 7, 1, 15, 10, 17, 15, 10, 21, 3, 0, 37, 10, 35, 10, 45, 6, 11, 10, 14, 0, 47, 3, 6, 3, 18, 10, 14, 3, 18, 1, 15, 3, 6, 15, 24, 10, 35, 10, 21, 3, 5, 10, 14, 6, 25, 15, 24, 10, 32, 1, 26, 6, 11, 6, 11, 6, 11, 10, 32, 10, 14, 0, 19, 3, 18, 15, 10, 0, 47, 3, 5, 1, 26, 6, 25, 1, 30, 0, 0, 6, 41, 15, 24, 10, 17, 15, 38, 3, 6, 3, 18, 1, 15, 15, 38, 1, 12, 10, 4, 10, 35, 6, 1, 15, 38, 10, 17, 10, 14, 3, 5, 1, 30, 3, 33, 10, 32, 6, 41, 15, 24, 6, 41, 0, 39, 6, 25, 10, 17, 10, 32, 1, 26, 6, 11, 0, 47, 6, 1, 10, 14, 15, 38, 3, 5, 3, 22, 3, 6, 1, 42, 10, 4, 3, 36, 0, 23, 0, 37, 10, 17, 6, 9, 21, 31, 3, 5, 1, 30, 0, 47, 10, 35, 3, 46, 1, 12, 6, 11, 3, 18, 0, 37, 1, 30, 6, 25, 6, 25, 3, 5, 6, 11, 15, 38, 6, 41, 6, 25, 1, 42, 10, 45, 15, 38, 3, 5, 1, 42, 6, 11, 3, 6, 6, 9]

Appendix G: GAP4 Code for the Restricted Four-Parameter Case

```
RequirePackage("sonata");

str:=[9, 20, 8, 9, 14, 11, 20, 1, 19, 20, 5, 9, 19, 1, 19, 15, 3, 9, 1, 12, 3, 15, 14, 3, 5, 16, 20,
1, 14, 4, 14, 15, 20, 1, 14, 1, 18, 20, 9, 19, 20, 9, 3, 15, 14, 5, 9, 13, 23, 9, 12, 12, 9, 14, 7,
20, 15, 19, 8, 15, 23, 7, 15, 15, 4, 20, 1,19, 20, 5, 9, 6, 9, 3, 1, 14, 9, 14, 19, 15, 13, 5, 2,
15, 4, 25, 5, 12, 19, 5, 19, 12, 9, 22, 9, 14, 7, 18, 15, 15, 13, 2, 21, 20, 15, 21, 18, 18, 5, 1,
4, 9, 14, 7, 12, 9, 6, 5, 9, 19, 20, 15, 15, 19, 8, 15, 18, 20, 6, 15, 18, 1, 23, 18,9, 20, 5, 18,
20, 15, 2, 5, 9, 14, 1, 14, 25, 23, 1, 25, 16, 15, 12, 9, 20, 5, 19, 9, 14, 3, 5, 8, 9, 19, 23, 15,
18, 4, 19, 5, 14, 20, 5, 18, 9, 14, 20, 15, 1, 14, 15, 20, 8, 5, 18, 19, 2, 18, 1, 9, 14, 9, 14,
19, 9, 12, 5, 14, 3, 5, 1, 14, 4, 9, 14, 20, 9, 13, 1, 3, 25, 8, 5, 19, 8, 15, 21, 12, 4, 2, 5, 1,
19, 8, 15, 14, 5, 19, 20, 1, 19, 23, 5, 1, 18, 5, 23, 9, 20, 8, 15, 21, 18, 19, 5, 12, 22, 5, 19,
0];

H:=ExceptionalNearFields(49);
N1:=H[1];
NN:=AsList(N1);
I:=Filtered(N1,a->ForAll(N1,x->a*x=x and x*a=x));
i:=I[1];
a:=NN[2];
```

```
a in Center(N1);
b:=NN[22];
b in Center(N1);
c:=NN[6];
d:=NN[22];
d in Center(N1);
AINVERSE:=Filtered(NN,x->a*x=i and x*a=i);
ainv:=AINVERSE[1];
BINVERSE:=Filtered(NN,x->b*x=i and x*b=i);
binv:=BINVERSE[1];
CINVERSE:=Filtered(NN,x->c*x=i and x*c=i);
cinv:=CINVERSE[1];
DINVERSE:=Filtered(NN,x->d*x=i and x*d=i);
dinv:=DINVERSE[1];

k:=1;
outlist:=[];

while k<= Length(str)-1 do
> s:=str[k]*a + str[k+1]*b; t:=str[k]*c + str[k+1]*d;
> for i in [1..49] do
> if(s=NN[i]) then u:=i-1;
fi;
> if(t=NN[i]) then v:=i-1;
> fi;
> od;
Append(outlist,[u]);
Append(outlist,[v]);
> k:=k+2;
> od;
outlist;
```

Appendix H: Sample Input/Output of Appendix G

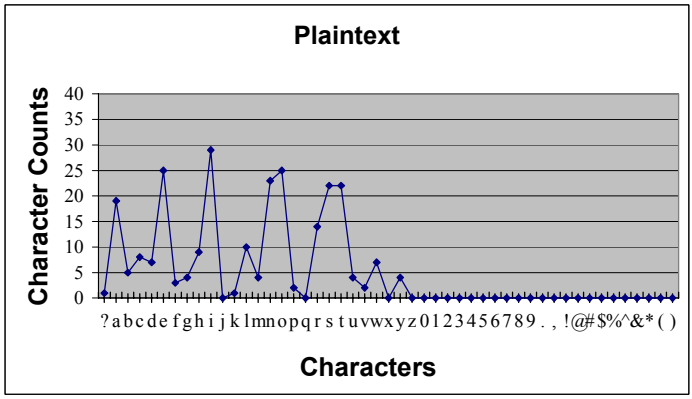
```
RequirePackage("sonata");
str:=[9, 20, 8, 9, 14, 11, 20, 1, 19, 20, 5, 9, 19, 1, 19, 15, 3, 9, 1, 12, 3, 15, 14, 3, 5, 16, 20,
1, 14, 4, 14, 15, 20, 1, 14, 1, 18, 20, 9, 19, 20, 9, 3, 15, 14, 5, 9, 13, 23, 9, 12, 12, 9, 14, 7,
20, 15, 19, 8, 15, 23, 7, 15, 15, 4, 20, 1,19, 20, 5, 9, 6, 9, 3, 1, 14, 9, 14, 19, 15, 13, 5, 2,
15, 4, 25, 5, 12, 19, 5,19, 12, 9, 22, 9, 14, 7, 18, 15, 15, 13, 2, 21, 20, 15, 21, 18, 18, 5, 1,
4, 9, 14, 7, 12, 9, 6, 5, 9, 19, 20, 15, 15, 19, 8, 15, 18, 20, 6, 15, 18, 1, 23, 18,9, 20, 5, 18,
20, 15, 2, 5, 9, 14, 1, 14, 25, 23, 1, 25, 16, 15, 12, 9, 20, 5, 19, 9, 14, 3, 5, 8, 9, 19, 23, 15,
18, 4, 19, 5, 14, 20, 5, 18, 9, 14, 20, 15, 1, 14, 15, 20, 8, 5, 18, 19, 2, 18, 1, 9, 14, 9, 14,
19, 9, 12, 5, 14, 3, 5, 1, 14, 4, 9, 14, 20, 9, 13, 1, 3, 25, 8, 5, 19, 8, 15, 21, 12, 4, 2, 5, 1,
19, 8, 15, 14, 5, 19, 20, 1, 19, 23, 5, 1, 18, 5, 23, 9, 20, 8, 15, 21, 18, 19, 5, 12, 22, 5, 19,
0];

H:=ExceptionalNearFields(49);
N1:=H[1];
NN:=AsList(N1);
I:=Filtered(N1,a->ForAll(N1,x->a*x=x and x*a=x));
i:=I[1];
a:=NN[2];
a in Center(N1);
b:=NN[22];
b in Center(N1);
c:=NN[6];
d:=NN[22];
d in Center(N1);
AINVERSE:=Filtered(NN,x->a*x=i and x*a=i);
ainv:=AINVERSE[1];
BINVERSE:=Filtered(NN,x->b*x=i and x*b=i);
binv:=BINVERSE[1];
```

```
CINVERSE:=Filtered(NN,x->c*x=i and x*c=i);
cinv:=CINVERSE[1];
DINVERSE:=Filtered(NN,x->d*x=i and x*d=i);
dinv:=DINVERSE[1];
k:=1;
outlist:=[];

while k<= Length(str)-1 do
> s:=str[k]*a + str[k+1]*b; t:=str[k]*c + str[k+1]*d;
> for i in [1..49] do
> if(s=NN[i]) then u:=i-1;
fi;
> if(t=NN[i]) then v:=i-1;
> fi;
> od;
Append(outlist,[u]);
Append(outlist,[v]);
> k:=k+2;
> od;
outlist;
```

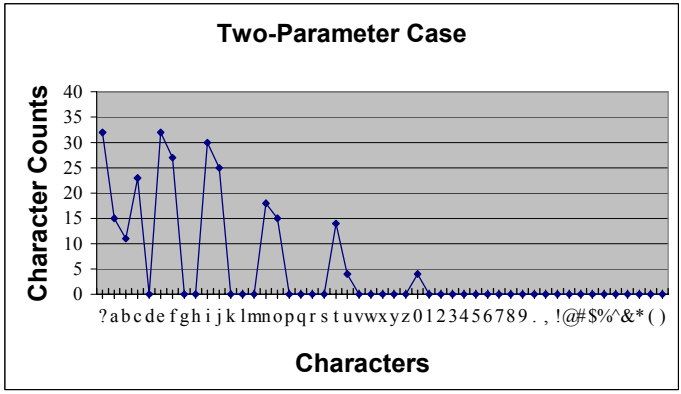
Appendix I: Frequency Analysis Graph of the Plaintext Characters with a Corresponding Chart of Letter Frequencies



Letter Frequencies for the Plaintext

?	**1**	l	**10**	x	**0**	9	**0**
a	**19**	m	**4**	y	**4**	.	**0**
b	**5**	n	**23**	z	**0**	,	**0**
c	**8**	o	**25**	0	**0**	!	**0**
d	**7**	p	**2**	1	**0**	@	**0**
e	**25**	q	**0**	2	**0**	#	**0**
f	**3**	r	**14**	3	**0**	$	**0**
g	**4**	s	**22**	4	**0**	%	**0**
h	**9**	t	**22**	5	**0**	^	**0**
i	**29**	u	**4**	6	**0**	&	**0**
j	**0**	v	**2**	7	**0**	*	**0**
k	**1**	w	**7**	8	**0**	(	**0**
						)	**0**

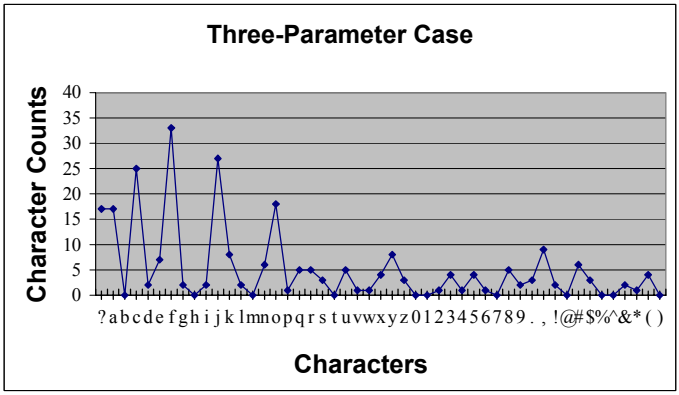
Appendix J: Frequency Analysis Graph of the Two-Parameter Case with a Corresponding Chart of Letter Frequencies



Letter Frequencies for the Two-Parameter Case

?	**32**	l	**0**	x	**0**	9	**0**
a	**15**	m	**0**	y	**0**	.	**0**
b	**11**	n	**18**	z	**0**	,	**0**
c	**23**	o	**15**	0	**4**	!	**0**
d	**0**	p	**0**	1	**0**	@	**0**
e	**32**	q	**0**	2	**0**	#	**0**
f	**27**	r	**0**	3	**0**	$	**0**
g	**0**	s	**0**	4	**0**	%	**0**
h	**0**	t	**14**	5	**0**	^	**0**
i	**30**	u	**4**	6	**0**	&	**0**
j	**25**	v	**0**	7	**0**	*	**0**
k	**0**	w	**0**	8	**0**	(	**0**
						)	**0**

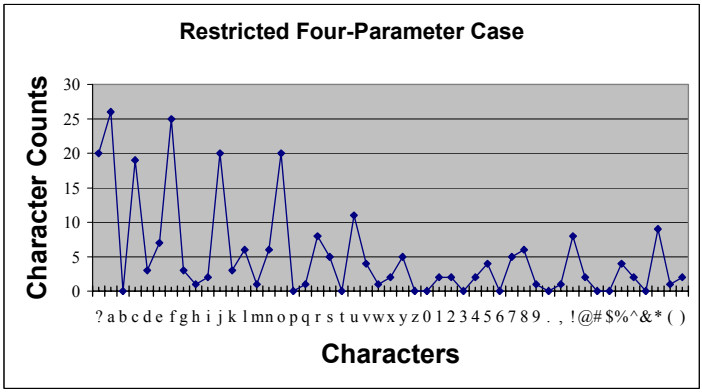
Appendix K: Frequency Analysis Graph of the Three-Parameter Case with a Corresponding Chart of Letter Frequencies



Letter Frequencies for the Three-Parameter Case

?	**17**	l	**2**	x	**4**	9	**2**
a	**17**	m	**0**	y	**8**	.	**3**
b	**0**	n	**6**	z	**3**	,	**9**
c	**25**	o	**18**	0	**0**	!	**2**
d	**2**	p	**1**	1	**0**	@	**0**
e	**7**	q	**5**	2	**1**	#	**6**
f	**33**	r	**5**	3	**4**	$	**3**
g	**2**	s	**3**	4	**1**	%	**0**
h	**0**	t	**0**	5	**4**	^	**0**
i	**2**	u	**5**	6	**1**	&	**2**
j	**27**	v	**1**	7	**0**	*	**1**
k	**8**	w	**1**	8	**5**	(	**4**
						)	**0**

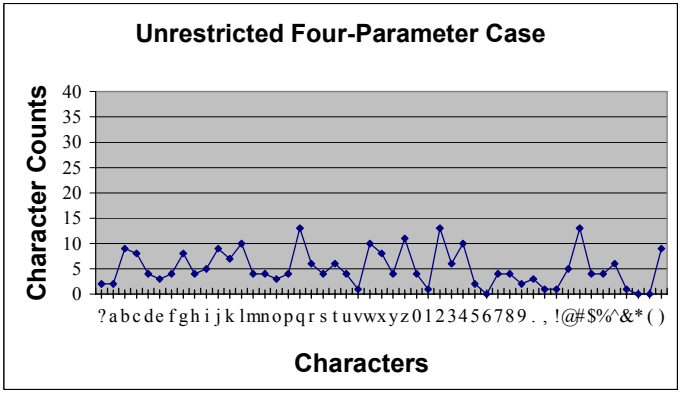
Appendix L: Frequency Analysis Graph of the Restricted Four-Parameter Case with a Corresponding Chart of Letter Frequencies



Letter Frequencies for the Restricted Four-Parameter Case

?	**20**	l	**6**	x	**2**	9	**1**
a	**26**	m	**1**	y	**5**	.	**0**
b	**0**	n	**6**	z	**0**	,	**1**
c	**19**	o	**20**	0	**0**	!	**8**
d	**3**	p	**0**	1	**2**	@	**2**
e	**7**	q	**1**	2	**2**	#	**0**
f	**25**	r	**8**	3	**0**	$	**0**
g	**3**	s	**5**	4	**2**	%	**4**
h	**1**	t	**0**	5	**4**	^	**2**
i	**2**	u	**11**	6	**0**	&	**0**
j	**20**	v	**4**	7	**5**	*	**9**
k	**3**	w	**1**	8	**6**	(	**1**
						)	**2**

Appendix M: Frequency Analysis Graph of the Unrestricted Four Parameter Case with a Corresponding Chart of Letter Frequencies



Letter Frequencies for the Unrestricted Four-Parameter Case

?	**2**	l	**10**	x	**8**	9	**2**
a	**2**	m	**4**	y	**4**	.	**3**
b	**9**	n	**4**	z	**11**	,	**1**
c	**8**	o	**3**	0	**4**	!	**1**
d	**4**	p	**4**	1	**1**	@	**5**
e	**3**	q	**13**	2	**13**	#	**13**
f	**4**	r	**6**	3	**6**	$	**4**
g	**8**	s	**4**	4	**10**	%	**4**
h	**4**	t	**6**	5	**2**	^	**6**
i	**5**	u	**4**	6	**0**	&	**1**
j	**9**	v	**1**	7	**4**	*	**0**
k	**7**	w	**10**	8	**4**	(	**0**
						)	**9**

Appendix N: Alphabet – Assignment of Characters to a Near-Field of Size 49

?	***n*0**	l	***n*12**	x	***n*24**	9	***n*36**
a	***n*1**	m	***n*13**	y	***n*25**	.	***n*37**
b	***n*2**	n	***n*14**	z	***n*26**	,	***n*38**
c	***n*3**	o	***n*15**	0	***n*27**	!	***n*39**
d	***n*4**	p	***n*16**	1	***n*28**	@	***n*40**
e	***n*5**	q	***n*17**	2	***n*29**	#	***n*41**
f	***n*6**	r	***n*18**	3	***n*30**	$	***n*42**
g	***n*7**	s	***n*19**	4	***n*31**	%	***n*43**
h	***n*8**	t	***n*20**	5	***n*32**	^	***n*44**
i	***n*9**	u	***n*21**	6	***n*33**	&	***n*45**
j	***n*10**	v	***n*22**	7	***n*34**	*	***n*46**
k	***n*11**	w	***n*23**	8	***n*35**	(	***n*47**
						)	***n*48**

Section III:
The Social Sciences

The Effect of a Nutrition Label on Food Consumption

Joanna Ferreri[1] (Psychology)

This study investigated the effects of nutrition labels on food consumption. Fifty participants (restrained and non-restrained males and females categorized as normal or overweight by body mass index) were tested in two conditions. In a preload/test meal design, participants received either a true fat label or a "no fat" label on the same granola bar (the preload). Prior to eating, participants were asked to consume as much macaroni and cheese as they wished (the test meal) and the amount remaining was weighed. Also throughout the study, participants were required to complete a measure of dietary restraint and three appetite rating questionnaires were administered at three different times throughout the study. It was hypothesized that the members of the true label condition would eat less of the macaroni and cheese than those members of the "no fat" label condition. It was further hypothesized that restrained eaters would be more effected by the label than those participants labeled as unrestrained. Finally, it was hypothesized that members of the higher body mass index group (overweight) would consume different amounts than those labeled normal. The results show that those individuals in the "no fat" label condition did not consume more macaroni and cheese than those individuals in the true label condition. Regardless of dietary restraint status, participants consumed similar amounts of macaroni and cheese in both label conditions. The failure of this study to demonstrate label effects is attributed to a number of methodological differences between this and other studies.

