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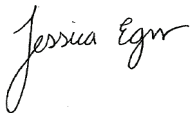
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A letter from the editor:

Parents, educators, and leaders alike are constantly encouraging students to continue their education, and for good reason. According to the U.S. Labor Department, college graduates earn significantly more over their lifetimes and have lower unemployment rates than high school graduates – a huge incentive in the weakened global economy of today. But with the rising costs of education, the majority of students graduate with loans averaging more than twenty thousand dollars. The availability of financial aid has decreased alongside mounting student fees, consequently rendering some college hopefuls unable to attend an institution of higher education.

Around the world, frustrated students have risen up against an increasingly damaged higher education system. In Chile, students are demanding an overhaul of the education system and an end to the existence of profit and inequality in higher education. In London, thousands of students are marching to protest a large increase in student fees. In the United States, record numbers of students are working twenty or more hours a week while student loans are at an all time high.

With the rising importance of obtaining a degree of higher education, it is rather ironic that the world is making it increasingly difficult to achieve. The Journal of Undergraduate Research and Scholarly Excellence stands behind all students who value their education and commit to producing extraordinary work. JUR is a place to celebrate those students who are going above and beyond.



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Determination of Survivin as a critical mediator for cross-resistance to Paclitaxel and Herceptin in breast cancer

BY ANDY VAUGHAN WITH BOLIN LIU, MD AND SHULIANG WANG, PH.D.

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STUDENT CANCER RESEARCH FELLOWSHIP

Abstract

A common problem in the clinical treatment of breast cancer has become the resistance of tumor cells to chemotherapeutic agents. Two types of such agents are the monoclonal antibody trastuzumab (Herceptin) and the antitumor drug paclitaxel (Taxol). The mechanisms of resistance of the two drugs have been extensively researched. Here, we investigate the possibility of cross-resistance between Herceptin and Taxol, thought to be possibly mediated by the protein Survivin. Survivin production was displayed to have a role in mediation of cross-resistance to Taxol and Herceptin. Thus, Survivin provides a future possible target for anti-cancer therapy.

Introduction

Resistance to these drugs has been encountered as both primary and acquired, and increase in the prevalence of acquired resistance will necessitate the exploration of resistance mechanisms for the possibility of positive clinical outcomes.^{1,2} Understanding the mechanisms that govern the resistance to these two anti-tumor therapies will be paramount in the further development of new anti-tumor therapies.

Herceptin is a monoclonal antibody that targets the growth factor receptor erbB2 and is used for treating breast cancers that over-express the erbB2 receptor. The antibody binds to the extracellular domain of the erbB2 receptor and prevents the activation of the intracellular tyrosine kinase.³ Herceptin-resistant breast cancer cells are thought to have developed their resistant phenotype through activation of the phosphatidylinositol 3-kinase (PI3K)/Akt signaling pathway.² We have recently reported that this downstream signaling is a result of heterotrimerization of three receptor tyrosine kinases (RTKs), erbB2, erbB3, and Insulin-like Growth Factor-I Receptor (IGF-IR).² When associated together, these three RTKs activate one another, overriding the inhibitory effects of Herceptin.² When these RTKs are activated, they upregulate several downstream signaling pathways such as the PI3K/Akt, Src, and MAPK signaling within the cell that are shown to inhibit apoptosis. The most

significant of the three will be the signaling of PI3K/Akt which has been demonstrated to be a result of interactions between the erbB2 and erbB3 receptors.⁴

Interactions between erbB2 and erbB3 have also been demonstrated in breast cancer cells resistant to a different antitumor drug known as Taxol.² Taxol works by hyper stabilizing microtubules so that cells are unable to function during metaphase of mitosis and are forced toward apoptosis.⁵ Our recent studies reveal that the paclitaxel resistance-induced by erbB2/erbB3 receptors is due to the upregulation of a protein called Survivin, a member of the IAP (inhibitor of apoptosis) family, via PI3K/Akt signaling-dependent mechanism.² However, the precise mechanism by which the erbB2/erbB3/PI3K/Akt signaling upregulates Survivin expression is unknown. It has also been suggested by some studies that activation of IGF-IR signaling may increase Survivin levels through a process of protein translation-induced by activation of Akt.⁶

The Herceptin-resistant cells have shown activation of PI3K/Akt and IGF-IR signaling.³ Both pathways are able to increase the production of Survivin in breast cancer cells permitting resistance to Taxol.^{2,6} Thus, it is conceivable to hypothesize that Herceptin-resistant breast cancer cells may exhibit resistant phenotype in response to taxol, and Survivin may be a critical mediator of this cross-resistance. We will evaluate the responsiveness of Herceptin-sensitive and -resistant breast cancer cells to Taxol-induced growth inhibition and/or apoptosis.

Experimental design and methods:

Cells and cell cultures

Human breast cancer cell lines SKBR3 and BT474 were maintained in DMEM/F-12 (1:1) medium (Sigma) containing 10% fetal bovine serum (Sigma). Both cell lines and the Herceptin-resistant sublines were cultured in a 37°C humidified atmosphere containing 95% air and 5% CO₂ and were split twice a week.

Cell proliferation assay

The CellTiter AQ Non-Radioactive Cell Proliferation kit (Promega) was used to determine cell viability. Cells plated onto 96-well plates for 24 h were then grown in a con-

trol medium or the same medium containing varying concentrations of Taxol and incubated for another 72 h. After reading at 490 nm with a micro-plate reader, the percentages of surviving cells from each group relative to controls, defined as 100%, were determined by reduction of MTS.

Quantification of apoptosis

An apoptosis ELISA kit (Roche Diagnostics) was used to measure quantitatively cytoplasmic histone-associated DNA fragments as we previously reported.^{3,5}

Western blot analysis

Cell lysates were boiled in SDS-sample buffer, resolved by SDS-PAGE, transferred to nitrocellulose (Bio-Rad), and probed with primary antibody. After the blots were incubated with horseradish peroxidase-labeled secondary antibody (Jackson ImmunoResearch), the signals were detected using the enhanced chemiluminescence reagents (Amersham Life Science).

Production of lentivirus containing specific shRNA

The lentiviral expression vector pLKO.1-ConshRNA or pLKO.1-SurshRNA and lentivirus packaging plasmids pCMV-VSVG and pCMV-ΔA.9 were co-transfected into virus packaging cell line 293T using FuGene6 (Roche). After 24 h, the culture media was replaced with fresh medium. The virus in conditioned medium was then harvested in 3 consecutive days, filtered with low-protein binding filters (Millex-HV, 0.45-mm polyvinylidene difluoride; Millipore Corp.) and stored at -80°C freezer.

Gene silencing with the lentivirus encoding specific shRNA

Before infection, the ConshRNA or SurshRNA lentivirus-containing media (5mL) were thawed completely at room temperature. Another 5 mL of fresh medium containing polybrene (8 μg/mL) was added into the virus-containing media which was used to replace the culture media of interested cells. After 24 h, the virus-infected cells were selected by puromycin (1 μg/mL) for 48 h and subjected to required assays.

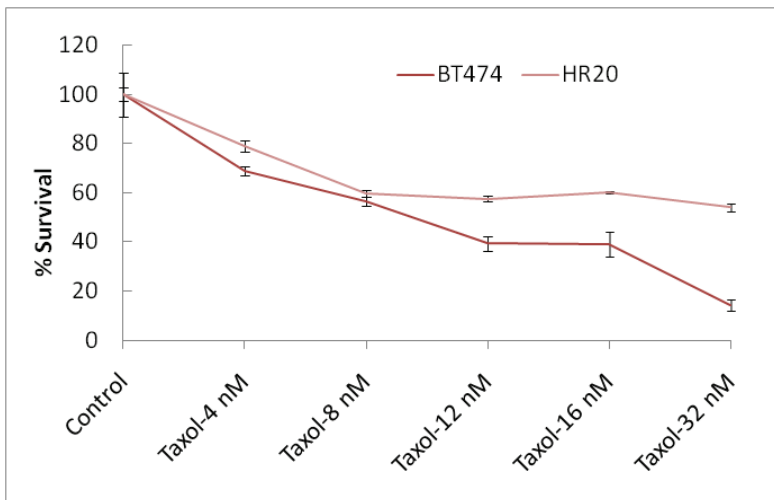


Figure 1. MTS assay analysis of BT474 and Herceptin resistant sub-line HR20. This analysis was compiled from data from multiple trials.

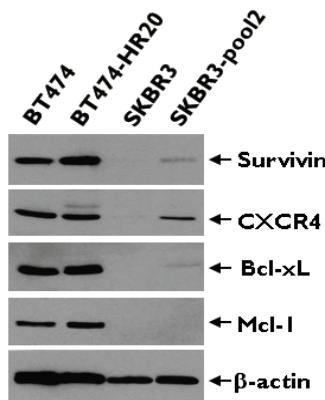


Figure 2. Western blot analysis of all four cell lines and presence of various proteins.

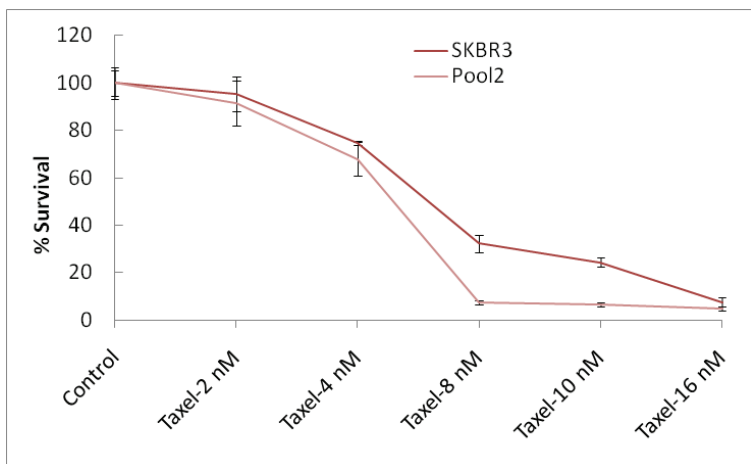


Figure 3. MTS assay analysis of SKBR3 and Herceptin resistant sub-line Pool2. This analysis was compiled from data from multiple trials.

Statistical analyses

Statistical analysis of all experimental data was performed using a two-sided student's t test. Significance was set at $P < 0.05$.

Results and Discussion:

To investigate the likelihood of cross-resistance between Herceptin resistant cells and resistance to Taxol, both cell lines and herceptin resistant cell sub-lines were plated in cultures of increasing concentrations of Taxol. Only one of the cell line pairs, BT474 & HR20, demonstrated significantly positive results. In MTS proliferation assay tests, HR20 presented with comparable survival rates at a dose of 4 nM Taxol and higher survival rates than BT474 at doses 8, 12, 16 and 32 nM Taxol. This is demonstrated in Figure 1. This data suggests that there is a high possibility of a link between resistance to Herceptin and an induced resistance to Taxol, but research with other cell lines is required to confirm this finding. However, the results of tests on the SKBR3 cell line and Herceptin resistant sub-line did not display positive results. Pool2 demonstrated comparable survival rates at doses of 2 and 4 nM Taxol and lower survival rates at doses of 8, 10 and 16 nM Taxol as is seen in Figure 3. It is very possible that Survivin does not play a role in Taxol resistance in this cell line.

Western blot analysis of all four cell lines revealed that HR20 had higher Survivin production than BT474 and SKBR3 and Pool2 had similar Survivin production. This is shown in Figure 2.

Due to the negative results with SKBR3 and Pool2 indicated by Figure 3 and the apparent difference of Survivin production in SKBR3 and Pool2 indicated in Figure 2, gene silencing was only carried out on the HR20 sub-line and one trial of Apoptosis ELISA analysis for this cell line was developed and can be seen in Figure 4.

The MTS assay, apoptosis ELISA, and western blot analysis on the Survivin silenced cell lines are all ongoing strategies to strengthen the hypothesis.

Although strategies to strengthen this hypothesis have not been completed and are currently ongoing, there is data to support the conclusion that Survivin is a critical mediator of the cross-resistance between Herceptin and Taxol. This is possibly the first instance of cross-resistance mediated by the same mechanism between two different types of therapy, monoclonal antibody therapy and chemotherapy. A reproducible link may be able to change the way antitumor therapy is approached. Positive results could also lead to new antitumor therapies that would target

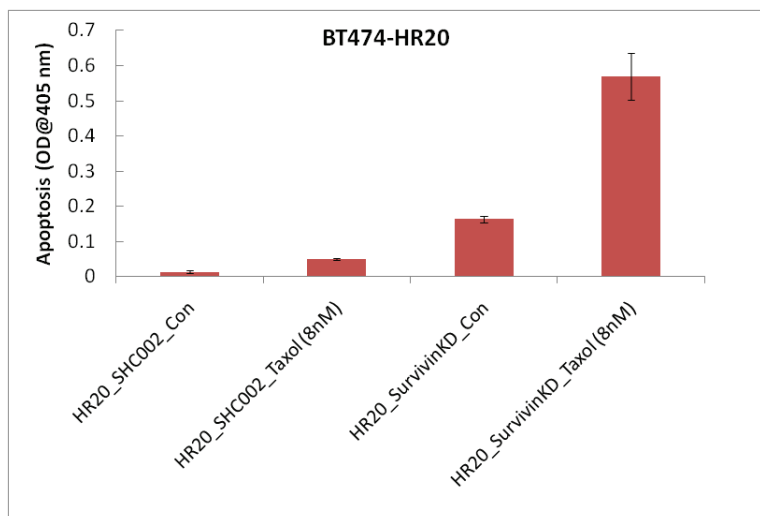


Figure 4. Apoptosis ELISA of the BT474-HR20 sub-line and a Survivin gene silenced counterpart.

the production of Survivin. Combining therapies that target Survivin and erbB2 or microtubules might allow physicians to bypass acquired resistance and to continue treating patients. Survivin production in Herceptin resistant cells would also indicate that patients with primary or acquired resistance to Herceptin have acquired resistance to Taxol

as well. Investigation of Herceptin resistant cells being resistant to drugs similar in form and function to Taxol and of Taxol resistant cells being resistant to Herceptin is necessary.

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SET/MYND lysine methyltransferases regulate gene transcription and protein activity

BY KRISTIN LEINHART WITH MARK BROWN, PH.D.
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Introduction

From regulated gene expression to mitosis, chromatin acts as a structurally flexible repository of the genome.¹ In this manifestation, an entire chromosome is sequentially compacted through a series of highly ordered packaging while distinct regions of DNA are selectively made accessible to transcriptional complexes.^{2,3} Thus, chromatin maintains a dynamic architecture that allows approximately 2 m of DNA to be condensed in the nucleus while retaining a remarkable degree of functionality.^{4,5} At its foundation, chromatin consists of a succession of nucleosomes, the basic structural units,⁶ consisting of 146 base pairs of DNA, wrapped 1.7 times around an octamer of core histones and separated by a linker region of approximately 50 base

pairs. The primary histones involved in the assembly of a nucleosome are histones H2A, H2B, H3 and H4. Histone tails interact with the poly-anionic backbone of the core DNA, marginally contributing to nucleosomal stability.⁷ Therefore, regulation of chromatin structure and transcription is often mediated through post-translational modifications that alter specific residues along these tails.⁸ These modifications can affect the accessibility of nuclear factors to DNA or induce the recruitment of such factors to transcriptional or chromatin assembly pathways.^{9,10}

Histone tail alterations encompass the greatest range of variation in epigenetic regulation, encompassing more than 50 known sites of modification.^{11,12} Histones are subject to several forms of post-translational modifi-

cation, including methylation, citrullination, acetylation, phosphorylation, SUMOylation and ADP-ribosylation.¹³ These modifications impart biological consequences by acting as marks for the specific recruitment of regulatory complexes and affecting the structure of the nucleosome. Acting in concert, the combination of different histone modifications is thought to constitute a "histone code" that is interpreted in the form of specific nuclear events.^{14,15} Although the interplay among various histone modifications is still largely nebulous, a paradigm is rapidly emerging whereby methylation, acetylation, or phosphorylation at independent sites work in tandem with other such modifications to convey unique biological consequences.¹⁶ Such crosstalk has already been clearly demon-

strated by a number of findings including the cooperation between acetylation and phosphorylation of histone H3 during the cell cycle,¹⁷ the correlation between acetylation and arginine methylation in the regulation of estrogen-responsive genes,¹⁸ and the competition between methylation and acetylation of histone H3, lysine 9 toward the establishment or disruption of heterochromatin.¹⁹ As new studies continue to highlight the importance of crosstalk in chromatin signaling, our early understanding of singular histone modifications have yielded to a more delicate model in which minor variations in broad patterns of modifications impart distinct outcomes.

While acetylation of histone tails is largely ephemeral in nature, histone methylation is widely observed to be a mark that confers long-standing epigenetic memory.²⁰ Mounting evidence suggests that histone lysine methylation is a critical factor in such pathways as transcriptional regulation, X chromosome inactivation, DNA methylation, and the formation of heterochromatin.²¹⁻²³ Catalyzed by histone methyltransferases, this modification ultimately mediates either gene activation or silencing, in a residue-dependent manner.²⁰ The level of specificity is heightened by the variation in biological consequences associated with whether a residue is mono-, di-, or tri-methylated.^{24,25} It has also been reported that many transient histone modifications work in tandem with histone lysine methylation, further increasing the potential complexity of this epigenetic modification.¹

Most histone lysine methyltransferases catalyze methyl transfer by way of the SET domain, a module encoded within many pro-

teins that regulate diverse processes, including some critical for development and proper progression of the cell cycle.^{14,23,26} Residue-specific histone lysine methylation typically correlates with distinct states of gene expression.²⁷ Most of the known targeted lysines of histone methyltransferases occur on histone H3 which thereby serves as a conduit of epigenetic regulation. In general, lysine methylation at histone H3, lysine 9 (H3K9), H3K27, or H4K20 corresponds with gene silencing, whereas methylation of H3K4, H3K36, or H3K79 is associated with actively transcribed genes. However, these paradigms are far too narrow to encompass the growing intricacies of the histone code.²⁷ Recent evidence implicates histone methylation in the recruitment of chromatin remodeling complexes, as is the case with CHD1, an ATP-dependent chromatin remodeling factor that specifically binds methylated H3K4.²⁸ Once thought to be a permanent modification, enzymes have been identified that are capable of reversing histone methylation at specific sites.^{20,29}

SMYD family

The SMYD family comprises a subset of five SET domain-containing proteins that have unique domain architecture. Specifically, this family of proteins is defined by a SET domain that is split into two segments by a MYND domain, followed by a cysteine-rich post-SET domain (Figure 1A).^{30,31} The SET domain is responsible for the methylation of lysine residues on target proteins³²⁻³⁷ and, indeed, the SET domains of SMYDs 1, 2, and 3 have been confirmed to be active catalytic domains despite the split nature of their architecture.^{14,23,31,38,39}

The MYND domain of SMYD proteins (Figure 1B) encompasses a putative zinc-finger motif that facilitates protein-protein interactions. This domain is present in several other transcriptional regulators where it is known to contribute in developmental processes.^{40,41} Interface at the MYND domain occurs through a PXLXP motif in the associating protein. For example, the associations of SMYD1 with HDACs and the transcription factor, skNAC, are mediated through these sites.^{30,42} The MYND domain is the key feature distinguishing SMYDs from all other SET domain-containing proteins.

Thorough characterizations have not yet been conducted for SMYDs 4 or 5. Thus the catalytic activity has not been determined for those proteins. In fact, other than their identification³¹ and data from Expressed Sequence Tags suggesting that they are expressed in a wide range of normal, tumor, and diseased tissues, little is known about SMYDs 4 or 5. The expression of SMYD5 appears to be responsive to retinoic acid which could have broad implications regarding the regulation of the SMYD family.⁴³ Computational analyses based on BLAST comparisons of the SMYD family using the protein database of the National Center for Biotechnology Information revealed that while the SET and MYND domains of the SMYD family members contain a high level of identity and similarity, SMYDs 4 and 5 are much less conserved in their other domains.³¹ The high degree of conservation in their SET and MYND domains suggests that these are likely lysine methyltransferases with the capacity to bind proteins containing the MYND cognate motif, PXLXP. As they are all but absent from the literature, this review will not cover SMYDs 4 or 5.

SMYD1-Regulator of heart and skeletal muscle development

Gottlieb et al. first identified SMYD1 as a cardiac- and skeletal muscle-specific protein that is critical for cell differentiation and heart morphogenesis during embryonic development.³⁰ Targeted deletion of SMYD1 was shown to hinder the differentiation of cardiomyocytes leading to malformation of the right ventricle. Using reporter assays,

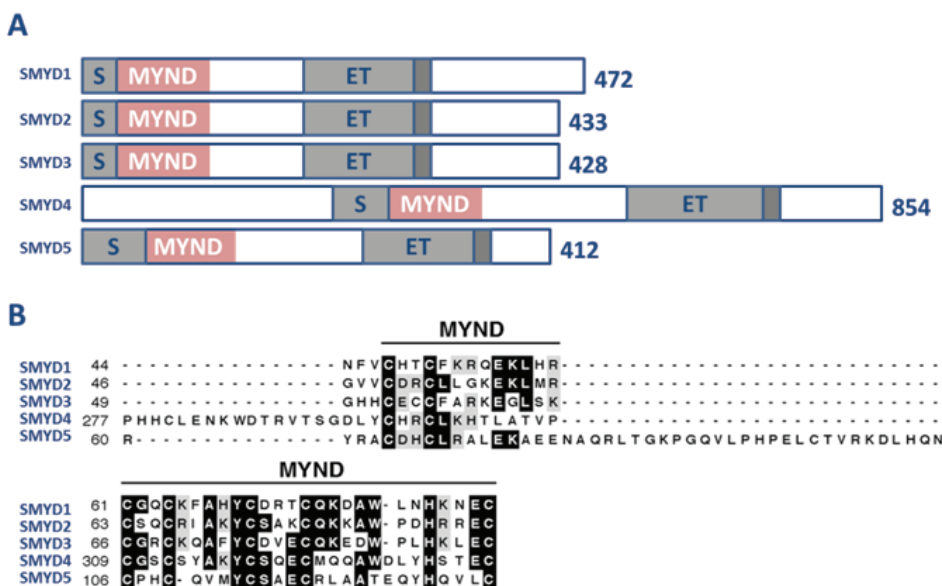


Figure 1. (A) Schematic representation of the five mammalian SMYD proteins. The split SET domain is shown in light gray; the MYND domain is shown in pink; the cysteine-rich post-SET domain is shown in dark gray; (B) ClustalW and BOXSHADE programs were used for alignment and shading of the MYND domains associated with each of the five SMYD proteins.

they demonstrated that SMYD1 functioned as an HDAC-dependent transcriptional repressor. The same group later demonstrated that SMYD1 interacts with the muscle-specific transcription factor, skNAC, by way of a MYND-PXLXP interaction between SMYD1 and skNAC, respectively.⁴² SMYD1 has more recently been shown to be an immediate target of the transcription factor, MEF2C during cardiac morphogenesis.⁴⁴

In 2006, Tan et al. published the first confirmation that the SET domain of SMYD1 is a catalytically active lysine methyltransferase.³⁹ Specifically, they determined that SMYD1 targets histone 3, lysine 4. In accord with previous findings associating SMYD1 with developmental processes of cardiac and skeletal muscle, this group further demonstrated that SMYD1 is essential for muscle contraction and myofibril organization.

This year, Sirinupong et al. published the crystal structure for SMYD1 45 providing the first detailed structural analysis for a SET/MYND domain containing protein. Their analysis illustrates the mechanism by which this family is capable of methylating target lysines despite the split nature of their SET domains. They also provide a plausible conjecture suggesting that the intervening sequence and unique C-terminal domain (CTD) contribute to an autoinhibitory mechanism. That domain is shown to facilitate the adoption of two distinct conformations thereby regulating the catalytic function of SMYD1. Given the partial occupation of the CTD in a site typically occupied by the pre-SET domain of other SET proteins, it is conjectured that the CTD may contribute to the stabilization of the SET domain in SMYD1. Finally, the resolution of the MYND domain confirms the structural basis for the role of that domain in guiding the protein-protein interactions of SMYD1. Lacking in their analysis is a thorough comparison of the SMYD1 SET with the SET domain of other proteins. Indeed, crystal analyses have been published for a number of other SET proteins.³²⁻³⁷ Given the unique architecture of the SMYD family SET domains, an attempt to align and overlay the SET of SMYD1 with other published SETs could provide a great deal of insight into the structural and mechanistic properties associated with the methyltransferase activity of SET domains.

SMYD2 - Lysine methyltransferase and regulator of tumor suppressors

The identification and characterization of SMYD2 was published by Brown et al. in 2006.³¹ In that report, SMYD2 was identified as a histone 3, lysine 36-specific methyltransferase. In contrast to SMYD1, SMYD2

was observed to be broadly expressed across several tissues with highest expression in the heart and the hypothalamus. Although most evidence suggests that histone 3, lysine 36 methylation is associated with actively transcribed genes, SMYD2 was shown to repress transcription in reporter assays. The Sin3A histone deacetylase complex, which has been linked to histone 3, lysine 36 methylation within the coding regions of active genes^{46,47} was shown to interact with SMYD2. This HDAC interaction provides a likely explanation for the observation of transcriptional repression in in vitro reporter assays where the effect of chromatin modifications imparted by SMYD2 on the recruitment of other factors could not be observed. Further evidence linking SMYD2 to transcriptional regulation was reported in the observation that SMYD2 interacts with RNA polymerase II and the RNA helicase, HELZ.⁴⁸

SMYD2 has also been shown to catalyze methylation of non-histone targets. Control of spatial and temporal expression of SMYD2 has been proven critical, as methylation of p53 at lysine 370 by SMYD2 was observed to repress the activity of p53.⁴⁹ Thus, SMYD2 has the capacity to function as an oncogene by eliminating the tumor suppressor functionality of p53. SMYD2 has more recently been linked to the regulation of the retinoblastoma tumor suppressor (RB) through its methylation of RB at lysine 860.⁵⁰ This modification has been shown to facilitate interaction with the transcriptional repressor, L3MBTL1 via the methyl binding domain of that protein. There is much left to uncover regarding the role of SMYD2 in oncogenesis. Its role in the regulation of two such critical pathways in tumor suppression make it a promising target for therapeutics.

SMYD3 - Transcriptional regulation and tumorigenesis

SMYD3 was the first member of the SMYD family for which the catalytic activity of the SET domain was confirmed. SMYD3 methylates histone 3, lysine 4 and has a role in the regulation of transcription through its association with an RNA polymerase complex.³⁸ SMYD3 is overexpressed in most hepatocellular (HCC) and colorectal carcinomas (CRC)³⁸ and its upregulation has been proven to be critical in the proliferation of breast cancer cells.⁵¹ Through microarray analyses, 80 genes have been identified that display altered gene expression in the presence of Smyd3.³⁸ Notably, one of these is Nkx2.8, a homeobox gene that exhibits upregulation in hepatocellular malignancies.⁵² Other affected genes include cell cycle regulators, oncogenes, and several that are critical in developmen-

tal processes.³⁸ In concert with the idea that SMYD3 is a transcriptional activator, it forms a complex with RNA polymerase II through its interaction with the RNA helicase, HELZ, and it was also shown to bind DNA directly by way of a sequence found in the promoter of Nkx2.8.³⁸ These findings not only provide targets for the histone 3, lysine 4 enzymatic activity of SMYD3 but they also implicate two methods for its direct interaction with those genes.⁵³

The findings that Smyd3 is substantially up-regulated in most CRCs,⁵⁴ HCCs,⁵⁵ and breast cancer tissues⁵¹ support a paradigm in which aberrant expression of chromatin-modifying enzymes, leading to a disturbance in established epigenetic patterns, can ultimately result in tumorigenesis. The recognition of the role of SMYD3 in tumorigenesis has led to studies regarding the effects of the knockdown of SMYD3 in cancer cells. RNA Interference in many types of tumor cells, leading to knockdown of SMYD3, has been observed to inhibit cell proliferation.^{38,51} Thus, SMYD3 has emerged as yet another promising target for therapeutic intervention in cancer.

Conclusions

The SMYD Family is a group of SET and MYND domain-containing transcriptional regulators that function, at least partly, through histone modifications. Future research on SMYD proteins, with strong emphasis on the unique organismal context, will shed light onto the biological functions of SMYD family proteins. Such emphasis may reveal new insights into the relationships between protein modifications and the development and differentiation of tissues and organisms as well as pathways through which aberrant activity of protein modifiers lead to tumorigenesis.

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An analysis of short-term memory and Dissociative Identity Disorder

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Introduction:

Background

According to the DSM-IV, Dissociative Identity Disorder (DID) is defined as two or more different identities in a single person that control behavior and involve “frequent gaps in memory.”¹ Inter-identity amnesia is described as “one identity being amnesic for events experienced by other identities.”²⁻⁷ Dissociative Identity Disorder has been the target of controversy, much of it dismissing the ability to have multiple distinct identities and complete amnesic experiences.^{1,8} Previous research has come short of revealing coherent evidence that supports or disproves the existence of DID.⁷ However, with DID being a fairly difficult disorder to study because of the difficulty and rarity of finding legitimate, diagnosed participants, research on DID continues to be a popular subject of debate. Recent research has focused on testing memory capability and various experimental designs have been used. These studies have included a group of participants who are told to simulate DID.⁷⁻¹⁰ Also in these studies, both DID patients and simulating groups were tested for their implicit and explicit memory in two different personalities. Results of these studies suggested that DID is a reaction to a traumatic experience, and DID participants are not completely amnesic to inter-identity experiences.^{3,7-10}

Previous literature

An inevitable weakness of research on DID is the limited number of participants diagnosed with DID. This is due, in part, to the rarity of the disorder and its questionable legitimacy as a disorder. Past studies found it difficult to include a multitude of DID participants as some had as few as four to 22 DID participants. However, the simulating control group (participants mimicking DID) has proven to be an essential aspect of many of the studies on DID.⁷⁻¹⁰ While there is not much that can be done regarding the number of DID participants in the study, a vast amount of non-DID (simulators) can be included to increase the validity of the experiment.

Another concern for studies on DID is priming among participants. In other words, there is a possibility that the participants are

making associations with words, pictures, and to some extent, numbers, with previous knowledge of that item when given stimuli. Schacter (1987) defines priming as “facilitation in the processing of a stimulus as a function of a recent encounter with the same stimulus.”¹¹ Although Huntjens et al. (2007) focused on measuring emotional associations with their words/pictures and gathered important data regarding the link between DID and trauma, the proposed study will examine the relationship between short-term memory and DID with the hope of decreasing the chance that associations will be made by the participants when given the numbers.⁹ This will be done in the proposed study by presenting different computer-generated randomized numbers given to both personality #1 and personality #2 of the same individual. Previous studies that used word and/or picture recall, with the exception of Huntjens et al.’s study (2007), failed to address the associations that may have occurred among their participants.⁹ However, in Huntjens et al.’s (2007) study, three participants were found to have learned the material presented to them when they switched to the second personality.⁹ One participant reported to have knowledge of one word, another participant “reported knowledge of two words,” and the third claimed knowledge of the procedure but not the material presented.⁹ Whether or not there is a significant difference in an associated word/number or a neutral word/number, this study will attempt to avoid association by using just numbers instead of words or pictures in order to raise external validity. This decision is based on the assumption that there are fewer associations to numbers compared to those of words in human cognition. Further research should examine word, picture, and number associations and how they may affect DID participants in memory tests.

The highly cited study by Miller (1994) explains that short-term memory can retain about 7 +/- 2 objects.¹² However, a study by Logan (1988) concluded that consistent mapping (material that is learned is held constant [e.g., A + 2 = C]) leads to faster recall as opposed to inconsistent mapping (material that can vary [e.g., A + 2 = C, but also = D, P, Z]).¹³ This can be explained because the participants were using previous recall strategies to remember that A = 1, B = 2, etc. Indeed,

practice in a task that is consistent will lead to better performance. It is expected then, when individuals are given increasing numbers of objects to recall, they will retain increasing amounts of objects because they learn how to memorize more as they are repeatedly (and consistently) tested for their ability to recall the objects. As mentioned, previous studies used words and/or visual cues as the objects presented to test their participants on their memory. Implicit and explicit memories of the participants were subsequently measured through memory tasks, word pair, and word-stem completion tasks.^{3,9,10} However, the use of numbers has not been previously used in experiments for DID. It is crucial that all methods be used to test DID in order to understand better the basis of the disorder. By using numbers instead of words/pictures, evidence to support previous research findings can solidify the empirical characterization of DID.

Past studies have revealed significant findings by using different types of control groups. These studies consisted of “normal” groups (groups that are considered mentally stable) that were pre-examined to meet the criteria of their experiments.^{7,8,10} Huntjens et al. (2006) even included a guessor group (described as an amnesic group that was not given the stimulus material) and concluded that the DID participants scored significantly higher ($p = .01$) compared to the simulating group but not differing significantly with guessor group ($p = .10$).⁷ Considering this finding, further studies should include a guessor group to extend on Huntjens et al.’s (2006) study and to provide further evidence of priming.⁷ However, this proposed study will include DID participants between two groups and a simulating group to gather data.

Some of the criteria used in Eich et al.’s (1997), Huntjens et al.’s (2006, 2007), and Kong et al.’s (2008) studies for inclusion of DID patients that should be noted are: a diagnosis from a licensed clinician, the ability to switch from one identity to another without interference, and the other identities are amnesic of events that occurred for the present identity.^{3,7-9} By using these criteria, their studies ensured that DID participants were legitimate and capable of participating in the study. This screening process is crucial as Kong et al. (2008) found one potential DID interviewee

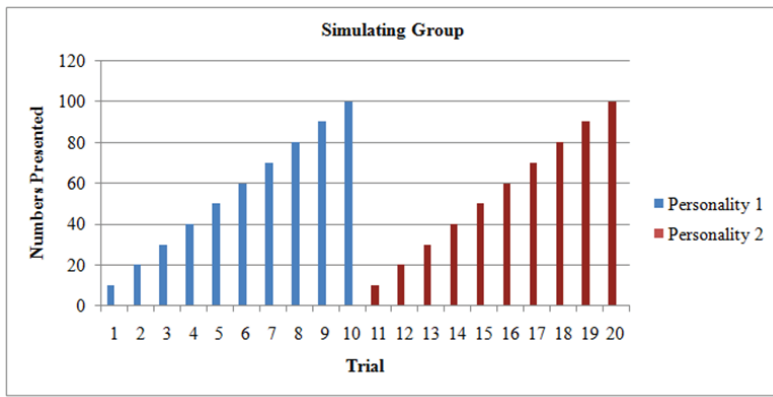


Figure 1. The simulating group will undergo the same procedure as the DID participant group.

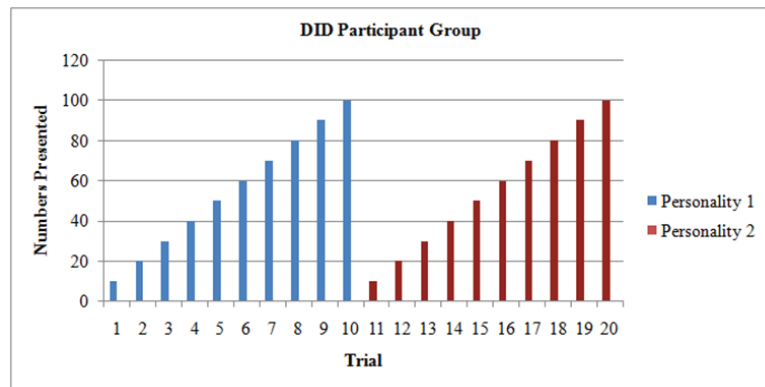


Figure 2. The DID participant group will use two personalities during the 20 trials.

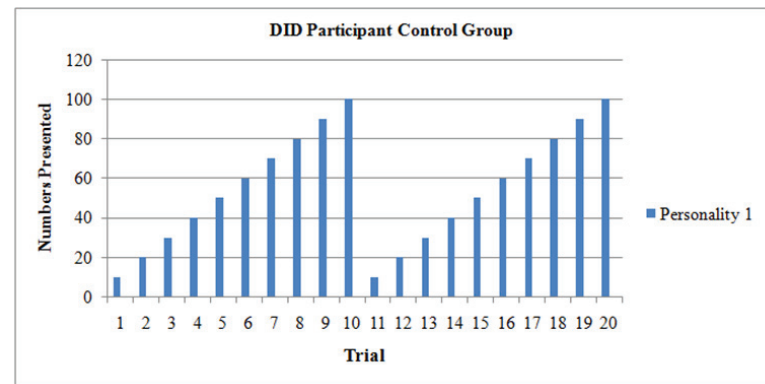


Figure 3. The DID participant control group will not switch personalities during the 20 trials.

that “did not meet the DID criteria.”⁸ For this proposed study, the non-DID participants will also undergo a similar examination of their history, mental health, and be tested on their ability to follow directions for the study to ensure internal validity.

Method:

Structure

By taking some of the procedures and methods used by Huntjens et al. (2006, 2007), we will use both a simulating group and DID participants to contribute to a more thorough understanding of DID.^{7,9} The criteria for DID legitimacy from Eich et al.’s (1997), Huntjens et al.’s (2006, 2007), and Kong et al.’s (2008)

studies will be reexamined and adopted for this proposed study.^{3,7-9} However, there will be several logistical differences in this proposed study. Using numbers as opposed to words is a key difference in this study. Ten trials, with the addition of ten new numbers for each trial, will be assessed for both personality #1 and personality #2 of the simulating and DID participant groups, accounting for 20 trials total (see Figure 1 & 2). After each trial, the participants will be given a recall test. This will continue until 10 trials are completed, and then the individual will be asked to change to personality #2. The DID participant control group will be assessed 20 trials for a single personality (see Figure 3). The in-

dependent variable will be whether or not the participant will have had previous exposure to the numbers. Through this method, it is hypothesized that personality #2 of the DID participant group will retain an increased amount of numbers when compared to personality #1, similar to the DID participant control group. This would imply that priming is active in DID patients that changed personalities (i.e. DID participant group) and provides evidence that personality #2 had prior knowledge of the tests (i.e. consistent mapping) instead of being completely amnesic and also doesn’t follow Miller’s Law of short-term memory of retaining 7 +/- 2 objects.^{12,13}

Participants

There will be three different groups associated with the study. The DID participant group will be carefully evaluated in order to meet the criteria for the study. A DID participant control group will be assessed and will be used to compare data to the DID participant group. A simulating group consisting of psychologically evaluated persons will also be included in the study. This group will mimic DID symptoms by creating two personalities to participate in the trials. All of these participants will be matched as close as possible by their age, education, gender, and socioeconomic status to their DID participant group or DID participant control group counterpart.

DID participants will be recruited via nationwide mailings, ads, and by contacting psychiatric and counseling centers until 50 individuals are screened and determined to be adequate for the study. We will seek DID participants throughout the United States because, compared to Europe, the United States has been found to have higher diagnosed rates of DID.¹⁴ Once these individuals are verified to participate in the study, they will be randomly assigned either to the DID participant group or to the DID participant control group. Licensed and accredited clinicians will screen the DID patients for legitimacy, psychological history, current mental health, and ability to participate in an experimental study with limited psychological repercussions. Additionally, the clinicians will screen for two conditions for the study. First and foremost, it is essential that the DID patients are able to switch between personalities while the other identities are not conscious of the events for the present identity. Second, the personalities must not interfere with the present identity during the trials. These two conditions are crucial in order to distinguish the personalities while the trials are in session.

Fifty mentally healthy individuals will be recruited from the United States for the sim-

ulating group. Individuals without previous knowledge of DID will be the most prevalent for this group. The simulating group will be similarly psychologically evaluated. The licensed and accredited clinicians will look at individuals' mental health and history. They will be matched to DID participants with similar age, education, gender, and socioeconomic status. The simulating group will be given information (i.e. description, history, and video of a person with DID) about DID and will be asked if they believe they are capable of mimicking the disorder. The 50 individuals are then matched with their DID participant counterparts and confirmed competent to mimic the symptoms through a psychometric test (short test of DID facts) created by our research team, and resulting data will be compared to the DID participant group.

Procedure

This proposed study will use a between-subjects single-factor randomized two-group design. The 50 DID participants will be randomly assigned either to the DID participant group (changes personalities) or to the DID participant control group (does not change personalities). They will go through 10 trials with a recall at the end of each trial for personality #1. This process will be repeated for personality #2. The DID participant control group will undergo 20 trials without changing personalities. The simulating group will also go through the same procedure as the DID participant group.

The 50 DID participants will be provided a summary of the study, excluding information on priming during personality #2 and Miller's Law of short-term memory. This is done to avoid the possibility that participants become conscious about their memory capabilities and alter their performance during the study. For the DID participant and simulating group, 10 trials and one recall trial will be given to personality #1 and will also be assessed to personality #2. Personality #1, as well as personality #2, will be exposed to 450 different randomized (i.e. consistent mapping) three-digit numbers generated by a computer over the ten trials. The first trial will consist of 10 three-digit randomized numbers. The second trial will consist of 20 different randomized three-digit numbers. The third trial will consist of 30 different randomized three-digit numbers and so on until 10 trials are completed (see Figures 1 & 2). The DID participant control group will continue until 20 trials are completed (see Figure 3). They will be given 10 minutes to study the numbers and then 5 minutes to recall as many numbers as they can. After the fifth,

tenth, and fifteenth trial, the participants will receive a 5 minute break to avoid fatigue. Following Miller's Law of short-term memory, it is expected that these participants will recall approximately 7 ± 2 numbers for the first trial and increasing amounts in subsequent trials (i.e. for the second trial, the personality will recall more than the first trial).¹¹

After personality #1 completes the first 10 trials, the participants (DID participant group and simulating group) will be asked to switch to personality #2 for the first trial that this identity will encounter. They will be given whatever amount of time they need to switch personalities and an additional 5 minute break. When personality #2 is ready, they will repeat the exact process that personality #1 was tested on. The numbers presented to personality #2 will be completely different from the 450 numbers presented to personality #1. This will be done to avoid any carry-over of possible learned numbers transferred between personalities and any associations previously made. If complete inter-identity amnesia actually occurs between the personalities of the individuals, personality #2 will begin the first trial with recalling only 7 ± 2 numbers instead of the increased amount of numbers as hypothesized in this study.

Previous exposure to numbers will be manipulated between participants, and it will be considered the independent variable of the study. The dependent variable will be the amount of numbers recalled for personality #1 and personality #2. If personality #2 of the DID participant group exhibits a superior short-term memory than does personality #1 in the first trial (i.e. first trial for personality #1, first trial for personality #2) and statistical significance is found to be true ($p \leq .05$) using an ANOVA test, it suggests that the DID participant group is no different than either the DID control group or the simulating group. Personality #2 of the simulating group and DID participant group is hypothesized to retain more than the numbers in the first trial to provide evidence of increased ability to recall numbers. The results of the simulating group will be compared to that of the DID participant group to see if there is any similarity.

After all of the data from the three groups are collected, the participants will be given a debriefing form; again, explaining the study, the purpose of the experiment, priming, and human memory. This study hopes to find results similar to those of previous studies, suggesting that complete inter-identity amnesia is a false phenomenon, and to provide supplementary evidence to the current DID literature.

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Gut microflora for prevention and management of chronic metabolic diseases

BY ANNA EBERHART

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The major chronic metabolic diseases of national and global importance include obesity, Type II Diabetes Mellitus, cardiovascular disease, and cancer. According to the Center for Disease Control (CDC) and data from the National Health and Examination Survey (NHANES), approximately 33.8% of U.S. adults are obese and 17% of children and adolescents ages of 2 years to 19 years are also obese.¹ Obesity arises as a consequence of how the body regulates energy intake (food intake), energy expenditure (exercise), and energy storage. This regulation of energy is known as “energy balance.” Excessive energy intake and low energy expenditure, for example, can lead to a disproportionate energy balance and results in becoming overweight or obese. In addition, the American Diabetes Association reported 1.9 million new cases of diabetes diagnosed in people 20 years and older in 2010.² In many cases, excessive eating and poor diet causes an excessive insulin release from the pancreas. Over-working the pancreas can result in β -cell exhaustion and decreased receptor function, leading to insulin resistance and thus, Type 2 Diabetes Mellitus. An emerging body of research is now directed toward the discovery of mechanisms and factors affecting the development of these metabolic diseases with growing global prevalence in children and adults.

Current research supports that nutrition, sedentary life-styles, environmental factors, and genetics are attributed to development of obesity, Type 2 Diabetes Mellitus, CVD, and cancer. Recent studies have been conducted to examine the role of gut microflora, consisting of microorganisms normally residing in the human gut, in the development of chronic inflammation that is a common process underlying these metabolic diseases. In one study performed at the Institute of Molecular Medicine in Toulouse, France, Cani et al. hypothesized that bacterial lipopolysaccharides (LPS), which are derived from gram-negative bacteria, may trigger inflammation. Cani et al. also found that a high-fat diet given to mice resulted in a significant increase of the dominant bacterial populations within the gut microflora. This response was associated with a considerable increase in plasma LPS, adipose tissue, body weight gain, liver hepatic triglyceride accumulation, inflammation, insulin resistance, and diabetes.³ In response to inflammation, the production of signaling

molecules, such as cytokines, amplify the inflammatory response. The Cani et al. study also evidenced that LPS is an effective stimulator of cytokines, which can also be key inducers of insulin resistance.³

Barbier de La Serre et al., at the University of California Davis, also determined that the development of intestinal epithelial inflammation was a result of a high-fat diet in rat studies. Their data also suggested that high-fat diets are a possible triggering mechanism in the appearance of hyperphagia, or chronic over-eating, and obesity.⁴ Another inflammatory response is metabolic endotoxemia, which is the presence of endotoxins in the blood from the breakdown of the LPS layer in gram negative bacteria. These endotoxins mediate low-grade systemic inflammation. Continuously consuming a high-fat diet will likely maintain elevated LPS plasma levels, which will result in a chronic systemic inflammation.

In another study at the University of North Carolina at Chapel Hill, Ding et al.’s study revealed that high-fat diets in mice induced two inflammatory biomarkers in the intestine, tumor necrosis factor (TNF- α) mRNA and nuclear factor kappa-light-necrosis factor (NF- κ B) activation.⁵ Macrophages can over-produce TNF- α in adipose tissue, and this may contribute to the development of insulin resistance, by limiting insulin receptor signaling. In addition, TNF- α activates inflammatory pathways such as NF- κ B, which are involved in the etiology of insulin resistance and Type 2 Diabetes Mellitus. Ding et al. also concluded that high fat diet induced inflammatory changes in the intestine occur prior to the development of weight gain and insulin resistance, and involve and enteric bacteria working together.⁵ The data from these studies suggest that high-fat diets induce intestinal inflammation and that biomarkers such as LPS levels, TNF- α mRNA, and NF- κ B activation merit further investigation as clinical indicators for assessment of obese or obese-prone patients.

Long-term changes in one’s life-style, including increased consumption of healthy foods and physical activity, are promising strategies for managing and possibly reversing or preventing obesity, Type 2 Diabetes Mellitus, CVD, and cancer. DiBaise et al. discusses that modulation and manipulation of

gut flora through the use of probiotics, prebiotics, and antibiotics, may be effective in reversing obesity.⁶ Prebiotics are valuable for increasing the growth of beneficial bacteria in the gut. In rats, Brugman et al.’s data revealed that antibiotic use decreased the incidence of diabetes in the diabetes-prone model. The onset of diabetes was also delayed in rats that displayed symptoms of the disease.⁷ Probiotics are live microorganisms that provide health benefits to the host when ingested. *Lactobacillus rhamnosus* is one of these probiotic bacteriums that produces linoleic acid. Lee et al. investigated this bacterium in diet-induced mice and found that the mice lost weight while managing their energy intake.⁸ These findings suggest that probiotics may play an important role during weight loss.

Obesity, Type II Diabetes Mellitus, CVD and some cancers share alterations in inflammation and overall metabolism. This relationship has motivated additional research examining gut microflora, specific diets, and the development of CVD and cancer. Ryan et al. determined that rice bran components when fermented with a yeast probiotic have enhanced bioactivity against cancer cells.⁹ Currently, the Bean/Bran Enriching Nutritional Eating for Intestinal Health Trial (BENEFIT) trial is being conducted as part of an academic-community partnership in Northern Colorado. The Colorado State University Animal Cancer Center has combined efforts with the Kendall Anderson Nutrition Center and Poudre Valley Health (PVH) Cancer Network to investigate how increased dietary consumption of cancer fighting foods modulate gut microflora. BENEFIT is a human clinical research study designed to examine the disease prevention properties of dry beans (e.g. navy, black, pinto) and rice bran (polished from brown rice) for cancer control and maintenance. Dr. Elizabeth Ryan and her research team are assessing changes in the gut microflora and metabolome using high throughput research tools.¹⁰ They hypothesize that these foods have multiple mechanisms for inhibiting tumor development and advocate that more human research is needed to support the evidence from animal studies with rice bran and beans. Beans and whole grain rice contain a number of substrates for microflora.¹⁰ The data generated from the highly collaborative BENEFIT study has strong potential to provide valu-

able information for developing public health strategies to prevent and manage cancer in diverse populations.

Continued research on modulation of the gut microflora by environmental factors such as diet and physical activity, and thus its role in the development of obesity, Type 2 Diabetes Mellitus, CVD, and cancer may prove to be beneficial for reducing the prevalence of chronic metabolic diseases affecting much of the population.

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Fiber optic cables for laser ignition applications

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Abstract

To fundamentally improve the combustion process for lean-burn natural gas compression engines, alternative ignition sources are considered. By use of a high power laser and fiber optic cables, a system is realized for the spatially complex high energy pulse transfer necessary for plasma spark formation inside the engine's combustion chamber. Given the multitude of styles of fiber optic cables available on today's market, considerations must be made to apply only the most suitable fibers capable of meeting this application's strict requirements. The following is an overview of the theory behind laser ignition and a review of the different styles of fiber optic cables considered for field application.

Introduction

Laser ignition is an ongoing area of research at Colorado State University aimed toward increasing the combustion efficiency and reducing the exhaust emissions of stationary natural gas internal combustion (IC)

engines. The scope of this project aims to completely reengineer the ignition system of an IC engine by implementing the use of laser power to induce combustion instead of an electric arc from a spark plug.¹ Similar to how a potential difference in an electrical system will increase with poor terminal connection, the quality and loss of laser transmission is highly dependent upon the pathway and medium transitions the beam encounters within the optical circuit. High quality transmission for IC engine applications requires an extremely precise optical circuit to be resistant from environmental influences such as inconsistent vibration and heat. A solution to overcome these concerns is to incorporate a fiber optic cable where the optical alignment of an open beam is most likely to be compromised. The following is an overview of laser ignition theory and a review of the fiber optic cables considered for high intensity pulsed laser transmission.