I. Introduction

Eating is dependent on many factors of everyday life; it is a social, physical and often a pleasurable activity. However, the primary reason for eating is nutrition; people eat because they must to survive. Usually, the amount of food consumed is subject to the discretion of the consumer. Psychological, physiological and environmental influences form a complex interplay, consequently creating numerous factors, to affect the amount of food people eat. Social setting, energy density, nutritional information and dieting are examples of some influences that have been found to have a significant effect on consumption (Kim & Kissileff, 1996; Krai, Roe & Rolls, 2002; Rosen, 1981; Wardle, Parmenter & Waller, 2000). Although these variables have been studied in depth, the

[1] Research performed under the direction of Dr. Laurence J. Nolan (Psychology)

effect of nutrition labels on food intake has rarely been investigated and is, therefore, the aim of the present study.

With the increased availability of low-calorie and low-fat foods, nutritionally important questions regarding the influences that beliefs about these food have on food selection have been raised. One of these factors lies in the packaging. Many food packages boast "fat free" or "low calorie" messages to encourage weight-conscious consumers to purchase their products. Food packaging and labels may play an important role in what foods consumers choose to purchase and how much of it they consume. A label implying that a food is "good" for the consumer can persuade one to buy the product it promotes. The packaging can also effect what consumers believe about the product inside not only by what information it provides, but also because of its appearance. Aspects of the packaging, such as the color, can cause consumers to believe something about what they are buying; for example, a green box tends to imply that the product inside is healthy (Bone & France, 2001).

Nutritional knowledge is an important factor in one's selection of food consumed. It has been found that higher nutritional knowledge can lead to an increased consumption of health conscious foods, such as fruits and vegetables, in a person's diet (Wardle et al., 2000). The low intake rate of fruits and vegetables among adults has been attributed to ignorance of the current intake recommendations (Krebs-Smith, Heimendinger, Patterson, Subar, Kessler & Pivonka, 1995). Also, knowing that consuming something is beneficial to one's health can lead a person to be more likely to consume that food, despite the food's novelty or unfamiliarity (Martins, Pelchat & Pliner, 1997). Therefore, labeling foods with nutritional information may be a necessary and essential stimulus in raising the awareness of nutritional importance and promoting choice of healthier selections.

In a fast-paced society where fast food and quick lunches have become the standard, eating healthy may not be an effortless behavior. In order to improve nutrition, people must make a conscious effort to educate themselves and find healthy foods, often times exerting more effort than usual. In addition, there are many other potential barriers to a reduction in fat in one's diet. Depending upon product availability, price and reduced taste quality, a low-fat alternative to a full-fat counterpart may be less acceptable to the general population (Llyod, Paisley & Mela, 1995) or to those with preexisting negative attitudes about them (Aaron, Mela & Evans, 1994). However, Llyod et al. (1995) found that when these barriers are diminished, use of a low-fat product was easily adopted and maintained. Not only may consumers be unaware of important nutritional facts, but they may also be unaware of the actual amount of fat and other nutrients they are consuming. A disinterest in lowering fat intake in one's diet may be attributed to a skewed perception of the amount of fat a person is currently consuming (Mela & Nolan, 1996). In one study,

participants reported a moderate drop in their fat intake when, in actuality, very little change had actually occurred (Mela & Nolan, 1996). Mela and Nolan (1996) attributed this result to a confusion between "foods considered 'fattening' (which may not be high in fat) and high fat foods."

This is an important distinction because diet selections among free-living consumers can be strongly influenced by what the consumer believes they are ingesting (Gatenby, Aaron et al.,1994). Since the food's label serves as an easily accessible source of nutritional information, consumers can use labels as their source of information about the foods they eat. The association between fat intake and health issues has raised the awareness of the importance of healthy eating. It is out of these concerns that low-fat alternatives of common foods have become increasingly available. These products provide an opportunity for consumers to ingest less fat without significantly altering their dietary habits. Thus, the potential nutritional impact of reduced fat and fat-free products is high (Caputo & Mattes, 1993). However, consumption of low-fat foods may not lead to lower caloric intake. Caputo and Mattes (1993) served the same low-fat meal every day for twelve days to human participants. Although the food did not actually vary, participants were informed on some days that it contained more fat than it did. A significantly higher amount of food was consumed when the meal was thought to be low fat as opposed to when the participants were told the opposite (Caputo & Mattes, 1993). Furthermore, it has been found that dietary restraint plays a role in the effect of this knowledge. Dietary restraint is defined as an "individual's cognitive attempt to consciously limit food intake for the purpose of regulating body weight" (Krai et al., 2002). For instance, research has found that restrained individuals eat more potato chips when they believe them to be "fat-free" as opposed to when they knew they were not (Miller, Castellanos, Shide, Peters & Rolls, 1998). The present study wanted to examine these issues through a different method, the preload/test meal design. One of the most useful and influential laboratory techniques used in the study of human ingestive behavior has been the preload/test meal design (Gray, French, Robinson & Yeomans, 2002). In this experimental design, a preload food or drink intake is manipulated (e.g. energy density, size, macronutrients) before participants are exposed to a test meal. By altering some aspect of the first meal (or preload), examiners are able to measure any intake differences between participants based on the amount of food consumed in the test meal. Due to its effectiveness in preceding investigations, this method has been utilized in the present study by manipulating only the nutritional label of a preload before consumption of a test meal.

The present study investigated differences in intake between two groups to detect any labeling effects on consumption. The groups were also broken down into restrained and non-restrained eaters, male and female, and normal weight and overweight

to detect any consumption differences among these groups. Participants were classified as restrained or non-restrained based on their restraint score on the three-factor eating questionnaire (TFEQ; Stunkard & Messick, 1985). Participants were classified as normal or overweight based upon their body mass index (BMI; kg/m2) which is a metric method for computing body mass by weight corrected for height. The BMI standards are the same for both men and women.

Based on the findings of preceding experiments, it was hypothesized that the different nutrition labels would cause a significant difference in the amount of food consumed between groups. Those participants that were offered the fat-free food label were expected to eat more of the test meal than those given the truthful label. It was hypothesized that due to being under the impression that the preload was fat free, those participants in the experimental group would consume more of the test meal. It was also important to examine whether participants were restrained or non-restrained eaters because restrained eaters eat more of the fat-free food item compared to its regular version when they were provided with information about the fat content of the food (Miller et al., 1998). Therefore, it was also hypothesized that restrained eaters would be more affected by the fat-free label condition than would those participants classified as unrestrained. BMI was also examined and it was hypothesized that participants in different BMI classifications (normal or overweight) would also show different eating behaviors. The results of the study described below did not support any of these hypotheses.

II. Method

Participants

Participants (N = 50, 17 male) ranged between the ages of 18 and 22 (M = 19.63 years, SD = 1.22) and their characteristics are described in Table 1. Participants were recruited from the undergraduate population of Wagner College; all participants participated on a voluntary basis. The mean body mass index (BMI) of the participants was 24.62 kg/m^2 (SD = 5.59). The mean restraint score of participants was 8.56 (SD == 4.97). Age and BMI were not reported by one participant. The fifty participants were randomly assigned to one of two groups, the control condition (label stating fat grams = 6) and experimental condition (label stating fat grams = 0). For the descriptive statistics for each group are reported in Table 2. Informed consent was obtained from each participant prior to study. Approval was obtained from the Wagner College Human Experimentation Review Board.

Overview

Participants were undergraduate men and women who volunteered to participate in a study in which they were asked to consume a granola bar (which they were required to eat in its entirety) followed 20 minutes later by a macaroni and cheese meal (which they were instructed to eat as much as they wished). The amount of each food provided was held constant for all participants, only the nutrition label on the granola bar was altered: one group was told the granola bar contained no fat and 90 calories (although it contained 6 grams of fat and 180 calories) and the other group was told the accurate fat and calorie content. All participants were asked to provide demographic information and to complete a measure of dietary restraint prior to the meal. Participants were also asked to rate their feelings with regard to items such as hunger, fullness, sickness, thirst, desire to eat and dessert desire at three points during the meal: prior to the granola bar, prior to the macaroni and cheese meal and after completion of the meal.

III. Procedure

Participants were recruited by means of a campus-wide email solicitation and by on-campus recruiting in undergraduate psychology classes at Wagner College. Each participant, as incentive to participate, was placed in a pool for the chance to win two free movie tickets. The pool was created by each participant writing their name and phone number on a piece of paper and placing it in a box. A name was then picked at random after completion of the study and the winner was contacted.

The participant was asked to attend the experiment by appointment; each appointment was forty-five minutes in length (see timeline of procedure in Figure 1). All appointments were either in the morning or early afternoon depending upon the participant's and examiner's availability. Each participant was tested individually.

After establishing an appointment time, the participant was instructed that they would receive a telephone call the day before the experiment to confirm their appointment and to receive instructions. At that time each participant was read the following statement: "Do not eat anything this evening after dinner," followed by one of the following: "When you wake up tomorrow, please do not eat breakfast and substitute your normal breakfast with the meal you will eat during the study" or "Please eat breakfast as you would normally and substitute your normal lunch with the meal you will eat during the study" depending on their appointment time.

Upon arriving for the experiment, the participant entered the room and was instructed to sit at the table. At this time, each participant provided informed consent and placed their name in the box for the movie ticket raffle. The participant was provided with a copy of the consent form for their records and a copy was retained by the

examiner. In order to ensure that each participant's papers remained together while ensuring anonymity, he or she was assigned a file number selected at random which was written on all papers associated with that participant. The questionnaires were organized so that one copy of each (TFEQ, three rating questionnaires) was placed in a pile and pre-assigned to one of the random file numbers. This number was written on each page of this package and sorted randomly. The numbers were assigned to the participant based upon arrival; the first appointment would receive the first package of questionnaires, the next would receive the second, and so on. The sheet on which the amount consumed was recorded was a list of the random numbers in a different order than the pile of papers to ensure that the participant's name would not be associated with any of the results.

After the informed consent form was signed and collected, the participant was given the TFEQ (Stunkard & Messick, 1985), which participants were verbally instructed to complete. The packet containing the TFEQ form included a request for demographic information (i.e. age, height, weight and ethnicity). The TFEQ contains two types of questions (true/false and multiple choice) and provides the examiner with three scores: disinhibition, hunger and dietary restraint. The present study only utilized the dietary restraint score.

Upon completion of the TFEQ, which took approximately five minutes, the participant completed the first of the three appetite rating questionnaires. This questionnaire (rating questionnaire 1 or RQ1) asked the following questions: "How hungry are you?" (hunger), "How full are you?" (fullness), "How sick do you feel?" (sickness),"How thirsty are you?" (thirst), "How much would you like to eat a meal in this situation?" (desire to eat), "How much would you like to eat a dessert in this situation?" (dessert desire), "How open are you to trying new foods?" (food flexibility), and "How much did you eat today?" (food intake). Each question was scored using a visual analog scale (VAS) with lines measuring 150 mm in length. The participant was verbally instructed to rate each item on a scale of "Not at All" to "Extremely"; "Not at All" being anchored at the far left of the line and "Extremely" anchored at the far right. A vertical line was to be placed on the line where they felt their feelings were best represented.

When RQ1 was completed, the participant was given the preload food. The preload consisted of two granola bars (Nature Valley, Oats 'n Honey Crunchy Granola Bar, 2 bars, 42 g total weight; see Table 3 for nutritional information) presented to the individual in a clear sealed bag on which a label indicating the fat and calorie content was affixed. Each participant was assigned to either the true label (control) or the manipulated label (experimental) condition alternately as they arrived for his or her appointment. For participants in the control group, the fat and energy content on the label accurately reflected the fat and calorie content of the granola bar and stated, "6 grams of fat, 180

Calories." For participants in the experimental group, the label was manipulated to reflect that the granola bar actually contained less calories and fat than it actually did. The manipulated label stated, "Fat Free, 90 Calories." The participant was then instructed to consume both granola bars in their entirety. At this time, the participant was provided with 115 grams of water to drink while the granola bars were consumed. Regardless of which label the participant received, the instructions given were the same. Each participant was read instructions from a script which stated, "Please eat this meal in its entirety. You will have five minutes to do so." The examiner remained in the room until the participant consumed the bars.

After finishing the granola bars, the second VAS questionnaire was administered to the participant (rating questionnaire 2 or RQ2) to assess what the participant now felt after consuming the first meal. RQ2 asked the participant to again rate hunger, fullness, sickness, thirst, desire to eat and dessert desire and now included questions for rating of satiety and intake variance of the granola bars. Questions on this questionnaire were the same as the first, except for the following changes. The question, "How open are you to trying new foods?" was replaced with, "How much did you enjoy this food?" (satiety) and the question "How much did you eat today?" was replaced with, "How different is this food from what you would normally eat?" (intake variance).

Upon completion of RQ2, the participant was instructed to wait in the room while the examiner prepared the next meal. During this time, the participant was permitted to read. This time allowed the examiner to ensure that there were twenty minutes between the completion of the granola bar and the consumption of the macaroni and cheese which provided time for the first meal to have entered the intestine (Kim & Kissileff, 1996). When the twenty minutes had ended, the examiner returned and the participant was given the macaroni and cheese meal (Kraft Velveeta Shells and Cheese, 500 g; Table 3). The meal was served on a paper plate and the participant was given a plastic fork with which to consume the meal. The size of the meal was in excess of what the participant was expected to eat to ensure the participant would eat what they wanted without emptying the plate. This allowed for the examiner to measure how much food was eaten and to guarantee that the participant did not stop eating because they ran out of food (Kim & Kissileff, 1996). Each participant was instructed to "Please eat at least some of this meal as the next questionnaire will ask you to rate your liking of the meal. When you are finished, please ring the bell and the examiner will return and collect the plate and utensils. You will have as much time as you need to complete the meal." The examiner was not in the room during consumption of the macaroni and cheese and only returned upon hearing the bell.

When the bell was rung, the examiner returned, collected the remaining food and administered the final VAS questionnaire (rating questionnaire 3 or RQ3). This

questionnaire was used for the participant to again rate hunger, fullness, sickness, thirst, desire to eat, dessert desire, satiety and intake variance and added a question for rating the participant's awareness of any effects of the granola bar's nutrition label on the amount of macaroni and cheese he or she consumed. The questions on RQ3 were identical to RQ2 with the following addition: "How much do you think what you ate first affected how much macaroni and cheese you ate?" (nutrition label effect on intake). This was used to discover whether the participant was aware of any affects of the granola bar's label on his or her intake of the macaroni and cheese, which would later be compared to his or her behavior. After the participant departed, the remaining food was weighed. The results were recorded and written on a form containing the participant's file number. All papers involved with the participant, except for the informed consent form, were stapled together and filed. The informed consent form was placed in a different folder to ensure anonymity. This concluded the participant's role in the study. The participant was informed of the purpose of the experiment, asked not to discuss this experiment with any other participants and informed that they may contact the examiner after April 15, 2003 to receive full results from the study. They were also told that they would be contacted shortly if they had won the movie tickets.

After the final participant's session was complete, the results were recorded and analyzed. Those participants with dietary restraint scores ≤ 9 were classified as unrestrained (N = 31) and those participants with a dietary restraint score ≥ 10 were classified as restrained (N = 19). Participants with a BMI < 24.9 were classified as normal (N = 31) and those participants with a BMI > 25 were classified as overweight (N=18). This experiment utilized a 2x2x2 independent groups design with labeling conditions, dietary restraint and BMI as the independent variables and with RQ1, RQ2 and RQ3 and the amount of macaroni and cheese consumed as dependent variables. A three-way analysis of variance (ANOVA) was utilized to measure differences in dependent measures.

IV. Results

An alpha (a) level of 0.05 was used for statistical analysis. Descriptive statistics are available by groups (label, restraint and BMI) in Tables 4, 5 and 6. A three-way ANOVA (Table 7) indicated that there was no significant difference in the mean amounts consumed between the control and low-fat label groups, $F(1,41) = .390$, $p > .05$. It also indicated that restrained individuals were not effected by the manipulated label more than non-restrained individuals in amount consumed, $F(1,41) = 1.720$, $p > .05$. Furthermore, it indicated that those individuals classified as normal did not significantly differ in amount consumed from those classified as overweight, $F(1,41) = 1.109$, $p > .05$. Therefore, contrary to the hypothesis, no significant differences were found among any of the main

effects (label condition, dietary restraint and BMI). Correlations were performed between the independent variables no relationships among them were detected (Table 8).

Additional correlations were performed among restraint score, BMI, amount consumed, and two rating questions deemed of particular interest: "How much did you enjoy this food" (satiety) and "How much do you think what you ate first affected how much macaroni and cheese you ate?" (nutrition label effect on intake). Both questions were from RQ3 and were answered after consumption of the macaroni and cheese meal. The first question referring to enjoyment was chosen in order to determine if enjoyment of the food was related to a higher amount consumed. There was a significant correlation between this question and amount consumed, $r(48) = .548$, $p < 0.05$. The second question was chosen to determine whether participants reported a label effect. Responses to this question were significantly correlated to the amount consumed, $r(48) = -.290$, $p < 0.05$. There were no other significant correlations between any other rating questionnaire questions and amount consumed. Therefore, the present study was unable to detect any main effects or or any relationships between amount consumed, restraint or BMI.

V. Discussion

The results suggest that contrary to other studies, nutrition labels do not have a significant effect on the amount of food consumed by college students. However, the fact that this study was unable to support the hypotheses does not provide evidence that the hypotheses were incorrect in general. Rather, it only establishes that the present study conducted in the manner described was unable to detect any statistically significant effects. Research conducted in other labs, however, suggests that this topic deserves further experimental attention.

The results of this study indicate that participants consumed the same amount of food regardless of restraint status, BMI or label information. Manipulating a label on a granola bar did not cause participants to eat more of the macaroni and cheese meal. However, previous studies show that simply the implication that a food is less fattening than it actually is causes people to consume more of that food than when they are exposed to the food's full-fat counterpart (Aaron et al., 1994; Miller et al., 1998). Thus, the labeling of a preload might potentially affect it.

Also contrary to previous findings, the present study's results imply that restrained eaters are no more effected by food's nutritional information than non-restrained eaters. Despite their heightened awareness of the fat and caloric content of food, restrained eaters did not consume less food when presented with the true label condition than they did when presented with the "no fat" label. Restrained eaters are usually more effected by a change in nutritional information than eaters classified as non-restrained (Miller et al., 1998).