Ignition is achieved within the combustion chamber by means of a high intensity

pulsed laser being directed toward an optical distributor (rotating set of mirrors) known as a multiplexer. The multiplexer sequentially distributes the laser pulses to a desired fiber optic cable dependent upon firing order and crankshaft speed. The pulse is then transmitted down the length of the fiber toward its respective cylinder. Analysis and testing of fiber optic cables for laser pulse delivery has shown that high intensity pulses and low output beam divergence are required for spark formation. Each fiber is connected to an optical spark plug which uses a plano-convex lens to tightly focus the laser pulse to a desired location within the combustion cylinder of the engine. A specific location in the cylinder that the pulse is to be focused can be controlled via the focal length of the lens. This allows for a more complete and uniform burn to occur leading to higher fuel efficiency and a greater power output.¹ The range of focal lengths that can be applied to this system is fundamentally bounded by the power and beam quality considerations imposed by the

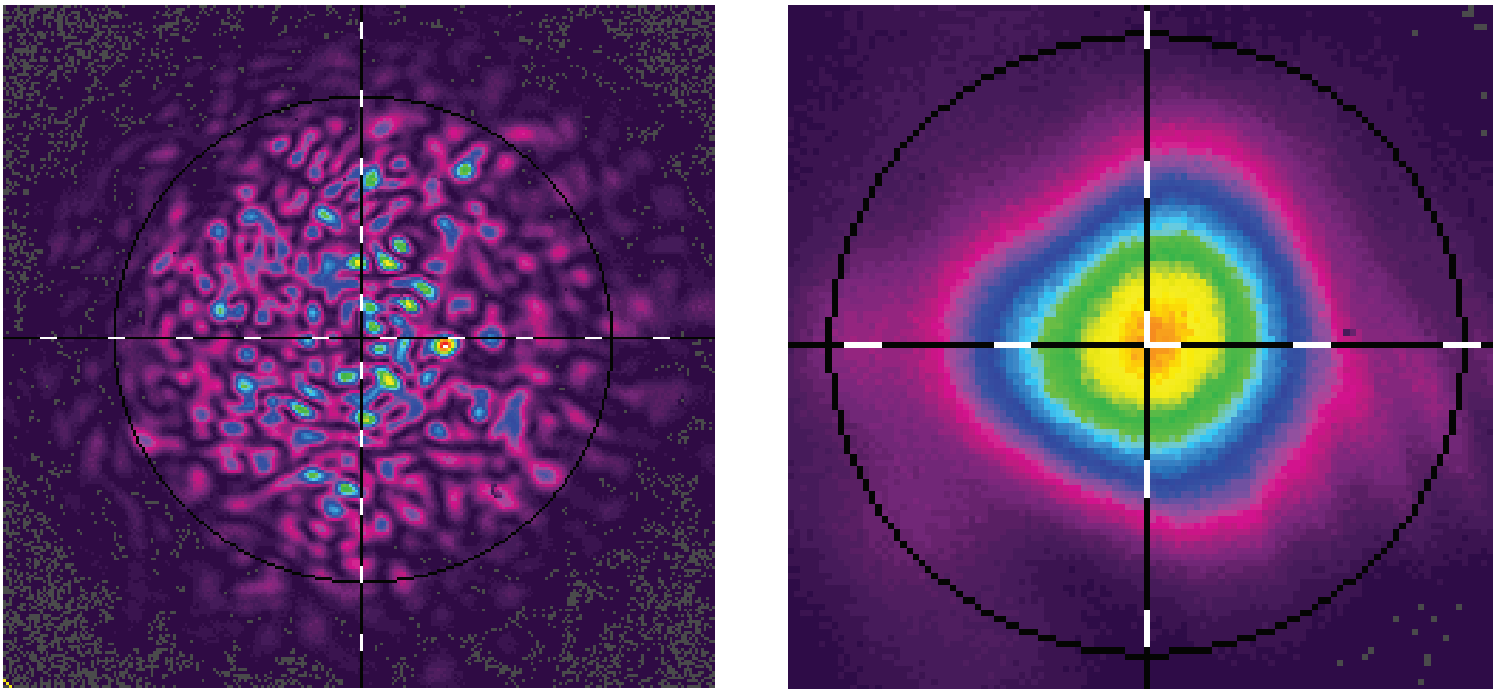


Figure 1. Output beam intensity profile due to mode coupling from externally induced stress (left), and desired beam quality output (right).

fiber. A longer focal length results in a larger spot size at the focal point of the lens requiring a greater laser power to initiate plasma formation.

Tightly focusing a high power laser pulse causes a high optical intensity at the focal point of the lens. If this local intensity is greater than the breakdown voltage of a given medium, multi-photon ionization will occur and release electrons onto the medium.² These new free electrons are accelerated by the electric field and collide with other atoms of the given medium. This further ionizes the atoms leading to an avalanche of electron release, referred to in this article as a plasma spark. At standard atmospheric pressure and temperature, the breakdown intensity of air for plasma formation is $\sim 100\text{-}200\text{ GW/cm}^2$.¹ A plasma spark is desirable in compression applications due to the decrease of a medium's breakdown intensity with increasing pressure.¹ This behavior will allow for the engine to be run at a higher compression ratio and a leaner air fuel mixture, effectively reducing the concentration of NO_x emission in the exhaust.

The amount of induced stress residing in the core and cladding of the fiber optic cable has been found to have a significant impact on the laser beam's intensity profile at the fiber's output. The quality of a beam is quantified by its M^2 value, dependent upon wavelength. It is a ratio of the actual beam parameters over the ideal Gaussian beam (TEM00) where the best possible beam quality has $M^2=1$.³ A fiber in a relaxed state where external influence is minimized provides a more desirable M^2 value than a fiber influenced by a force (bending, surface load, etc.). An exception to this is a uniformly distributed bend or coil which will cause a reduction in transmission efficiency but will also cause the fiber to lose its higher order modes resulting in higher beam quality. Figure 1 shows the difference in output beam quality of a fiber induced with external stress compared to the desired output profile. The most stress occurring in a fiber oriented in a relaxed state is found to be localized in the connector. The connectorization of large core fibers for high intensity pulse transmission requires the proper epoxy selection and curing time to minimize these stresses allowing for less attenuation. An epoxy with a high thermal conductivity along with a 0% curing volumetric expansion rate is desired to minimize the induced mechanical and thermal stress transmitted to the fiber's core and cladding from the epoxy. Increasing the core and cladding stress in a fiber causes mode coupling to occur and will lead to local intensity peaks. If the intensity peak is greater than the

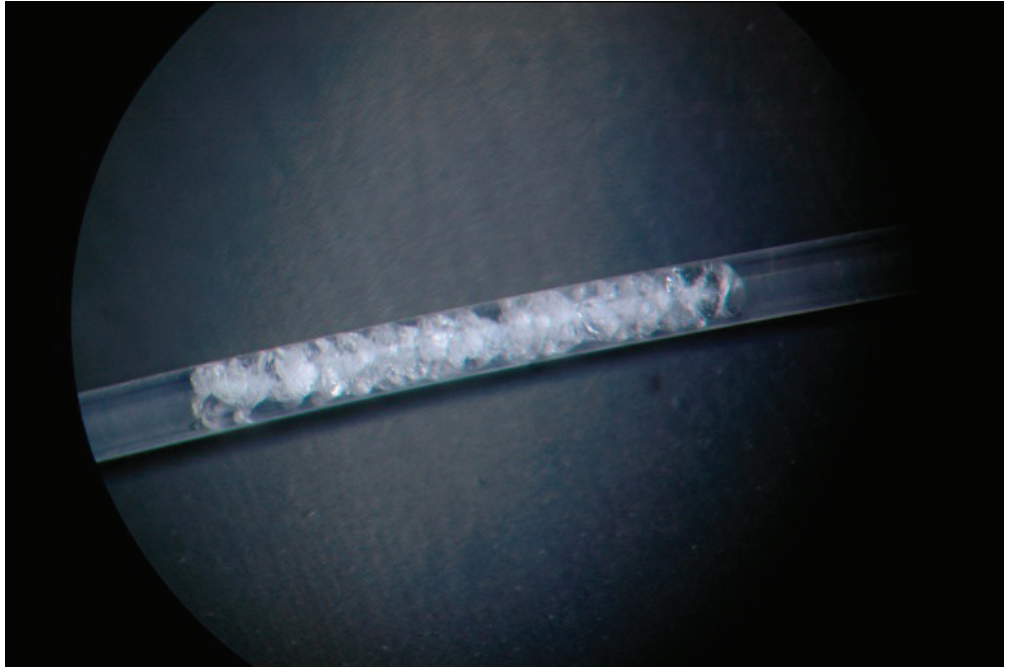


Figure 2. Solid core step index fiber with exceeded damage threshold of $\sim 1\text{-}5\text{ GW/cm}^2$.⁵

damage threshold of the silica core, the fiber will suffer damage and be rendered useless.⁴

Preparation of the input and output ends of the fiber cable are very critical to obtain the best possible pulsed transmission. A uniformly spatial beam distribution across the fiber face is strongly desired and is obtained by having a perfectly flat surface polish. The polishing process is a laborious procedure which must be conducted with the utmost cleanliness and care to ensure the final quality of the fiber's face. A poor surface finish will lead to unwanted light scattering, Fresnel back reflection, a high M^2 value and may cause damage to the fiber via mode coupling and local intensity peaks.⁴ The fiber shown in Figure 2 has reached its damage threshold due to undesired mode coupling near the fiber's input face. It is this silica to air medium transition that is most critical for high energy and high beam quality transmission.

In order for laser ignition to be applied to an IC engine, a means of transmitting a high energy laser pulse is required to be impervious to harsh engine conditions. Several styles of fiber optic cables are considered to accommodate the task of megawatt pulse transmission necessary for plasma spark formation. Fiber cables are attractive due to their flexibility, which is needed for routing from a remotely located laser and multiplexer to a designated engine cylinder. A durable exterior jacket on the fiber is also desired to ab-

sorb vibrations induced from the engine and to protect the core-cladding interface. The implementation of a fiber optic cable will provide the optical alignment necessary for the ignition system to function properly in field applications.

Fiber optic cable review

There are several styles of fiber optic cable which vary geometrically and in material composition to compliment a specific application. Only a select few have the necessary features to accommodate the requirements for laser ignition. These fibers must be able to transfer megawatt power laser pulses of adequate beam quality to allow for the breakdown threshold of gas to be reached at the fiber's focused output. For gases such as methane, the breakdown intensity of a reasonable air fuel mixture is $\sim 100\text{-}200\text{ GW/cm}^2$ which presents an optically challenging situation for pulsed laser delivery.^{1,6,7} Breakdown has been achieved with energies as low as 4 mJ at 10 ns pulse durations, however ignition of most air/fuel mixtures is achieved with pulse energies of $\sim 15\text{ mJ}$.^{5,8} The following discusses the styles of fibers that are considered for laser ignition applications.

Hollow core

An attractive means of high power pulse transmission is by use of a hollow core fiber. The hollow core fiber is composed of an inflexible hollow quartz tube with a polymer

coating and is typically covered with a highly reflective material such as silver or nickel.³ This reflective material is the limiting feature for high intensity pulse transmission and has a relatively high damage threshold. Energies as high as ~35 mJ for ns pulse durations have been transmitted through the fiber's atmospheric medium producing an exit intensity of 2 GW/cm², proving them to be a viable candidate for spark production.⁷

For field applications, hollow core fibers are limited by their bending performance and fragility. A typical stationary natural gas engine can operate at frequencies anywhere from 300 to 500 rpm. Since the output of the fiber must be coupled to the cylinder head, the fiber will experience the frequency and amplitude at which the engine is operating. The brittle nature of these fibers makes them less than ideal for operating in parallel with the harsh conditions of an engine. As a hollow core fiber is bent, beam transmission dramatically decreases and exit beam divergence (M²) value increases. Therefore, bending loss is a large limiting factor for hollow core fibers applied toward laser ignition and are not ideal for field use.

Photonic crystal fibers

Another fiber type considered for laser ignition is a photonic crystal fiber which typically has a hexagonal core pattern in structure. The patterned structure of the photonic crystal fiber is designed to modify the refractive index of the cladding. This is done to maintain a consistent relationship between the core and cladding, effectively allowing the fiber to operate in single mode transmission.⁷ There are two main types of photonic crystal fibers that have the potential for spark delivery: hollow core photonic bandgap (PBG) fibers and solid core photonic crystal fibers (PCF). Since the output beam of a PCF is approximately single mode, the fiber can therefore deliver high intensity pulses. Single mode output allows for plasma generation to be achieved with ease. The structure of the PCF allows for bending and vibrational loss to be kept to a minimum which is ideal for field applications. Large mode area (40-80 μm) PCFs have been shown to be capable of delivering 1064nm, ns pulses with 0.55 mJ at the output and to have a higher damage threshold of ~3X than that of a PBG.^{5,7} Due to the large energies required to create a plasma spark, PCFs are more desirable for plasma generation than PBGs.

Although the PCF operates in single mode and has low loss due to bending and vibrational influence, the amount of power that can be transmitted is comparatively limited. PCFs have been proven capable of creating

plasma sparks in air but only at elevated pressures with low pulse energies of <~1mJ.⁷ This is an insufficient amount of energy for the ignition of lean air/fuel mixtures and, therefore, use of these fibers is challenging for laser ignition applications.

Fiber laser

The output of a fiber laser is fundamentally fiber delivered and provides a means of integrating the desirable fiber delivery medium with a laser source. A fiber laser has a doped fiber as a gain medium and resonator and is a comparatively compact option. Recent developments in fiber laser technology have expanded to an increased core diameter, and due to the inherent integration of the source with the medium, have led to a relatively high beam quality output. It is this combination of large core area and high beam quality which makes fiber lasers highly beneficial for spark generation. Laser breakdown in air has been successfully accomplished using 0.7 ns duration with 2.4 mJ pulse energies.⁷ This is an insufficient amount of energy to effectively ignite a lean air/fuel mixture, and further fiber laser improvements are required to better fit the application. Fiber lasers are a rapidly growing area of interest and have the potential to become an ideal component in laser ignition research.

Single mode solid core fibers

The applicable solid core fibers for laser ignition intentions come in several styles and constructions. A solid core fiber optic cable is only capable of supporting a discrete set of modes which is a strict function of the transmission wavelength, refractive index profile and geometry of the fiber. Modes which are not supported by the fiber will either leak out of the fiber resulting in an increase in overall transmission loss or be canceled out due to interference effects.³ Regardless of the wavelength at which a pulse is to be transmitted, there is a certain amount of radiation that will not be totally internally reflected and will leak out of the core and into the cladding. This produces an isolated radiation mode which may cause loss to the signal at the fiber output. How the radiation modes affect the output is a function of the cladding size. A properly sized core/cladding ratio will allow for maximizing the transmission peaks in the spectra of fiber modes allowing for ultimate transmission to be achieved. Alteration of the fiber's structure also allows for the modification of the transverse distribution of radiation intensity within the fiber's core. This allows for waveguide transmission to occur for the fundamental mode of the fiber.⁵

Perhaps the most common types of solid

core fibers are single mode fibers with core diameters of ~8 μm. These fibers are most widely used for telecommunication applications and are designed to transmit low energy signals over long distances. Although the single mode output is ideal for plasma generation, these fibers are limited by the amount of energy they can transmit without reaching their damage threshold. The small cross sectional core size is the limiting feature in a single mode fiber since the fiber's damage threshold is quickly reached at high input powers.

Multimode gradient index solid core fibers

A more useful fiber for high intensity transmission is a solid core fiber with a graded core index. The graded core has the highest refraction index at the center of the core and decreases radially as the core approaches the cladding interface with a parabolic distribution. The gradient of the index change has a profound impact on not only the power distribution throughout the fiber but also on the overall optical loss and the velocity at which various modes propagate as well. The effect of this graded index is that each mode is gradually refracted as the beam traverses the fiber. It is this property that ensures only the highest order modes reach the core cladding interface. The graded core allows for a better output beam quality and a peak intensity at the focal point of about five times that of a step index fiber of similar core size.³ This makes the graded core fiber a highly viable candidate for high intensity pulsed transmission. The steep intensity peak is ideal for cutting and drilling applications but may be harmful to sensitive optical setups and equipment. Although a graded core fiber can allow for higher peak intensity to be achieved at the focal point compared to that of a step index fiber, the peak power that may be transmitted through a graded index is less than the peak power that may be transmitted through that of a step index due to tighter focusing that occurs within the fiber's core.

Also to be considered is the alteration of radial index profile as a bend in the fiber is introduced. A bend causes stress to be induced on the fiber's core, leading to an effective non-symmetric radial index profile. The latter has been shown in uniform index fibers as well. The index change is more significant in a graded core fiber, and when influenced by stress will result in a skewed parabolic index contour and rather unpredictable mode coupling.

Multimode step index solid core fibers

Step index fibers are perhaps the most ideal fibers for high intensity pulse transmission.

Their construction is of a constant refractive index across the core of the fiber followed by an abrupt index increase at the cladding interface. A coating and jacket layer surround the cladding to make the fiber more resistant to external influence such as stress, bending and heat. The core/cladding ratio is available in several different configurations dependent upon wavelength and application and can be fabricated to nearly any size desired (~50-1000 μm core). Under ideal fiber operation, total internal reflection will occur at the core/cladding interface for all of the modes the fiber supports. The consistency of the core's refractive index results in a more uniform intensity profile at the step index fiber's output. It is this quality which makes step index fibers attractive for laser ignition applications.

Recent advances in the research of step index fibers (core/clad=400/720) have shown that the transmission of 3mJ at 10 ns pulse durations using 1064nm light is capable of producing 100% plasma spark generation in air at atmospheric pressure.⁸ Although this energy is below the minimum energy required for ignition of applicable gases, much higher transmission energies can be achieved at longer laser pulse durations. This presently makes the solid core step index fiber optic cable the most applicable style of fiber for laser ignition applications.

Conclusions

Prior to the full implementation of a laser based ignition system, more testing is required to understand fully how a fiber optic cable will behave in a harsh engine environment for high power transmission. The transition between air and the fiber's silica core is the most critical aspect of pulse transmission through a fiber and is a significant limiting factor for laser ignition applications. Future experimentation will be focused on minimizing the back reflection and local intensity peaks by selective fusion splicing and investigating the use of index matching fluid for high power applications. The effects of beam quality output from externally induced vibrations are to be considered as well. Proven to be the most applicable candidate for laser ignition, these tests are to be performed primarily on multimode step index solid core fibers. A better understanding of how these fibers respond under specific design conditions is a major stepping stone to practical application. This study and implementation of a laser ignition system is constantly progressing and is sure to be a revolutionary aspect in the future development of internal combustion engines.

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See you soon, grasshoppers

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The falling leaves would show a countdown to another amazing winter. The cold mornings would capture frozen grasshoppers on the sidewalks as they tried to warm themselves. A compassion for grasshoppers and tress that soon undergo a harsh winter, which can sometimes be referred to as lifeless, enriches the human senses of how precious life forms can be. Sustaining itself with rotation by the sun, the earth repeats its cycle of life. It springs inspired artists such as mathematicians, scientists, writers or simply painters to learn from the white winter as a blank sheet of paper, evolving ideas that depict nature's process of beauty.

Los chicos de la calle

TOMÁS VASCONCELO VILLALOBOS
LA UNIVERSIDAD DE VALPARAÍSO



El descontento social ha llevado a varios sectores sociales a hacerse parte de las movilizaciones estudiantiles, en su diversidad niños que siempre han visto vulnerados sus derechos salen a las calles a demostrar su descontento con la sociedad, quizás de la única forma que han aprendido, la violencia.

The boys of the street

TOMÁS VASCONCELO VILLALOBOS
LA UNIVERSIDAD DE VALPARAÍSO



The recent social unrest has led distinct social classes to take part in the student demonstrations. In all their diversity, children who have continuously had their rights violated take to the streets to protest their discontent with society, possibly in the only way that they have learned, violently.

Girl on a bed

NICOLE GREBB
COLORADO STATE UNIVERSITY



I drew this from a photograph that I took of a friend while in New York City for the summer. I used colored pencil on 14 x 17" bristol paper.

Girl in black dress

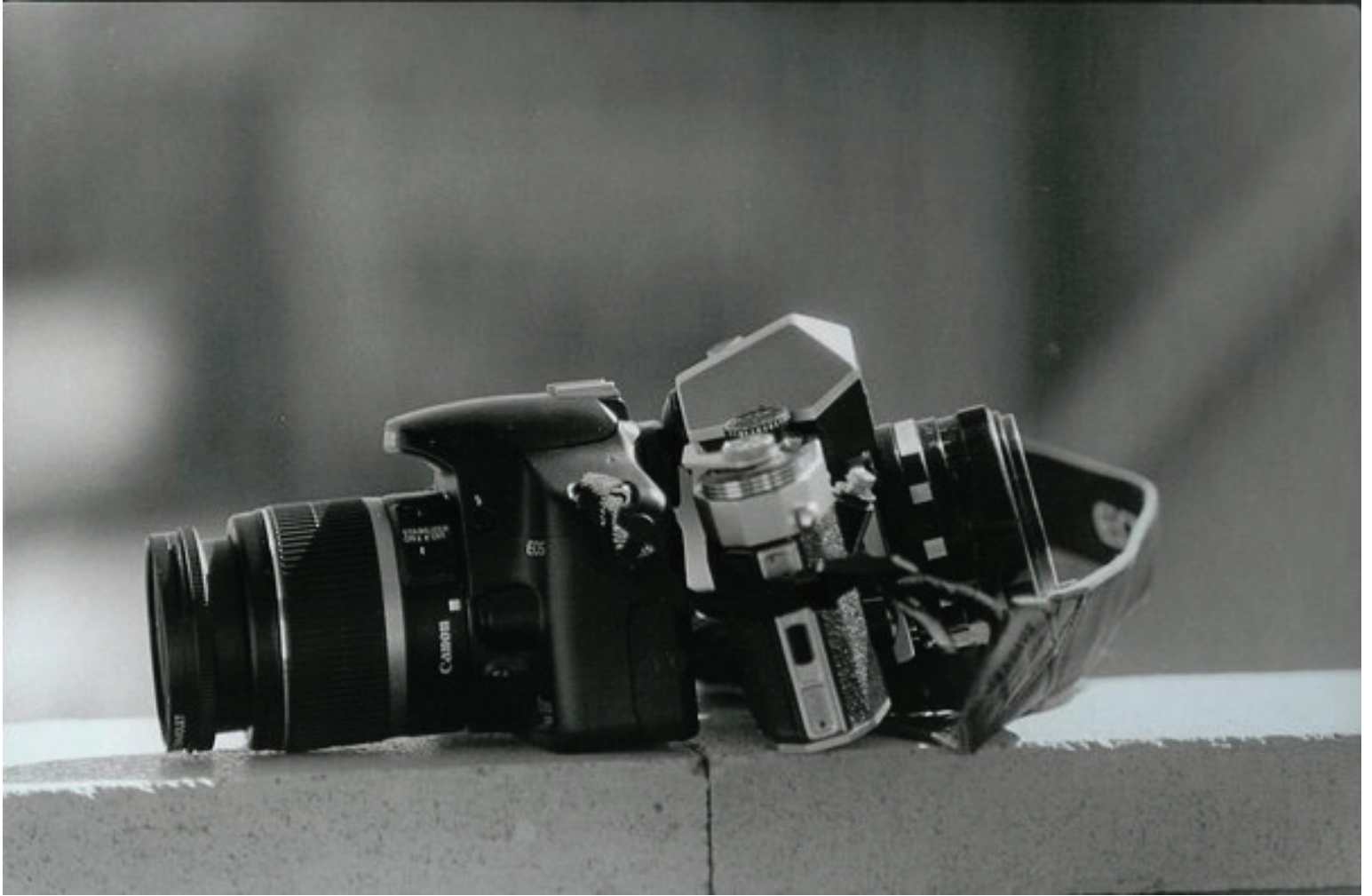
NICOLE GREBB
COLORADO STATE UNIVERSITY



This is a realistic fashion illustration that I created, using my own observations and creativity. 18 x 24" Colored Pencil Finished in November 2011

Shift in times

BY CIARA HINDMAN
COLORADO STATE UNIVERSITY



I took this photograph in an effort to represent the contrast between traditional and digital photography. The photo was taken with a 1960's 35mm camera, and I processed and developed the film on my own. Not only did I want to show the contrast between the two cameras, but also show how crisp traditional photography can be.

¡Y va a caer, va a caer la educación de Pinochet!

BY TYANNA SLOBE

COLORADO STATE UNIVERSITY

Boys as young as thirteen were covering their faces with scarves to protect themselves from tear gas and to hide their identities. People were all over the sidewalks smashing stones against bricks in preparation for the war between students and police. They were lighting tires smothered in gas on fire all over the streets and setting up barricades to get the paco's attention. There were old men on the side of the road selling lemons, because sucking on lemons is about the only thing that you can do to help with tear gas. About twenty minutes passed before the police finally came over to attempt to put out the fires and break up the crowd - and that's when all hell broke loose.

El Guanaco came speeding in from around the corner, spraying some sort of acid-water mixture at anyone and everyone. While many people, myself included, went running in the opposite direction others went forward pelting whatever they could at the police - rocks, lemons, bombs. For a twenty-year-old English major from a suburb of the Twin Cities, homemade bombs falling from the sky were a definite first. We ran to the end of the block and tried to get out of the area, but around the corner was a barricade of fiery tires blocking the street. I held on to my friend Pato's arm for dear life as we contemplated other ways out and looked for the rest of the group. Suddenly a tear gas shell landed a few feet away from us and we ran back, coughing and crying.

We only had to run another block or so before we were out of the immediate dangers of flying rocks and Guanaco water, and were able to turn and watch the combat. Water bottle bombs were flung in all directions and the sounds were incredible. Chanting. Booming. Screaming. Sirens. Gun shots? We were too far away to see exactly

what was happening so I asked Pato if that's what we were hearing. "No, son bombas no más." Only bombs—as if that would make me feel better. In fact, the noises I heard were guns; the police were shooting rubber bullets at rioters. One of my compañeros had gone forward to take more pictures of the action and was shot in the arm by a stray rubber bullet. We stayed back to absorb the madness of fires and flying objects for when the Guanaco and the fighting crowd took a turn for our direction. While the tear gas initiated it, I was now crying because I was so scared, and I asked Pato and Alfonso to take me home.

When I came to Chile this semester I expected to be taking classes with Chilean professors and making all sorts of amigos hispanohablantes. Tomorrow though when I go to class at La Universidad Católica de Chile the person sitting next to me will almost definitely be from California, not Chile. I will have to dance my way through a marching band of protesting students and then climb over a mountain of chairs barricading the entrance to my classroom. If the professor comes he will likely end up cancelling class when students storm into the room banging on pots and pans and chanting. High schools and university students all across Chile are on strike.

Access to free education was available to every student in Chile from the 1800s until 1973 when Augusto Pinochet came into power through a military coup. Free education is not the only thing that Chileans lost during the seventeen year dictatorship. After the coup, thousands of leftists were taken from their homes and put into concentration camps where they were tortured and often disappeared. The military government was able to maintain its conservative pow-



"Resistance"
"Resistencia"
Photograph by Tomás
Vasconcelo Villalobos



Above: "National movement"
"Movilización nacional"
Photograph by Tomás Vasconcelo Villalobos

Left: "Family movement for education"
"Movilización familiar por la educación"
Photograph by Tomás Vasconcelo Villalobos



er until 1990 through the constant threat of torture and death that faced anyone who spoke out. During Pinochet's capitalist rule the rich became richer and the poor became poorer. Rich kids went to good private schools, poor kids went and still go to terrible public schools. Pinochet denationalized Chilean mines and sold them to private investors, taking even more money away from the Chilean people. When the dictatorship ended people expected that the government would give the people back many of the things that they had lost during the time of Pinochet - free and quality education included. However, twenty-one years have passed and while many things have changed, too many have stayed the same.

Chile's education system today is undeniably suffering. Anyone who can afford it sends their children to fancy private schools where they are taught by the best teachers and prepared for the best colleges. Universities base their admission and scholarships on a single test called the Prueba de Selección Universitaria. Expensive private schools spend years preparing their students for the test. Public schools cannot afford the same quality of education, so most students have no hope of even scoring high enough to get into the best universities, let alone get scholarships.

For the past three months students across the country have been going to extreme lengths to protest the injustice that is education in

Chile. Various high schools and universities are either *en paro* or *en toma*. To be *en paro* means that students are striking and not going to classes. A *toma* is when students literally take over their school; nobody but students are allowed in, professors and administration included. Students live inside of the buildings and plot ways to help support the movement. Every week students come to an assembly at the school and vote on whether or not they are going to continue with the strike or resume classes. Some schools have been either in strike or *en toma* for as long as three months. Additionally, every day there is some sort of event relating to the movements - concerts, marches, flash mobs, staged pillow fights, etc.

Sounds fun, right? With all of the excitement of positive parts of the protests it's easy for an outsider to forget the reality of the situation. Many students have already lost a semester and some are approaching the entire year. They are sacrificing their own privileged access to quality education for the sake of everyone else's: they have already paid for the semester's worth of education that they are not receiving! Several students have even gone as far as going on hunger strikes and have not eaten in months. Chillingly, President Sebastian Piñera is still unwilling to come to an agreement with the masses.

While on one hand what the students are asking for seems a little extreme—free and quality education (universities included)—on the other hand it seems completely reasonable. Chilean universities are the second most expensive in the world after the United States, while average income in Chile is but a fraction of that in the US. Rather

than being a radical new idea, Chileans had access to equal education, which was partially funded by the nationalized mines. It is easy to understand people's anger and the violent protests against the government when you take into consideration the recent history of Chile and what was taken away from the people during the dictatorship. For years the same people that are protesting today were suppressed under Pinochet. Tens of thousands of Chileans were murdered, disappeared, tortured, or exiled. People are not just provoking and attacking police officers for the fun of it, they are lashing out against the injustice that has been served to them for decades. They are attacking a government that tormented and terrorized them. El pueblo wants its social rights back and they are willing to go to great lengths to restore them - hunger strikes and violence if necessary.

This may seem like the semester abroad from hell - no classes, no Chilean peers, tear gas on the metro, bombs. But truthfully I could not have asked for a better experience. Rather than sitting in my classroom learning about Latin American social movements, I am living one. Seeing the selflessness of students who are taking to the streets is exciting and inspiring. Por eso, you can find me in the streets with my would-be classmates chanting, "¡Y VA A CAER, VA A CAER LA EDUCACIÓN DE PINOCHET!"



"Pasacalle por la educación gratuita"
 "Pasacalle for a free education"
 Photograph by Tomás Vasconcelo Villalobos

Antecedentes y desafíos de la educación chilena

BY ALFONSO SAMUEL TAPIA BRIZUELA
LA PONTIFICIA UNIVERSIDAD CATÓLICA DE VALPARAÍSO

El escenario actual de las movilizaciones nos lleva a cuestionar, como sociedad y como país, la forma en que se lleva a cabo la formación de los estudiantes bajo el actual modelo económico – social.

En síntesis, ha sido demostrado, desde los estudiantes movilizadados hasta los intelectuales y profesionales que participan del movimiento, que la educación es concebida no como un modelo de desarrollo personal y colectivo, sino que como un bien de consumo, tal como lo señaló el Presidente de Chile, Sebastián Piñera. En efecto, nuestro futuro es manejado por empresas que, amparándose en la libertad económica imperante y en la ausencia de una legislación eficiente, ofrecen sus servicios al precio que ellos quieran, llegando al punto de establecer los aranceles más caros del mundo, sólo superados por Estados Unidos; cualquier análisis concluiría que los ingresos per cápita del país norteamericano no pueden ser comparados bajo ningún parámetro con el poder adquisitivo de los chilenos, quienes se ven forzados a solicitar créditos bancarios que llevan al endeudamiento a millones de universitarios. Entonces, es posible inferir que la educación en Chile es concebida como un proceso en el que desde la infancia se forman consumidores, quienes al egresar de la universidad deben integrarse, casi de manera automática, al mercado.

Esta visión de la educación como bien de consumo contrasta con lo que fue la manera en que se entendía la educación antes del golpe militar y la dictadura de 1973. En efecto, la razón por la que el Estado aseguraba educación gratuita en todos los niveles, era la siguiente: se formaba a un ciudadano integral en la enseñanza básica y media, que luego recibiría una formación valórica e intelectual en la Universidad, y no debía pagar por ello, por el sólo hecho de ser miembro de la

sociedad que constituye al Estado. Luego, una vez egresado, el ciudadano, mediante los conocimientos adquiridos en la Universidad, debía aportar para mejorar la sociedad en el área que se había especializado, estableciendo de esta manera una retribución a la sociedad (y, en último término, al Estado) que le había dado la oportunidad de estudiar en la educación superior.

Como se ha demostrado este año, las nuevas generaciones, aquellas que nacieron y crecieron en democracia, han querido rescatar esta concepción de la educación, ya que no se sienten parte de un mercado abusivo y descontrolado, sino que recuperan aquel sentimiento de pertenencia a una verdadera sociedad, alejada del individualismo propio del neoliberalismo.

Entonces, el “despertar” propiciado por los jóvenes impone a la sociedad su mayor desafío desde la vuelta a la democracia, que no es otro que, paradójicamente, volver a ser una sociedad, dejar atrás el “milagro del modelo chileno” de los Chicago Boys. Precisamente la manera más efectiva de volver a ser ciudadanos como tal es a través de la educación, donde se enseñe de manera efectiva los pilares y valores democráticos sobre los cuales debe cimentarse la sociedad chilena. Atendiendo a la realidad del país, que presenta uno de los niveles de desigualdad más altos del mundo, según la OCDE, es necesario que el Estado vuelva a entregar educación gratuita, ya que el desarrollo intelectual de las personas durante la Universidad ayuda a corregir los niveles de desigualdad. Es menester también señalar que la enseñanza superior no sólo debe ser la instancia donde se entregue conocimiento en bruto, sino que debe ser la oportunidad donde los jóvenes conozcan a cabalidad todas las realidades sociales, a fin de producir un intercambio cultural que lo enriquezca como ser humano, algo que hoy es imposible en el sistema chileno de hoy, que posee niveles de segregación socio.

La transición desde la dictadura aún no ha terminado, y la democracia real sólo será efectiva una vez que a todos los ciudadanos se les asegure la protección de todos sus derechos; no sólo la educación, sino que también otros que en el futuro se vislumbran serán el centro del debate en las conversaciones cotidianas de los chilenos (como lo es hoy la educación), que podría ser el caso de la salud pública y la previsión social.

Salvador Allende, antes de su muerte, dijo que “se volverán a abrir las grandes alamedas (refiriéndose a la “Alameda” que es la calle principal de Santiago) por donde pasará el Hombre Libre.” Su histórica frase se hace realidad este año, ya que los jóvenes que no vivieron la dictadura han marchado por las calles con mucho color y creatividad para demostrar que quieren la alegría que no llegó cuando volvió la “democracia;” y no sólo en Santiago, sino que en casi todas las ciudades de Chile. Por ejemplo, en Valparaíso, uno de los puertos más importantes del país, marchamos por sus calles, y uno de los lienzos decía: “vivimos en democracia con leyes de dictadura.” Sólo depende de la juventud que desea la verdadera libertad que dicha frase se acabe.



“Piñera get out”
“Piñera entiende ándate”
Photograph by Tyanna Slobe

History and challenges for Chilean education

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The current situation of the student movements leads us to question as a society and as a country, the way in which education is conducted under the current social-economic model.

It has been shown - from the students themselves protesting to the intellectuals and professionals who also participate in the movements - that education is currently conceived not as a model of personal and collective development but rather as a commodity. This view of education is the one that Chile's president Sebastián Piñera supports. Our future is driven by companies who rely on prevailing economic freedom and the absence of effective legislation to offer their services at whatever price they want, to the point that they have established the highest tuition in the world, surpassed only by the United States. Any analysis would conclude that the average North American income could not be compared by any means to the purchasing power of Chileans, who are then forced to borrow millions to finance their university education. That is, education in Chile is a process that creates consumers that will have to join the market almost automatically.

This view of education as a consumer good is the opposite of how it was understood before the military coup and dictatorship in 1973. In effect, the reason that the previous State ensured free education at all levels was as follows: a citizen was formed through vital primary and secondary schooling, and later would receive a valuable and intellectual education in a university; all of which he should not pay for, but receive merely because he is a member of the society that constitutes the State. Then, once graduated, with the knowledge acquired from the university the citizen should contribute to improving society in the area in which he specialized; thus giving back to society (and ultimately the State) for giving him the opportunity to study higher education.

As demonstrated this year, the younger generation, those born and raised in democracy, want to reinstate this concept of education as they do not feel part of the abusive and uncontrolled market, but instead want to recover the sense of belonging to an honest society away from the individualism of Neoliberalism.

Thus, the "awakening" fostered by Chile's youth imposes on society its biggest challenges since the return to democracy in 1990. Paradoxically, this challenge is not other than going back to be a society and leave behind the model of the "Chilean Miracle" imposed by the neoliberal technocracy since the late 70s. Indeed, the most effective way of returning to being full-fledged citizens is through an education which teaches the foundations and values on which Chilean society should be built. In response to the reality that our country has one of the highest levels of inequality in the world, according to the OECD, it is necessary that the State once again provides free education, because the intellectual development that individuals experience in the university helps to correct inequality gaps. It must also be noted that higher education should not just be aimed at a base level, but should be an opportunity for young people to become fully aware of social realities with the aim of creating an enriching cultural exchange. This is something impossible to find in the current Chilean educational system which shows such an extremely high amount of social inequality.

The transition from dictatorship has not ended yet and a real democracy will only be attained once all citizens have secured their rights, not just in education, but also in terms of public health and social security.

Salvador Allende, before his death, said "Se volverán a abrir las grandes alamedas por donde pasará el Hombre Libre"* His famous quote is becoming reality this year, now that the youth that did not live through the dictatorship have taken to the streets with color and creativity. They are fighting for the happiness that did not come when Chile returned to a "democracy," not only in Santiago, but in almost every city in Chile. For example, in Valparaíso, one of the country's most important ports, we march through the streets, and there is a sign that reads "We live in a democracy with laws of a dictatorship." Everything depends on today's youth who want true freedom and to do away with this slogan.

*"They will return to open las grandes alamedas (or "the grand avenues," referring to "Alameda" which is the main street through Santiago) through which the Free Man will pass."



"We live in a democracy with the laws of a dictatorship"
 "Vivimos en democracia con leyes de dictadura"
 Photograph by Tyanna Slobe

Native American communities and tourism as development: Pine Ridge Reservation case study

BY ANDREA AKERS
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Introduction

Although tourism as a form of economic development has frequently proven detrimental for the people being “developed” in terms of the community and environment, there is promise for indigenous tourism in the United States and Canada.¹⁻¹⁷ Tourism as a form of economic and community development has worked well for indigenous communities in the United States because of their unique history and contemporary political status as dependent sovereign nations. These communities have a degree of control over their land and tourism policies that other indigenous nations do not have.^{1,3,6-8,10,11,13-18} Canadian First Peoples do not have the same relationship with the Canadian government as do indigenous communities in the United States but there is evidence that tourism, initiated and controlled by First Nations communities, can be used to support land claims for communities without land ownership.^{3,10,11}

This paper will review the available literature on indigenous tourism in the United States to examine both the potential benefits and negative consequences of tourism as economic development. In addition, a case study of the Lakota on the Pine Ridge Indian Reservation in South Dakota is provided to better situate this literature in tribal experience.

Negative consequences

In order to understand tourism as a form of economic development, the positive and negative effects need to be considered. Many authors cite the possible negative consequences with tourism development but most nevertheless argue that most indigenous communities had benefited overall from tourism development.⁴⁻⁹ The possible negative consequences of tourism include, but are not limited to:

- increased crime
- alcoholism
- smuggling
- heightened tension between Natives and non-Natives
- creation of phony folk culture
- loss of meaning of cultural traditions and arts due to commodification of culture
- the encouragement of acculturation through cultural exchange
- the appropriation of tribal culture by outsiders
- reliance on a seasonal and often volatile economy
- encroachment on sacred and culturally meaningful sites and land⁴⁻⁸

Katie Johnson and Tamara Underiner present one of the only examples of a problematic tourism experience of the Tillicum Village off the coast of Seattle.¹² The authors argue that there is a problem in the presentation of the tribal dances as a way to travel to the past rather than as a contemporary experience, which has been cited as a concern for other tribes as well.²² Johnson and Underiner argue that at first glance the problem of cultural commodification and appropriation

is apparent, but with further exploration they came to understand that the people of Tillicum Village have more agency in this cultural exchange than was previously thought. They conclude that the native people of Tillicum Village are “co-producers (although perhaps not yet equal) of this cultural experience” through their deliberate decision to participate in the dancing displays for tourists.^{1,2,12,22}

Benefits

The benefits of tourism for indigenous communities can outweigh the detriments if tribes are able to manage tourism and restrict tourists in certain ways. The stated benefits of tourism are:

- employment opportunities
- income generation
- external investment
- increased sovereignty
- revitalization of local traditions
- ceremony and art
- infrastructure and resources for residents
- decreased stereotypes and increased understanding of Native Americans
- preservation of natural resources^{3,6-8,10,11,13-18}

One especially informative example comes from John Colton who studied tourism in Canada with the Woodland Cree First Nations peoples (WCFN).³ Colton argues that the WCFN peoples considered many factors outside of economics in their decision to pursue tourism, including social, cultural, political, and environmental factors. For many First Nation communities, tourism is a way to strengthen traditional land-based activities and to supplement wage labor and subsistence production.³ Tourism provides a way for First Nations communities to gain control over their natural resources and can strengthen land claims if the community decides to make one.³ Finally, for the Woodland Cree, the revitalization of cultural traditions and the inclusion of their youth in tourism activities offers a source of hope for the future of the community, both spiritually and economically.³

A second example is that of the southwestern pueblo communities in the United States. Both Jill Sweet and Carol Lujan’s research focused on pueblo communities and tourism. Pueblo communities utilize different traditional cultural values in order to mitigate and manage tourists and tourism in their communities. One of the ways they do this is through secrecy.^{16,20} This secrecy is facilitated through the restriction of tourists to certain ceremonies and in what documentation tourists can walk away with (e.g. photographs and notes).²⁰ According to Lujan, the Taos Pueblo has succeeded with tourism due to the strength of their cultural and religious foundation prior to the incorporation of tourism and due to the degree of control the Taos have over tourists.²⁰ In this way the pueblo communities are able to benefit economically from tourism while maintaining their cultural values and ceremonies.

Pine Ridge case study – Oglala Lakota voices

In 2009 the Pine Ridge Area Chamber of Commerce (PRACC) received a grant from the Administration for Native Americans for its plan to combat the negative images of the Lakota that continue to harm the success of the businesses in the area. The way that the PRACC proposes to solve this issue is to educate tourism officials both on and off the reservation to foster relationships with the larger tourism destinations in the state, including Mt. Rushmore National Park, Crazy Horse Monument, and Badlands National Park, and to support businesses in creating and disseminating an authentic Lakota story.

Like many other tribes in the United States, the Lakota are interested in developing tourism on the reservation not only for its economic benefits but also for the cultural continuity of the tribe through education and the dispelling of myths and stereotypes.^{17,18} John Hunt, Lawrence Royer, and Perry Brown argue that the need for a changing of perceptions of indigenous communities and tourism is also important for the Utah Navajo. In 1973, Hunt, Royer and Brown’s solution to this problem was for the Navajo to become more Western in their portrayal in order to cater to a wider tourist audience.⁹ According to the PRACC, the Lakota have identified their image as a hindrance to tourism development on the Pine Ridge Reservation but their goals in changing this image rely on promoting their traditional cultural values to dispel myths rather than to acculturate to Anglo values and expectations of tourism.¹⁸

The Lakota have started on their endeavor to dispel myths and stereotypes by arming themselves with data from many different sources, including Colorado State University. This data includes information on the desires of the Lakota presented in Melanie Graham’s thesis and in studies conducted by The South Dakota Native Discovery project.^{17,18} These sources document the desires of the Lakota in regards to tourism development on the reservation. The following table from Graham shows that the overall sentiment toward tourism is positive:

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Tourism brings economic growth to the reservation	Households (n=47)	0%	15%	11%	68%	6%
	Business Owners (n=37)	0%	3%	0%	62%	35%
	Employees (n=15)	0%	0%	7%	73%	20%
Tourism is good for Lakota culture	Households (n=48)	0%	15%	15%	65%	6%
	Business Owners (n=39)	0%	5%	15%	64%	15%
	Business Owners (n=39)	0%	13%	20%	67%	0%
It is important to share Lakota culture and history with tourists	Households (n=48)	2%	8%	4%	73%	13%
	Business Owners (n=39)	0%	3%	15%	67%	15%
	Employees (n=15)	7%	0%	0%	60%	33%

Also apparent in Graham’s study was the Lakota’s understanding of the potential detriments of tourism. The main concern that was voiced was the consequences of potential spiritual commodification and appropriation of Lakota religion and identity by tourism businesses and by tourists.¹⁷ The Lakota also identified two actions to avoid the risk of spiritual commodification and appropriation: the creation of an entity with the purpose of monitoring and the use of traditional social sanctions in order to curb unacceptable behavior.¹⁷

Lacking in these surveys are the trends, desires, and suggestions from the tourists themselves. This information is important in un-

derstanding what stereotypes need to be addressed and what services can be catered to solving the problem. The first part of the PRACC’s three-year survey was conducted in the summer of 2010 by Colorado State University on the Pine Ridge Reservation in order to get a sense of who comes to the reservation and for what reasons. The survey revealed that the current travelers to the Pine Ridge Reservation fall into five main categories: faith-based interest (34.29%), leisure interest (25.71%), work (5.71%), residence (11.43%), and other (14.29%). This survey gives an idea of where the PRACC can focus its tourism marketing efforts. Because South Dakota receives a large amount of leisure tourists at Mt. Rushmore, the Black Hills, Crazy Horse, and the Badlands, there is a large pool of tourists that Pine Ridge can pull from.¹⁸ When tourists were asked about future attractions they would like to see, they suggested horseback riding, water slides park, river rafting, more signs, more information about contemporary life on the reservation, more information about customs and stories, more food, retail, and vendors. A few respondents mentioned the need for tourism to stay Lakota owned and operated and the need for tourism to help improve the quality of life of the people.

The overall sentiment of the tourists in the 2009 survey was positive. Of the 71% of those who responded to the question, 92% were either ‘satisfied’ or ‘extremely satisfied’ with their visit to the reservation. The narrative of these respondents is also informative with quotes such as:

“Wonderfully spiritual and beautiful.”

“Lovely people, great scenery.”

“It is an interesting place to visit to learn about the Lakota people both present and past.”

“Lakota people and culture are wonderful and have so much to teach others. The economy on Pine Ridge is very difficult and people need help creating a positive local economy.”

Ninety-two percent also said they would recommend the reservation as a tourist destination to others. These trends of increasing satisfaction provide hope for the success of the PRACC making a difference in tourists’ opinions of Pine Ridge and in attracting more tourists to the area. It will be interesting to watch Pine Ridge over the next few years to see if their plan to incorporate an authentic Lakota story into the mainstream attractions of Mt. Rushmore, Crazy Horse, and the Badlands has a positive effect on their tourism rates and on their economy.

Conclusion

After careful consideration of the available literature on indigenous tourism, it can be argued that tourism—with sustainable planning, contributions from the entire community, and control in the hands of the indigenous community—can benefit the economy and culture of the community.

The one worry that is not addressed in the literature is the extent to which the literature is not necessarily representative of tribes. There are over 500 tribes in the United States which means there are many different opinions and experiences with the use of tourism as development, but the current literature is not representative of these views or experiences. Only one author, Alan Lew, takes a pan-Indian view of tourism by examining many tribes throughout the United States. Lew’s research determined whether or not tribes throughout the United States are involved, or intend to be involved, in tourism ventures rather than the impact that tourism has had on the communities or the experiences that tribes have had with tourism.²¹ More comprehensive studies of tribes throughout the United States and their actual experiences with and opinions of tourism are needed in order

to provide models by which tribes can follow to successfully utilize tourism as a form of economic and community development.

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English only in Valle Verdeⁱ

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This paper examines the unequal racial formations derived from English-only policies in a northern Colorado school district. For historical background, the formation and dissolution of bilingual education at the national, state, and local levels is presented. In the analysis, I first utilize Michael Omi and Howard Winant's multiple paradigm approach to examine the interrelated concepts of nation, ethnicity, and class in accordance with race formation. Second, I use Charles Mills' epistemological assertions to examine formal and informal relationships between signatories, beneficiaries, and the marginalized Other to expose racial undertones associated with English-only policies.ⁱⁱ And last, I pull from the works of Virginia Dominguez to examine the ways in which local, state, and federal governing bodies uphold racial disenfranchisement. When viewed through the lens of race formation theory, it is clear that educational policies at the national, state and local levels are often implemented to maintain a hierarchical social order.

Methods

I interviewed four Valle Verde community members, all of whom are represented by pseudonyms. I started with an informal interview in 2010 with an elementary education teacher who had taught in Valle Verde for over twenty years. She, identified as Kelli Andersen

in this study, provided me with over 600 pages of material including school board minutes, documents from her service among multiple committees, newspaper clippings, bilingual education articles, and several books. This material was loaned to me for a three-month period and was used to guide and direct my archival investigation of both national and local shifts in policy.

Several weeks later I set up another informal meeting with Kelli Andersen and three other people whom she identified as plausible interview participants. For over an hour we sat around a table and they shared experiential information on the history and demise of bilingual-bicultural education in Valle Verde. One Mexican American lady, identified as Margaret Sanchez, served as the Bilingual Unit Director for the Colorado Department of Education from 1977-1981 until the English Language Proficiency Act (ELPA) replaced the bilingual legislation. She later became the principal at Torreze Elementary, continuing the bilingual-bicultural program for fifteen years until 1998 when she retired. Similar to Mrs. Andersen, Ms. Sanchez also provided me with many archival documents.

Equally influential in providing information was a lady identified as Sandra Ramirez, a second generation Mexican American who was born in Valle Verde and has taught there for thirty-five years. She will

retire in 2011. In addition, Jorge Villarreal, a second generation Mexican American born and raised in Valle Verde, provided me with information from the viewpoint of a former community liaison, counselor, teacher and continual advocate for equity and justice. In May of 2011, the five of us met together one last time to edit this manuscript and to discuss future applications of this research. It is the intense documentation and meticulous organization of these individuals, as well as their willingness to share, with precise detail, historical and present events that have provided the momentum and authenticity of this research.

National inequity

“To separate them [colored children] from others of similar age and qualifications solely because of their race generates a feeling of inferiority as to their status in the community that may affect their hearts and minds in a way unlikely to ever be undone.”¹

The 1954 ruling of *Brown v. Board of Education* established criterion which became the basis for bilingual education policy during the late twentieth and early twenty-first centuries. However, policies resulting in race-based exclusion continue despite the monumental and unprecedented *Brown v. Board of Education* verdict which concluded, “[I]t is doubtful that any child may reasonably be expected to succeed in life if he is denied the opportunity of an education. Such an opportunity, where the state has undertaken to provide it, is a right which must be made available to all on equal terms.”¹ Contentious debates abound and many remain unresolved as children today, just as in the past, are marginalized in American school systems.

While Chief Justice Warren’s vernacular within *Brown v. Board of Education* created judicial momentum for bilingual education, the Civil Rights Act of 1964, which stated, “Grants will be made for operation of institutes to train school staff, for support of specialized personnel, and for local in service training programs to meet problems occasioned by desegregation,” provided financial momentum by mandating funds toward educational programs.² Furthermore, provisions from the Office of Education supported such educational programs. However, the Director of the Bureau of the Budget, Kermit Gordon’s supplemental appropriations statement for the Civil Rights Act empowered local school districts despite federally mandated desegregation. His statement read: “The Office of Education will provide technical assistance upon request of local schools and will prepare a report on the availability of equal educational opportunities in public educational institutions in the United States.”² Thus, as of 1965, school districts were given the executive power to decide whether assistance was needed to desegregate the classroom, unless the Department of Health, Education, and Welfare (HEW) utilized authorization under Title IV of the Civil Rights Act of 1964 to ensure localities were properly desegregating.²

The Elementary and Secondary Education Act of 1965 (ESEA) was passed shortly after the Civil Rights Act “to strengthen and improve educational quality and educational opportunities in the Nation’s elementary and secondary schools.”³ The ESEA mandated financial assistance to low income schools and “authorize[d] a 5-year program for making grants for... vitally needed educational services not available in a sufficient quantity and quality.”³ However, the quality and opportunities of education for English Learners was not an explicit concern within legislation until the 1968 Bicultural Education Act (BEA) was passed as Title VII of the 1965 ESEA. The BEA was enacted to address inequities involving the “millions of children of limited English-speaking ability due to the fact that they come from environments where the dominant language is other than English, or where a language other than English is commonly used.”⁴ Despite the educational reforms mandated through previous policies since *Brown v.*

Board of Education, according to the BEA, “little headway ha[d] been made on solving this problem [aforementioned] and that there is an urgent need for comprehensive and cooperative action now on the local, State, and Federal levels for new programs to assist these children.”⁴ Accordingly, Section 703(c) of the BEA authorized programs which included native language instruction, bilingual and bicultural programs including appropriate history and cultural programs, and efforts to hire and retain bilingual and biculturally sensitive faculty.⁴ Yet despite congressional rhetoric emphasizing the advancement of “children whose primary language is not English, and whose cultural heritage needs to be understood and appreciated both by themselves and by their fellow American citizens,” the administration remained fiscally conservative.⁴ The House Report concerning the BEA stated, “The President did not include additional funds for bilingual education in his budget . . . as would be authorized by this bill. This is the worst possible time, in our judgment, to add spending authorizations unless they are absolutely necessary.”⁴ The House Report concluded, “While we oppose enactment of this particular bill for reasons other than the importance of the subject matter, we urge the Commissioner [of Education] to promote the accomplishment of the purposes of this legislation,” dismissing federal responsibility for perpetuating equity within school systems.⁴ This conclusion and the lack of monetary appropriations followed the House’s scrutiny of the Commissioner of Education’s incompetency and inability to promote bilingual-bicultural education with the preexisting budget and legislation.⁴

Despite disregard by some representatives, the BEA provided the authority under Title VII of the ESEA “for local educational agencies to plan and conduct bilingual and bicultural education programs,” ignoring the reality of racially discriminatory, local educational agencies across the nation—agencies which would not accept the funds to further advance their students and successfully integrate their school system.⁴ However, Title VII money was offered “for school districts to create experimental and demonstration programs designed to better meet the educational needs of students who come to school speaking languages other than English.”⁵ Local school agencies hampering bilingual-bicultural implementation, however, were not reprimanded until the mid 1970s during California’s *Lau v. Nichols* case. The case regarded “[t]he failure of a San Francisco school system to provide English language instruction to approximately 1,800 students of Chinese ancestry who do not speak English, or to provide them with other adequate instructional procedures.”⁶ The U.S. Court of Appeals ruled that California imposed standards which promoted inequality “by providing students with the same facilities, textbooks, teachers, and curriculum,” which, “effectively foreclosed [students who do not understand English] from any meaningful education.”⁶ In continuing, the Court stated that “those who do not understand English are certain to find their classroom wholly incomprehensible and in no way meaningful,” which implied that equal access to facilities did not create equal treatment and equal educational opportunity.^{6,7} Without learning in their native tongues, students were denied education—the “foundation of good citizenship,” as defined by *Brown v. Board of Education*.¹ Such denial of education was a structural tool utilized to prohibit access to U.S. citizenship or at least a method to marginalize non-English speakers. In conclusion, the Court declared the San Francisco school system in violation of Section 601 in the Civil Rights Act of 1964 which reads, “No person in the United States shall, on the ground of race, color, or national origin be excluded in the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.”⁶ Accordingly, the Court barred discrimination among students on account of race or national origin.⁷

Using statehoods to cover educational inequities

When *Lau v. Nichols* brought inequitable barriers perpetuated by racist state policies to the national forefront, states reexamined education policies to access remedies for inequitable education—remedies which were not outlined in the *Lau v. Nichols* decision. Though the Office of Civil Rights published the *Lau Remedies* in 1975 and consequently the *Lau Regulations*, enforcement at the state and local levels proved difficult.⁸ However, in 1975 Colorado passed the Bilingual and Bicultural Education Act (BBEA) to mandate bilingual programs in Colorado schools enrolling at least twenty English Language Learners (ELL) speaking one common language.⁵ The comprehensive bilingual law, according to the former Bilingual Unit Director for the Colorado Department of Education, provided the structure for “a strong diagnostic prescriptive English language development component, the use of the native language to reinforce basic skill subject matter, cultural relevance, self concept enhancement and parental involvement.”⁹ In addition the program took “place within the context of an integrated classroom based on voluntary participation.”⁹ However, despite the monumental gains of the BBEA, after a shift in political parties during the mid-1970s, English proficiency advocates and racist litigators stifled the momentum of educational equity in Colorado.