Similarly, overweight individuals did not consume a significantly different amount of food than individuals classified as normal. This result suggests that regardless of body mass index, a person will consume the same amount of food when presented with a low-fat or a full-fat food. Previous research has found that overweight or obese individuals consume more food on average than individuals of normal body weight (Cinciripini, 1984). When testing for correlations between variables, no significant relationships were found. This suggests that there were no relationships between the variables. Therefore, not only was the amount consumed not correlated with restraint or body mass index, but also that BMI was not related to restraint score, for example, overweight individuals did not tend to be categorized as restrained. This results is inconsistent with previous findings indicating a positive correlation between BMI and restraint.

The only significant relationships were those between the amount consumed and the two ratings on satiety and label effects. Those individuals that enjoyed the macaroni and cheese tended to eat more of it. The other question, which asked participants to rate the degree to which the label influenced his or her behavior indicate that low BMI's were correlated with a high rating of label effect. However, although these individuals reported a label affect, their behavior indicates otherwise. This finding is interesting in that it implies that the participants are not aware of their own consumption.

In summary, the results of the present study do not indicate any effects of nutrition labels but, as mentioned earlier, there is still sufficient reason to believe that this topic deserves further attention. Food packaging and nutritional information have proven to have significant effects on behaviors such as food consumption and food selection (Bone & France, 2001; Krebs-Smith et al., 1995; Caputo & Mattes, 1993). Therefore, it is likely that combining the two together (the packaging and the information) into the nutrition label would have significant effects on behaviors such as consumption.

The preload/test meal design is a common method used to examine different effects on meal size. This method was different in many ways from previous studies of this type. First, some studies required participants to complete take-home reports on intake for a period of time before the study and throughout its completion (Caputo & Mattes, 1993). Through this, the researchers were able to determine how much a person had consumed on the day of the experiment and how much that amount varied on a day to day basis.

It is also common for experiments using a preload/test meal design to use a repeated measures design, where one participant is tested repeatedly in different conditions and behavior is recorded. It allows the examiner to clearly discern changes in behavior by using the same individual. It is common in a preload/test meal design to implement repeated measures (Caputo & Mattes, 1993; Gray et al., 2002; Kim &

Kisseleff, 1996; Krai et al. 2002). This study implemented an independent groups design in which two groups are tested under one condition each. In this case, individuals were tested only once and were randomly assigned to one of two label conditions. A repeated measures design was not used in this study as it increases the chances the participants would discover the purpose of the study. Furthermore, there was concern that participants would not return for a second visit without compensation.

This study was also different from other preload/test meal experiments in that it did not manipulate content of the preload, it simply manipulated the label providing information about the preload. It is common to manipulate different aspects of the content of a preload such as energy density (Krai et al., 2002), fat content (Caputo & Mattes, 1993) or volume (Gray et al., 2002). The preload manipulation is determined by what the experimenter is interested in studying, therefore, the nutrition label was manipulated in this case. It is possible that manipulating the label of a preload is too weak an effect to cause a significant change in test meal size. A preload/test meal design, therefore, may not have been suitable in this study.

There were many limitations to the present study that need to be considered in order to interpret the results. One limitation was that of the experiment's setting. Without the availability of a dedicated area for testing, participants in the study were required to complete the experiment in the Psychology Department's computer lab. This room presented less than ideal conditions for which to run a psychological experiment. The room provided distractions such as computers, windows and external noises from adjacent class rooms. These distractions may have caused enough of a disturbance to result in a retention of the null hypothesis.

In addition, the lack of dedicated examination space left the researcher unable to schedule as many participants as she would have liked. With the resources to test only one participant at a time, the total number of participants tested was low. Furthermore, recruitment of participants was often difficult as there was not a readily available source of student participants to employ.

In addition to the less than ideal room setting, the examiner was restricted by time constraints. First, the room in which participants were seen was only available in the mornings and early afternoon. Also, the researcher was restricted by her own class schedule and the class schedules of the participants. A steady pool of participants may have created a more available range of students available at the same time as the examiner. As a result, participants were seen at varying times throughout the mornings and early afternoon. This may have had an effect on the amount of macaroni and cheese a participant consumed. If, for instance, the participant attended the first experiment of the day (in the morning) it may have caused them to eat less than a participant that arrived for an appointment scheduled closer to lunch. However, participants were evenly spread

throughout the appointment times and therefore, this potential confound should have balanced out.

The study was also limited by the makeup of the participants. Due to the experiment being conducted by an undergraduate student on a college campus, it was difficult to recruit subjects outside of the classification of college student. Had the study been performed on a wider range of ages and lifestyles, the results may have been different. However, the participants studied were well distributed in the study in that the number of restrained individuals was roughly equivalent in both the experimental and control group. Also, the study was dominantly performed on white participants. The number of other ethnic groups was insignificant.

It is also possible that the foods chosen for the study were not ideal. The combination of a granola bar and macaroni and cheese may not have presented the participant with an appetizing meal combination, especially for those participants tested in the morning. This, therefore, may have caused the granola bar to have had an effect on the macaroni and cheese consumption for different reasons than initially hypothesized. Although, the granola bar/macaroni and cheese combination may have negated any effects of a label on meal size. It is possible that the granola bar was so satiating, that it overrode any effects of the labels. Also when considering food selection, the examiner should have taken into account the possibility that participants would be familiar with the granola bar and be aware that it is not a fat free food. Even if the participant was unaware of the type of granola bar, there is still the possibility that they are aware of the fat content of granola itself. During the debriefing, some participants informed the examiner that they were aware that the label on the bag was inaccurate. This would remove any effect the label would have had on consumption. However, due to lack of resources, use of a homemade preload was not an option and the examiner was constrained to the use of a commercially available product. Awareness of the label was essential to the success of this study and deserves particular attention at this point of the discussion. As mentioned earlier, the label containing the nutritional information was affixed to the clear plastic bag containing the granola bar. However, the examiner could not ensure that the participant was aware of the label. Despite placing the bag flat on the table in front of the participant with the label face up, the possibility that the participant did not observe the label still existed. The examiner could have verbally instructed the participant to take note of the label; however, by doing so, faced the chance of drawing too much attention on the label. This could have led some to believe that this "label" was a manipulated factor in the experiment. This was a reasonable assumption since the majority of participants in this study were recruited from the undergraduate psychology classes of Wagner College. Therefore, many participants were familiar with the deceptive techniques used in psychological testing. This issue was brought to the examiner's attention by several

participants during their debriefing. Other participants informed the examiner that they did not notice the label on the bag. In order to detect how significant an effect this factor may have had on the results, the examiner should have included a question on the rating questionnaires asking the participants whether they saw the label and, if they did see it, what the label said.

There is also reason to believe that the effects of nutritional information have been underestimated, not only in this study, but in previous studies on this issue. There is sufficient evidence to conclude that nutritional information does have a significant impact on cognitive food decisions. It has been discussed that a reason for finding a weak correlation between nutritional information and consumption was in fact a result of poor testing methods rather than an incorrect hypothesis (Wardle et al., 2000).

According to Wardle and colleagues, one reason for inaccurate test results in previous studies may be due to the conduction of the studies with unreliable instruments. This would reduce the power to detect any associations of the variable with the tested material. Also, Wardle found that although clinical results may not prove to be statistically significant, there are other real, and therefore, significant effects that are simply more modest and harder to detect in an experimental setting. Wardle also concluded that the previous studies on the relationship between food intake and nutritional knowledge was too busy concentrating on the "fat content" and ignored many other factors such as energy, density and other health factors associated with food. These factors may also be taken into consideration for the failure of the present study to support its own hypothesis.

In conclusion, future research on this issue must take into consideration all of the issues described above. Future research on nutritional information and its effect on consumption could lead to many useful discoveries about eating behavior. By ascertaining different influences on the amounts of food people consume, researchers may be able to modify the behavior of overweight individuals or prevent overeating in others.

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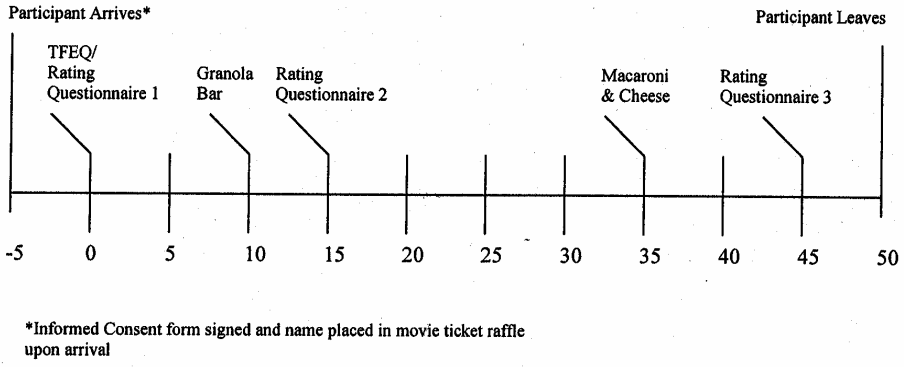

Figure 1: Timeline of Experimental Procedures

Table 1: Descriptive Statistics of Age, BMI and Restraint Scores of Participants

Variable	N	Mean	Standard Deviation
Age	49	19.63	1.22
BMI	49	24.62	5.59
Restraint Score (TFEQ)	50	8.56	4.97

Table 2: Descriptive Statistics of BMI and Restraint Score by Label Condition

True Label Group (Control) N=26,9 Male			
Variable	**N**	**Mean**	**Standard Deviation**
Age	26	24.51	5.86
BMI	26	8.58	4.93
Restraint Score (TFEQ)	26	19.38	1.17
"No Fat" Label Group (Experimental) N=24,8 Male			
Variable	**N**	**Mean**	**Standard Deviation**
Age	23	24.74	5.39
BMI	24	8.54	5.11
Restraint Score (TFEQ)	24	19.91	1.24

Table 3: Nutritional Information of Food

Food	Serving Size	Fat Content	Calorie Content
Nature Valley Oats`n Honey Crunchy Granola Bars	42g (2 bars)	6g	180
Kraft Velveeta Shells & Cheese	500g	52g	144

Table 4: Descriptive Statistics of Amount Consumed (grams) by Label Condition

	Control	**Experimental**
M	260.10	254.68
SD	123.79	122.00
N	26	24

Table 5: Descriptive Statistics of Amount Consumed (grams) by Label Condition and Dietary Restraint

	Control	**Experimental**
Restrained	M=213.26 SD=58.06 N=9	M=258.82 SD=122.90 N=10
Non-Restrained	M=284.89 SD=142.73 N=17	M=251.73 SD=125.90 N=14

Table 6: Descriptive Statistics of Amount Consumed (grams) by Label Condition and BMI

	Control	**Experimental**
Normal	M=236.07 SD=108.74 N=18	M=243.22 SD=120.06 N=13
Overweight	M=314.15 SD=145.58 N=8	M=265.42 SD=135.30 N=10

Table 7: ANOVA Test Results of Between-Subjects Effects of Amount Consumed

Main Effect	df	F	p
Label Condition	1, 41	0.390	0.845
Restraint Group	1,41	1.720	0.197
BMI Group	1,41	1.109	0.298
Restraint by Label	1,41	2.477	0.123
Restraint Group and BMI Group	1,41	0.999	0.323
BMI Group, Label	1,41	1.920	0.664
Restraint Group, Label and BMI Group	1,41	2.105	0.154

Table 8: Correlations

	Satiety	Label Effect	Amount	Restraint
Label Effect	r=0.151 p=0.294			
Amount	r=0.548 p=0.000	r=-0.102 p=0.481		
Restraint	r=-0.008 p=0.954	r=0.269 p=0.059	r=-0.235 p=0.101	
BMI	r=-0.117 p=0.422	r=-0.290 p=0.043	r=0.148 p=0.312	r=0.104 p=0.476

Section IV: Critical Essays

The Invention of Homosexuality

Frank G. Garritano [1] (Psychology)

Sexuality, as we know it, did not exist much before the 20th century. Surprising as it may be to some, our sacrosanct definition of human sexuality, embodied in the "Heterosexual / Homosexual" paradigm, did not exist before the late 1800's. With only a cursory glance at the current state of affairs, it seems fairly self-evident that indeed, heterosexuality and homosexuality are very much real parts of our lives. This leaves one wondering -- what was human sexual life like before the late 19th century? Sexual life no doubt existed, was, and is a fundamental aspect of the human experience – but in what ways did that experience differ? Through the objective examination of previous modes of categorizing sexual behavior, we hope to demonstrate that the current system of classifying sexual behavior is a fairly recent invention, with many unforeseen consequences. With this in mind, we can then subject the current system of "Hetero" and "Homo" to dissection and closer examination, revealing some of the problems intrinsic to this mode of classification. Lastly, unburdened by the rigid requirements imposed by the "Hetero / Homo" paradigm, we can attempt to arrive at a more accurate depiction of the fundamental nature of human sexuality.

The first task in unraveling the tangled web of contemporary sexuality is to attempt to demonstrate that our current system of classification is, at best, arbitrary, and at worst, harmful. The simplest way to demonstrate that our hetero/homo system is inadequate is to devote some time briefly to introducing past methods of organizing sexual behavior, most specifically those of the Greeks and of pre-19th century individuals. This forces one to acknowledge that our current way of classifying (Hetero / Homo) may in fact not be the universal truth it has been exalted as, and may actually impede the discovery of said truth.

Before we begin, it would first seem prudent to mention briefly the context of the contemporary debate over homosexuality. The essence of the debate has long been argued from one of two intellectual camps: constructionism, or essentialism. The constructionists argue that homosexuality is a social construction, and as such, is a peculiarity specific to our way of life and not necessarily an integral part of the human psyche. Essentialists argue the other side of the coin, maintaining that homosexuality is an essential part of the human experience and so must have existed throughout all of

[1] Research performed under the direction of Dr. Miles Groth (Psychology)

time. However, as with so many other things, neither is entirely true, and neither is entirely false. The truth, instead, seems to lie somewhere in between.

Many people make the mistake of assuming that the ancient Greek relationship with boys is an analogue for modern day homosexuality. In fact, the crux of the essentialist argument rests very strongly on the assumption that Greek pederasty relationships are identical, or at least comparable, to modern homosexuality. This is a very dangerous assumption to make, and one that is easily called into doubt. Firstly, most Greek males who participated in these relationships were "bisexual" – meaning that at some points, they would enter into sexual relationships with boys or men, and at others they would participate in the more "traditional" sexual relationship with one's wife (How to, 2002). This clearly jives with our current system of sexual classification. David Halperin, in his book "One Hundred Years of Homosexuality," also reminds the reader that the ancient Greeks viewed sex not as a consensual act in which two people participated, but as an act performed by one person unto another (1990). The act of penetration was associated with the masculine, and the act of being penetrated was associated with the feminine. This is representative of the very intimate way in which sexual roles, social class, age, status, and masculinity were related to the sexual act. The Greek relationship with boys was a relationship characterized by differences in age, social class, power, social responsibility, citizenship and masculinity. There is no question that contemporary homosexual relationships exist which could be characterized by many, if not all of the same values. But it would be a grave 'category mistake' to assign to homosexuality all those things which embodied the Greek pederasty relationships (How to, 2002). Therefore, any reading of history in which a person analogizes Greek pederasty with contemporary homosexuality is guilty of projecting the present into the reading of history – of forcing Greek sexual culture to fit into our narrow, rigid definitions of hetero and homosexuality.

Moving a bit closer to the present, our attention is drawn to that seeming limbo existing between the definition of the modern notion of sexuality and all the rest of history. In 1892, the word "homosexuality" was first created, although it did not appear in popular academic or colloquial use until much later. David Halperin states, "Before 1892 there was no homosexuality, only sexual inversion. Sexual inversion, the term used most commonly in the nineteenth century, did not denote the same conceptual phenomenon as homosexuality" (One Hundred, 1990). In fact, the term 'sexual inversion' denoted quite a large variety of sexual pathologies and deviant behavior, of which homosexuality was only one type (One Hundred, 1990). Instead, the new terminology centered on what is referred to as "sexual object choice;" or more simply, a persons preferred sexual partner. Halperin goes on to continue to suggest that a "blandly descriptive, rigorously clinical" term like "homosexuality" may appear to be innocuous

as a taxonomic device, but points out that the distinction carries with it a large amount of ideological baggage, and has in fact presented "a significant obstacle to understanding the distinctive features of sexual life in non-western and pre-modern cultures" (One Hundred, 1990). The existence of categories such as hetero and homo presuppose that there exists in every individual some "seat of power" from which a persons "sexuality" (embodied in their "sexual object choice") reigns supreme, a notion absent from any pre-modern accounts of human sexuality.

After only a brief review of certain types of sexual relationships to be found in ancient Greece and pre-modern history, it becomes painfully obvious that the distinctions made between sexual object choice in the contemporary classifications of hetero and homosexuality are seemingly arbitrary. At no point does a reason present itself for the removal of homosexuality from the far-reaching category of "sexual inversion" to the dualistic, object-choice based paradigm of hetero / homosexuality. In addition, it would also appear that our sexual-historical endeavors have been so greatly contaminated by our projection of contemporary sexuality into the past (as evidenced by the way many people identify pre-modern and historical Greek relationships with modern day systems of classification) that we can longer envision a world in which things exist differently than the way they currently do.

As Halperin notes, "homosexuality" does indeed appear to be an innocuous taxonomic device (One Hundred, 1990). However, the truth of the matter is that our current system of sexual classification has created a whole host of problems, and perhaps undermined efforts to determine the features characteristic of human sexuality in general. Perhaps the most pervasive of these problems are heterosexism and homophobia, which share an unmistakable yet oft-unnoticed relationship.