During the late 1970s, school districts utilizing Title VII funding in accordance with the BEA and the BBEA were dismayed at the changing tides within legislation. Legislation was circulating through the State which would derail the equity and progress which the BEA and BBEA had mandated. In 1977, Attorney General and republican from Fort Collins, Colorado, Duane Woodard spoke to the state legislature: “The Bilingual-Bicultural Act is relatively new as an educational program in the State of Colorado and its provisions are deeply appreciated by the Hispanic people from whom it has special meaning. These people comprise a significant minority of the population of the State of Colorado.”¹⁰ Recognition of Hispanics in Colorado and their validity during political reform was important to many progressive politicians, dedicated school teachers, and active community members of both the dominant and marginalized societies. However, Woodard’s constructive cynicism and morality struck the legislative floor and fell on deaf ears as he spoke: “We the Majority always seem to have the correct perceptions and answers, even on programs that more fully impact on another language and culture.”¹⁰ After explaining the importance of Hispanics in American history and culture, Woodard humbly concluded, “Is it any wonder that these people appreciate what the bilingual-bicultural program offers? A respect for their heritage and a better chance in tomorrow’s English dominated society.”¹⁰ With a legislative body comprised of discriminatory policy makers, Woodard faced ostracism and was not reelected. His career exemplifies the political downturn of officials who defy the status quo among society’s power holders.

Despite the Colorado State government’s declining attention toward minority education during the late 1970s, English Language Learners benefited from bilingual programs during that time. In February of 1981, the Bilingual Unit Director for the Colorado Department of Education reported an executive summary of Colorado School Districts to the U.S. Secretary of Education. “[T]he excellent results obtained are a result of state and Title VII support of Bilingual Bicultural Education,” she wrote.⁹ However, the English Language Proficiency bill (S.B. 462) was enacted in 1981, despite dissenting letters from both school board superintendents across Colorado and state school board representatives, concerned community members, state legislators and a comprehensive study funded by the Department of Education reporting the effectiveness of bilingual programs.^{iii,11} The act eliminated the inclusive and highly effective bilingual-bicultural

education programs and initiated a “program of intensive English language instruction over a period of 2 school years for students with deficiency in the English language.”¹¹ State Representative and Education Committee member Laura DeHerrera (D-Denver) denounced the bill which “was assigned to the House Committee on Finance,” and completely by-passed the Education Committee to expedite its passage and for fear that “the bill would be substantially amended by members on the Education Committee.”¹² DeHerrera explained the immense progress achieved by Bilingual Education. She then cited data of Colorado’s 21% minority population and added that over 50% of minorities comprised the dropout rate.¹² She continued explaining that “[t]he test scores of all the children who have participated in these programs have shown significant gains.”¹² In conclusion, DeHerrera openly pondered the discriminatory legislature: “We are facing a regressive turning point. And it is strange moves such as S.B. 462 that makes one wonder whether the legislature wants the dropout rates to go down.”¹² In addition, as Welner and Escamilla from the Education and the Public Interest Center recalled, “The ELPA program allowed school districts in Colorado to choose which type of instructional programs they felt were in the best interests of second language learners,” further strengthening localities against past national education policy.⁵ English-only sentiment had infiltrated Colorado school districts through the venue of discriminatory political discourse and legislation.

Valle Verde

National and state education policies concerning non-English speaking students and English Language Learners have racially shaped local school systems and communities. Luis Torrez Elementary School in Valle Verde, a rural town in northern Colorado, has experienced an educational roller coaster as policies have been shaped and reshaped for decades. Though racist sentiment is prevalent among some of the locals, events are consistently held throughout Valle Verde which meet the needs of both English and non-English speakers. Regardless of race and ethnicity, cooperation and engagement is necessary to orchestrate events such as fairs, art shows, family nights and meet-and-greets. However, English-only education policy has created stringent divides in the school system and community.

Torrez Elementary School once provided a model of multilingualism after which regions throughout the area admired and modeled their programs. Bilingual education began in the district during 1972 when Valle Verde became one of the first Colorado districts to receive Title VII (BEA) money. In the beginning, one class in each grade was monolingually taught. According to the school principal at that time, the majority of parents preferred their children be enrolled in integrated bilingual classrooms.¹³ Teachers endorsed with English as a Second Language (ESL) were well versed in cognitive learning approaches for native speakers which included cognitive academic language proficiency (CALP) and basic interpersonal conversation skills (BICS), recalled Mrs. Andersen, a teacher who has spent over twenty years with the district.¹⁴ According to Mrs. Andersen, “Students needed to learn in their native language. We couldn’t just skip over their cognitive learning for five to seven years. So we provided instruction in their native language. If it was English, it was English, if it was Spanish it was Spanish.”¹⁴ Students, whether native English or native Spanish speakers, along with their parents, mapped out a preferential course that would lead the student toward dual language proficiency, meeting the foreign language standard for high school graduation in the district.¹⁵ In the late 1990s when curriculum was finally mandated toward English-only, Mrs. Andersen explained that students were taught subject matter in English. However, students were not cognitively developed in accordance with the English lan-

guage. Therefore, by seventh grade some native Spanish speakers were linguistically fluent in English but could not understand the content.¹⁴ This is still a problem today.

Despite the national and state discourse of English proficiency in lieu of bilingual-bicultural education, the Valle Verde School District, with a high degree of native Spanish speakers, respected the multi-ethnic complexity within the district and promoted English proficiency through a multilingual program. One school pamphlet in the late 1990s was subtitled, "A School with Multi-language Program Choices."¹⁶ Spanish speakers and English speakers remained integrated through the Two Language Program (TLP), the English Enrichment (EE) "for parents who wish their children to be taught in English with no second language instruction," or the English-Spanish Enrichment (ESE) "for English speaking children who also wish to learn to speak Spanish."¹⁶ The multi-language programs suited a diverse population as curriculum was tailored to suit individual developmental and cognitive needs while promoting a bilingual-bicultural atmosphere. Ms. Ramirez, a teacher born in Valle Verde has taught in the area for thirty-five years. She recollected, "My classroom, of course it's not bilingual anymore due to mandates, but before we had the culture in the classrooms. We had English decorations but we had Spanish too... We taught the culture too and we did finger plays, we did songs, we did music, we did plays, but we did them bilingually."¹⁷

During the 1990s, numerous studies supported dual language programs such as the integrated programs at Torrez. Virginia Collier, Professor Emerita of Bilingual/Multicultural/ESL Education at George Mason University, conducted numerous studies and found that "language majority students taught through a minority language for part of the school day may experience an initial lag in [native language] skills . . . which usually disappears by the middle grades of elementary school."¹⁸ She then added, ". . . in many cases bilingually schooled students demonstrate superior academic performance by the end of elementary school."¹⁸ In addition, Wayne Thomas, Professor Emeritus of Program Evaluation and Research Methodology at Virginia Tech., and Collier, in a longitudinal study funded by the U.S. Department of Education, found that "Native-English speakers in two-way bilingual immersion programs maintained their English, added a second language to their knowledge base, and achieved well above the 50th percentile in all subject areas on norm-reference tests in English."¹⁹ They concluded, "These bilingually schooled students equaled or outperformed their comparison groups being schooled monolingually, on all measures."¹⁹ Two-way developmental bilingual education, the method once performed at Torrez, resulted in greater student progress from grades three to eleven than did any other program. All ESL approaches, such as the one currently used at Torrez due to local and state mandates, had significantly fewer positive results.²⁰

Despite the progress made at Torrez Elementary, political currents changed in the local, state, and national arenas. At one point in the late 1990s a plan was proposed to segregate Torrez. Ms. Ramirez recollected:

There was one year when we still had bilingual, but they wanted to move all the bilingual classrooms over to the other end, including kindergarten. . . . What is that going to show having all the Spanish speaking students in one area? They wanted to call it the Español Calle. . . . They wanted to throw us way over there where the dumpsters are.¹⁷

During her recollection, Mr. Villarreal, a former community liaison, counselor and lifelong Valle Verde community member inter-

rupted, "Across the tracks," the school board proposed segregating the school just as the community was segregated by the train tracks.²¹ Fortunately the community banded together and the segregationist idea was short lived. However, racist momentum was building.

Mrs. Andersen who served on the Council of Curricular Achievement remembers struggling to maintain bilingual education and the district standard of graduating with foreign language competency by speaking at school board meetings and to the local community.¹⁴ With two of her children having graduated as bilingual and one who became an aerospace engineer, she experienced the benefits of bilingual education.¹⁴ However, despite gains in maintaining the dual language requirements, the national No Child Left Behind Act in 2001, along with state level Colorado Student Assessment Program (CSAP) testing, hampered the momentum built by the Council of Curricular Achievement, concerned parents and staff, and community members. Ms. Sanchez remembers the positive momentum until CSAP was mandated and the superintendent told her, "We don't have time to wait for the kids to learn English, we've got to get them into English right now," insinuating that integrated bilingual programs would be relinquished in favor of English proficiency programs.¹³ During 2004 a new superintendent was initiated for Valle Verde. Ms. Ramirez recalled a meeting between teachers and Superintendent Watson:

One of the kindergarten teachers said, "Well [Ms. Ramirez] who's been here a number of years, her belief and her philosophy is that students need to learn in their dominant language first and when they're ready to make that transition into English, then they'll move into English." And [Superintendent Watson] said, "Well I said English only," and I just stood quiet and they kept talking and talking. . . . [T]hen finally I did raise my hand and I did tell him. I said, "As a Masters student who took many classes, I learned [students] are supposed to learn in their dominant language first and then when they're ready they make that transition into English." . . . [H]e said, "I said ENGLISH ONLY." . . . So I just kind of stood back and said, "I'm not saying anything anymore."¹⁷

Several days later a teacher asked Ms. Ramirez, "How come you never say anything at these meetings?" Ms. Ramirez replied, "For what? He shut me down completely. . . . So I didn't say anything because he wasn't willing to hear."¹⁷ Ms. Ramirez along with countless staff and community members were being alienated by institutional discrimination.

Mr. Watson "came in with his agenda," according to Ms. Sanchez, who is stalwartly dedicated to bilingual-bicultural education and has held numerous education administrative positions at the local and state levels.¹³ She remembered at his "very first meeting of county administrators he stood up in front of the whole assembly and said, '[Valle Verde] has a dirty little secret. That secret is that a student can enter kindergarten speaking Spanish and graduate still speaking Spanish.'¹³ Within minutes, Ms. Sanchez recalled Valle Verde's assistant superintendent received three different phone calls from superintendents who asked astonishingly, "Do you know what the man you just hired said?"¹³ Though Mr. Watson's webpage boasts of the district's dedication toward "data-driven decision making processes," his English-only policies continue in 2011 despite the empirical data upholding bilingual, bicultural and multi-language programs.²²

Racial formation analysis

When consequences are viewed through the lens of race formation theory, it is clear that educational policies at the national, state and local levels are often implemented to maintain a hierarchical social order. In their book *Racial Formations in the United States: From the 1960s to the 1990s*, Michael Omi and Howard Winant employ multiple paradigms to examine race formation and the interrelated concepts of nation, ethnicity, and class.²³ They state, “None of these paradigms stand alone. There is necessarily overlap among them.”²³ Omi and Winant continue, “Though none of the three paradigms can grasp the nettle of race, each is able to develop certain fascinating insights into racial phenomenon.”²³ When used in conjunction, however, the multiple paradigm approach strengthens the dissection of race formation, uncovering entangled relationships between oppressive policies, legislators and the Other.

“In the nation-based paradigm,” according to Omi and Winant, “racial dynamics are understood as products of colonialism and, therefore, as outcomes of relationships which are global and epochal in character.”²³ This approach uncovers oppression throughout the globe as the exploitation of marginalized communities by institutionally oppressive regimes.²³ A nation-based approach analyzes race through the geography and territoriality of people groups.²³ Therefore, historically derived ethnic enclaves and marginalized areas in the U.S. can be understood as resultants of core/periphery relationships, whereby marginalized or peripheral segments of society are viewed by the dominant or core society as in need of paternalistic intervention and are also often ostracized. Likewise, the success of core expansion is predicated on the appropriation of resources from peripheral societies.²⁴ Accordingly, a considerable amount of Hispanics in present day Colorado were descendants of Mexicans and indigenous First Nation peoples who lived in the area before it was U.S. acquired territory. Many of them inhabited the migrant worker camps of Colorado and specifically camps in Valle Verde.¹⁴ Consequently, national, state and local hegemonic powers assumed control over ethnic enclaves in the region to maintain the status quo. Therefore, Hispanics as workers in the fields surrounding Valle Verde are one thing (a representation of wealth appropriation by the core) while Hispanics with bilingual education and political representation are another (a representation of wealth dispersal across racial and class boundaries).

The status quo is maintained through the political and socioeconomic domination by “racial separation and white supremacy.”²³ When examined through a nation-based lens, policies are uncovered as institutions necessary to strengthen superstructural control over marginalized communities. In this way, assimilative English-only policies hamper cultural continuity of the marginalized Other and reinforce the existing racial superstructure. The necessity of such policies to perpetuate superstructural control was demonstrated by the ostracism of Attorney General Duane Woodard who never passed a bill and was not reelected after his speech to the legislature in which he asked, “Is it really fair to continue to treat Hispanic peoples as second-class citizens? . . . Spanish language and culture was dominant . . . in the Southwest United States for better than a century before the first contact with English speaking Americans ever occurred.”¹⁰

Though nation-based approaches examine the hegemonic implications among people groups, according to Omi and Winant, an ethnicity-based approach is needed to examine the “dynamics of incorporation” among an enclave or group of people.²³ “Ethnicity theory,” they state, “is therefore concerned with questions of group identity; with the resolutions of tensions between the twin pressures of assimilation (dissolution with group identity) and cultural pluralism (preserva-

tion of group identity). . . .”²³ Legal, political and social institutions are structured to discourage unity among and within ethnic minority groups through policies which encourage assimilation to the dominant culture. Institutions, then, enforce assimilation and the adoption of values that are often foreign and contradictory to the values of ethnic minorities. Therefore, discriminating against culturally relevant festivities such as the use of piñatas, practices such as communicating in the native tongue, and bilingual-bicultural finger plays and songs creates dissolution of group identity and a void within Mexican heritage preservation. By implementing English-only policies, the Valle Verde administration decreased ethnic pride and self-esteem among Spanish-speaking children. Ms. Ramirez lamented, “I would get kids [the following year] and say, ‘Hi María,’ and she’d say, ‘That’s not my name, my name’s Mary.’”¹⁷

Degraded esteem and confusion within the hearts and minds of children creates barriers within the family and community. Community strife occurs as individuals and families venture different avenues of assimilation toward the dominant culture. Omi and Winant examine “the prospects for political integration via normal political channels” within ethnicity-based approaches.¹⁷ However, “normal political channels” are not easily accessible when institutions seek to marginalize the Other within communities. Nevertheless, political representation is necessary to preserve group identity and to protect disempowered groups from racist political maneuvers such as English-only policies. To obtain their voice within Valle Verde, families utilized different mechanisms, including the opposite poles of cultural dissolution and heritage preservation. “There was mixed emotions from the people from Mexico coming here,” Mr. Villarreal recalled.²¹ “Some would get here and tell their kids, ‘Don’t speak any Spanish anymore because we’re all English.’ . . . And the other ones, they thought like the bilingual program, the goal is to learn English and keep your native language. I saw a lot of changes like that [but] a lot of them felt powerless.”²¹

Although institutions demand assimilation by the Other, the relinquishment of traditional values and acceptance of dominant norms by the Other does not guarantee political representation of disenfranchised groups. According to Omi and Winant, an ethnicity-based approach uncovers the oppressive ploys of minimizing political representation of ethnic minorities. These ploys are utilized to distribute “resources which [are] not only economic, but also political and cultural” toward already enfranchised groups. Simultaneously, the politically enfranchised, neoconservative regimes responsible for these ploys hoard appropriated resources to maintain the established hierarchy.²³

Not only do neoconservative regimes utilize an ethnicity-based agenda to exclude minority groups from politics, they also employ racist sentiment.²³ According to the “boot-straps model,” the level of achievement obtained by an ethnic group is directly correlated with the effort put forth by members of that ethnic group. Omi and Winant opine, “. . . the concrete sociopolitical dynamics within which racial phenomena operate in the U.S. - are ignored in this approach.”²³ Therefore Hispanics failing in U.S. schools are perceived as victims of Chicano values not victims of an inadequate school system.²³ As George Frederickson uncovers, “Scapegoating the available and vulnerable Other [is] one way of dealing with the bitterness and frustration resulting from the failure of nationalist projects” such as the U.S. public school system.²⁵ Racist sentiment emphasizes ethnic assimilation for minority groups to succeed in the dominant society and ignores the negative socio-cultural, economic and psychological effects of the “boot-straps model.” Meanwhile, blame for the socioeconomic underachievement ascribed to ethnic minorities is placed on the val-

ues of ethnic minorities.²⁵

While neoconservatives attribute underachievement to the retention of traditional values by ethnic minorities, Omi and Winant utilize a market-based, class paradigm to examine the “social allocation of advantage and disadvantage, winners and losers, and the origins and structure of discrimination.”²⁵ Understanding the complexities of class within a given physical or ethnic space uncovers the inequitable access to resources such as education, political representation and economic security. Inequitable access to culturally appropriate education including bilingual-bicultural integrated classrooms and fundamental learning in a child’s primary language further disadvantages English Language Learners.²⁶ Neoclassical economists prescribe words such as ‘free’ or ‘equal’ to the market economy, proposing that resources are available to all and that any inequalities arising from economic interactions should be addressed by political institutions.²⁷ Yet currently, bilingual schools are often in areas with higher household incomes, such as Harris Bilingual Immersion School in Fort Collins. Though the parents and staff of both Harris Bilingual and Torrez Elementary vehemently opposed the Colorado Amendment 31 proposal during 2002 which sought to strictly enforce English-only policies, Harris Bilingual remains bilingual, while the programs that once enriched the hallways of Torrez are a part of history. A class-based approach, as proposed by Omi and Winant, uncovers unequal opportunities within the market economy as a result of institutional and socioeconomic maintenance of the status quo.

Whereas a market-based approach examines the inequitable allocation of resources according to class, Mills, in *The Racial Contract*, correlates inequitable resource allocation to race. The classic “social contract” associates political, moral and epistemological assertions as necessary to shape society. Mills, however, examines political, moral and epistemological assertions as the basis of race formation.²⁸ According to Mills, “the purpose of the [Racial] Contract is always the differential privileging of the whites as a group with respect to the nonwhites as a group, the exploitation of their bodies, land, and resources, and the denial of equal socioeconomic opportunities to them.”²⁸ Thus the privileges of colonial white hegemony were obtained and power was asserted by the exploitation of labor among nonwhite peoples and the appropriation of nonwhite land and resources.

Currently, a colonial mindset is perpetuated through the “racial contract,” which Mills describes as a “set of formal or informal agreements or meta-agreements” which exist both sociopolitically and epistemologically to uphold the structure of white rule.²⁸ This is still the case for Hispanics, migrant workers, and brown-skinned people born within the U.S. borders and south of the U.S.-Mexican border. U.S. constituents admire the hardworking capabilities and necessary presence of people within the U.S. global agricultural sector, yet continually deny workers the right to expedient residency or citizenship. Mr. Villarreal correlated English-only discrimination at Valle Verde with that of the Jim Crow era: “This even goes back further into the 40s and 50s, the prejudices . . . It was like going back to the black people, ‘Sit in the back of the bus’ . . . There was a lot of that stuff way back then and some of that stuff still is.”²¹ Though people dedicated to equity and social justice acknowledge this mindset as racist, a color-coded hierarchy renders whites as beneficiaries of “the racial contract.”²⁸ Due to the privileges associated with skin color, whites or people with lighter skin tones can often navigate social, political and economic barriers that are unavoidable to nonwhites. So despite white reluctance toward participating in racist actions or actively perpetuating racist epistemology, whites still benefit from the system more so than darker skinned people.²⁸ Concurrently, whites blatantly subscribing to racist policy and ideologies are signatories of the “racial contract.”²⁸

Signatories strengthen the sociopolitical and epistemological institutions which favor white rule and empowerment while simultaneously disenfranchising and disempowering the Other.

As Mills correlates privilege with race, signatories strategically use racial divisions to maximize profit and productivity toward the upper tiers of society. Consequently, these divisions, often in the realm of labor, perpetuate socioeconomic immobility and political disenfranchisement of the Other.²⁸ This vicious cycle, prevalent between white and Hispanic populations, can be scrutinized using the “racial contract.” In this way socioeconomic immobility and political disenfranchisement can be examined as results of English-only policies and other policies related to marginalizing the Other. Ms. Sanchez remembers the overtly racist mentality within Valle Verde during her first year in the district when Superintendent William Singer, the namesake of Singer Elementary, the other elementary school in the town, stated, “[T]he school board only encouraged [Hispanics] to go to school ‘til the 8th grade because they are needed to work in the fields.”¹³ Additionally, Mr. Villarreal added there were many families that sent their children to work solely so the family could survive.²¹ With such economic disparities and emphasis on survival, political and social representation was difficult for Hispanic populations. Thirty years later the elements of survival have changed, yet extreme inequality and impoverishment of Hispanics within the community are still resultants of marginalization by local, state and federal political systems. Furthermore, socioeconomic immobility and political disenfranchisement limit the opportunities for marginalized groups to contest discriminatory educational policy changes, continuing the cycle of marginalization.

Though Omi and Winant’s multiple paradigm approach provides a framework for understanding racial formation, Dominguez, in *White by Definition: Social Classification in Creole Louisiana*, suggests that the differing privileges between racial categories is maintained by evolving discriminatory political institutions.^{23,29} Dominguez refers to “the continuous historical pattern of determining race by man-made law rather than by processes of nature.”²⁹ Thus laws have passed at local, state and federal levels to uphold racial inequities at particular points in history. Utilizing an archival approach to examine policy change in accordance with social movements’ regime changes provides insight into the oppressive nature of legislative powers. Accordingly, English-only policy in school systems can be examined as attempts to stifle movements of tradition, ethnic solidarity, ethnic pride and equality of the Other while maintaining the status quo of the dominant society. According to Dominguez, historical patterns of legislative changes are often “considered too manipulative to be true.”⁹ Therefore, an archival approach, such as the one outlined in this paper, is necessary to examine the historical and political contexts of racially motivated policies. Concurrently, beneficiaries are often unaware of the racist implications of legislative changes.²⁸ As such, policies are often uncontested by beneficiaries or the Other, yet another ploy utilized to maintain the whitened power structure.²⁸

Conclusion

Using Omi and Winant’s multiple paradigm approach to examine race formation is critical in understanding the socioeconomic and political impacts of English-only policies on national and local scales. Mills’ *Racial Contract* further explains the appropriation of socioeconomic and political resources on the basis of race, marginalizing the racial Other and minimizing the voice of marginalized communities during dissentious political maneuvering. Finally, Dominguez provides an explanation for the continual restructuring of legal institutions to maintain the status quo of dominant society. Together these frameworks expose the unequal racial formations derived from and

perpetuated by English-only policies in Valle Verde.