Heterosexism can be defined as "a setting-level process that systematically privileges heterosexuality relative to homosexuality, based on the assumption that heterosexuality, as well as heterosexual power and privilege are the norm and ideal" (Chesir-Teran, 2003). Take a moment to simply read those words, and entertain their meaning for a moment. Many people fail to realize the extent to which we live in a heterosexist world (i.e., the extent to which heterosexism is enshrined in our public institutions). Many people also internalize the values of heterosexism, sometimes without even fully realizing it. But what are those values, and why are they such a problem? The basis for the heterosexist belief is that heterosexuality is in fact superior to homosexuality -- be it for whatever reason. There are many reasons that someone might choose to accept this statement at face value, and to many I am sure the statement does not appear to be so inappropriate or problematic. However, consider for a moment the dangers inherent in this belief. In an article entitled "Conceptualizing and assessing heterosexism in high schools" in the *American Journal of Community Psychology*, Daniel Chesir-Teran posits

(quite convincingly), that evidence of heterosexism can be found in "reduced feelings of school safety, increased sexual risk, fewer same-gender friendships, and more rigid attitudes about gender appropriate activities, goals, and careers" (2003). In other words, the reason homosexual boys have such difficult times in high school, both anecdotally and as evidenced by school records, is heterosexism. Increased suicide rates among homosexual youth, higher rates of illicit drug use and unsafe sexual practices – just about every single pitfall that modern homosexuals face on the rocky road to adulthood can be related to heterosexism. In a paper of such limited scope, it is difficult to impress upon the reader the urgency of this message without approaching a level of detail that is simply unrealistic for this work. However, the structure of heterosexism is the same as every other "ism" used by a majority to oppress a minority – it bears the same, unfounded assumptions as to one groups "superiority," it imposes unfairly on a whole group of people a 'lower' level of ethical and moral consideration (since that is the definition of inferior), and it gives to the ruling group a sense of superiority and "rightness." This is all excluding the inevitable potential for violence and "gay bashing" that goes along with such a system, and, in fact, this system of heterosexism neatly explains the reason that homosexuals are considered to be "acceptable targets" for abuse by many elements of society today. Heterosexism is, in short, oppression of a minority by the tyranny of a majority – an act condemned as it repeats itself throughout history, yet, American society remains oddly acquiescent over the presence of heterosexism.

So, heterosexism exists – that much appears incontrovertible. The extent to which it may or may not saturate the world we live in is not so clear. However, why does heterosexism exist? To begin, it would be fruitful for us consider homophobia. Little time needs to be spent documenting the fact that feelings of homophobia are positively correlated with feelings of homosexual desire. One such example is a study done by Adams, Wright, and Lohr in which they demonstrated that homophobic men showed greater physiological sexual arousal to consensual male homosexual activity than those who did not report negative affect towards homosexuals (1996). It is sometimes postulated, as a way of explaining this relationship between homophobia and homosexual desire, that homophobic individuals, "shamed" by society's view of their innate homosexual desire, sublimate that desire into homophobia. It seems, in addition, the "shame" felt by these individuals could be considered evidence of precisely just how deeply people internalize the heterosexist norm under which we now live. Those individuals may internalize societies heterosexist rhetoric so deeply, that in the end, they feel quite ashamed of their desires, causing them to display those characteristics we would ascribe to homophobes. Let us now consider heterosexism and homophobia in the same vein: heterosexism is the systematic privileging of heterosexuality over homosexuality, and homophobia is marked by a certain 'fear' of homosexuality and

homosexual behavior, predicated on an individuals own subconscious homosexual desire. Could homophobia be the root cause of heterosexism? Could not the method by which heterosexism has come to dominate sexual thought in America be through homophobia? If homophobes do in fact have homosexual desires themselves, it is possible we have a solution: homophobes, discouraged from their own feelings of homosexual desire by societies heterosexist attitudes, instead sublimate those homosexual desires into a homophobic attitude. Similarly, society's heterosexist attitude is reinforced and affirmed by the feelings of homophobic individuals. The presence of one half-of the equation seems to buttress and otherwise reinforce the other, hence the reference to an "intimate relation" between homophobia and heterosexism – each by its very existence allows the flourishing of the other. Incidentally, this reasoning may also leave room to adequately explain a problem that has eluded psychologists since Freud himself: the "problem" of strictly heterosexual desire felt for women by heterosexual men.

After all of this, it seems fairly self-evident that perhaps the heterosexual / homosexual paradigm is lacking, and fails to embody the complexities inherent in human relation. It becomes very easy to question the stability and rationality of the current sexual economy, but it is much more difficult to take those criticisms and observations and to use them in the creation of a newer, more humane sexuality. (Note: The use of the word 'humane' conjures up vivid images, but what could we call our system of sexuality if not "inhumane," for the irreparable damage that it does to the psyche of countless homosexuals reared in a heterosexist and homophobic world)?

The system of sexual classification under which we live would appear to be at fault for the problems discussed previously. The root of all those problems, however, can be effectively traced back to a single, psychological mechanism that everybody employs – defining what it is that is and is not normal. David Schwartz, in a paper in the *Journal of Psychoanalytic Psychology*, argues very strongly against psychoanalytic theories of human development (1999). Schwartz states, "developmental models are myths of origin for the modern age," providing "science-*like* paradigms of the sources of disturbance, psychopathology, and perversion" (1999). Schwartz is driving at the fact that developmental models, or any model where an individual is "fit" into carefully laid out paradigms of normality and abnormality, without regard for that individual, are inherently flawed. This idea can be taken and applied to our modern day "Heterosexuality Paradigm," where it serves as an explanation why the system of sexual classification we are saddled with today came to fruition in the first place – to attempt to define what it is that is abnormal (homosexuality), and to thusly arrive at that which is normal (heterosexuality). A questionable goal, if ever there was one.

After laying out the groundwork for the critical analysis of our modern day heterosexuality paradigm, we are left with little. Unfortunately, our own contemporary

perceptions as to the nature of human sexuality have so clouded our perceptions that we no longer have the freedom of thought to easily conceive of sexuality existing in a framework outside of the one in which we live. However, it is not entirely impossible to imagine sexuality existing in some other manner, and relating in some different way to human experience. Taking what we have learned about pre-modern and ancient Greek sexuality, along with what we have learned about the problems our current system of thought leaves us with, we can attempt to identify some of the features that would seem to be innate to our human sexuality.

The first, most startling notion to demand attention is the seemingly ambiguous and amorphous characteristic of our sexuality. After envisioning sexuality in a strictly hetero/homo framework for so long, it can come as quite a surprise to see how bi-directional our sexuality can be. For example, it is no secret that inside prison, many otherwise "heterosexual" men engage in homosexual sexual acts. It is also no secret that this is usually not a "permanent" change and that as soon as the men leave prison, they generally return to their "heterosexual" way of life. Similarly, in ancient Greece, men who were otherwise married and actively participating in domestic and civil life also engaged in pederasty relationships with boys. Contrast this to our modern world, in which nearly everyone is polarized: either exclusively heterosexual or exclusively homosexual. The idea that sexuality is amorphous flies in the face of the idea that our sexuality is directed at a particular sex – the two cannot coexist – one is necessarily more correct than the other. Unfortunately for us, the model that we have chosen appears to be, for lack of a better word, simply wrong. As Kinsey put it in his landmark study in 1948, "People do not represent two discrete populations, heterosexual and homosexual...It is a fundamental fact that nature rarely deals with discrete categories. Only the human categorizes and pigeonholes…" (Kinsey, 1948).

Another feature of the modern era is our *obsession* with sexuality. Since Freud and the development of psychoanalysis, every aspect of human existence has been considered psychosexually, and indeed, Freudians still see "a phallus" or "an Oedipal complex" in every feature of human psychic life – the sexualization of the psyche, if you will. Everywhere we look we are saturated in sexual imagery – television, billboards, the very clothes that we wear. The final conclusion thus becomes not only, "Maybe we got the idea of human sexuality wrong," but also "maybe we are making a big deal out of nothing," meaning perhaps our *obsession* with sex is not only unnatural, but harmful.

Indeed, after all of our inquiry we are left with many more questions than we are answers. Sexuality is indeed a feature of human existence, but agreement tends to stop there. The roles sexuality should have in our lives as well as the nature of our own sexuality are puzzling questions without simple answers. The truth is, we do not know what it is that makes us sexual beings, or why it is that we experience sexual attraction

and feeling in the way that we do. Through methodological historical inquiry however, we have been able to identify the features of pre-modern and ancient Greek sexuality, and thusly to compare the characteristics of such with our own system of sexual classification. Doing so has yielded not only invaluable information about the system of sexual organization that exists today, but also provided insight into the elusive "nature" of our own sexuality. We are certainly not close to the level of social change that would be required to institute a shift from a hetero/homo framework to one more attentive to the features and nuance of our own sexuality. However, the vehicle for social change is discussion, and without discussing where we are, we will never be able to accurately identify how we got here, or how to move forward.

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A Concern for an Individual Will Bring Forth a Concern for the Whole

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The Sky, the Stars and the Wilderness by Rick Bass (1997), is a novella which exemplifies various environmental views that exist in the world. One of the main issues that defines an environmental view is how a person relates to other species. Do they think species should be protected or regulated or left alone? These questions can only be answered when it is clear where a person's concern lies. Is their concern with an individual, or a species? Or is it a total disregard for nonhuman species altogether and a focus on only what the use of the environment is to humans? According to ecological holism, as explained in *Environmental Ethics* by Joseph R. Des Jardins (2001), "the value of an individual organism is derived in part by its function, role, operation, relationships and the like" (190). As Des Jardins explains, the environmental view that thinks in terms of the individual often leads to misinformed and risky management policies. Anne, the narrator of *The Sky, the Stars, and the Wilderness,* feels a connection with the individuals of nature and proves that the more concerned a person is with the individual of a species, the more responsible and reverent they will feel towards the species as a whole, and will therefore make decisions based on this view.

Anne experienced a unique childhood where she was immersed in a natural environment each and every day. She holds nature in very high esteem and views nature as a part of herself and as something to be respected. She was raised to hold such values by her grandfather, mother, and in a lesser respect, her father. Her grandfather taught her that "it was important to know the names of things--that once the names could be spoken, knowledge would follow" (Bass 99). He appreciated each individual species that was on the land that they lived on, and his granddaughter inherited this appreciation. She strived to learn the names and characteristics of each and every bird species. She related to them from the beginning of her life. She imagined the birds that would have been around in the season that she was born. She learned how different species of birds hunted prey, and the different songs the birds would sing (Bass 129).

Anne, however, was not only interested in birds but also in the many other creatures that existed near her home on Prade Ranch. Grandfather had a guidebook where he showed her what each creature, or flower or smell or sound was (Bass 93).

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[1] Research performed under the direction of Dr. Kim Worthy (Writing Center)

Anne developed such an interest in all wild things that she explored the country with maps her Grandfather made or with her Grandfather. The year after her mother had died, Anne felt obligated to learn all that her mother had about nature as well as new things that her mother might not have known on her own (Bass 93). Anne was intent upon knowing every aspect of the land on which she lived, just as her Grandfather did. She knew that it would take her an entire life to accomplish such a large feat (Bass 125). The land had impressed itself upon Anne and she learned and imprinted the rules and systems of the land (Bass 114). As she grew, the land became a part of her. Because of this, she felt a connection not just to the birds or her family home, but to the land as a whole from the trees to the animals to the river and rocks, as well as to the spirit of her mother.

Anne's mother died when Anne was still a young child, only eight years old. Her mother, like her grandfather, had a great appreciation and love for nature which she shared with her children. When she died, Anne did not refer to her "burial" but her "planting". Her mother became a part of the nature that she and her daughter loved dearly. When Anne felt the need to be with her mother, she would run through the woods and experience all the beauty that nature holds and she felt like her mother was all around her. She viewed her mother as once an individual, but after her death, as a part of the whole environment. The narrator found her mother not only in the place she was "planted," but throughout the natural environment. She continued to visit her grave and shared her thoughts with the presence of her mother's spirit (Bass 137). By experiencing the environment as a whole, Anne was able to experience her mother's individual spirit.

Because her brother was so young when their mother died, Anne wanted to share with him the presence of their mother's spirit which she found in the woods. "There is no other way to explain it: we'd run until Mother was alive…We'd run until we ignited, until we blossomed, in her presence" (Bass 105). By immersing themselves in nature, Anne hoped that her brother would be able to feel and remember their mother. Anne and her brother would stay in the woods late, past midnight. This seems unusual, it would be expected that the Father who had already lost his wife, would be over protective of his children. But he appeared to have understood that his children could experience their mother by experiencing nature in its entirety. Even if he did not understand completely, he respected Anne's connection with her mother through nature.

Anne's family respected the environment as a whole, although they did utilize individuals of the environment for their own benefit. For example, on a trip to the beach, her father and her grandfather's friend, Chubb, caught fish and "that was enough for breakfast" (Bass 143). They did not use anymore than they needed. Anne realized the difference between fishing individual fish for food and hunting individual animals for sport. Hunting for sport displays a disregard for the individual as well as the whole. This lifestyle is very similar to that which Deep Ecologists promote, that is, a lifestyle which

"treads lightly on the Earth." This lifestyle is simple, self-reliant, and found in decentralized communities (Des Jardins 226). This was the life that Anne grew up in. Although her family did use animals for food, they never killed more than what would feed the family for one meal. When Anne brought her boyfriend Stan, to her family home, he was wary of eating meat because he was a vegetarian. Anne forced him to eat the venison ham from the deer her Father shot the year prior. Although it seems that she is disrespecting her boyfriend's beliefs by coercing him into eating the meat, it is clear where her respect lies. Anne had a respect and concern for the environment as a whole which makes the allowances for individuals of a species to be used by humans.

Also on this trip to the beach, Anne learned the respect and power other forms of nature can have. Her family had decided to camp out on the beach. When the tides came in, Grandfather wanted the family to "Stand your ground. It'll be all right" (Bass 139). However, the rest of the family disagreed and as the tides became larger and closer to where they were had set up camp, they moved the car out of reach from the ocean. The next morning, Anne described the beach as looking calm and friendly again (Bass 141). Even her Grandfather, who had taught her so much about nature, still had things to learn especially regarding the power that these forms of nature have.

The way Grandfather wanted to "stand ground" against the ocean was similar to the lack of respect that the Predator's Club had for the animals they killed. Although the Grandfather did not seem to want to eliminate the ocean, the yearning for dominance is still evident in his urging his family not to back off from the powerful waves.

The Predator's Club was an organization whose purpose was to eliminate the predator species that they claimed were threatening their crops or livestock. The view of the Predator's Club is that of domination. The Predator's Club views nature as something that is only present to be utilized by humans. To them, "it was all a huge game, like chopping firewood for the winter: seeing who could gather the biggest stack of dead wild animals to take in for bounties" (Bass 145). The Predator's Club was not killing a wild animal that attacked their cattle or sheep. They were killing wild animals before there was an attack. The Predator's Club was not trying to kill individual wild animals to protect their livelihood, but an entire species for no good reason except "sport."

The Predator's Club also used poisons which not only affected the wild animals they were trying to kill but also the other animals such as robins, rabbits, raccoons, dogs, cats, foxes and squirrels. As the narrator describes, "The land was aching with poison. For the first time, we were afraid to drink the water straight from the river, as we'd done all our lives" (Bass 152). The Predator's Club did not seem to realize or care that all aspects of nature are connected. When some aspect is changed or poisoned, there will be an affect on the other species. Another effect the Predator's Club had on the environment

was that the lack of coyotes, hawks and eagles, caused an increase in the rabbit population. As Anne was driving home from college on the weekends, rabbits would run out into the middle of the road, and she would "swerve to miss one and would hit another one…It was impossible to miss them and it would make me angry" (Bass 155). It made her angry because she felt responsible for the overpopulation because of her sin of omission. Because she failed to tell her father about the proof she had that there were illegal killings of certain species by the Predator's Club, certain species such as hawks were becoming extinct in her town. As a result, the entire food chain was disrupted and certain creatures, such as the rabbits, were multiplying and not dying out. There is a balance to nature and when humans disrupt it, there are consequences. Anne felt that she was responsible for this disruption because perhaps if she had informed her father, the killings by the Predator's Club would have stopped.

Although the Predator's Club killed off the coyotes and eagles, it was Anne who felt responsible for their extinction in her town. Anne went to school with Alicia, the daughter of the Predator's Club President. Anne felt that there was something wrong with Alicia; that because her father was so mercilessly killing wild animals, Alicia just was not right. When Alicia told the kids at school that her father kept eagle talons and beaks from the eagles her father killed, no one believed her. When Alicia approached Anne with solid proof, bracelets made out of eagle talons, Anne was amazed by the power she felt from the talons, even after the eagle's death (Bass 152). That eagle represented much more than just an illegal killing. Anne had several difficult decisions to make because that girl showed her a bracelet. She could have told her father and the Predator's Club members could have gone to jail for killing endangered species. She also could have befriended Alicia, who was a lonely young girl who was less than invisible to her schoolmates.

Another sin of omission that Anne committed during her childhood that shows her strong sense of the whole through the individual, was not telling her father of the golden eagle that she discovered in the woods which had been shot with a bullet. She believed initially that the eagle was just resting. She tried to keep the eagle warm, but it was already dead. Anne disposed of the eagle's body in a very strange way. Anne hid the eagle because it was proof that the endangered eagles were being shot and killed which was illegal. She climbed up to the top of a mountain and carried it up above the cliffs and placed the eagle on a huge dead oak. She tied the eagle to the tree so that it could "see" down to the river. She posed it in such a way that it appeared to still be alive (Bass 149). The eagle, though dead, was still a part of nature and would continue to be so as its body returned to the earth to nourish it, in a cycle connecting it with every other part of nature.

Anne chose not to say anything to her father on both of these occasions because she was afraid that the Predator's Club would try to kill her father to keep themselves from going to jail (Bass 146). Looking back, Anne seems to regret her decision of not telling her father. In hindsight, she believed that it would have made a difference and the predator species would not have died out. This is a large responsibility for one person to bear, especially since she never hunted an eagle. If she had told her Father about the individual eagle that she had found shot, he might have been able to prove that the Predator's Club members were illegally killing eagles. However, with the power the Predator's Club had they might have killed Anne's father in an attempt to silence him. Anne had to choose how to protect the eagles whom she felt were a part of herself or her father. In the end, she sacrificed a part of herself to save her family as a whole.

Anne had a strong connection with nature during both of these incidents and displayed a guilty conscience because she truly believed that if she had informed her father of the incidents she had observed, that a significant difference would have been made and she could have protected the nature that she held in such reverence. She did not agree with the dominant views of the Predator's Club because she viewed nature as something that was not to be dominated but as something that humans should be able to live alongside and experience without controlling.

Ecofeminism plays a large role in *The Sky the Stars and the Wilderness.* Ecofeminism is an environmental worldview which makes the connection between social domination and the domination of nature (Des Jardins 249). Ecofeminism also looks to the society to find the source of underlying environmental problems (Des Jardins 235). It is clear that the dominant force in Anne's community is the Predator's Club. They tried to dominate nature by controlling the predator population. Socially, the members of the Predator's Club drove fear into other members of the community. Anne was fearful of telling her father about the dead eagles because she knew that the Predator's Club would have no reservations about killing her father to keep from going to jail.

The domination of both social situations and the environment creates a contrast to Anne's view on life which is consistent with Aldo Leopold's view that first one must "love, respect and admire the land before applying land ethics" (Des Jardins 252). The Predator's Club's environmental ethics were from a point of view that was not from love, respect or admiration but rather from a view that was based strictly on domination and looking at the natural world as something that should be used for human benefit. Anne and her family had a respect for individuals of nature. Because of this, they also had a respect for nature as a whole. By growing up in a place where nature was viewed as such an important part of life, Anne developed a love and respect for nature. Out of this love and respect grew a feeling of responsibility to make sure that the nature that was a part of herself was protected from those who wanted to change it or remove species.