Beneficiaries of the system and those oppressed by the system must work in tandem to contest racially motivated policies and the unequal formations created by policy implementation. This cooperation leads to local gains, such as the prevention of the Español Calle in Valle Verde during the 1990s, as well as state and national gains such as the successful defeat of Ron Unz's 2003 Colorado anti-bilingual initiative "English for the Children." Currently, Valle Verde is a town with high levels of integration between the Hispanic and English-speaking populations. However, the local, state, and federal power structures are comprised of predominantly non-Hispanics who, according to historical and present policy, uphold the self edifying structure at the cost of human individuals. At the national level, the current administration has denounced neoclassical economics more so than any other administration in the past thirty years, due to the inability to examine inequity and social injustices within a neoclassical framework.³⁰ Accordingly, the Obama administration and the U.S. Department of Education issued "A Blue Print for Reform: The Reauthorization of the Elementary and Secondary Education Act" in March 2010. In the blue print introduction, President Obama wrote, "A world-class education is also a moral imperative – the key to securing a more equal, fair, and just society."³¹ He continued, "We will not be able to keep the American promise of equal opportunity if we fail to provide a world-class education to every child."³¹ Utilizing resources to remain politically active and to maintain civil rights proponents within the national legislature further weakens racial ploys of disenfranchisement and social inequities directed toward marginalized communities. Currently, segments of the Valle Verde population are working adamantly to achieve equal representation on local school boards, fire departments and other local governing bodies, but this has been an arduous task due to the historically white-washed hierarchy in the region. Beneficiaries then, along with their marginalized friends and neighbors, must work integrally at all levels, regardless of skin tone and linguistic differences, to ensure future equal opportunities within the U.S. education system.

Notes

¹All locations, names, occupations and other identifiers associated with the four informants in this study have been altered to protect the community patriots who have dedicated decades of service to school districts across Colorado and to Hispanic/Latino communities. Despite the many defeats they have experienced competing against the local, state and federal structures for equity in the Colorado school system, many still teach and mobilize today, hopeful for future triumphs.

²I use the term Other to encompass people groups whose histories are, in the words of Charles Mills, "focused on issues of conquest, imperialism, colonialism, white settlement, land rights, race and racism, Jim Crow, reparations, apartheid, cultural authenticity, national identity, indigenismo, Afrocentrism, etc." In particular, this paper uses the term Other to indicate linguistically, politically, and racially marginalized people in Valle Verde.

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Hypothetical heresy: Faith and science as antagonistic worldviews

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A popular invocation of Galileo Galilei is often as the father and hero of modern science, an exemplar of truth and reason who was unjustly censured and arrested by the science-condemning Inquisitors of the Church, seeking wrongly to suppress the truth of Galileo's influential work. Galileo's advocacy of the Copernican heliocentric model of the universe directly clashed with the authority of scripture and its literal concurrence of a geocentric universe, leading to his Inquisitional conviction, and later recounted as the "Galileo affair."¹ Consequently, it is with the events that led to the Church's counteractions to those of Galileo's that serve as the historically interesting, and often overlooked, catalyst for the mythic Galileo. As such this imagery raises pertinent philosophical questions about dichotomies and discrepancies that divide faith and science as worldviews through which humans come to understand the nature of the universe and their places therein. These divisions necessitate two parallel modes of analysis, both of which are concerned with the role and contingency of 'time.' First, an assessment of faith and science as systems of thought during the "Galileo affair" needs to be developed. Second, the mechanistic nature of our world is understood as different, necessarily, according to the tenets of faith and the tenets of science; these also need to be developed. This is the case due to conceptual disparities of time and its relation to these respective worldviews – frameworks for devising, applying, and advancing knowledge. This calls for definitional assessment of how 'time' affects affirmations of worldview-defined truth-claims, and, ultimately, how this renders the coexistence of faith and science as incommensurable worldviews, distinctly different and separate from one another.

Because the "Galileo affair" serves as our historical case study, the following work will therefore be grounded in a particular historical methodology and interpretive philosophical reconstruction that will highlight the cleavage between post-Galilean science and the Christian faith, thereby demarcating between the two, as based on different conceptual understandings of time. Further, the following analysis of the "Galileo affair," as emblematic of the issues inherent in dialogue across faith and science divides, will be developed in the vein of a Kuhnian critique. Motivation for this approach rests on the fact that scientific revolutions come to represent not only the contemporary status of science, along with its practical and theoretical operations, but also the scientific revolutions and how their resultant paradigm shifts affect society far beyond the scientific realm, thus playing an integral role in how epochs are historically interpreted, defined, and reinterpreted. As such this is an inquiry concerning the epistemological differences that manifest faith and science as antagonistic worldviews. An expositional evaluation of these worldviews, beginning with the "Galileo affair," will help to flesh out inherent dichotomies between religious faith and the enterprise of science.

Galileo's work sought to show that through science humans could gain a working knowledge of the mechanistic underpinnings of nature by observing the world around them. Sensory experience and replicable demonstration here serve as the essential premises that engender the practice of scientific inquiry. Accordingly, Galileo reasoned that "the importance of necessary demonstrations ... in conclusions about natural phenomena," carries empirical weight due to

"sensory experience."² It was through conclusions arrived at by posing questions about the world and investigating through modes of observation that led Galileo to adopt Nicolaus Copernicus' heliocentric model of the universe, further supported by Galileo's own repeated telescopic observations and mathematical derivations (e.g., the discoveries of the phases of Venus and the moons of Jupiter). This outlook of sensory experience and replicable demonstration served as the criterion basis for the Scientific Revolution's application of methods of precise measurement and repeated observation, according to philosopher and historian Isaiah Berlin. "Consequently," Berlin says, "only the measurable aspects of reality were to be treated as real."³ Regarding this historical outlook, Galileo's empirical approach to scientific discovery had the conceptual effect of bifurcating natural philosophy into two distinct, though still connected, disciplines: philosophy proper and modern science. Following this, the methodological shift from Aristotelian demonstrations from first principles, to experimental demonstrations as essential to scientific research, serves as Galileo's lasting contribution to modern science.

Galilean science was progressive: in advancing heliocentrism, Galileo's work, along with its promotion and defense, refuted the biblically consistent Ptolemaic cosmology of the universe. In so doing, his work necessitated an ideological retooling of theology and biblical hermeneutics, Aristotelian philosophy, and, most importantly, the methods and practices of scientific inquiry. In recalling Thomas Kuhn's philosophy of science outlined in *The Structure of Scientific Revolutions*, Galileo's advancement of Copernican heliocentrism represented the impetus toward a paradigm shift in Renaissance science and astronomy.⁴ But because he was unable to convey the truth of heliocentrism beyond strong rhetoric and conjecture, which rested on his work inspiring scientists who were to follow, Galileo and the authority of science were censured by the religiopolitics of the Church, only to be fully and officially vindicated by the Holy Roman Catholic Church in 1992 by Pope John Paul II.⁵ Here the words of philosopher Daniel Dennett are reminiscent of the "Galileo affair" awaiting the realization and confirmation (Newtonian dynamics) of its paradigmatic shift: "Again and again in science, yesterday's heresies have become today's new orthodoxies."⁶

But the "Galileo affair" was not simply the Church suppressing Galileo's voice of truth as heresy against scripture. Rather, the "affair" was sociopolitical in context with religious and judicial oversight because the institution of the Church saw Galileo as going against its authority – the arbiter of God's Word. Beyond his advancement of telescopic observations of the universe, which revolutionized astronomy in addition to his seminal work on physics, "Two New Sciences" (1638), which became fundamental to the later work of Sir Isaac Newton, Galileo's strong defense of Copernicanism in *Dialogue on the Two Chief Systems of the World* (1632) resulted in an epistemological crisis of faith when his understanding of science, along with his scientific proclamations, met the condemnation of the Inquisition.² Thus Galileo has come to serve as a martyr for science. And while he was in fact a devout Catholic who abjured for his transgressions against the Church, Galileo's convictions about the place and importance of science serves to show that, as modes of understanding our world, the

differences between faith and science embody divergent notions of authority. That is, Galileo's trial debates (1616 and 1633) over biblical hermeneutics – used to support a hypothetical heliocentric universe awaiting conclusive (Newtonian) confirmation – rendered the “affair” an ideological battle of the primacy of faith versus the primacy of science, insofar as both represent different sources of truth – hegemony. Consequently, the central issue in the trials against Galileo was the clash between opposing worldviews. This is the case because science and faith are not merely concerned with different notions of truth, but because the former is a continually changing, contemporarily-defined human pursuit of naturalistic knowledge; the latter being a constant metaphysics concerned with the supernatural, which is inherited through tradition and accepted on the basis of that tradition.

The question then becomes: What makes a scientific worldview different from attempts to understand the world through the lens of a faith-informed religious worldview? According to philosopher of science Peter Godfrey-Smith, “[s]cience is different because it is a process in which beliefs are shaped by observation. Ideas are assessed not in terms of their origins but in terms of how they stand up to testing.”⁷ It is through this process of observation that testing and subsequent results are assessed in a public forum. Results and public perception within the scientific community are what determine the contemporary reception of the authority of science. This is founded on the ideological principle that “[s]cience is open-minded ... and flexible,” says Godfrey-Smith.⁷ Religion, on the other hand, is the manifestation of traditions and doctrines culminating in organized practices of beliefs with particular abiding worldviews and prescribed to its followers as authoritative and definitive. Regarding the truths about nature, the Christian worldview is concerned with ontological and theological particulars of how the universe is organized as ordained and overseen by a providential god of creation. Conversely, the enterprise of science constitutes a collection of general propositions concerning general truths about the nature of the universe and conducts itself according to a determinate set of guiding principles – scientific method in an open forum, thus allowing for replicability, verification, revolution, and normalization. Here particulars are essential only as instances of general principles. Resultantly, both religious faith and the enterprise of science purport truth-claims, though both arrive at their respective conclusions through vastly different presuppositions and procedures. And it is these presuppositions, procedures, and conclusions that define the particular worldviews though which humans come to understand nature, which simultaneously divide them from one another as congruent.

Because the Bible is not concerned with matters beyond spiritual salvation, it is therefore clearly not a book of science, and its readers should not circumvent real-world observations with conflicting appeals to biblical literalism. It was with this understanding that Galileo saw faith and science as serving separate functions to the human experience and therefore not in contention – ideologically – with one another. “Holy Scripture and nature derive equally from the Godhead,” wrote Galileo, “the former as the dictation of the Holy Spirit and the latter as the most obedient executrix of God’s orders.”² This sentiment served to affirm and explain the notion of God as the author of two books through which human understanding derives: the book of nature (science, philosophy, and mathematics) and the book of scripture (the Word of God and its dissemination administered by the Church). It is with the book of nature that the realization and employment of human intellect and reason afford experiential conclusions about the world in which we live. The book of scripture is concerned with faith and salvation and therefore cannot serve to explain the natural disposition and mechanistic underpinnings of the world beyond its purported first principles of creation and its contingent

eschatological end of history.

Galileo wrote that “[Natural] Philosophy is written in this all-encompassing book [of nature] that is constantly open before our eyes, that is the universe; but it cannot be understood unless one first learns to understand the language ... in which it is written.”² And according to Galileo that language was mathematics. It follows that science and philosophy, along with the metalanguage of mathematics, are all integral to the employment of intellect and reason as well as the overall human experience. “[S]o one must not ... block the way of freedom of philosophizing about things of the world and of nature, as if they had all already been discovered and disclosed with certainty. Nor,” Galileo continued, “should it be considered rash to be dissatisfied with opinions which are almost universally accepted; nor should people become indignant if in a dispute about natural phenomena someone disagrees with the opinion they favor.”² Science informs us about nature and in turn that understanding helps us interpret the makeup and workings of ourselves, our world, and our universe. Accordingly, Kuhn says that scientific revolutions (i.e., paradigm shifts) cause scientists to see the world of their research differently.⁴ It was with this type of understanding about the autonomy of human knowledge that Galileo met with opposition from the Church. Galileo truly believed that where religious dogma and articles of faith contradicted scientific conclusions, that it was the duty of the religious institution (i.e., theologians) to adjust itself and its scriptural interpretations to accord with experience and reason – scientific conclusions about nature – rather than to treat observational truth wrongly as religiously erroneous, biblically inconsistent, or outright heretical in character. Consequently, Galileo concluded that “[i]n disputes about natural phenomena, [scripture] should be reserved to the last place.”²

The Church, though, did not recognize this Galilean division between faith and science and understandably so: potential backlash from the Protestant Reformation loomed, in terms of ideology and presumed individualism, which ultimately threatened the institutional authority of the Catholic Church. Additionally, notions that the Bible served the purpose of making sense of life as preparatory for the afterlife and that the task of “making sense” belonged strictly to Church theologians, stood as oppositional to Galileo’s treatment of scripture. Consequently, very serious and frequent ways that interpreters and “expositors” (i.e., theologians) erred in reading and understanding scripture, says Galileo, are “to limit oneself always to the literal meaning of the words” and in turn use those words to define experiences in the natural world.² It is clear that the Church and Galileo had different understandings of scriptural interpretation, which therefore resulted in antithetical emphases regarding the place and importance of science. It follows, then, that Galileo was censured and arrested, not because he affirmed the Copernican heliocentric model of the universe, but because he supported that hypothesis with reinterpreted scriptural passages.^{ii,8}

As an ideological debate, the “affair” shows inherited faith to be an unsubstantiated (beyond tradition) truth compared to the observational (experiential reality) truth that informs scientific theory, with both being interpreted in temporal contexts, though resulting in varying norms and values. The effect was not in Galileo’s time, nor is it now, simply a difference in starting places and motives for the projections and progressions of faith (accepted finality) and science (methodological approach to know the not-yet-known). But more importantly, faith and science serve as different modes of interpreting and understanding the world and human experience. Consequently, the presuppositions and purposes of faith and of science become confounded by different conceptions of time and how time relates to notions of progress. It is the co-evolution of these worldviews

that prove them to be incommensurable pursuits of truth and ways of understanding such truths in time. As a result, the very different institutional evolution of faith from that of science is the result of a biblically-based conception of time in the Christian worldview: time, here linearly defined, manifests as a belief concerned with a purposeful beginning and end – creation and eschaton. Between the beginning and the end is temporal reality in time. But in the Christian worldview, as noted in Revelations 21-2, this is a time of waiting, a transitional period between the Christ's resurrection and his return and reconstitution of creation. But this locates time as contained and constrained within a beginning and an end, further confounded by a Christian teleology. This transitional period sees the propagation of believers perpetuate end-goals of happiness in the now by looking to an eternal, more important life in the ever-after. In this schema human progress is easily and often interpreted as developmentally linear, or progressing toward a determined, exponential end – pre-millennial in nature.

An understanding of time as a linear progression of developmental progress proves difficult when one attempts to understand natural phenomena within it (i.e., within time). The typological Christian understanding of linear time mentioned above can be quite dangerous, according to Isaiah Berlin, and in line with Kuhn, because “[scientific] problems change from one age to another, representing no straight line of progress ... as human thought and language change under the impact of the factors which determine the forms and the concepts in which men think, feel, [and] communicate.”³ What is more, mythologist Joseph Campbell posits that “philosophically it is not permissible to speak of a ‘time’ when time was not or when time will cease to be. There is no before and after time that is not itself time.”⁹ And when biblically-based understandings of time or notions of God-ordained human progress enter the scientific arena, the result has historically been one of science being subordinated to a metaphysical supremacy that is informed and defined by an authoritarian faith, not bound by time – thus science regarded by the Church as the “handmaiden” of theology.^{iii,10}

Kuhn asserts “the tendency to [recognize] the development of science [as] linear hides a process that lies at the heart of the most significant episodes of scientific development.”⁴ This “process” being what he refers to as problems and revolutions in science that result in paradigm shifts – significant changes or discoveries that so greatly affect understandings of the world that conceptual reversions to pre-paradigmatic changes are impossible and that dialogue between paradigms is also impossible. This is what Kuhn regards as the “incommensurability” between paradigms. Subsequently, Kuhn recognized that Galileo’s work served to advance science while simultaneously awaiting the conclusive evidence to confirm the heliocentric hypothesis. He says of Galileo that “[h]is example typifies one important aspect of theoretical genius in the natural sciences – it is a genius that leaps ahead of the facts, leaving the rather different talent of the experimentalist and instrumentalist to catch up. In this case catching up took a long time.”¹¹

Galileo’s advancement of heliocentrism called the geocentric position into question by way of logically sound, though temporally inconclusive, refutation. But the Church could not accept a scripturally supported hypothesis that did not directly cohere with said scripture, interpreted literally. Acceptance of truth had to wait until Newton’s mathematical confirmation of the legitimacy of heliocentrism, which made returning to geocentric understandings of the universe counterproductive to science, thus confirming the Galilean paradigmatic shift and normalizing heliocentrism as the basis for modern astronomy. This was the case because “[a]fter a scientific revolution many

old measurements and manipulations become irrelevant and are replaced by others instead,” asserts Kuhn.⁴ It follows that science is in a continual process of change. Such changes, though, are not fully recognized until new understandings and conclusions about the constitution of our world, new theoretical developments, and new methodological approaches impart and advance revolutionary knowledge, thus becoming what Kuhn calls “normal science.” In line with this analysis, Galileo penned a similar proclamation concerning the state of contemporary science: the results of scientific investigations drive the “necessity of changing the previous conception of the constitution of the world.”² As a result, scientific inquiry becomes a pursuit of knowledge that is located contemporarily, hence epoch-defining. In comparison, inherited faith represents a constant metaphysics that is accepted on the basis of belief, which only changes insofar as is necessary to contend as a venerable worldview in a scientifically informed and evolving world.

Galileo often affirmed the law of noncontradiction throughout his writings, referring to his understanding of the truth-claims of faith and those of science as parallel.² But historian Vern Bullough raises pertinent questions about these assumed parallel truth-claims that highlight the cleavage between faith and science across time: “How does one incorporate ... new [scientific] discoveries into theological thinking? Should they be incorporated? Should religious belief be based on science?”¹² Or are they different realms, different ways of understanding the world and understanding life? Bullough qualifies these questions by suggesting that religious faith and the enterprise of science represent two different “magisteria.” His employment here of “magisteria” denotes the realms of faith and science as distinct worldviews with different kinds of truths, different understandings of the world, different notions and values pertaining to the concept of time. It is immediately evident that Galileo’s philosophical ideal of two truths recalls the problems inherent in authority and hierarchy while also embodying issues of contingency and temporality. Can the truths in question – scientific observations about nature and references and teachings about nature in scripture – both claim to represent truth as such? That is, granting Galileo’s proclamation, are we to regard science (as a human endeavor) at the theoretical level with the Christian faith, or any faith for that matter (as belief in the otherworldly), as the overarching metatheory? It seems that while these two “magisteria” can more or less cohabitate, they cannot cooperate while simultaneously remaining autonomous because one worldview would necessarily be required to subordinate or defer to the other, thereby satisfying Galileo’s misguided appeal to the law of noncontradiction.

A contemporary analysis of Galileo’s harmonization of faith and science shows that even though science is definitionally afforded a certain autonomy – science being the discipline through which philosophical inquiries pertaining to the constitution of our world and its place in the universe can contemporarily be observationally and satisfactorily conducted – as a human endeavor, science would necessarily fall under the purview of the primacy and finality of religious faith. The result – which, to be sure, was not Galileo’s analytical aim – manifests in the form of metaphysical apologetics: if faith and God above are recognized as truth on the basis of their authoritative truth-claims, then science’s autonomy is merely a guise for religion’s first principles and final causality, according to articles of faith of the Christian tradition. The issue here is hegemonic preeminence. And whether it is faith as such or religiopolitical authority, which itself is a human institution, in Galileo’s time, as in ours, religious faith presumes to lay claim and preside over and above all human endeavors as ‘Ultimate Truth.’ The “Galileo affair,” then, exemplifies how faith’s truth-claims can become politicized and used wrongly to judge scientific matters,

fallaciously disregarding the epistemic differences that separate scientific knowledge from theological knowledge. This presumed religious oversight serves as counterproductive to both religion and science and shows the Church to have disregarded Galileo's warning that, in so doing, "we would deny our senses and reason," as well as human intellect, experience, and demonstrations of "physical conclusions."² Religious scholar Michael Horace Barnes authoritatively concludes that "[r]eligious thinkers do not serve humankind well by undercutting the method of science...[because] undercutting the best means available for judging the validity and reliability of truth-claims will hurt people in general, including those in communities of religious believers."¹³

Faith and science thus represent incommensurable ways of viewing the world and deriving intelligible knowledge about the world. Because religious faith requires the inclination to accept the very authority that promises its truth, the criterion for belief creates a tautological circularity that proves immensely difficult for dialogue across scientific (empirical) and religious (faith) divides. "[T]he status of the circular argument," according to Kuhn, "is only that of persuasion. It cannot be made logically or even probabilistically compelling for those who refuse to step into the circle."⁴ Consequently, when religion and politics become conflated, all aspects of life are thus affected due to a presumed God-ordained hegemony, thereby requiring worldly 'truths' to cohere with an unsubstantiated 'Ultimate Truth.' Resultant religious authority manifestly operates as "monolithic, centralized, esoteric, resistant to change, and self-protective," says philosopher Richard Blackwell. "By contrast," Blackwell continues, "authority in science ... is pluralistic, democratic, public, fallibilistic, and self-corrective."¹⁴

The Church's loss of societal influence from once-dominant political authority – including in matters where religion had no place (e.g., the "Galileo affair," or, more broadly, the enterprise of science) – to a lower level of societal influence corresponded with the rise of importance and power of science in modern society. As a result, the Church has assumed a reactionary and defensive position toward the scientific community's increased legitimacy. This is the case because faith is an emotive belief that cannot explain natural phenomena beyond purported first principles and can neither be proved nor disproved by science. But, this does not comport with what we can see and what we can know as derived from experiential fact. By extension, Christianity and other religions are pseudo-theoretically tenable but are not themselves 'theories' because they lack falsifiability and operate outside of logical parameters. Therefore, to ascertain a coherent understanding about the intricate workings of nature, one ought to look to the enterprise of science. It follows that modern science, in keeping with Galileo's criterion of method and observation, clearly falls outside religion's presumed jurisdiction over all human endeavors and is therefore not subject to accord with or to subordinate to articles of faith. Conversely, in recalling an important Galilean theological distinction, resultant discrepancies between scientific conclusions and religious conjecture necessitate reconciliation on the side of faith, albeit an apologetic effort, due to the fact that inherited Christian understandings of time, creation, and eschaton must be made consistent with observations and facts.

To conclude, not only does science change, but also human understanding changes along with it, and the methods of science represent the best means of explaining natural phenomena and the mechanistic disposition of the world and its place in the universe. Therefore, the continued significance of the "Galileo affair" serves to exemplify the necessity and importance of intellectually differentiating between religious faith and the enterprise of science, for the relationship between

religion and science and science and religion is asymmetrical. Thus, these two worldviews have been shown to be incommensurable.

Notes

¹While not the first scholar to employ the umbrella term, the "Galileo affair," Maurice Finocchiaro's analysis and reconstruction of the "affair" serves as foundational to understanding the contextual developments which began in 1613 and ended with the Inquisitional trial against and condemnation of Galileo Galilei in 1633.

²Nineteenth century historian of science Andrew Dickson White reasoned his way to the same conclusion, saying, "Galileo was condemned, not because he affirmed the motion of the earth, but because he supported it from Scripture."

³The metaphoric image of science as the "handmaiden" of the Church is an illustrative extension of the Medieval understanding of theology as the "Queen of all Sciences" and is developed in detail by David Lindberg.

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Horses in war: A history

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The sound of thundering hooves fills soldiers' ears as their horses flatten out, lower to the ground as the increased stride length gobbles up terrain. Wind whips by, chafing faces, stinging eyes, and a wild cry tears from the lips of hundreds of men. The enemy is in sight, and the soldiers are closing in. Lances level and mounts maneuver toward any slight gap between the shields of the opponent's infantry. Five strides to close the distance. This is what man and beast have trained for, practicing for years to meld into one body, one mind, one spirit. Three strides, targets picked, aim taken. One stride, all hell breaks loose. Lances aim true, piercing the enemy through armor and shattering with the impact; others go wide missing the target and enemy infantry swallow rider and horse. Comrades and horses are screaming, injured, fallen, and bloodied. The surviving force wheels to the right, flying back to the reserve forces to regroup. A cavalry shock charge just turned the tide in a raging battle.

The domestication of the horse led to societal advances. Horses were first kept as a source of meat and milk, much like cattle.¹ Although impossible to date exactly when horses were domesticated, there is archeological evidence dating from as early as 4000 BCE that indicates horses were used for riding or driving.² It is suspected horses were domesticated before this, but horses, unlike dogs, underwent very few physical changes with the process of domestication making it impossible to determine an exact time period when horses became more than just food.¹ However, according to Dr. Sandra Olsen, who has extensively researched the history of the Botai people in northern Kazakhstan, it is probable horses were domesticated and ridden in this region as early as 3600 BCE.¹ It is also believed that the Sredni Stog peoples of the Ukraine were the first to ride horses based on archaeological evidence indicating horses were ritualistically buried with bit-like equipment.¹ This type of burial indicates horses were already of extreme importance.

Although difficult to pinpoint exactly when and where riding first occurred, the earliest artifact resembling a bridle was found in the Eurasian steppes north of the Black Sea.¹ At some point, early man rode the horses, perhaps to move with the herd being kept as a food source. Regardless of why, control was needed. The first bridle had cheek pieces designed to hold the bit (a soft mouthpiece) in place.¹ This technology was slow to spread; horses were first used as beasts of burden or to pull carts. With continued horse-human interaction, the concept of riding slowly spread, giving rise to a powerful weapon – mounted warriors. Cavalry revolutionized warfare. Warriors were faster, more mobile, and deadlier when combined with the power and strength of a horse. Horses were a huge technological leap from standard infantry.³ This advance was the most revolutionary until the invention of firearms. For nearly six thousand years, the outcome of battle was dependent on the strength, speed, and heart of the horse. Napoleon was quoted saying, "Without cavalry, battles are without result."⁴ From Asia Minor, across Europe, into Africa, and eventually into America, horses changed the world one hoof beat at a time.

Horses were the ideal candidate for mounted warfare. Elephants could not adjust easily to various climates and were more difficult to maneuver through tightly wooded areas. They were used with success in some regions but were hard to control and had a nasty habit of stampeding when frightened.³ Rhinoceroses were not sufficiently

intelligent, and dogs were less effective due to their size. Camels were also used with success in some areas, having greater endurance and increased ability to survive on minimal forage and water; however, they lacked the speed of horses.² Horses flourished in many locales around the globe and were readily available. Mounted warfare fell into two main categories, heavy cavalry and light cavalry. This lethal combination made the superior cavalry the deciding factor in a skirmish.