Anne, the narrator of *The Sky, the Stars, the Wilderness*, felt a connection to individuals and made decisions for the whole because of her connection to individuals. She and her family had a belief system which is most closely associated with that of Leopold where decisions based on land ethics were applied with a point of view of love, admiration and respect for the land. Because there was respect for the land and its inhabitants, the decisions that Anne and her family made were not of dominance but of coexistence, unlike the Predator's Club who sought to dominate the land and those animals they felt were nuisances. Environmental ethics, the question of which is the best course of action as time progresses will continue to be debated. However, it is clear from the example of Anne's Grandfather and the ocean that not all forms of nature can or should be dominated. Anne viewed the many parts of the land as part of herself, and made decisions with this view in mind. Nature is an unavoidable centrality of everyday life, even in the most industrial parts of the world. It is evident that the way people perceive nature's role in their lives will dictate how they will view nature when the subject of environmental conflict is at hand.

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Scheherazade of Latin America: *Eva Luna* as Archetypal Storyteller

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Eva Luna, by Isabelle Allende, uses storytelling as a way of formulating characters, communicating with the outside world, and dealing with the trials of daily life in a therapeutic way. Stories are used as a source of strength, lending power and clarity to characters in the novel. The storyteller acts as a communicator between the physical world with its daily hardships and the internal world of the mind where events from the past are stored away. The role of storytelling, the storyteller and the power that stories in general yield over daily life and ultimately over our existence as a whole, along with the influences that have lent themselves to this story about the making of stories, are central to *Eva Luna*.

In "The Child's Connections to the Universal Power of Story," Shirley Raines and Rebecca Isbell describe a story as "a personal experience that evolves into a story and helps children gain a sense of identity, control and connection with others. The story provides a means of exploring the world, as well as extending and exerting power over experiences" (164). Although the article seems to focus solely on children's experience with storytelling, it goes on to dissect the power that stories hold over human beings in general. According to Raines and Isbell, "a story's power lies in its ability to be remembered, entertain, teach, inspire, create and know" (164). These are the exact characteristics of the stories told by Eva Luna. Her stories existed to entertain those around her, to teach them or ultimately herself a lesson, to inspire those she loved and cared for, to create new perceptions of the world around her and to gain a sense of control over the events of her life, transforming her own identity.

Stories provide two different views of the world, external and internal. There are the stories that describe a sequence of events and then there are those that provide a glimpse into the core being of a person. The external stories are easy to decipher, allowing listeners to lose themselves in a fictional arrangement of ideas and events. But it is those that tell an internal story that are the most important because they give the listener/reader insight into the events that have transpired to create the character's inner self:

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> The essence of a story, is not only to bring people together to jointly experience events, but also to process reality and to discover and create who we are. In this way, stories wield tremendous power. In their telling and re-telling, they can keep us angry, fearful and locked in combat, or on the contrary, with some guidance, lead us to forgiveness and transformation, to a lessening of our pain and suffering. (Stringer)

The most significant example of this idea of a story being both an external and internal view into the life of a person is the scene where Eva creates a new story just for Rolf Carle. She weaves the story of a woman who ultimately loses herself in the creation of a past for a soldier she meets during her travels. The female character is described as "a woman whose lifework was telling stories" and the soldier was described as "weary" and having a "strong odor of melancholy" whose heart, which was incapable of loving, had been speared by "solitude and violence" (280). These are characteristics that connect the story Eva tells to the real life story about herself and Rolf. The storyteller "spoke for a very long time because she wanted to offer him the novel of his life, and she had to invent it all" (281). When she was finished, "she understood that in her desire to please him she had given him her own memory: she no longer knew what was hers or how much now belonged to him; their pasts had been woven into a single strand" (281). This story can be interpreted both ways. It can be seen as an external view into the life of Eva as a distinguished and talented storyteller able to create a beautiful story at a moment's notice in order to transport a person away from daily troubles. Or a listener can look even further into what the story is saying about Eva and Rolf's real life story. The character's eventual surrender "to the pleasure of blending with him into a single story" (280), signifies how much of herself Eva already has sacrificed, or is willing to sacrifice for Rolf. The woman searched deep within herself for the parts of the soldier's past, and so has Eva delved into her inner self for the parts of her that have become connected with Rolf. Without coming out and directly saying it, Eva was able to portray her love for Rolf through one of her many stories.

According to Belinda Hopkins in, "Transforming Tales", this transformation or delving into the inner-self, is a process of growth that is essential to the resolution of all life's conflicts and ultimately personal expression. Every event that transpires throughout life has a profound effect on a person, whether the change is apparent right away or is recognized over time. As Hopkins states, "Sometimes this transformation comes about because of outside factors but sometimes it happens because the protagonists themselves have somehow been transformed in the process of seeking resolution" (Hopkins 275). The resolution that is sought after comes in the form of a stronger sense of self, developing a higher self-esteem, expressing inner needs and feelings and claiming

emotions. Eva Luna takes the events of her life, the good, the bad, the ugly, the beautiful, the terrifying, the tragic, etc…and creates her own resolution through her storytelling.

Storytelling serves not only as a way for people to share of themselves with the outside world, but also as a way for Eva to bring her audiences together. Eva Luna is a prime example of this skill. Her stories form a connection between herself and her audience as well as herself and the outside world. Her words allow people the chance to lose themselves for a moment and to be transported to another time and place. There exists a certain type of magic in a story, according to Hopkins, that is used to connect a storyteller with the audience; this is a skill that Eva masters:

> [People] are drawn together as a group to share that world of myth, fantasy and magic to which storytelling holds the key. Everyday concerns can be forgotten or perhaps examined in different ways. There is a tangible magic which weaves itself around the storyteller and the audience, glimpsed in the shining eyes, the half-open mouth and that wonderful deep sigh when the tale comes to an end and the spell is broken. (Hopkins 295)

This magic behind the stories told by Eva Luna and the story that is *Eva Luna* itself, came from many sources, one of which was *A Thousand and One Arabian Nights*, or more familiarly known as *Arabian Nights*. The story's unknown origin gives it even more of a mystical air and gives the art of storytelling more power over reality and the unknown combined. A tale from Persia and the story of a young orphan growing up in the streets of South America may not seem to have anything in common; however there are two direct references to the story of Scheherazade made in *Eva Luna*. During Eva's time with Riad, she comes into contact with the exotic culture of the East. Riad was constantly singing songs of the East and even taught her the art of belly dancing. There are numerous fantastical references that coincide with the themes of *Arabian Nights*, such as Eva being "calmed by the moon" (277) and communicating "in the language of the stars" (215). Mimi claims to have read in her cards that Eva's "destiny was to tell stories and that everything else was wasted energy" (249), something that Eva states she has always suspected since the first time she read *Arabian Nights*. Her first introduction to *A Thousand and One Nights* came from Riad Halabi. It was then that she received her first real taste of fanaticism. She says that, "Eroticism and fantasy blew into my life with the force of a typhoon, erasing all limitations and turning the known order of things upside down" (153). The story opened up a door of endless possibilities that she never knew existed. Storytelling took on a whole new meaning, becoming a source of her own self-expression rather than just a tool of basic survival.

The young girl in *A Thousand Nights*, Scheherazade, essentially saves her own life through her ability to tell stories, thus making her story an excellent example of the

power of storytelling that attracts so many authors, such as Allende, to her legacy. After marrying the king, whose decree it is to kill his newly wedded wife each morning, Scheherazade prolongs her sentence by weaving intricate stories that capture the king's interest, ultimately causing him to reevaluate his decision. According to A.S. Byatt, in the article "Narrate or Die: Why Scherazade Keeps On Talking", "Schenerazade triumphs because she is endlessly inventive and keeps her head". Eva Luna also triumphs over life because she is able to take the events she witnesses, the horrors she experiences and the people she meets along with the stories she hears on her way and create her own system for dealing with her life. Byatt states, "The stories in *A Thousand and One Nights* are stories about storytelling without ever ceasing to be stories about love and life and death and money and food and other human necessities. Narration is as much a part of human nature as breath and the circulation of the blood". Storytelling is essential to both Eva Luna's and Scheherazade's existence.

Besides embodying the true identity of a storyteller, the two female narrators share many other similarities. Eva's stories were born out of her life as part of the lower class and from her time working as a servant and living on the streets. The stories of *Arabian Nights* came from the oral tradition held in such high regard in the cultures of the East. Just as the majority of Eva's listeners, herself included, were illiterate and focused on the power emoted from the spoken word, so did the people of the East who passed along the mystical stories told by Scheherazade and later included in *Arabian Nights*. They intricately weave themselves into the stories that make up their lives. This transposition of themselves into their works as a way of maintaining their existence is the key to the power behind the stories they tell. This is because "The greatest tribute which can be paid to a storyteller, is that [their] own personality is temporarily forgotten, because [they] have so completely identified themselves with [their] role" (Shedlock 144).

Eva's skill lies not only in her ability to weave an entertaining sequence of events and intriguing group of characters, but also in her ability to draw people's attention. *In The Art of The Storyteller*, Marie Shedlock says that one of the oldest truths behind obtaining and maintaining the effect of a story is through dramatic presentation. She says that "dramatic presentation is the quickest and surest method of appeal because it is the only one with which the memory plays no tricks. If a thing has appeared before us in a vital form, nothing can really destroy it; it is because things are often given in a blurred faint light that they gradually fade out of our memory" (99-100). Eva's stories are anything but faint. Just as Raines and Isbell describe the role of a story to "capture another time and place that [people] could not understand unless the storyteller tried to entertain" (Raines), so do Eva's stories take her audiences away from their daily lives.

The key element to any story is emotion. When describing the art of storytelling, Marie Shedlock states that "The medium that has been used in the telling of the story is a purely artistic one which will reach the [person] through the medium of the emotions" (148). Without emotion, Eva's stories would not exist or accomplish what they do. When she would recount the serials from the radio she would incorporate a certain degree of emotion that made the endings more dramatic and touching. Melesio and La Senora praised her by saying, "Your stories are better than the movies, there's more suffering, they would sob" (127). The quality of her narratives was better because she used elements of her own human suffering to play on the emotions of her audience.

Eva's stories provide an escape route for individuals suffering under the trials of life. Her stories provide them with a way in which to lose themselves, if even for a moment, and reevaluate how they are living their lives. Shedlock touches upon this idea when she says, "One of the immediate results of dramatic stories is the escape from the common-place. This desire for escape is a healthy one, common to adults and children when we wish to get away from our own surroundings and interests, we step into the land of fiction" (Shedlock 111). There are numerous examples in *Eva Luna* of stories being used as forms of escapism. For instance, the scene where Eva and Rolf Carle wait in the darkness for the events of the guerrilla uprising to take place the next day. Rolf says to her, "Tell me a story, to get our minds off things" (280). This moment directly mirrors the instant Allende captures from *A Thousand and One Tales of the Arabian Nights*. The quote that reads, "Then he said to Scheherazade: 'Sister, for the sake of Allah, tell us a story that will help pass the night…'" alludes to the power that storytelling has to transport an individual away from daily existence before the novel even begins. Another example of Eva's stories providing peace in a chaotic world, is when Eva tells the Professor a few falsehoods strung into a story to give him a sense of peace on his deathbed. She also has a skill for altering the endings of stories in a way that makes real life events more tolerable and pleasing to the listener. An example of this is when Eva reconstructs the events of Rolf's life, much like she did for the soldier in her story. She makes Katharina's lonely death into an endearing experience as she remembers her brother in the warm sunlight as her spirit slips away. She also takes Rolf's concern for his mother's unstable state as she lives alone, far away from him, and turns it into an empowering experience for her as she finds peace with her memories and the knowledge that all her children are happy. The alteration of a few events creates a sense of peace for Rolf and allows him to deal with the unhappiness that has overcome him. The only person who was somehow negatively affected by her storytelling was Zulema. Although she demanded that Eva tell her love stories, which she used as an attempt to connect Zulema with her new life in a strange place as Riad's wife, they merely made her more upset. Instead of teaching her a lesson or giving her insight into life and how blessed she

truly was, they served as a blatant reminder of a place where she so desperately wanted to be. Eva says, "My stories did not make her happy; they merely filled her head with romantic ideas, and led her to the dream of impossible escapades and borrowed heroes, distancing her totally from her reality" (155). Also, near the end of the novel, after Eva has grown up and refined her skills as a storyteller and channeled them onto paper, she explains how she writes. She describes reality as "a jumble we can't always measure or decipher, because everything is happening at the same time" (300). She goes on to say, "I try to open a path through that maze, to put a little order in that chaos, to make life more bearable. When I write, I describe life as I would like it to be" (301). It is here that she touches upon the extreme power of perception that she has as a storyteller.

In order for a storyteller to effectively produce a story, he or she must first become part of the story itself. The narrator of any story is described as being "responsible for the whole drama and the whole atmosphere which surrounds it. [They have] to live the life of each character and understand the relation which each bears to the whole" (Shedlock 31). Eva's stories become just that, a compilation of the world around her and her inner feelings. How her imagination was directly affected by the different experiences that were presented to her throughout her life can be seen from her reaction to the Minister's house, where she works for a time as a child. She says,

> My imagination took wing when I saw that corridor of locked doors; behind every one I thought I heard whispers, moans, laughter. At first I put my ear to the doors and peeked through the keyholes, but soon I found I did not have to do that to divine the universes hidden there, each with its own laws, time, and inhabitants, safe from the decay and contamination of the everyday world. (110)

These new additions to her imagination allowed her to expand her horizons of storytelling. She says,

> While I watched from behind the draperies of the grand salon, fascinated with the refinements that furnished a wealth of new material for embellishing my stories. Now I would be able to describe royal feasts, reveling in details I could never have invented… (111).

Her characters and plots came "from things that are happening and from things that happened before I was born – from newspapers, from what people tell me" (301).

As time passes, Eva compiles her life experiences in the form of stories just waiting to be set free. According to Raines and Isbell, "Interpretation depends upon the mind and life experiences of the listener. The story symbolizes a greater truth that the listener will grow to understand. After hearing a story, many times at different ages, the listener will use the lesson to understand human nature." Many people come and go in Eva's life and she goes through multiple transition periods along with many life-altering

events. Each one has a different effect on her that she might not be able to process at the time and so she stores it away in her mind to be used later when the time or audience is right. She takes in so much along the way but must live with what she knows and perceives the world to be until the right opportunity and audience presents itself. This is because the preparation for any story involves, "living with it for a long time, until one has really obtained the right atmosphere, and then bringing the characters actually to life in this atmosphere" (Shedlock 141-142). It's a long process that Eva masters with maturity and experience.

As she got older she began to question the world around her and how she fit into it all. She began to realize the immense power that a storyteller yields over his or her audience and their perception of the world around them. Raines and Isbell describe storytellers as conductors of the greater power of stories in general. According to them, "Storytelling figures represent the power of story. Some people are blessed with a special gift for story, but the power of story is not totally dependent upon the storyteller's talent." The more she matured, the more she began to respect the power of a story within itself. She recognized her talent but understood that there was a greater force at work: the imagination. This can be seen in her reaction to her first experiences as a writer. She says,

> I began to wonder whether anything truly existed, whether reality wasn't an unformed and gelatinous substance only half-captured by my sense. There was no proof that everyone perceived it in the same way; maybe Zulema, Riad Halabi, and others had a different impression of things; maybe they did not see the same true colors or hear the same sounds I did. If that were true, each of us was living in absolute isolation. The thought terrified me, I was consoled by the idea that I could take that gelatin and mold it to create anything I wanted; not a parody of reality, like the musketeers and sphinxes of my Yugoslavian *patrona*, but a world of my own populated with living people, a world where I imposed the rules and could change them at my will. In the motionless sands where my stories germinated, every birth, death, and happening depended on me. I could plant anything I wanted in those sands; I had only to speak the right world to give it life. At times I felt that the universe fabricated from the power of the imagination had stronger and more lasting contours than the blurred realm of the flesh-and-blood creatures around me". (187-188)

From this quote, another parallel with *Arabian Nights* can be drawn regarding the power of storytellers.

> *Arabian Nights* is both a work of literature and a genre in the process of growing: the stories are shape shifters. The power of stories to forge destinies

> has never been so memorably and sharply put as it is in this cycle, in which the blade of the executioner's sword lies on the storyteller's neck. (Warner)

This direct power of the storyteller seen in *Arabian Nights* is the exact power that Eva Luna struggles with as she gets older. As she matures, the influences in her life change, allowing her different opportunities that she might not otherwise have had access to. As she entered adolescence, a time when sexuality and lust are both a mystery, her perception of the world broadens.

It was her experience with *Arabian Nights*, a strong influence on Isabel Allende's creation of this novel from the very beginning, that forces her to confront her own sexual and female identity. Her contact with the book, a copy of which was given to her by Riad, awakens feelings in her that she was not aware existed. It was her storytelling that provided her with the outlet she needed to sort through her feelings. While Scheherazade utilized storytelling literally to save her life, Eva uses her skills to stop herself from drowning in a sea of confusion and loss of identity. Their storytelling not only rescued them, but also set them apart from other people while at the same time giving them a sense of female empowerment at a time when they were both extremely lost.

Telling stories becomes a way in which Eva is defined as a person. On several occasions she is introduced as a storyteller by trade. For example, when she is first brought to La Señora's house by Huberto, he explains his reasoning as to why he brought her there by saying, "She can keep you company, she knows how to tell stories" (117). And later, when Melesio and Eva encounter one another after much time has passed, she, now identified by the name Mimi, recognizes Eva and asks, "Aren't you the girl who used to tell the stories?" (206). Eva's stories filled a void in La Señora's lonely house and also filled a void within herself when it came to her mother's death. Her stories gave her a sense of peace that allowed her to deal with the loss of her mother and draw upon her memory when she was frightened. This can be seen in the scene where she later escapes from La Señora's house during the "Revolt of the Whores" and finds herself alone and penniless on the streets. She summons her memories, categorized by stories stored in her mind, to calm her fears and to give her a sense of security. By putting so much of herself into her stories, Eva not only creates her own identity but also gives those who hear her the opportunity to look deep within themselves. The idea of an internal view into a person through a story presents itself again. As Sean Buvala touches upon this notion of stories serving as a reflection of both the teller and audience member when he writes in his article, "Personal Telling has Power," "With good personal tales, we are not called to gaze on the teller reflected in the mirror of story, but rather to stand next to the teller and see our own reflection and stories along with the teller".