Cavalry allowed warriors greater mobility and speed and increased their ability to outflank an enemy.⁴ However, cavalry was most effective in high quantity, so it was of utmost importance to have stud farms or breeding programs to maintain the stock of horses. Depletion of horse stock was the downfall of many great societies, even the Romans, who in later years had to rely on conscripts from surrounding tribes to field an adequate supply of both horses and men to maintain the cavalry.³ At first, horses used for cavalry purposes were quite small. This was a predicament as people were also shorter; however, larger horses were able to carry more weight in arms and armor, and as such, were more desirable.² Caring for these horses was difficult, but the horses were such a valuable asset, they were well-treated and given the best care possible at the time.⁴

War horses needed to be highly trained to perform the maneuvers necessary for survival. One of the oldest training records, written by Xenophon, dates to the first century CE.⁵ This document, the *Ars Tactica*, has a section specifically on cavalry. Xenophon's work is one of the first documented sources urging riders to understand the mentality of the horse. He wrote about the art of horsemanship, emphasizing the importance of daily care of the horse to keep it happy and healthy.⁵ Much of Xenophon's advice is still followed today. The cavalry section of the *Ars Tactica* deals largely with the maneuvers warhorses performed. The practice for these maneuvers was carried out in a festival-like setting, with civilians gathering to observe the impressive display of charging, wheeling, and synchronization essential for an effective cavalry attack.⁵ This created a safe environment in which to practice. Practice was crucial because a cavalry unit needed to function as one. Practice gave the horses time to acclimate to the noises of battle and to learn it was possible to charge without injury into what appeared to be a solid mass of opponents. Group training played to the herd instincts of the horse, fostering a competitive nature useful on the battlefield. Romans started their horses at three years old, training them in round pens similar to what we use today.⁵ High expectations were placed on these horses, but Xenophon knew that horses should be rewarded with kindness for a job well done and with a quick reprimand for misbehaviors in order to be successful.

The term warhorse implies a sturdy, reliable, fearless steed, all natural qualities of a horse.⁴ Horses are herd animals that flee for survival. Although, a horse, if forced into a threatening situation, will fight using teeth and hooves, it generally prefers to make a speedy escape from that which frightens it. An effective war mount would have great trust in his rider and be accustomed to the sights, sounds and scents of the battlefield.⁴ These horses would need years of training to become highly efficient fighters. Horses also have a great memory for past experience. All preparatory training would have been specifically designed to be trauma free. The very act of charging into a solid

looking object is unnatural to the horse; they are not stupid animals and are adept to stopping on a dime. Taking the time to introduce a horse to everything encountered on the battlefield was a key aspect of preparation. The adrenaline rush of a cavalry charge may have helped mask pain and stress the horses encountered in battle. If horses associated pain and fear with charging to battle, it would be difficult to convince the horses to charge again.⁵

Horse care varied with different cultures. Mongol horses led the most natural lifestyle, spending much of their time grazing. The Mongol horse ate only grasses, unlike horses that are kept in stables and are supplemented with grain. This, coupled with the terrain of the steppes, made these horses tough and hardy, perfectly suited to Mongol style warfare. Most other nations kept horses much as they are today, in large pastures, supplementing their diet with grain and hay. This meant cavalry upkeep was too often dependent on supply trains bringing in hay, grain and necessities. Training methods varied based on preferences to warfare. Some horses were taught to lie down and wait for their riders to return so soldiers could fight on foot. Horses were taught to kick, bite in order to maim, cripple, and kill the enemy. In Europe, stallions were preferred, as it was sometimes easier to emphasize these behaviors. All warhorses needed to move easily off leg pressure and give to the bit.⁴ They needed skills like jumping, surefootedness, ability to traverse all terrain, as well as basics like standing to be mounted. In addition, horses had to be accustomed to the noises of battle, be willing to charge at an enemy, and have enough trust in their riders to respond quickly and correctly in any situation.

Classical dressage movements such as the levade, volte, and capriole evolved from training. Circles were used to make the horse more supple, increasing its strength and flexibility, while rollbacks allowed for a quick directional change.⁵ Horses were taught leads and put through exercises that combine aspects of dressage, reining, cross-country jumping, polo, and police horse work. These horses needed to be able to rear and strike at the enemy with ease, to travel great distances at speed, and to carry a man with armor and weaponry. This was incredibly taxing on the horse and required years of training and practice to reach the high level of understanding and communication necessary for success. In battle, there was no time to correct a rowdy mount; it would make both horse and rider an easy target. Horse and rider had to work together to keep each other safe. Trust in his horse allowed the rider to worry less about judgment calls over terrain and battle position. A horse that knew his job could anticipate the proper maneuvers needed, allowing the rider to maintain focus on the battle. Horses were bred for speed, stamina, and size, all necessary traits to be able to carry a man in armor and ideally some horse armor as well.

Battles could be easily won if there was an element foreign to the enemy's horses. For example, elephants used in the Punic Wars were terrifying to horses that had never seen nor heard them before. It would be nigh impossible to get these frightened horses to charge in the orderly manner in which they had been trained. Horses are very sensitive to details and often time bolt before realizing what an object might be. The introduction of something as huge and foreign as an elephant was sure to make even the staunchest and most experienced warhorse uneasy. The Sarmatian people carried a standard that had a metal head and long windsock-like tail that produced a wailing sound when the wind whipped through it. These devices were very successful at frightening horses if they had never seen them before, and as such, were copied. Costuming armor by adding wings, plumes, facemasks, and other material that would change the appearance of a rider to an enemy's horse was a good way to throw off opponents. Introducing a variety of unusual objects to a young horse without

exposing him to undue trauma was the only way to train a war mount that was not panicky in nature.

Cavalry is separated into two categories. Light cavalry was comprised of quick horses paired with an accomplished archer or javelin thrower. Lightning fast attacks could be made on the enemy, zooming into range and peeling away with a parting shot before action could be taken. Light cavalry was propagated by nomadic groups, especially those of the steppe cultures. Light cavalry was useful for conducting raids, scouting, spying on the enemy, distracting the enemy, and using hit-and-run, blitzkrieg-type attacks.³ Protection from injury depended on speed and surprise. The horses' tack was simple, often just a saddle pad or blanket and a soft bridle. The riders would bring the essentials needed to travel great distances in the wild, and the horses would be accustomed to covering many miles, even at speed. Traveling lightly without a supply train eliminated the risk of being cut off from food and necessities. Light cavalry was less expensive than heavy and practical for traversing inconsistent terrain between battles, especially if soldiers were accustomed to foraging for food while on the move.⁴ Light cavalry carried a sword or a weapon suited for close combat in addition to projectile weaponry.

Genghis Kahn offers a brilliant example of the effectiveness of light cavalry. As a nomadic group, horses were used to travel, giving rise to well-trained sturdy endurance horses.⁶ The Mongols were a terror on horseback; they were highly accomplished riders. Famous for the "Parthian," or parting shot, Mongols could fire their bows while retreating.⁶ These horses would be the modern endurance type, hardy and well-conditioned, although they were shaggy and stocky in appearance. Generally, the Mongol warrior had his own string of horses so they could be switched out to allow traveling at greater speed. Each warrior was responsible for his own animals.⁶

Heavy cavalry mounts are the stereotypical warhorses. These horses were large draft types, trained to charge into enemy lines carrying a fully armed man with a lance and long sword for close combat. Both horse and rider wore more armor, as both were in the heart of a raging battle. Speed was not essential: This cavalry attack focused on power. Horses needed a calm, obedient disposition. Shying out of a line of charging horses would cause disaster in the ranks. The primary heavy force beginning circa 200 CE was the cataphract, a cavalry soldier equipped with leather lined scale or chain mail, lance and long sword.² These horses were not able to charge as quickly or to retreat as quickly as they were severely weighted down. Stirrups were helpful, especially as armor became increasingly heavy. The stirrup increased the force of a lance on impact, and the rider would not easily be unhorsed in a collision. Heavy cavalry developed as horses were bred for increased size and stamina. One of the downfalls of a heavily armored horse and rider was heat. Overheating could put the cavalry in jeopardy if the horse was overtaxed. Heavy and light cavalry were used in conjunction as each had a specialized role. Heavy cavalry was very intimidating to an enemy, and one charge could be enough to break enemy lines.

Roman horses in the first few centuries CE were equipped with both saddle and bridle. Other groups did not use saddles, but rather a simple blanket or pad. The Roman saddles were constructed with four horns, one at each "corner" of the saddle.⁵ These saddles did not fit the horses well and had to be used with many layers of padding to prevent chafing and soreness. Another common early saddle type had a wooden arch in both front and back connected with leather that formed a pillow on each side of the horse spine. Both types had an ill fit that made horse care paramount, as weakening or injuring the horses could cause the loss of a campaign. The front two horns on the saddle created a seat belt of sort, passing over the rider's thighs

and securing him in place.⁵ Increasing the length of these horns so that more of the thigh was covered increased the stability of the rider much like a stirrup would. Longer horns were more dangerous: If a horse were to flip over in battle the rider would be trapped. The rear horns of the saddle stabilized the rider on impact. When a lance charge met resistance from the opposing army, the rider would have to absorb most of the shock.⁵ The rear saddle horns made that absorption easier and decreased the chance of losing one's seat.

The Roman bridles were similar to those of modern day. Metal bits were utilized, and remains of many different varieties have been found in archaeological digs. These bits were often harsh on the horse. According to Ann Hyland in her book *Training the Roman Cavalry*, these bits were necessary for a warhorse to operate at his highest performance. The author tried a replica of these bits on her own horses and found that with a light hand it worked very well for horses with less sensitive mouths. These bits had a port with sharp edges which lay flat unless the rider lifted his hands. This activated the port, driving it into the palate of the horse's mouth. The rings of the bit were fit with metal spokes which turned as more force was applied, pressing on the outer sides of the horse's mouth. This was to keep the horse directly on the bit, eliminating any chance of avoiding contact and thus being less responsive on the battlefield.⁵ There was also a metal piece that went under the chin, making it uncomfortable for a horse to open his mouth. This bridle tells us one of three things: The Romans were exceptional horsemen with steady hands even in the heat of battle, the horses the Romans used were particularly hard-mouthed, or, although unlikely, the horses were very tolerant of their mouths being ripped open. Hyland hypothesizes that in the heat of a battle with the horses galloping toward a row of pike men or enemy cavalry (which would be against the horse's nature of flight), these bridles would be necessary to ensure the horses paid attention and did not break ranks. Snaffle bits, bits with rollers, bits with different ports, and curbs could also be found from the same age. Reins were later coated in metal to prevent the enemy slashing them.¹ Some cultures did not use bridles but rather a neck rope, steering the horse by applying pressure opposite the side in which the horse was to travel.¹

Horseshoes were not developed until the sixth century CE.⁷ The Romans created what was called a hipposandal, a device similar to the sandals they wore. The hipposandal could be secured on the hoof with leather straps. It was not widely utilized, functioning more on an as-needed basis. It is thought leather or woven booties of some sort may also have been used in Asia before the horseshoe was invented.⁷ Although some debate the usefulness of horseshoes even to this day, for horses expected to be running over hardened surfaces and rough terrain, horseshoes can minimize soreness. Horses have relatively small feet in comparison to the amount of weight they bear, and injury to one foot can end the useful life of any mount. The foot is sensitive to mere pebbles, let alone broken bits of lances, arrows, dropped knives, and mutilated armor all likely to be underfoot in a battle. Studded horseshoes could give grip over icy or slippery grounds, turning the horse into a veritable all-terrain vehicle. Horseshoes were made of bronze originally, having six nails and a slightly scalloped appearance.⁷ Over time, the shoes were made of heavier iron and were less scalloped with eight nail holes. Horseshoes have remained common for horses in heavy work to this day.

The stirrup is a highly controversial invention. Some sources claim the stirrup was necessary for any cavalry charge to be successful, while others point out that lance charges were common before the invention of stirrups.³ Although possible to charge with a lance while riding bareback, the stirrup lent security and increased striking force of attacks to the rider. The earliest form of the stirrup was a toe ring,

utilized in India possibly by the Huns.³ This ring would have been uncomfortable and impractical if wearing shoes. The modern stirrup is thought to have originated in China circa 300 CE. It is mentioned by a Chinese general writing in 444 CE.³ The stirrup was slow to spread, taking hundreds of years to migrate east. If it had made a huge difference in battle outcome, it would have spread quickly, especially as cavalry units were noted for adopting technologic advances.³ The most useful part of the stirrup is ease of mounting. Although jumping on a horse bareback can be easily accomplished, adding armor and weapons increases the difficulty and complexity of this task. Not only is a higher jump required to hoist the added weight on to the horse, but also added care must be taken not to injure horse or rider with weaponry. Wasting time mounting would be unacceptable for efficacy in attacking. Warriors had to be ready quickly, and horses had to be accustomed to being mounted from any angle. The stirrup would decrease time needed to mount and therefore the time needed to prepare for a charge. Stirrups also increased the safety, comfort, stability and reach of the rider. Stirrups allow a rider to lean to the side to deliver a sword blow, much like polo players today are able to twist out of their saddles to strike. The slow spread of stirrups may have also been due to many cultures viewing them as an admission of weakness.³ German tribes were known to go out of their way to engage parties who were using stirrups to prove they were an unnecessary piece of equipment.³

Cavalry charges were conducted in a variety of manners, but for heavy charges there was always a line of riders. The charge of heavy cavalry is known as mounted shock combat.⁸ The overall formation may have been that of a wedge, rhombus, or square, but if the first line consisted of multiple horsemen, these horses were expected to charge at the same pace with the riders traveling toe to toe with their neighbors, creating an intimidating semi-impregnable wall of horseflesh and steel.⁵ When the cavalry carried shields, it was possible to protect yourself, your neighbor and your horse by staying in tight formation, but to work effectively, it required horses to travel at similar speeds and be of like size. Longer lines with less depth were ideal as it was difficult for horsemen in the rear to push through their comrades in the front, unlike infantry who could easily do so. Unfortunately, the horses were the easier target in these charges. Wedge or rhombus formations were considered more effective, as it was easier to change the direction of the charge.⁵ Square formations were much more difficult to turn. Wedges were formatted so that the heaviest horse with the most armor and experience led the charge getting progressively lighter toward the rear.⁴ This allowed the cavalry to take advantage of the slightest gap in enemy lines: If the first horse could squeeze through, the following horses would widen the hole until the enemy's line had broken. The last 300 meters of a charge closed at a canter or gallop, taking less than one minute to reach the enemy.⁴ When pistols were used in the charge, it was carried out at a trot to allow time to reload the weapons. It was customary for infantry to follow cavalry in attack; foot soldiers could easily slip through the holes created by the cavalry. If multiple charges were called for, three to four cavalry lines were utilized. After the first line of cavalry collided with the enemy, if possible, the cavalry wheeled to the right (shields were carried on the left, so turning right would lend the most protection) and reformed behind the last line.⁸ This was a difficult tactic for an enemy on foot to withstand. The goal was to force the opposing infantry to break rank and flee. Cavalry against cavalry were more likely to stay engaged in close combat, especially if equally matched in skill and weaponry.

Many different tactics were used to oppose cavalry. A solid phalanx of interlocking shields and pikes was effective. It was difficult to coerce the enemy's horses to charge into a solid wall with sharpened projectiles if the warriors could stand their ground. Celtic warriors

would actually fight as individuals against a horse, trying to slash the horse in the legs or belly to bring down the rider. This required great skill and daring and was not a commonly employed technique but was highly effective when properly executed. Often when charging opposing cavalry or infantry, it was a game of who would flinch first. Anti-horse obstacles could be used by the infantry (flooding the terrain, setting pikes into the ground to create an angled wall of spikes, digging deep trenches) to force the cavalry to attack from a certain direction.⁸ Deception and innovation were key when fighting cavalry or when leading a cavalry unit. Feigning retreat was a common tactic, and if properly performed, it was possible to convince the enemy to give chase, break ranks, and thus be rather easy to defeat with an organized charge.⁸ Leadership was often the determining factor of success, more so than quantity of soldiers. With the advancement of the long bow and sturdy pikes, it was not difficult to take down the horses with archers. Since killing the horse meant that the rider was often killed or disabled, the horse was an optimum target. Although possible to protect both the horse's face and chest with some armor, it was impossible to encase the legs in a manner that offered both adequate protection and freedom of movement. At the peak of longbow prowess, even human armor was not impervious to penetration.

Germanic warriors had unique cavalry. The heavy used larger, heavier lances, subsequently requiring larger horses to bear the weight. These lances were so heavy that neither the rider nor the horse was armored.⁹ These lances were balanced on the left shoulder to allow the horses to wheel away to the right. The large lances Germanic warriors used caused crushing impact and deep penetration of enemy forces. Germanic groups also had specialized horse stabbers and hewers.⁹ These fast runners kept pace with the horses (which charged at a canter, not a gallop). Horse hewers were armed with curved knives specially designed to rip through tendons with a pulling motion.⁹ They were often the squires of those involved in the mounted charge, and both mounted and foot warrior would work together to bring down the enemy. Horse stabbers would face a charging horse, attempting to roll between the horse's front legs and gut it mid charge. To avoid entanglement, these warriors fought in minimal clothing, often simply winding a cloth around their forearm to guard against blows.⁹ Germanic cavalry served as the personal guards for the Roman Empire for many years due to the cavalry's excellence in combat.¹⁰

Between 200 and 400 CE, cavalry quantity increased dramatically.² The standard heavy cavalry used strong mounts capable of bearing a complete set of armor. This included scale or chain mail, the inside of which would be lined with leather, helmets covering most of the rider's face, and some armor for the horse. Soldiers wearing this heavy set of armor did not carry a shield and were called *clibanarii* ("oven-men") by the Romans, as wearing such equipment was very hot! Tack included a breastplate and often a crupper or haunch harness to help hold the often ill-fitting saddle in place. Horse armor varied based on size of the horse, weight of the fully armed rider, and available technology. Early horse armor was simple and consisted of a heavy cloth covering made of canvas, leather or quilted fabric. Chamfrons, or faceplates, were used to protect the horse's face and could be made of leather or metal. Some chamfrons also had protective eye coverings, or horns, spikes, and decoration to make the horse look fearsome and to allow the horse's head to function as a battering ram. As horses got larger and were able to carry additional weight and as armor became more advanced, more pieces were added. Breastplates, made of scale, chain, and eventually plate armor, were common. Chain mail was fantastic because it was lighter than plate and was ventilated while still offering a good deal of protection. Full horse armor covered the neck, chest, and haunches and could be made of lamellar scale armor,

chain mail, plate, or a combination of all of these. Armor was padded to provide extra comfort.

The weapons carried by cavalry members varied, but bows, lances, spears, javelins, swords, knives, long-handled axes, maces, and even quarterstaves were all possible weapon choices. The horses had to be accustomed to any weaponry the rider might choose to wield. Composite bows, or re-curve bows, were suitable for mounted use, and some were specially designed to be shorter on the bottom half to allow ease of use. These bows were often reinforced with buffalo or cattle horn at the tips to protect the bows from the strain of the re-curve. Javelins and spears could be thrown from the horse while lances were used to impale the enemy during a charge. Lances ranged in length from twelve to almost twenty feet. Longer, heavier lances had to be wielded two-handed, making it necessary for the horse to respond entirely off leg commands. Lances evolved to have either a counterweight on the back, allowing the lance to be gripped further back and lending an increased reach to the warrior, or to have a second tip on the butt end in case the front was broken or became lodged in an enemy. Lances could be held in a variety of positions, two-handed crossing the body diagonally with the point past the horse's left ear, over the shoulder held with the thumb pointed to the rear, out to the side with the thumb pointing forward, or couched – tucked under the arm. Sword type differed greatly, but the swords were always long and were designed to give maximum striking force. Some cavalry swords had a wrist strap to ensure they were not lost in the battle.⁴ Horses also carried quivers or sheaths attached to their saddles to store the weapons the rider was not using.

The major downside to cavalry was transportation and care of the horse. The logistics of transporting a large number of horses was a nightmare that would plague cavalry leaders endlessly.¹ Assuming the average horse at this time stood 15 hands high and weighed about 1500 pounds, each animal would need roughly 25 pounds of feed per day (including both hay and grain). Coupled with the amounts of fresh water needed, transporting horses required a lot of preparation. Care also needed to be taken in removing manure and supplying enough horseshoes, nails, farriers, and people to care for the horses.

Medieval cavalry is the common image that comes to mind when thinking of horses in warfare. Jousting tournaments were simply practice for the battlefield. Early tournaments were a free-for-all in which groups of up to 200 knights tried to capture each other for ransom. The only governing rules were designated areas for rest, re-arming, or holding defeated foes. Financial compensation was the general motivator for tournament participation.¹ Tournaments offered a chance to show off; horses were decorated in ornate cloths with the knight's personal crest. High backed saddles were used in this period to give the knights greater leverage and stability. Lance skills were practiced in tournament games such as trying to collect small rings on the tip of the lance or hitting a quintain, a shield-like apparatus that spun when struck, more points being scored with a higher number of rotations.

The number of knights decreased drastically in the seventeenth century, but heavy cavalry was still the predominant source of charge, and light cavalry the predominant source of protection, pursuit, and reconnaissance. Horses had been bred for increased size, but with the increased gun power, horses that were light and fast were the new ideal.¹¹ Armor was decreased, with horses wearing none and soldiers wearing only breast and/or back plates. Riding had become an art, with the foundation of the Spanish Riding School in the mid 1500s and a later addition of a French riding school in Versailles. Polish cavalry, French cavalry, and Italian cavalry were the dominant players in the Renaissance era and into the eighteenth century. By this

time, cavalry was standardized for the most part, with the only significant differences being between eastern and western cultures.¹¹ Eastern cultures focused on speed, with sudden, unexpected attacks to wear down the opponent. They were much better horsemen, using the horse on a day to day basis, with each soldier caring for his own mounts. In western cultures, horses were cared for by stable boys, and only the wealthy could afford such a luxury. The horses were used for offensive shock charges and were not needed in times of peace.

Later notable uses of cavalry are found in America, the land founded upon horseback. Hernando Cortez proclaimed, “[N]ext to God we owe our victory [in the new world] to our horses.”¹² The native populations who had never seen such a creature, held horses in awe, as the horse had been absent from North America for thousands of years. Native Americans were quick to learn to ride the horse and became renowned for their skills on horseback, taking excellent care of their mounts and achieving a high level of partnership with minimal gear. The Native Americans fought in a style similar to that of the Mongols, conducting raids and making heavy use of archery. The war paint the horses wore often symbolized the feats the horse had achieved. For example, a left handprint on the horse’s right hip indicated the horse had brought his rider safely back from battle after the rider had been seriously injured. Tail braiding was common to prevent the enemy from grabbing it or it catching while traveling. Manes were often sheared short so not to obstruct projectile launch.

As guns became more prevalent, change in tactics was needed. Some cavalry fired their pistols first then charged into a battle with swords drawn, others dismounted to fire their guns, and some waited until close enough to ensure accurate fire before shooting. Horses were expected to charge into heavy musket fire, but if they made it to the infantry square, they were often impaled on bayonets. The chaos and smoke from gunpowder made controlling cavalry even more difficult. Uniforms became a standard in the late 1600s to help distinguish friend from foe, and most forces had designated runners to communicate between battle groups. The runners had uniforms that designated them as non-combatants to attempt safe passage through the clashing armies.

The American Civil War era cavalry was established in 1833. It consisted of dragoon regiments with the later addition of mounted riflemen. At the onset of the war, the South held the advantage as horses were more commonly ridden there, while in the north horses were more often driven. The confederate soldiers used their own horses, which were considerably superior to those supplied by the union.¹ Horses were used not only in the war but also to help expand the western frontier, combating Indian raids. Cavalry was generally followed with artillery and was used for scouting missions, for covering the flanks of the main army, and for the general disruption of the enemy. The U.S. saw the cavalry as an unnecessary expense, and just as ancient cultures had, struggled with the time and money needed to raise, train, and maintain a strong cavalry force. As the Civil War wore on, remounts were scarce, and the cavalry was not nearly as well cared for as it should have been; horses were gathered, trained, then shipped to the needed location, often to people who had insufficient knowledge, skills, or abilities to ensure they were properly maintained. Soldiers who traveled great distances with their mounts (30-35 miles a day in some cases, a number that had not changed since the time of Alexander the Great) found that traveling lightly allowed the horses to cover more distance without tiring as quickly. Many horses were lost due to disease and inferior care. Cavalry weapons at this time consisted of sabers, revolvers, and the occasional rifle or shotgun. Multiple firearms were common, reducing the amount of

time needed to reload. Soldiers fought both mounted and on foot, sometimes even training horses to lie down to present a smaller target while shooting. By the late 1800s, cavalry was more effective if the soldiers rode to the site of battle then fought on foot. This change was slow to take place, as it was hard to forgo the glory of being a cavalry soldier. Although cavalry use declined drastically with the invention of gunpowder, regiments were still functioning into the early twentieth century.¹² Advances in guns are what truly ended the use of cavalry. When guns took several minutes to reload and were horribly inaccurate, a quick cavalry charge could still be successful. Mechanized guns ended this. Machine guns that could fire hundreds of rounds in minutes meant there was no hope of a successful cavalry charge.⁴ Horses were used through World War II but could not compete with trench warfare, barbed wire, and powerful new firearms. The 5,000 year reign of the horse came to an abrupt end in a blast of gunpowder and smoke.

What made cavalry so special was not the armor, arms, or warriors’ skill, but the speed, strength, and heart of the horse. Horses gave their lives for their human riders, an ultimate sacrifice. Cavalry has never been forgotten and still influences modern life. Any film set in those 5,000 years is sure to include a cavalry charge of epic proportion. Although the exact tactics may not be accurately recreated, nor the armor or arms, film is still able to capture the raw power and frightening force the cavalry emitted. Inevitably, the charging cavalry saves the day. Jousting tournaments still occur with people dressed in armor from the period and charging to victory. Classically trained dressage horses still perform the levades, caprioles, and voltes that were created as part of the training for cavalry mounts. Mounted shooting competitions showcase the age old skill of maintaining a steady hand while riding. Polo players score points with strikes similar to those which cleaved enemy infantry. Lessons are given without stirrups to improve a rider’s seat. People ride using only one hand, leaving the other to perform tasks such as roping, swinging a mallet, shooting a gun, or simply opening a gate. The skills of the cavalry soldier are still needed by those who ride, no matter the discipline. Though mounted warfare may no longer exist, the influence, power, and glory of its reign will never be forgotten.