Eva Luna is a phenomenal storyteller and her skills are even more apparent when looking at *Eva Luna* as a whole. The novel encompasses the journey that Eva endured to become the person and storyteller that she is at the end of the story when she finally finds the peace and security she has been searching for. Throughout the story, Eva is constantly making references to herself as a character within her own story. For example when she begins to write her stories down for the first time in what would eventually become the manuscript for the novel, she says, "I could see an order to the stories stored in my genetic memory since before my birth, and the many others I had been writing for years in my notebooks" (251) and "Little by little, the past was transformed into the present, and the future was also mine; the dead came alive with an illusion if eternity; those who had been separated were reunited, and all that had been lost in oblivion regained precise dimensions" (252). She continues on to identify herself as one of her own characters, as the all-powerful storyteller who was acting as the voice for a life that would have otherwise gone unnoticed. She writes,

> As soon as I had begun dusting off memories and weaving destinies, I saw that I did not know where I was going, or what the resolution would be – if there was one. I suspected that I would reach the end only at my own death and was fascinated by the idea that I was another character in the story, and that I had the power to determine my fate, or invent a life for myself. (252)

It is at the time when the novella, *Bolero*, is coming together that Eva fulfills her own prophecy as a storyteller. She recognizes herself as a character in her own story called life and finds her sense of self and inner strength. These discoveries she makes are what her stories have been accomplishing all along; it's just at the end when she finally is able to reap the benefits of her skills and bring everything together.

Eva recognizes her story, ultimately the novel, *Eva Luna*, as a story for life when she refers to the stories within her dreams that still remain to be told. She identifies herself as a character within her own story when she says to Rolf, "I also try to live my life as I would like it…like a novel" (303). By living her life as a story to be told, she preserves herself in history in the cycle of oral tradition. After all, "stories provide a link between past and future generations" (Raines). Her stories become her life, "in keeping with the principles that we can construct reality in the image of our desires" (307).

It is through her story that Eva Luna gives every person the power to tell his or her own story. She doesn't tell stories or write for fame; rather she focuses on the real power behind a story to preserve a memory or life in time. After all, "Why not focus on changing the world from where you sit, with your own stories, with the stories of the ancients, with the stories of truth? […] let's not forget the real truth that storytelling starts

with just two people and a story to tell" (Buvala, "Remembering"). Eva sets all her listeners/readers on the quest to find the truth about themselves and the world they live in.

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Witchcraft and French Popular Culture: An Explanation of the Occult

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Having intercourse with the Devil, changing into animal figures, killing babies, removing penises, casting spells: these were all devices thought to be used by a witch in Early Modern Europe. Today, if someone admitted to these acts, we might look at them in disbelief for a split second, but then shrug it off. "The person must be insane!" we would think --- or perhaps they have a vivid imagination. However, these incantations, spells and deeds were all too real for the Early Modern European. The height of the witchcraft craze was in the sixteenth century, and thousands of people, mostly women, were tried for the crime of witchcraft. More than half of them were found guilty and executed. The trials and witch-hunts were extremely uneven throughout the European continent. Some witchcraft trials took place in the church, others, most after 1550, in secular courts. The courts ruled a kingdom, principality, or just a small village. The distribution of cases was also highly uneven through Europe. Some villages experienced a high number --- over hundreds and thousands of people tried over the course of three centuries --- of witch trials, while other places witnessed very few. Rural areas were more prevalent to witch trials than the cities (Levack 1). What were the cultural and popular roots of witchcraft? What were the villagers saying about the deeds of witches? The knowledge of witchcraft was transmitted, particularly in France, through oral traditions and folklore. This paper will explore one such folktale, Le Petit Chaperon Rouge ("Little Red Riding Hood"), and the message that it sent to the peasants and children who heard this story.

To truly understand the popular culture and society's thoughts on witchcraft, one must investigate the areas in which the witch craze was most powerful. Geoffrey Scarre points out in his book *Witchcraft and Magic in Sixteenth and Seventeenth Century Europe* that in France the major trials were held in the rural mountainous areas. He says, "If one excludes Lorraine and French-Comte … the areas most badly affected by witch trials were the Pyrenees, Languedoc, the Alps and the North East" (21). Emmanuel Le Roy Ladurie also realizes that the bulk of witch trials were happening not in the cities, but in the countryside. In his book *The Beggar and the Professor*, a historical memoir of

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three generations of a family, Ladurie cites Thomas Platter, one of the family members, as being extremely apprehensive of witchcraft. Platter explains during his travels through France the geographical reason as to why the witch craze was only in certain villages. Ladurie dictates:

> "Where are the witches' villages …? Where is the Devil most powerful? And he [Platter] answered, where the dispersed population, terrain, etc., prevents the peasants from attending Mass or sermons; where pastoral visitations are difficult; where ignorant rustics have no access to Scripture. Thus they are an ideal prey for the Devil. Entrenched in their crannies, they secrete the agrarian ideology par excellence, witchcraft. So Rouergue, the mountain of Saint-Pons, spiritually abandoned, are nests of witches --- a witchcraft of lost corners" (169).

Ladurie, as well as Thomas Platter, understand that the most accessible and gullible people to the evil spirits are the peasant people living in remote and mountainous areas. The Devil does not have to fight off the scripture, God's word, or the church with agrarian people. Peasants living in such far-away and inaccessible places might even appreciate the contact and attention the Devil could give. Therefore, the men and women succumb to the Devil's wishes and become witches, man- and maid-servants to the Devil.

Thomas Platter also fears another popular cultural belief that witches could perform: ligature (aiguillette) or satanic castration. He exhibits this fear in his narrative, explaining that at the moment when a priest blesses the marriage, "a witch slips behind the husband, knots a thread, and throws a piece of money on the ground, while invoking the Devil. If the coin disappears, the couple will be unhappy, sterile, and adulterous" (167). The outcome of this would, in effect, make the husband's genitalia useless, worthless and lost. Platter, a physician, writes that in Languedoc "not ten weddings in a hundred are celebrated publicly in a church. Couples, accompanied by their parents, go secretly to a nearby village to receive the nuptial benediction" (167). By employing secrecy for the marriage, a witch has a harder time finding the couple to cast the spell. However, Platter shows fear that because the panic of ligature and witchcraft is so terrible, the local populations are experiencing a decrease in weddings (167).

Most important to popular culture is the folktale. Several tales were widely circulated throughout Europe, especially France, during the witch craze of the sixteenth and seventeenth centuries. Some tales demonstrate the role of women as threats to the natural order of society, thus promulgating hatred towards women. The stories were based on women threatening society through being sinful and without guidance from men (Chase 769). However, Gerhild Scholz Williams sees that some negative information towards women found during the trials and persecutions of witches were not necessarily about women at all. She quotes Joan Scott, saying that the information found about

women was "necessarily information about men … denoting cultural construction of gender, which is a social category imposed on a sexed body" (11). The men wrote information about their relationship to history, law and the order of society as well their curiosities, fears, anxieties, and passions and superimposed these feelings onto a woman character. They were curious of the unfamiliar, especially death. Men also wrote about evil women because it fit so perfectly into the narrative of the Christian Church --- the fight between "good and evil, Adam and Eve, Eve and Mary, Christ and Satan. They are ultimately expressions of a single, gendered dichotomy: the flesh that is woman stands opposite the spirit that is man" (11). Folktales were most likely spoken by men and thought up by men. They were used to keep women at bay and lower in the social order. Folktales, as demonstrated by Williams Scholz, were also used to mirror the practices and teachings of the Christian church.

Little Red Riding Hood is one such folktale. Its origins are in the form of an oral story passed down through generations during the witch persecutions in France during the sixteenth and seventeenth centuries (Chase 769). Richard Chase, Jr. and David Teasley state that Jan Brunvand, a folklorist in modern times, finds a similar legend in France around 1579 where a witch in animal form is exposed of her true identity after her hand is injured. Both stories --- Little Red Riding Hood and the aforementioned --- are also similar to the tale of *Jasmin's Witch*, a story of a Huguenot woman accused of witchcraft in the sixteenth century which is retold by Ladurie (770).

The first recorded version of Little Red Riding Hood was written by Charles Perrault in 1697, but has been changed and sanitized many times over most notably by the Brothers Grimm. While traveling through villagers via the word of mouth, the story was probably originally told around fires in peasant cottages in mountainous villages, similar to the ones in which witches were being persecuted and burned (Darnton 9).

The story spread most throughout the Loire basin of France, which is also coincidentally where the greatest number of werewolf trials were held. Witches could transform into a number of different animals, including wolves and cats. E. William Monter states, "Of course animal transformations can take many forms, but the animals chosen will often include those most feared by a given society. Over much of Western Christendom the wolf was such an animal" (157). The wolf in Little Red Riding Hood could have been a fellow witch, but probably for the sake of the folktale and its symbolism, was Satan.

Although the story changed shape while traveling throughout many regions, three symbolic key elements of the story remained exactly the same. The first was the choice of the path that the girl and the wolf selected (Chase 770). The wolf in the story asks the little girl, "Which path are you taking, the path of the pins or the path of the needles?" She replies, "The path of the needles" (Darnton 9-10). The wolf in the story

then takes the path of the pins. The fact that Red Riding Hood chose the path of the needles indicates her decision to become a prostitute because women of ill repute struck deals on "the basis of a package of bodkins or lace-needles" (Chase 771). The fact that the wolf chose the path of the pins suggests his allegiance to Satan. A form of witch-hunting was to prick the body with many pins in order to discover the Devil's mark (771).

Another feature of the tale was the cannibalism that Little Red Riding Hood displayed when she ate her grandmother (770). "He [the wolf] killed grandmother, poured her blood into a bottle, and sliced her flesh onto a platter." Later on, when the girl enters, the wolf offers her the "meat and wine in the pantry. So the little girl ate what was offered; and as she did, a little cat said, 'Slut! To eat the flesh and drink the blood of your grandmother!'" (Darnton 10). Such an act of cannibalism mocks the Christian tradition of communion, when congregants partake in the bread and wine, or body and blood, of Jesus Christ. Also, the presence of the cat "suggests that Red Riding Hood is engaged in witchcraft. The cat, acting as Red Riding Hood's demon familiar, informs the girl that her promiscuous behavior is linked to cannibalism and witchcraft" (Chase 771).

A cat always suggested witchcraft. Darnton states, "To cross one at night in virtually any corner of France was to risk running into the Devil or one of his agents or a witch abroad on an evil errand" (92). Witches also transformed themselves into cats, "they howled, fought, and copulated horribly under the direction of the Devil himself in the form of a huge tomcat" (92). There was only one way to protect oneself from sorcery of cats: to maim it. One was to, "Cut its tail, clip its ears, smash one of its legs, tear or burn its fur" (94). This would break the evil power. Darnton also gives evidence that cats were witches in disguise. He says, "Peasants frequently cudgeled cats who crossed their paths at night and discovered the next day that bruises had appeared on women believed to be witches" (94). Even if a cat was not a witch in disguise, they still had evil powers. They could, "Prevent bread from rising if they entered bakeries in Anjou. They could spoil the catch if they crossed the path of fisherman in Brittany. If buried alive in Béarn, they could clear a field of weeds" (94). However, cats could also be remedies for the common maladies:

> "To recover from a bad fall, you sucked the blood out of a freshly amputated tail of a tomcat. To cure yourself from pneumonia, you drank blood from a cat's ear in red wine. To get over colic, you mixed your wine with cat excrement. You could even make yourself invisible, at least in Brittany, by eating the brain of a newly killed cat, provided it was still hot " (94).

Cats were also known to smother babies and harm households. They would repeat gossip they heard. Most importantly, their power could be used either for a person or against them (94). Hence, the present-day imagery of witches usually involves a black cat.

The last feature of the tale is when the girl gets eaten by the wolf (770). The early text reads, "'Oh, grandmother! What big teeth you have!' 'It's for eating you better, my dear.' And he ate her" (Darnton 10). It wasn't until the Brothers Grimm's version, did the hero, the huntsman, emerge (Chase 775). The girl in the story also undresses --- a sort of seductive dance for the wolf --- and gets into bed with him. The wolf then eats the girl, without much explanation in the text. Chase and Teasley state, "The rapidity of its execution without need of comment reveals a merciless value system that was deemed just at the time. The moral is obvious: choose a dissolute life and punishment will be swift and certain. The girl's death also restores God's natural order" (772). Little Red Riding Hood served to influence the behavior of sixteenth and seventeenth century children. This popular folktale taught them the consequences and horror that came with witchcraft. It was a way of using popular culture to teach values and morals.

Little Red Riding Hood is just one example of popular culture's response to witchcraft. Women and some men were innocently burned and persecuted; villagers lived in fear every day. They not only feared that a witch would put a curse on them, but also that they would be accused of witchcraft. Due to the fear and panic, culture changed and with it, stories developed. Was there a fear of sterility as Thomas Platter described? Probably. Was it a witch that cursed the man to make him sterile? One cannot be too certain. Witches were tortured in order to confess, thus releasing all validity of their confession to modern-day historians. By studying popular culture during this time, historians do learn one thing: witchcraft, real or not, haunted the peasants' lives for centuries. To them, witchcraft was real indeed.

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Gene Therapy: How Therapeutic Is It?

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Within the brief history of gene therapy, the first protocol was performed in 1990 on a four-year-old girl with adenosine deaminase (ADA), and the first protocol that resulted in the death of one of its patients occurred in 1999. There are several different ways to administer gene therapy, and even in the wake of the first death in 1999 and recent restrictions placed on gene therapy protocols in 2003, there are new protocols that various research labs are currently investigating. Gene therapy is highly controversial, and while it could potentially provide treatments and cures for once terminal diseases, there are many social and ethical issues that have to be weighed when determining how far this science should progress.

I. Introduction

According to the "Human Genome Project Information" website (2003), gene therapy is "a technique for correcting defective genes responsible for disease development." The site goes on to list four different methods of performing gene therapy, but the two most common are somatic cell gene therapy and germ-line gene therapy. As defined by Hubbard and Wald (1999), somatic cell gene therapy attempts to modify the way certain tissues in the body function by inserting genes into the cells of those tissues. According to Reilly (2000), germ-line gene therapy involves the genetic modification of a single egg or sperm prior to conception, or the genetic modification of 4-8-cell embryo created in a test tube. Gene therapy, though relatively new in terms of its practice, has given rise to tremendous amounts of controversy in all areas of society. Even before gene therapy was legally attempted, it suffered a setback due to an overzealous hematologist, Dr. Martin Cline, who misled colleagues and patients into participating in an experimental procedure that was not approved by the National Institute of Health. Cline's violation in 1980 triggered extreme social, political, and scientific obstacles for other scientists interested in gene therapy to surpass in order to bring their ideas to fruition.

It was not until September 13, 1990 when the first legitimate gene therapy treatment commenced under the direction of Dr. French Anderson, Dr. Michael Rosenberg, and Dr. Kenneth Culver. Since then, the progress of gene therapy continues

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to move slowly, particularly since 1999 when a patient, Jesse Gelsinger, died of complications resulting from his gene therapy regiment. The purpose of this paper will be to give a history of gene therapy, including the history of the treatments and the reactions of those in and outside of the scientific and medical communities. It will also discuss the mechanics of gene therapy, current views and treatments being explored by scientists and physicians. In particular, this paper will discuss how far gene therapy can and should go, and how researchers and society should determine how far is too far.

II. Information

John Fletcher (1990) cited 1967 as the beginning of the gene therapy debate when the Nobelist Marshall Nirenberg "wrote of programming cells with synthetic messages, and recognized the promise and danger of this scientific procedure." The next major event in the history of gene therapy occurred between 1970 and 1973 when Stanfield Rogers and a German physician, to treat sisters suffering from hyperargininemia, performed the first vector treatment. They used the Shope papilloma virus (SPV) in hopes that it would cause the expression of the defective gene.

By 1974, the National Institute of Health (NIH) recognized the growing interest in gene therapy, and created the Recombinant DNA Advisory Committee (RAC). This committee had the responsibility of approving all research projects involving recombinant DNA (rDNA) performed in the United States, as well as handling any gene marking research, and any gene therapy protocols with the Food and Drug Administration (FDA). In conjunction with the National Commission for the Protection of Human Subjects and its Belmont Report of 1978, the RAC and FDA established the guidelines for gene therapy studies, and provided the hierarchy of approvals researchers need to obtain before their research can commence. "Preliminary approval was required by the home institutions' institutional biosafety committee (IBC) and institutional review board (IRB); final approval was then required by the RAC" (U.S. Office of Science and Technology Policy 1991). Such approval is necessary for all institutes utilizing federal funding for gene therapy projects, regardless if the experiments are performed in the United States or abroad.

Dr. Martin Cline was the first person to attempt human gene therapy in 1980, and regretfully for the pro-gene therapy community, his research caused a major setback for its development. Cline was a researcher at the University of California at Los Angeles (UCLA), and did not receive approval from the UCLA IBR for his recombinant DNA (rDNA) transfer research. Cline ignored the rejection, and performed his rDNA transfer in bone marrow cells on two patients in Italy and Israel, both of whom had a blood disorder. Cline was not forthcoming with the fact that his experiment had not been approved in the United States, and because there was no IBR in Italy at the time, and

because he had not been completely honest about what the research entailed to the Israeli IBR, Dr. Cline was able to perform the rDNA transfer. The Los Angeles Times published a full report of his defiance, and Cline was forced to step down from his department chairmanship at UCLA (Jacobs 1990).

The main reason why scientists, like Dr. Anderson, have made their lives' work researching and creating methods of gene therapy is because they wanted to develop a way to eliminate the most horrific genetic diseases that have no cure and no hope of survival for those afflicted. However, due to Dr. Cline's disobedience, it was very difficult for people like Dr. Anderson, Chief of the Molecular Hematology branch of the National Heart, Lung, and Blood Institute at the time, to get approval for any gene therapy experiments from the Recombinant DNA Board and the NIH. During the decade between Dr. Cline's mishaps and Dr. Anderson's approval for the first gene therapy treatment, the number of biotech companies and research labs established for the purpose of pursuing gene therapy grew in anticipation of Dr. Anderson's breakthrough, which began on September 13, 1990.

III. The First Treatment

Ashanthi DeSilva was a four-year-old girl that had been diagnosed with an extremely rare immune deficiency disorder called adenosine deaminase (ADA). The disease is caused by a defect on chromosome 20, and those afflicted with it must take extreme care to avoid infections and other such ailments that require a normal immune system to beat. Three years prior to Dr. Anderson's administration of the first gene therapy treatment for ADA, "scientists had developed a way to administer the bovine version of this missing enzyme in a way that allowed it to circulate long enough in the body to restore some measure of immune function" (Reilly 2000). This treatment was not a cure, and was not as affective as what Dr. Anderson's gene therapy experiment promised to be.

The reason why ADA was an ideal choice for the first gene therapy treatment was because while it was a rare disease that did not afford many people to actually need the treatment, the disease lent itself to this form of action. ADA is a disease that is a single gene disorder, which means that it afflicts only one group of cells. This particular group of cells is very important to the area that deals with immunological defenses. The method by which Ashanthi's gene therapy was going to work was by inserting a cloned version of a properly functioning adenosine deaminase gene into her cells. This differs from traditional bone marrow therapy in that with bone marrow therapy, the patient has two versions of a particular cell existing together in the body (Reilly 2000). With Dr. Anderson's proposed method of gene therapy, the patient would only have two versions of a single gene co-existing in the body.

Ashanthi's gene therapy began with doctors removing white blood cells from a sample of collected blood. Next, they added chemicals to the blood to speed up the cell division process. Once that had been completed, the scientists inserted an attenuated virus that was known to invade white blood cells, which contained the cloned adenosine deaminase (ADA) gene. The goal of this procedure was for the functioning copy of the ADA gene to actually be accepted into Ashanthi's DNA, and as the new cells continued to divide, the normal ADA gene would replace the malfunctioning ADA gene. These new, corrected cells would then be transferred back into Ashanthi's body through intravenous therapy in her arm. While this procedure seemed medically and scientifically feasible, there was no absolute certainty that the new cells with the corrected gene would function properly in Ashanthi's body. Not only was it a concern of whether or not the new DNA would function properly, but also could this treatment potentially harm Ashanthi?

Thankfully, Ashanthi was not harmed by this procedure, and she is still alive and well today. While other children with Ashanthi's same disorder have received the same treatment that she first received over a decade ago, these patients with ADA continue to need follow-up treatments for their disease. Though there is evidence that some of the corrected DNA is being utilized in their bodies, this mode of gene therapy is not a cure for ADA. In fact, Dr. Anderson's gene therapy did not replace the bovine treatments already in existence for adenosine deaminase, but what it did do was open the door for many other scientists and labs to further explore gene therapy methods (Reilly 2000). All of these methods have proven to be less effective compared to the vectors, with the exception of the liposome, which is currently being used by scientists at UCLA researching a treatment for Parkinson's disease.

IV. Gene Therapy Methods

There are four different means by which gene therapy can be performed. The method utilized by Dr. Anderson for treating Ashanthi is termed somatic cell gene therapy. In this form of gene therapy, the patient has a target group of cells removed from their body, and these cells are manipulated in the lab *ex vivo*. The "therapy" involved in somatic cell gene therapy includes inserting the prepared cells with a vector that is carrying the normal version of the defective gene that they are looking to correct. Once this normal gene is inserted into the cells, the hope is that it invades the DNA of the cells, and replaces the damaged gene. This new DNA that results from the combination of the vector inserted into the cell and the hosts' original DNA are called recombinant DNA. As the cell division continues, the new cells that are created should have the normal gene, and are then reinserted into the patient's body. The idea is that these vectors that carried the normal gene can find their way to ingratiate themselves into that

patient's genome, and finally produce a properly functioning gene, thus eliminating the disorder.

The vectors that are utilized in somatic cell gene therapy are commonly a variety of viruses that can be modified to be capable of carrying the normal genes to the appropriate cells. Once the viruses are manipulated, they have a way of holding onto the therapeutic genes, and knowing what cells to deliver them to in order to correct the problem. Some of the viruses that are utilized by gene therapists include retroviruses, adenoviruses, adeno-associated viruses, and herpes simplex viruses (Human Genome Project Information 2003) (See Figure 1 in Appendix A). There are also non-viral methods of delivering normal genes to targeted cells. These methods include directly putting normal DNA in human cells, creating liposomes that can transfer DNA through the cell's membrane, chemically linking the corrected DNA to a molecule that will bind to special cell receptors, and creating a 47th artificial human chromosome into target cells (Human Genome Project Information 2003).

Retroviral vectors "are retroviruses from which all viral genes have been removed or altered so that no viral proteins are made in cells infected with the vector. Viral replication functions are provided by the use of retrovirus "packaging" cells that produced all of the viral proteins but that do not produce infectious virus" (Miller 1992). Retroviral vectors are capable of successfully infecting 100% of its target cells and are thus "ideal for many *ex vivo* applications of gene therapy" (Mulligan 1993). However, their effectiveness is completely "dependant upon the existence of the appropriate viral receptor on the target cell" (Mulligan 1993). The main problems associated with retroviral vectors are that they cannot work in non-dividing cells, and that they do carry some risk possessing contaminants that cannot be removed.

Unlike retrovirus vectors, "adenoviruses are capable of efficiently infecting non-dividing cells and expressing large amounts of gene products" (Mulligan 1993). Adenoviruses can carry large amounts of DNA, and are suitable "for infecting tissues *in situ*, especially the lung" (Miller 1992) According to Miller (1992), the disadvantages of utilizing adenovirus are that these vectors "may stimulate immunity or have other adverse effects," and have the possibility of "potential instability of gene expression because the vector does not integrate into chromosomal DNA."

Adeno-associated viruses (AAVs) and herpes simplex viruses are less-used vectors compared to retroviruses and adenoviruses. "AAVs are relatively small viruses, remarkable stable, and can infect human cells" (Miller 1992). However, AAVs are "less efficient than retroviral integration, and also less precise, as tandem viral genomes with slight deletions or rearrangements (or both) are often observed" (Miller 1992). AAVs deliver their genetic material to a specific site on chromosome 19 (Human Genome Project Information 2003).

Herpes simplex virus vectors can be used to target DNA in neurological cells. Mulligan reports, "because of the complex regulation of viral replication, it has been difficult to generate stocks of recombinant virus that are completely incapable of replication" (1993). Researchers are currently working on methods to prevent the expression of these genes that lead to making the infected cells toxic.

The primary arguments against somatic cell gene therapy arise out of concern of risk to those patients that embark on this procedure. Those against somatic cell gene therapy argue that extreme care and safety must be taken by the researchers in the labs that manipulate the cells, and that those patients involved with the treatment are made fully aware of risks and benefits of undergoing such measures. To combat these fears, there are many published guidelines that the labs, biotech companies, and those that manufacture supplies that will be used in somatic cell gene therapy procedures must adhere to. These reports include *Guidance for Industry, Guidance for Human Somatic Cell Therapy and Gene Therapy*, published by the Center for Biologics Research and Evaluation, part of the Food and Drug Administration, as well as *A Proposed Approach to the Regulation of Cellular and Tissue-Based Products*, also produced by the Food and Drug Administration.

Another method of gene therapy is germ-line gene therapy, and is much more controversial compared to somatic cell gene therapy. This method (which is not currently being used on humans) involves the manipulation of the germ cells (reproductive cells) to correct the defective gene before it is passed on to future generations. This can entail either modifications to the individual egg and sperm, or the manipulation of a 4-or-8-cell embryo conceived in a test tube. It is thought that corrections in gene dysfunctions can best be made at this point because the embryo is at such an early stage of development. Once the defective gene is corrected, it will be implanted into the mother by in-vitro fertilization. "The rational for Human in Utero Gene Therapy (IUGT) is that it may allow the correction of some types of genetic diseases before the appearance of any clinical manifestations" (Zanjani and Anderson 1999). Those that are in favor of IUGT also see this method as a means to replace somatic cell gene therapy, and more importantly, allowing patients to avoid the risks and cost of that form of therapy.

The biggest obstacle facing germ-line gene therapy is that there is the large amount of uncertainty involved with the treatment. There is no assurance of the amount or extent of possible clinical risks, or long term affects of this form of gene therapy. People also argue that because this treatment would be performed on embryos, and because these embryos are unable to consent to such treatment, it is unethical because they will have to live with the ramifications of the treatment for the rest of their lives. They also believe that this kind of gene therapy can open the door to modifying genes that are not defective, in order for parents to create the "perfect" child. This could upset

social balance by providing only those that could afford gene therapy extra advantages in life over those that could not.

In examining the cost-effectiveness of germ-line gene therapy, skeptics question whether this is the best use of research funds because of the uncertainty of the effectiveness of gene therapy, and the ethical and social ramifications of the procedure. Again, it is important to remember that this form of gene therapy has not been used on humans, and that perhaps these concerns can be somewhat relieved as scientists fine-tune the process.

The other two lesser-known methods of gene therapy are repairing genes through selective reverse mutation, and the regulation of a gene by turning it off. The second method, also referred to as gene silencing, can be used to block the production of mutant proteins that cause genetic disorders (Holmes, 2003). Short interfering RNA (siRNA) is added to a cell, and joins with proteins to create a silencing complex. "The silencing complex binds to RNA copies of the faulty gene and destroys them" (Holmes 2003), but does not interfere with the RNA copies of the normal gene.

Following the success of Ashanthi DeSilva's gene therapy treatment, the interest from biotech companies and research labs to explore new gene therapy methods for other diseases continued to grow, and people began investing large sums of money into these businesses. While it was Dr. French Anderson's plan to focus on rare, emotionally draining diseases such as SCID and ADA, other people set their sights higher, searching for gene therapy cures for AIDS and cancer. Unfortunately for those with such lofty aspirations, little progress in finding gene therapy treatments for these diseases has transpired since the early 1990's. Dr. Harold Varmus, the NIH director during the 1990's, did not like that so many scientists were focusing their gene therapy efforts towards finding treatments for non-genetic diseases. Dr. Varmus also believed that the science was too shoddy to push forward with human testing and did not like that he had to sign off on protocols that were already approved by the Recombinant DNA Advisory Committee (RAC) (Stolberg 1999). He felt as if it were redundant because the FDA already had to approve such protocols, and he viewed the RAC as an opportunity for biotech companies to raise money.

V. The First Fatality

However, in the mid-1990's a treatment was being developed by researchers at the University of Pennsylvania to treat a genetic disease occurring in one out of every 40,000 births that more often than not resulted in death within 72 hours of birth (Stolberg 1999). The disease, called ornithine transcarbamylase (OTC), is a urea-cycle disorder (See Figure 2 in Appendix A). "The urea cycle is a series of five liver enzymes that help rid the body of ammonia, a toxic breakdown of protein" (Stolberg 1999). If there is a

deficiency or complete absence of these enzymes, the ammonia can accumulate in the blood, and then travel to the brain, which can cause a coma and eventually death. This disease results from a genetic mutation on the X-chromosome, which means that it is most likely carried by the mother, and passed onto their sons. Dr. Mark Bradshaw, a pediatrician and an expert in OTC, helped develop the first treatments for this disease. This therapy did not, however, prevent the initial coma that signifies the disease and often leaves the child with significant brain damage. When Dr. Bradshaw joined the staff of the University of Pennsylvania, he could only dream of one day developing a gene therapy treatment for this terrible disease (Stolberg, 1999).

During this time, the University of Pennsylvania was the largest academic gene therapy institution in the nation. In 1993, Jim Wilson, regarded by Dr. French Anderson as "the best person in the field" (Stolberg 1999), became the director of Institute of Gene Therapy at the University of Pennsylvania, and within a month began collaborating with Bradshaw on a treatment for OTC. Wilson and Bradshaw utilized OTC-deficient mice, and developed an adenovirus vector that would deliver the normal genes right to liver. The mice that were treated with this therapy survived two to three months, while the mice that did not receive this therapy did not (Stolberg, 1999). With these positive results, the team wanted to move onto human subjects. Wilson wanted to jump right to babies that were afflicted with OTC, yet Arthur Caplan, a bioethics expert at University of Pennsylvania, warned that parents of these ill children would not be in the right state of mind to give informed consent (Stolberg 1999). Thus, the team sought out volunteers (mothers that carried the OTC gene) at the 1994 meeting of the National Urea Cycle Disorder Foundation to donate blood to be studied.

When Wilson and Bradshaw were ready to propose their gene therapy protocol to the RAC and NIH, Varmus did not shun their proposal because they were working with a rare genetic disorder, and they had done extensive research with animal testing prior to moving on to human subjects. There had been a few animal casualties due to side effects in their research, including three monkeys dying of a blood-clotting disorder and severe liver inflammation. The monkeys did, however, receive a dose that was 20 times the highest dose that would be utilized in the human protocol. The team admitted that it was hard to say exactly how human subjects would respond to the treatment, which involved running the adenovirus vector through catheter through the hepatic artery to the right lobe of the liver, sparing the left lobe of any possible damage (See Figure 3 Appendix A). The team outlined the major risks involved, including bleeding at the sight of entry and/or bleeding during a surgical procedure that may be necessary if there was significant liver damage (Stolberg 1999). If liver failure were to occur, a transplant may be an option for treatment, but it could subsequently lead to death.

Jesse Gelsinger was the youngest of 18 people that were participating in the initial trial. Jesse had a mild form of OTC that resulted from a mutation of the gene during conception (meaning it was not passed onto him by his mother), and he in fact had two different cell lines, one normal and one abnormal. He was able to control his disease through diet and a pill regiment, but was encouraged by his father to see if he could participate in this new treatment. Jesse qualified, and was the last person to be treated by Wilson's and Bradshaw's protocol.

Jesse's treatment began in Philadelphia on September 13, 1999. He received the highest dose within the protocol guidelines, and the interventional procedure seemed to have gone well. That evening, Jesse became very ill with a 104.5-degree fever. The next morning, Jesse's eyes were jaundice, which indicated that either his liver was not functioning properly or that he was experiencing a blood-clotting disorder that meant that his red blood cells were breaking down too quickly. The jaundice was not an anticipated side effect of the treatment, and approximately 24 hours after Jesse had his treatment, he was in a coma. The doctors set Jesse up for dialysis, which helped him briefly, but by that evening his lungs were not providing enough oxygen to the blood. Jesse eventually suffered multiple organ failure and respiratory distress syndrome, and died that Friday, September 17. Jesse was the first person to die from a gene therapy treatment. No other person from the protocol died or even became significantly ill, yet the NIH put a hold on all related research trials, and conducted a full investigation of Jesse's death.

Jesse Gelsinger's death in 1999 caused a major setback in the field of gene therapy due to increased security and regulations for trials in order to prevent future deaths. To this day, the FDA has not approved any gene therapy product to be put on the market for sale. Not only is this because of Jesse's death, but also because there has not been any significant evidence of gene therapy being an effective treatment for diseases since 1990 when the first trial began. The gene therapy community suffered another set back in 2003 when the FDA put "a temporary halt on all gene therapy trials using retroviral vectors in blood stem cells" (Human Gene Project Information 2003). This action was the result of the two children in France developing a leukemia-like condition after receiving gene therapy treatment for SCID in August 2002. The FDA is currently meeting to develop new safeguards for somatic cell gene therapy trials involving the use of retroviral vectors.

VI. Discussion

While these roadblocks have in some respects stood in the way of the development of gene therapy, there are several labs that are currently working on some new gene therapy protocols. A research team at the University of California at Los Angeles is currently working on creating a "molecular Trojan horse" that can deliver

normal genes to areas of the brain that are defective, and help correct conditions such as Parkinson's and epilepsy (Ananthaswamy 2003). They say that the brain is a tough area of the body to fix because the blood barrier surrounding the brain is difficult for large cells to penetrate, meaning that the viral vectors typically used in gene therapy do not work here. The team at UCLA has created a liposome that can get through this barrier and deliver the normal genes to the brain. The liposome is covered with a polymer called polyethylene glycol (PEG). They say that this polymer is necessary for the liposome to pass through because they put antibodies in the polymer to latch onto the brain-capillary receptors, and "trick" the brain into letting the liposome pass the barrier (Ananthaswamy 2003). This treatment has been successful in rats and monkeys, and does not appear to have any toxic side affects. However, this treatment does have to be repeated monthly because the new genes are not integrated into the genome.

At the University of Iowa, Beverly Davidson and Henry Paulson are working on a treatment for Huntington's disease that would reduce the production of the defective proteins that cause the damage and the deterioration of the brain. Huntington's disease is an autosomal dominant genetic disorder whose gene is found on the short arm of chromosome 4. In their mode of gene therapy, Davidson and Paulson would be silencing the gene that causes the mutated proteins to be produced by pairing a short piece of double-stranded RNA (siRNA) against RNA that codes for a particular protein, which will stop the production of that protein (Holmes 2003). The team found that it couldn't shut off the gene completely because the brain cells would not survive without some of the proteins produced by the gene. However, they believe that reducing the number of toxic proteins being produced even slightly will improve the condition. It is important to remember that with Huntington's disease there is usually a good copy of the gene along with the defective one that causes the disease, and thankfully this treatment will only help alleviate the problems caused by the defective gene, and does not detract from the effectiveness of the normal one that is naturally present.

In 2002, Ryszard Kole and his research team at the University of North Carolina published evidence that they could repair the dysfunctional messenger RNA (mRNA) that causes Thalasseaemia, a blood clotting disorder. With this particular disorder, the malfunction occurs in the production of beta hemoglobin. There is a mutation in the gene's mRNA, which causes the creation of extra splice sites, thus making extra coding sequences that produce malfunctioning hemoglobin molecules (Penman 2002). Kole suggests that they can "trick" the cells into producing normal hemoglobin by using antisense RNA to block the creation of additional splice sites (Penman 2002). The antisense is delivered to the cells through a modified lentivirus (a type of retrovirus), and in the lab they have already attempted this treatment *ex vivo* using bone marrow samples.

They report that these bone marrow samples have produced 20 to 30 percent of a healthy person's level of hemoglobin (Penman 2002).

For many parents of children with genetic disorders, decisions of whether or not to attempt new medical treatments that could help their children (such as gene therapy), especially if these treatments are experimental and possibly fatal, are difficult. It is important to remember that the first gene therapy trial conducted was performed on a four-year-old girl, and the first person to suffer death under a gene therapy trial was 18-years-old, and was the youngest person in that protocol group. While these treatments are new and carry with them a deal of risk, parents may realize that they are the only hope for survival or meaningful life that the child has.

Another question that arises with gene therapy and children is testing them for diseases. Some people question whether it is right for children to have to bear the burden of knowing that they are a carrier for a genetic disease or code for a gene that could potentially result in the development of a disease, such as the BRCA1 and BRCA2 genes that could pre-dispose a person to breast cancer. On the other hand, it can be relief to know that one's child is not a carrier for a disease, and this can prevent them from having to undergo extra examination or doctors appointments, which can in turn save them money and give them piece of mind.

A final gene therapy consideration for parents and/or future parents will occur when (and if) germ-line gene therapy becomes available for humans, thus making it possible to correct defective genes before or immediately following conception. Should parents have the right to make those kinds of decisions that were once only decided by nature and genetics for their child? Parents are expected to make many decisions for their children without their consent because children are not capable of making those types of decisions themselves. Most parents want to give their child the best life possible, and one could argue that by alleviating their children (or future children) of a genetic disease that could cripple or end their life prematurely, the parents would be ensuring that the children's quality of life is the best one scientifically possible. Yet by changing the genes, they could be taking away something that makes that child unique, and they would not be creating the person meant to be created by the union of those particular egg and sperm. Is it fair for a parent or anyone else to deny that unborn person's unique existence, and on a bigger scale, to deny the world of that person's existence?

Many parents and/or future parents that are at risk of conceiving and/or bearing children with genetic disorders are now seeking guidance from their physicians and genetic counselors as to how they can handle the possible outcomes. Now more than ever, it is imperative for physicians and counselors to give these patients complete and honest answers to all their questions, so as they can give informed consent for treatment

if they so choose. According to Parker and Gettig (2000), informed consent is "the most prominent bioethical and legal doctrine to emerge in the early years of bioethics." The concept of informed consent is that when patients are considering whether or not to participate in any type of gene therapy treatment, they are made aware of all the risks and benefits that exist when embarking upon the treatment, and they are the ones that are making the decision to partake in gene therapy based upon their own values and beliefs. Informed consent exists to protect the patients from any undue influence as to whether or not they should try a gene therapy treatment, and presents a guideline for physicians and genetic counselors as to how they should supply their patients with the information they need to make their decision.

In looking at this issue from a social standpoint, how will discrimination change if parents were able to "program" their children to meet their specifications? The United States has progressed immensely with its discrimination laws to provide equal opportunities for persons with disabilities. If germ-line gene therapy were to exist, would a new form of discrimination against persons that were not modified come into existence? Walters (1999) raises the question of whether it is a "remediation or enhancement" to perform germ-line gene therapy on an embryo that would allow that child to have an IQ of 100 rather than 60 or 70. With the public schools moving towards inclusion methods to better integrate children with disabilities into classrooms with "normal" children, this country seems to be at a point where now more than ever, people are much more tolerant of those individuals with disabilities than they ever were previously. Walters (1999) ends his discussion of the ethical issues of gene therapy by saying, "We can applaud the war on disease that genetic research is waging. It will be a great day when a child is definitively cured of cystic fibrosis or when a particular family line is liberated from the burden of fragile X syndrome. But we will be humane warriors only if, in the midst of the battle, we also show respect for those who courageously cope with disability and for those who cannot yet be cured." The United States is almost to a point scientifically that while they could prevent unborn children from ever having to endure devastating diseases, gene therapy can also create a host of new social problems and inequities that did not previously exist, and may prolong discriminatory attitudes towards those that live with the disabilities that gene therapy is attempting to eliminate.

VII. Conclusions

With the emergence of hundreds of biotech companies and research labs over the past 20 years that are dedicated to exploring and discovering methods of administering gene therapy to those that need it, there has been little progress in the field. The biggest set-back for gene therapists came in 1999 when the gene therapy community lost its first patient, Jesse Gelsinger, due to complications with his therapy for his liver

disease ornithine transcarbamylase (OTC). Since that time, the Food and Drug Administration (FDA) has produced stringent guidelines for researchers to follow, as a means of preventing further death. While it is important to have these rules in place to protect people, it is becoming apparent that the rules governing protocols and procedures for somatic cell gene therapy will not be nearly as important as the rules that will need to be made to govern germ-line gene therapy. While germ-line gene therapy may someday provide children with the opportunity to live a life free of genetic disease, it may also give their parents the opportunity to change society and create a new form of discrimination. Gene therapy has the potential to change the world and the lives of those suffering from once irreversible disorders. However, it could also provide the opportunity to genetically engineer humans, thus creating a new era in eugenics. The benefits are astronomical, but the risks could lead to the "racial cleansing" situation similar to the one witnessed in Europe during World War II. Gene therapy is the next logical step for the treatment, and someday the prevention, of terrible genetic disorders. Nevertheless, if these treatments have the potential to be abused, perhaps this step should not be taken.

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Vectors Used in Gene Therapy

Vector	Characteristics	Applications
Adeno-associated virus (AAV)	Integrates into specific chromosomal site Long-term expression Nontoxic Infects dividing and nondividing cells Carries small genes	Cystic fibrosis Sickle cell disease Thalassemias
Adenovirus (AV)	Large virus, carries large genes Transient expression Evokes immune response Infects dividing and nondividing cells, particularly in respiratory system	Cystic fibrosis Hereditary emphysema
Herpes	Long-term expression Infects nerve cells	Brain tumors
Retrovirus	Stable but imprecise integration Long-term expression Most types infect only dividing cells Nontoxic Most established in clinical experience	Gaucher disease HIV infection Several cancers ADA deficiency

Figure 1: The four viral vectors utilized by gene therapists, their characteristics, and their applications (Lewis 2003).

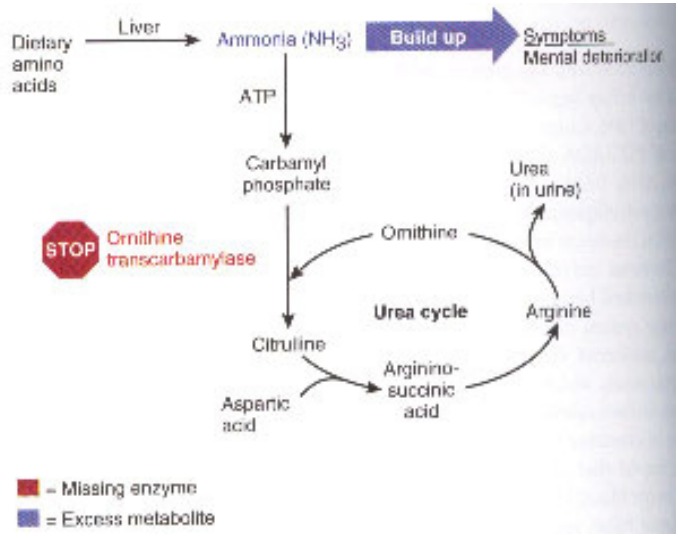

Figure 2: The manifestation of ornithine transcarbamylase (OTC) (Lewis 2003).

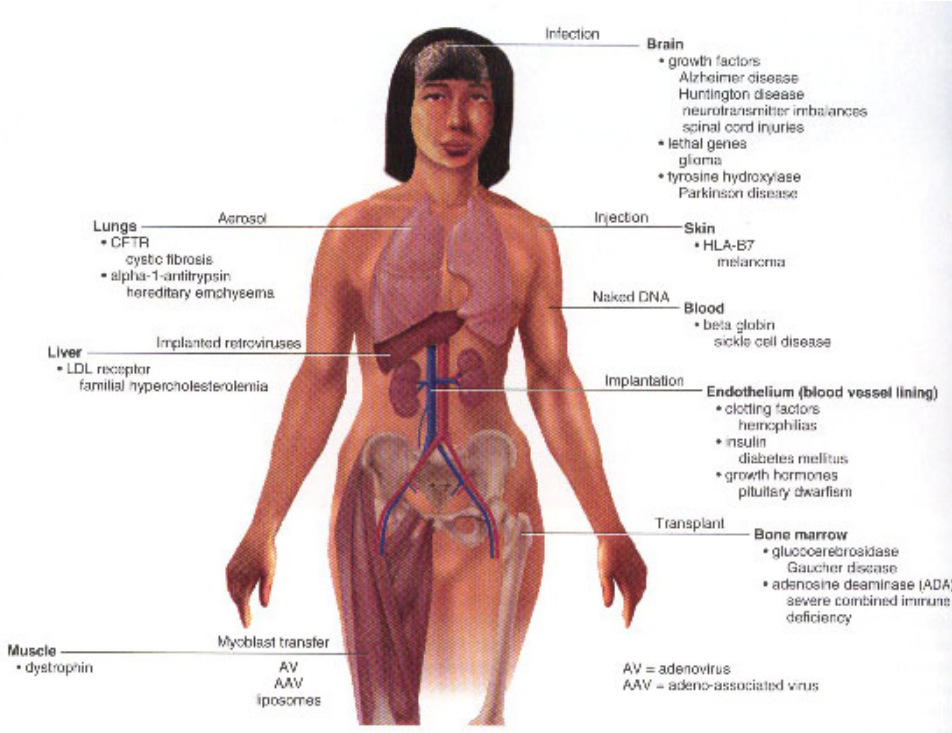

Figure 3: Gene therapy sites (Lewis 2003).

"And there are no Footprints in the Dust Behind us…"

Language as the Source of Human Power and Identity in The Telling

Bradley Seymour[1] (English and Psychology)

Language, in both written and spoken form, is a uniquely human characteristic. Every other living being in the world is ostensibly able to function without language in this conventional form. This is because all living beings aside from humans are able to operate by fundamental sets of instinctual actions and processes; something that can be referred to as a being's inherent nature. Humans, oddly enough, are without this hard-wired nature. We, as a consolation, are rather imbued with the capacity to utilize language.

Language is how we construct our world view and our own identity. We think not only in pictures and symbols, but also in words and phrases. Therefore, complex thought is made possible by our capacity to understand language. It is how we relate to things, and it is the vehicle with which we define purpose. As a uniquely human function, "language is, like nest-building or hive-making, the universal and biologically specific activity of human beings. We engage in it continually, compulsively, and automatically. We cannot be human without it" (Roberts 141). Other forms of animal life and most certainly plants do not have this ability, but they do have their own unique characteristics than can be referred to as forms of power, such as superior speed, physical strength, longevity and endurance. Each of these forms of life has its own niche in existence; its own purpose: "They know the way, they know where to go and how to go, following their nature" (Le Guin 134). But as humans, our purpose and our place in existence are fluid and variable, and it is the power of language that allows humanity to construct that purpose and place for itself. Because of this, language is the source of human power and identity.

Therein lies the potential for language to be a tool for control. Since language is essentially the key to everything, those who feel so inclined can use language as a means to manipulate human identity and create hierarchical structures (or as I will refer to them in this essay, *orders*) that force people into subjectivity. Meanwhile, those in power

[1] Research performed under the direction of Dr. Susan Bernardo (English).

remain in power by continuing to manipulate language to their benefit. After all, "control of language … means control of one's life" (Roberts 144).

There are three fundamental orders within Ursula K. Le Guin's The Telling (or rather, two orders and one anti-order). All three utilize and illustrate the power of language in vastly different ways. The first is that of the omnipresent Corporation, which uses the power of language by nearly depriving its subjects from language entirely. Next is the fanatical Unist Religion, which rules its own subjects with false language. And the final order, or anti-order, is that of the Telling, which uses language in its true unadulterated form and, because of its anti-hierarchical nature, comprises an amazing threat to the first two orders.

In illustrating the idea of language as human power, speculation on the consequences of the total absence of language is an effective method for understanding its utter importance. According to Uming Ottiar:

> Without the telling, the rocks and plants and animals go on all right. But the people don't. People wander around. They don't know a mountain from its reflection in a puddle. They don't know a path from a cliff. They hurt themselves. They get angry and hurt each other and the other things (Le Guin 134-135).

A world without language is a world of chaos. It is a world without order that causes humans to lose their sense of place, purpose, and power, so they will degenerate into violent modes of behavior and bring about their own ruin and that of everything around them. Language is necessary in order for human identity to exist, since it is the vehicle for history and memory. Without it, "there are no footprints in the dust behind us," (Le Guin 30) because without language, we do not know where we have been, where we are going, or even where we truly are. Truly, we are nothing. Language is needed to maintain the natural order. Without it, "everything is confused. Everybody's sick". (Le Guin 135)

The order of the Corporation, the dominant force on the planet Aka, places heavy restrictions on language. In fact, it tries its best to wipe out nearly all language, especially that which is written. If the Corporation is able to keep its subjects uneducated and without identity, it is much easier for it to control those subjects and force them to produce and consume. Individual thought is no longer a problem, as the individual no longer truly exists. All that remains is the faithful "producer-consumer," living life from one business transaction to the next. Sutty encounters people of this sort in the Akan city early in the book:

> Conversation went by program. At the banquets people talked business, sports, and technology. Waiting in lines or at the laundry, they talked sports and the

> latest neareals. They avoided the personal and, in public, repeated the Corporation line on all matters of policy and opinion. (Le Guin 33)

These people "avoided the personal" because there simply is no personal. There is no individual identity among these people, so the only discourse they can manage is on superficial topics such as this. All of their "thoughts" are in accordance with Corporation ideas, as they are nothing more than mindless drones of the Corporation. Because of this strict system of control, the economy certainly remains stable. Those in power will remain in power, as those without power do not know enough to realize they are without it, or even to bother finding out what it is and why it is so important.

The order of the Unist Religion, the dominant force at one point back on the planet Earth, uses language in quite a different manner than does the Corporation. Rather than restrict all language, it exploits false language, or rather a vastly corrupted and perverted version of language. It controls its followers not by keeping them silent and without identity, but rather by projecting upon them a fanatical, closed-minded and ultimately false identity. It concerns itself with ignoring and even eliminating language that does not serve its own purpose, and therefore produces a twisted, false form of propagandized language that gives rise to identities that are equally as twisted and false in its subjects.

Though the Unist Religion is not discussed in as great length as is the Corporation, it exists in the text in the past tense; it once existed and has since killed itself off. All the lies, the fanaticism, and the propaganda eventually turned the aggression of Unism in upon itself: "they were all dangerous, they were all violent… they'd always use violence, because their belief justified it. It told them that God rewards those who destroyed unbelief and the unbeliever" (Le Guin 220). The power of language was even able to override the man-made controls that the Unists placed upon their subjects. Language is so powerful that, when utilized in a false manner such as this, it becomes a double-edged blade with the potential to do as much damage to its manipulator as it can to its target. But Sutty's own description of the matter is a better illustration: "There's a Hainish parable of the Mirror. If the glass is whole, it reflects the whole world, but broken, it shows only fragments, and cuts the hand that holds it" (Le Guin 228). Indeed, the raw power of language is the mirror.

Because of this amazing power, the order of the Telling is indeed a horrendous threat to the first two orders. Sutty first begins to see proponents of this order in the people on the riverboat: "but on the riverboat, people talked. They talked personally, intimately, and exhaustively" (Le Guin 33). This is because these people actually have authentic identities as a result of their freedom to use language to construct those identities. Where the first two orders mentioned earlier both use language (or the lack thereof) as a means for control and establishing and perpetuating a socioeconomic or

religious hierarchy, the Telling naturally emphasizes that these hierarchies are false and unnatural constructs. Indeed, the Telling could be looked at as being almost anarchical in nature, and that is undoubtedly the word that would be used for it in both the Unist and Corporation regimes. But the Telling does not exist to harm anything, as it is apparent to its proponents that "hate eats the hater" (Le Guin 205). The Telling is rather about love and truth. But of course, the orders that thrive on hatred, fallacy, and social or religious oppression would never acknowledge that.

The Telling has the potential to destroy both the Unist Religion and the Corporation. This is because the proponents of the Telling do not seek to further personal interests, unlike those who endorse the Unist Religion and Corporation. In the order of the Telling, there are no leaders and no followers. There are just people who tell stories – all the stories – and do not discriminate between them or force one opinion over another. There is true freedom for those who believe in the Telling for each and every person to develop a unique and authentic identity. It is this true identity that keeps them from being controlled. Truly, there is nothing to gain in the Telling by using the power of language except for eventual understanding of the fundamental truths of the universe.

The only real danger associated with language – the true source of human power and identity – is that the subjects of the Corporation and the Unists will realize that they are under illegitimate rule and will rebel against that rule. This is true not only for these two orders but, for that matter, any socioeconomic or religious institution in which the masses are ruled by a select few based on man-made, and therefore false and unnatural, assumptions. Uming Ottier realizes this, and it is during his extended tirade that he speaks of it: "Those false maz, those big munan, those boss maz. Telling people that nobody knew the truth but them, nobody could speak but them, everybody had to tell the same lies they told" (Le Guin 135). Truly, no one person has the right to assert dominance over another, as all people are equal. He understands entirely the falsehood of the rule that people had been subjected to, and it is his involvement in the Telling that allows him to do so.

This theme of language as the source of power is not uncommon in Le Guin's writing. In her Earthsea stories, there is an obvious link between language and identity, and identity and power. In fact, the three are inexorably linked together. All power over an object stems from one's knowledge of that object's true name. And no true name can exist without language. Here, too, language is the source of power. For those in the Earthsea stories, "languages allow their users in certain specific situations to change the physical nature of reality" (Comoletti and Drout 3). In the more realistic The Telling, however, the transformative power of language is not of the physical realm, but rather of the social, religious, and mental.

Language truly is the source of human power. Everything that makes a human uniquely human stems, on some level, from language. From language springs memory, history, purpose, and identity. Language is that set of footprints in the dust that defines humanity's past, present, and future. And to have control of language is to have control of human life. This is precisely the reason for the Corporation and the Unist Religion to fear the power of language to the point where it must be regulated, monitored, and in some cases eliminated, in order to assure the perpetuation of their hierarchies. The equalizing force of language, however, ultimately has the power to break these hierarchies apart, whether from the outside or from within.

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Section V: Index to Articles Published in Earlier Volumes

Table 1: Past Papers

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Increased Functionality and Copy Protection for Online Images: Dynamic Flash Images and the Web	Jason W. Nadal and Dr. Adrian Ionescu	A. Ionescu	Fall 2002
Speciation of Arsenic Metabolic Intermediates in Human Urine by Ion-Exchange Chromatography and Flow Injection Hydride Generation Atomic Absorption Spectrometry	Sarah Alauddin and Dr. Mohammad Alauddin	M. Alauddin	Fall 2002
The Impact of Thin-Ideal Depicting Media on Disordered Eating Among College Students	Jessica Morin	A. Eshleman	Fall 2002
The Effects of Mortality Salience on Social Evaluation	Matteo Rosselli	R. Brower	Fall 2002
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Alcohol-Induced Malformations in Zebrafish Embryos: Zebrafish as a Model Animal to Study Fetal Alcohol Syndrome	Jacqueline Whittenburg, Renee Sudol, Prof. Linda Raths and Dr. Zoltan Fulop	L. Raths and Z. Fulop	Spring 2003
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Taking the Job Home	Melissa Mason	R. Brower	Spring 2003
The Representation of Class in Chaucer	Eric DeBarba	A. Schotter	Spring 2003
The Role of *ESS1* in Transcription Elongation	Anne Rossettini	E. Perry	Spring 2003
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From Vision to Reality: Development of a Utopia in *Parable of the Sower*	Emily Dillon	M. Kiss	Spring 2003
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Investigation of Iron(III)-based MRI Contrast Agents	Maryanne Gaul	N. Richardson	Fall 2003
The Effects of Conscious Sedation on Anxiety in Oral Surgery Patients	Dina Gramegna	L. O'Hare	Fall 2003
Redefining Love: The Interrelations Between Love, Attachment Styles and the Triangular Theory of Romantic Relationships	Jaime T. Carreno	A. Eshleman	Fall 2003
Memory: Effects of One's Gender on Memory Retention	Nicole Gaeta	R. Brower	Fall 2003
GPA and Study Habits: The Relationship Between Study-Habits and Grade Point Average in College Students	Jenny Ludvigsen	R. Brower	Fall 2003
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