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Smile

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“Can you walk?” the skinny, Vietnamese waiter asked me.

The question shocked me. I guessed he did not see me walk into the Wax bar, which was an oceanside bungalow made of cement and a palm leafed roof. Why did he ask? I sat at my chair and looked up at him. He waited with his fingers laced together while the ocean rolled behind him and the humidity sat on our shoulders like blocks.

“Yes I can,” I said. I did not know how else to answer. I stood up from my chair. I felt my bare feet hug the cool cement. I showed him my small chunks of calves flexed with years of carrying my body. My scars that looked like dried canyons along the inside of my ankles and feet. My small feet were covered with veins and hair, and my toes wiggled with less life than dried, curled worms on a sidewalk. But they worked.

“Oh I see,” he said with high eyebrows. He pulled up a chair and threw his right elbow on the wooden bar top. He was a twenty-one-year-old, he said, and his name was Huynh (pronounced *yo*). He talked with a loud voice, small hand gestures, and pauses in between his sentences. The Wax bar and restaurant was empty except for the yellow shirted staff members and my iced coffee as I waited for a bus that would leave in two hours. Soon, the ship where I lived and studied for four months would leave for India later that evening.

“Aaaa.. I wanted to know if you could walk because, aaah, because my cousin has legs like those,” Huynh explained and pointed at my legs. “Only he can’t walk.”

Huynh told me his cousin was a fifteen-year-old who lived in a house all day without access to a wheelchair. I tried to imagine him. I tried to imagine that life. Was this person confined to a bed all day? Maybe his family members assisted him out for gatherings and cook-outs. When was the last time he saw a doctor? Did friends visit him? I hoped that he was not isolated in a bedroom with darkened windows and light from a TV smeared across the room. I hoped he did not hate looking outside because when you are stuck in a bed, hot air and sunlight taunt you as you lay like breathing stones. I hoped he did not cry at night while he gripped a pillow and begged for an answer to the question: *Why was I born with this body?*

My obligation to pound coffee into my system and leave for the bus stop dissolved. I even forgot about the beauty of this town, Mui Ne. Stoplights and busyness were absent, kite surfers and fishermen skimmed empty roads, and palm trees yawned in the wind. Then there was that blue ocean that stretched toward the horizon. Each square of the place was worthy of a photograph, and in fact I had taken many pictures. I scribbled down details and words in my journal and looked at my camera that sat inside my bag which rested on the bar top. I was determined to get a picture with Huynh before I left. I wanted to remember him the same way I wanted to remember a sunset on the ocean.

Huynh tapped his fingernails on the wooden bar top. “Was there a – a time... when you couldn’t walk?” he asked loudly.

“Yes,” I replied and explained how between the ages of nine months and seventeen years old I had ten major surgeries to fix my spine and feet. When I was born in Riverton, Wyoming, my feet jerked toward my crotch and my spine was attacked by odd pieces of vertebrae.

When I was born the doctors told my parents, “This baby is born for a lifetime in a wheelchair.”

I told Huynh of the visits to Shriners Hospital in Salt Lake City, Utah. I remembered colorful carpets, the x-ray machines, giant dome ceiling, the happy therapists, nurses, and surgeons who roamed the floors. Most of them knew my name because of my frequent visits and my mother who worked there as an occupational therapist. We moved from rural Wyoming to Salt Lake City after my parents divorced. I was seven years old when we moved and my mom got the job at Shriners. I remembered the years I dangled my feet from the squishy doctor’s table to see if my x-ray showed that I could go another six months without a surgery. I remembered the IV burrowed in my hand, the white gown covering my body, and the bed that held me like a hand offering me to scalpels and peeping white lights. I remembered the thin flexible rod poked into my spinal cord that injected morphine directly into my system. The catheter invaded my penis and kept me jailed to a bed. Gloved hands inspected my stitches which zipped my flesh from a surgery that lasted anywhere from two hours to eleven.

When I lived in Wyoming other kids also asked me if I could walk. I always shook my head no while I sat with casts, metal twister cables, or braces that held my feet straight. My first surgery was when I was nine months old. The doctors at Shriners did not guarantee that I would walk. From nine months through three years of age, I underwent four major foot surgeries, hours of physical therapy, and a requirement to wear braces and twister cables. My mother often lifted my small body with her hands wrapped around my torso and hoped one day she could let me go.

One late morning at the age of three, with my legs and feet gripped by metal and plastic, I played with a toy truck pushing it back and forth in our narrow kitchen. My mom stood by the table and flipped through paperwork as she enjoyed the sunlight that breathed through the windows. She occasionally glanced out at the hills and fields of northeastern Wyoming. At some point, I stopped the wheels of my toy truck and lifted my body to stand. I imagined that my knees snapped and felt for the first time my weight plunged upright. My small pale muscles awakened and bulged inside the cage of my braces. My shoes that kept my feet straightened were hungry to eat up the path ahead of me. I imagined my hands wanted to be wrapped around my mom’s long legs that stood across the kitchen. I plopped one foot, then another on the yellow and brown linoleum floor. I left my toy truck behind in the wake of my first steps with a giant three-year-old smile on my face. I imagined my mother’s back erupted with ripples, a tornado of light clustered in her chest, and her mouth pulling oxygen. I imagined how her eyelids blinked and questioned if what she saw was real as my legs carried me. I hugged my mom’s legs. Tears dripped from my mother’s eyes. She wanted to tell all the doctors and all the people that doubted me, “I told you so.” It took four surgeries, years of therapy, and twenty tons of hope for my legs to lift my body through that kitchen.

Since then, my legs had lifted me to many places, including the Wax restaurant in Mui Ne, Vietnam, where I talked to Huynh. I saw him take in my story. He sat crunched in his seat with occasional eyebrow lifts and low hums of the voice. I felt his imagination swirl. I won-

dered if he thought: *What if my cousin was born in America?* I threw my senses to my feet. My soles perched on the wooden legs of my chair. I remembered the feeling of the day before when I pushed pedals thirty miles on a rusty cruiser bike along the coast. Sweat poured out of my skin, and pain clicked in my ankles. I would never hate that feeling. I wanted that feeling of gearing through thirty miles of thick humidity and earth swallowing sun. I wanted the ability to see small villages with squared wooden homes, oxen pulled carts, and the smell of sour fish. I wanted to hear tires crunch the asphalt. I wanted to see scenes of a rock island calmly sleeping under the protection of night where the moon hung spherically in the sky and yelled white light onto the ocean and road.

Huynh looked at the bar top and told me Vietnam did not have any places like Shriners. He had family members who were in England trying to get his cousin to Hong Kong or America where a surgery could be done, but they lacked money to make it happen. I asked him if he could ever go to college.

“No, it’s not like America. We don’t get the same schooling. No university near here,” he said with a crushed face and lowered head. A breeze rolled on top of the counter and slapped the leaves that dangled from the roof.

I crunched my jaw. I felt guilty for complaining about taking a test, writing papers, and attending classes. Huynh maybe wanted the stresses I had in college. He might like opportunity to travel, to take college classes, to ride a bike up the coast of a foreign country, to visit with the locals, or not to work at the Wax bar.

I grabbed my calves and squeezed. Why was I born in America and

Huynh’s cousin born in Vietnam? I had the luck to be born in a place that fixed my deformed bones for the cost of nothing, a place with skillful surgeons who gave me a vehicle to experience the world. I could sweat and grind up the coast of Vietnam, travel from my homeland, see Mui Ne’s beauty, and meet Huynh without needing a wheelchair. I was born in a place where I didn’t have to work in a restaurant as a waiter my whole life. I could become a fully educated person and gain the tools to give something back to the world and visit parts of it. I released my calves and took a deep breath.

It was time for me to leave. I asked Huynh to write down his contact information and the word for smile in his first language: *cười*. Something I asked every local I met. The other yellow shirted staff came over to see what Huynh was writing. They began smiling and laughing.

After Huynh was done writing, he straightened his back and made a declaration. “You are coming to dinner tonight with us. And you will eat a traditional Vietnamese meal with us.”

I painfully turned down the offer. Huynh looked saddened. I gripped my camera in my bag. Huynh did not have a camera. He lacked the luxury to capture this moment in a photo or of any moment around him in beautiful Mui Ne. For that moment, I wanted to own the memory in the same way as Huynh. I left the digital camera in my bag.

I walked onto the beach away from the Wax restaurant and wished I had one more night. I waved goodbye to Huynh and to the other staff members who wore yellow shirts, smiles, and blurred hands. I smiled back and felt the hot sand pile over my bare feet.

Wonder as a rhetoric of ineffability in ekphrasis and translation in Chaucer’s *The Book of the Duchess* and Coleridge’s “The Garden of Boccaccio”

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“The Garden of Boccaccio” (1828), a poem by Samuel Taylor Coleridge, is probably not a direct imitation of Geoffrey Chaucer’s longer poem, *The Book of the Duchess* (circa 1370). However, the two works overlap in one significant respect: they are both narrations from the first-person point of view in which the author “wonders” at a work of art but struggles with the problem of incomplete or defective expression. The speaker of each poem describes his own relation to the subject work of art in terms of wonder and has difficulty with the ineffability or inexpressibility of that relation. The narrator of Chaucer’s poem is freed from chronic insomnia when he “wonders” at a romance (a medieval genre characterized by courtly adventure) he finds in a dusty old book. The saving knowledge he gleans from its pages affects him so profoundly that he falls asleep, experiencing wonder again in his dream but again failing to express this experience in the poem he writes afterward. Coleridge’s speaker instead eagerly surrenders his own mature mental state to gain a childlike ignorance, thereby more closely appreciating the art that is the subject of his poem but shutting out his readers in the process. Both poems, then, are ekphrastic in that they describe other works of art; furthermore, both express their meaning by failing to express it. Even though won-

der is demonstrated differently in the two poems, both Chaucer and Coleridge choose to fuse the occasion of ekphrastic wonder with the rhetoric of ineffability, a structure which in turn prompts their readers to have the same kind of experience by “wondering” at the poems they are reading.

Before beginning a discussion of wonder in Chaucer, we should first qualify “wonder” by briefly tracing this concept from the Greeks to Chaucer’s day. Aristotle and Plato both named wonder (*thaumadzein* in Greek) as the beginning of philosophy, but neither discussed it at length.¹ Subsequent philosophers did not change this function of wonder: its relationship to philosophy as the founding passion was a consistent one from the Greeks to Dante Alighieri.² One sense of what the Greeks meant by wonder is particularly useful to trace to Chaucer: *paradoxos*, a Greek synonym of *thauma* (that which causes one to marvel). *Paradoxos* is that which is “contrary to or surpassing common opinion or belief.”³ This sense of wonder finds its way into the *Consolation of Philosophy*, a prosimetrical (written in alternating verse and prose sections) work written in Latin in the sixth century by the Roman-born philosopher and statesman Boethius.

The Consolation is very important for studying Chaucer, even without the link of *paradoxos*, because he, more even than most other medieval figures, felt Boethius' influence acutely. He was one of several prominent figures, including Alfred the Great and Elizabeth I, to translate *The Consolation* into English. Boethius wrote the work in prison in the time between being stripped of his wealth and status and being executed. It is set up as a conversation between the allegorical figure Lady Philosophy and Boethius himself in which she "consoles" him. At one point in *The Consolation*, Lady Philosophy impersonates Fortune in order to impress on Boethius the legitimacy and naturalness of Fortune's caprice. It is at this point that *paradoxos*, the source of wonder discussed above, appears as the mental tactic with which Lady Philosophy causes Boethius to wonder. As Dennis Quinn summarizes and explains,

Dame Fortune was constant to her own nature, which is to be fickle. This is more than a clever turn of speech; it is a paradox in the literal sense of the term, a teaching that seems contrary to common opinion, which expects fortune to be faithful. Paradox is a rhetorical trope that evokes the emotion of wonder precisely because it seems to express a contraction.⁴

In Quinn's interpretation here the English word "paradox" is used to signify specifically the thing that causes wonder - the source of wonder.

We might parse this apparent source of wonder even further, however, by questioning the functional difference between paradox and anything that cannot be known. Does Boethius wonder at paradox in and of itself, or does he wonder at paradox because it is one in a group of things which cannot be known—which, when observed, summon an awareness of ignorance? (For clarity's sake I will henceforth refer to "awareness of ignorance" as "awe," though the word "awe" is not usually defined this narrowly.) If no words adequately express paradox, then it cannot be known and therefore reminds the observer or reader of this lack of knowledge. As Wilbur Urban asserts, "Truth . . . is always a function of expression, and the relation between an expression and that which is expressed can only be one of adequacy."⁵ If no language is adequate to express a paradox, then that paradox cannot be known fully and "awe" results.

This barrier to understanding would seem to cause the viewer to give up, but Lowry Nelson suggests that poetry which uses the "rhetoric of ineffability"⁶ works by convincing the reader to join the speaker in his or her impossible task. Nelson writes: "In particular, mystical poetry is fraught with a basic paradox—the impossibility of expression and, though doomed to fail, the attempt at it."⁷ Both the speaker and the reader make this attempt: "we find ourselves, as readers, committed to paradox."⁸ (Nelson's interest is in classifying "mystical poetry," but his discussion is useful whether or not we classify Boethius' text as mystical.)

This crisis is where another source of wonder, "esteem," comes into play. Quinn holds that these two sources, ignorance and esteem, commonly appear in pre-modern and early modern literature—from Homer to Milton, in fact.⁹ Esteem is a favorable reaction to that which is known, just as awe is a favorable response to that which is unknown. (We can also name, with questionable usefulness, the two possible "negative reactions": peremptory dismissal of what is unknown and informed disapproval of what is known. These would not result in wonder at all but rather kill it. That which one knows thoroughly is subject either to deserved criticism or to informed praise; that which one does not yet know, like an unread book, or that which

cannot be fully known, like a paradox, is subject either to dismissal or awe.) If the reader does not esteem the art he will not "commit to the paradox" but rather reject it in skepticism. Fortunately, in Boethius' case, veneration for Lady Fortune and her songs abounds. After she sings a certain lyric, he is left amazed: "*me audiendi avidum stupentumque arrectis adhuc auribus carminis mulcedo defixerat*"¹⁰ - The song has "made me remain astonished, attentive, and desirous to hear her longer."¹¹ It is an expression of astonishment, delight, and, notably, a desire to sate his mental appetite by continuing to listen to Lady Fortune. Her song, since it is plagued by ineffability, has not been able to sate his curiosity, so paradoxically he desires more.

In Chaucer's *The Book of the Duchess*, wonder appears similarly; the work also contains several instances of ekphrasis, a word I intend to use in a sense which differs from its usual meaning. The word is traditionally defined as "a verbal description of, or meditation upon, a non-verbal work of art, real or imagined, usually a painting or sculpture."¹² But this study concerns works of art that cannot be easily relegated to pure text or pure image. In *The Book of the Duchess*, the narrator's experiences with artworks involve many that are probably heavily illuminated with colorful illustrations, designs, and initials. Even more generally, in an age before printing, the text alone on the page was not merely a functional notational system but a labor of scribal love that when finished constituted an expensive physical product of skilled craftsmanship. Coleridge's poem, too, blends the text and the image of the artwork into one entity by its focus on a pictorial representation of the location of literary creation. The name of the poem, "The Garden of Boccaccio," references the garden of a country estate where the stories that make up Boccaccio's *Decameron* were told. The premise of the work's frame narrative is that a group of highborn citizens have gathered at a country house to escape the plague that is ravaging their cities; they pass their time by telling stories to each other in the garden. The speaker in Coleridge's poem has come upon a work of art that depicts this garden. Even though the subject work of art is visual, then, it is a visual work of art whose significance rests upon yet another piece of literature. For all these reasons, "ekphrasis" in the usual sense of the word will not suffice; I use it in this study to mean a verbal meditation on verbal or non-verbal artworks. (I address the fine distinction between this use of "ekphrasis" and "intertextuality" below.)

The narrator in Chaucer's *The Book of the Duchess* has an experience with a romance that is similar to Boethius' experience with Fortune, though less overtly philosophical. The structure of *The Book of the Duchess* is unique and somewhat complex. The poem opens with a first person narrator complaining of insomnia and the accompanying unhealthy state of "sorful ymagynacioun"¹³ and "melancolye."¹⁴ (We may compare the narrator's state to the "stupor"¹⁵ of Boethius.) He then picks up a romance "that me thoughte a wonder thing,"¹⁶ reads it, and reproduces it for his reader in paraphrase. One notable element in the romance is that a character Alcyone prays to Juno to cure her of her insomnia. This "saving knowledge" causes him to wonder: "Me thoghte wonder yf hit were so, / For I had never herd speke or tho / Of noo goddes that koude make / Men to slepe, ne for to wake."¹⁷ After he finishes reading, he is immediately freed to sleep and begins a long dream which occupies the greater part of the work.

From the beginning, the narrator's wonder is variously plagued by problems of expression. After praying for sleep and receiving it, the narrator enters a "sweven, / so wonderful that never yit / Y trowe no man had the wyt / to konne wel my sweven rede."¹⁸ The events of the entire dream, then, are expressly incapable of being interpreted or understood fully. Similarly, he attempts to describe the music he hears at the beginning of his dream, a technically impossible task given the

fundamental differences between the two media of art. He cannot even paraphrase the music as he could the romance. He has to resort to comparisons: "Was never herd so swete a steven / But hyt had be a thing of heven."¹⁹ At a loss to duplicate the musical sound precisely through the linguistic means of poetry on a page, the narrator spends nineteen lines comparing the sound he hears to other music and repeating adjectives like "mery," "swete," "mete," and "crafty."²⁰ He has been spurred by an experience that defies expression. "When wonder begets poetry," Quinn writes, "it very often takes the form of praise, which is an acknowledgement and expression of that which is beyond the poet."²¹ This is exactly the process that the *Duchess* narrator has undergone.

Having tried to describe a sound, Chaucer's narrator then relates the images on the walls of his cell. Once again, he attempts to convey his awe for a work of art to the reader; this time, though, his references to the art pieces have diminished from description to name-dropping. In his room are depictions of two very important texts, *The Iliad* and *The Romance of the Rose*. "Hooly al the story of Troye"²² is depicted in the stained glass windows of his cell, and "Alle the wallles with colours fyne / Were peynted, bothe text and glose, / Of al the Romaunce of the Rose."²³ The first thing to notice is that these texts are not represented partially but "hooly al" is present and even present in multiple media of expression. The word "all" appears three times in eight lines and is each time stressed by the meter of the line. For *The Romance of the Rose*, there is "bothe text and glose."²⁴ This phrase is strange enough for Larry Benson to spend a note on it in *The Riverside Chaucer*, suggesting many possibilities but commenting at the end that it is "perhaps simply a formula meaning 'the whole story.'"²⁵ For us the phrase helps to emphasize that the entire *Romance of the Rose* was available to the narrator as a work of literature at this moment in time; the presence of a "glose" (an in-line glossary) even removes any barriers to comprehension. His consciousness has been exposed to the entire utterance of the poem, not merely a paraphrase.

We, however, are obviously not told the entire poems. Our experience of the art the narrator mentions is a paraphrase for the romance, a description for the music, and a mere flourish of proper names for the two poems. Cleanth Brooks would suggest that not even Chaucer's paraphrase of the romance is adequate for expressing the original text. Brooks agrees with Wilbur Urban that "what [a poem] 'says' can be rendered only by the poem itself."²⁶ In Brooks' theory, it is impossible for Chaucer to express the romance without repeating it word for word in its original language. To complicate things, contemporary textual evidence suggests that when the poet Chaucer was reading this romance to include it in his poem, he used a medieval French translation, the "Ovide moralisé," as well as the original Latin poem written by the Roman poet Ovid.²⁷ Therefore, its reproduction in *The Book of the Duchess* is in a language different from either of his sources as well as significantly reduced in content.²⁸ The Ovidian tale that we read in Chaucer's text is therefore different from the poem that Chaucer read in Latin or in French. Unless we have just come from reading this passage in Ovid's *Metamorphoses* in Latin, we will understand the *Duchess* narrator's experience differently, basing our reaction to his wonder on the tale he has summarized for us instead of on the tale he has read. The same is true for the music he hears and for the "text and glose" of *The Romance of the Rose* and *The Iliad*.

It may be objected here that there is difference between a reader's and a speaker's consciousness of other works of art in virtually any work in the Western tradition and that this is merely the reality of intertextuality, not ekphrasis proper. In responding to this, it is useful to distinguish between what the *Duchess* narrator seems to believe is common knowledge and what he believes is too obscure or too

important not to attempt to relate for the reader. He chooses to paraphrase the Ovidian tale and tries to describe the music he hears in his dream, but the two other texts he merely mentions by name, knowing that his medieval readers would be familiar with the "story of Troye"²⁹ and *The Romance*. The wonder he felt at reading about Juno's gift of sleep was so powerful that he wanted to relay that story in a work of art along with the emotions and the dream it caused him to have.³⁰ The narrator believes he is producing for his reader the only representation of these artworks that his reader will ever have the opportunity to experience; his writing is translation in the case of the Ovidian tale and ekphrasis in the case of the music. Ultimately, however, Chaucer's narrator can only express his reaction to the Ovidian tale instead of the tale itself, creating another poem in the process. The poem therefore exemplifies a hermeneutic, "testing" a certain type of reader response within a second poem.

The remarkable effect of a poem like this is that it, too, inspires wonder through the discourse of ineffability. The reader of Chaucer's poem gets a taste, even a plot summary, of the original subject art but is denied that art in its entirety. He is made aware of something (the Ovidian tale) of which he is ignorant but his desire to know (read) that subject art is not satisfied. Since ignorance is one of the sources of wonder, the reader is invited to "wonder" at the original work of art. Wonder is inspired in him from "esteem" as well: the reader is prompted to imitate the *Duchess* narrator's praise. *The Book of the Duchess* demonstrates the cyclical tendency of poetry containing translation to adopt the discourse of ineffability in attempting to produce in its reader the wonder it expresses.

Before leaving Chaucer, I will take a more synchronous perspective to discuss briefly another conception of wonder particularly relevant to the Middle Ages: the vice of *curiositas*. Christiane Deluz summarizes the condemnation of this emotion from Augustine until the advent of humanism: it was "refusée par Augustin comme '*concupiscentia oculorum*', condamnée par Bernard de Clairvaux comme contraire à la '*stabilitas*', opposée par Thomas d'Aquin à la '*studiositas*."³¹ Chaucer's view in this poem seems to be an exception to this Christian fear of curiosity, especially since *The Book of the Duchess* contains a romance and pagan gods. A desire to know is never dogmatically condemned as what Augustine calls the "disease of curiosity."³² In fact, Chaucer's wonder heals him of the disease of insomnia. Wonder is an overwhelmingly positive emotion in this work.

A convenient and somewhat necessary stepping stone between Chaucer and Coleridge is the Renaissance poet Edmund Spenser (1552-99), who attempted to sound Chaucerian by using archaic words and spellings in his poetry and was generally highly regarded and imitated by Romantics like Coleridge. Despite the fact that Spenser actually created a false and fantastical sense of what Chaucer's English was like, later figures like John Dryden (1631-1700) praised Spenser for his quaint medievalism. Dryden spoke of the "infusion sweete" of the Chaucerian past in Spenser's poetry, claiming that "the Soul of *Chaucer* was transfus'd into his Body; and that he was begotten by him Two hundred years after his Decease."³³ Dryden may have only been interested in praising Spenser, but many Romantics might have read this as a belittlement of Chaucer. Thomas Warton (1728-1790), for instance, insists that Spenser's "archaic diction . . . had 'much improved upon [Chaucer's]."³⁴ Warton's sentiment is an early indicator of the widespread worship and imitation of Spenser that would develop throughout the Romantic era.³⁵ Coleridge was no exception: his "Lines in the Manner of Spenser" is not in Spenserian stanzas but uses Spenserian rhymes and diction like "ypluckd,"³⁶ "wight,"³⁷ and "bowers."³⁸ "The Garden of Boccaccio," the poem whose mode of ekphrastic wonder is of interest to this study, also exhibits

strong features of the Spenserian style.

The Spenserian elements of the poem are worth a brief discussion if only in order to articulate the stylistic connection between two poems that may never have been paired so specifically as they are in this essay. “The Garden of Boccaccio” is organized into heroic couplets, echoing (even if only incidentally) the Chaucer’s preferred metrical mode. The rhymes also take on a Spenserian quality:

Even in my dawn of thought—Philosophy;
Though then unconscious of herself, pardie,
She bore no other name than Poesy;
And, like a gift from heaven, in lileful glee, ...³⁹

“Pardie” especially stands out as somewhat archaic, though the *OED* finds uses consistently up until Rudyard Kipling in 1930. The subject matter is also clearly medieval, though in the following passage it is specifically Spenserian:

Fair cities, gallant mansions, castles old,
And forests, where beside his leafy hold
The sullen boar hath heard the distant horn,
And whets his tusks against the gnarlèd thorn;
Palladian palace with its storied halls;
Fountains where Love lies listening to their falls;⁴⁰

Even more than diction, rhyme, or subject matter, however, the poem exhibits a Spenserian psychology. Romantics identified a certain interiority in Spenser, a “self-reflexive ‘inscape.’”⁴¹ Coleridge called it “mental space”⁴² and in this poem we see it in the private and introverted concentration of the poet on Thomas Stothard’s illustration of Boccaccio’s garden: “Gazed by an idle eye with silent might / The picture stole upon my inward sight.”⁴³ This interiority is distinctly Spenserian and becomes an interesting addition to the Chaucerian model of ekphrastic wonder.

Other than this internal psychology and the related Romantic preference for the wonder of childhood (which is discussed below), Coleridge’s “The Garden of Boccaccio” is strikingly similar to *The Book of the Duchess* in its structure and treatment of ekphrastic wonder. It, too, begins with a helpless speaker trapped in a “numbing spell”⁴⁴ who is awakened from his stupor by an illustration depicting the garden from the beginning of *Decameron*, Day 3, where the various tale-tellers told their stories.⁴⁵ This image, placed on the speaker’s desk by a “Friend,”⁴⁶ transforms his mental state from a “dull continuous ache”⁴⁷ to standing “possest.”⁴⁸ The first four lines describing his reaction to the picture express such a spontaneous rush of praise for Boccaccio that they lack a main verb. The syntax is that of a list:

Boccaccio’s Garden and its faery,
The love, the joyance, and the gallantry!
An Idyll, with Boccaccio’s spirit warm,
Framed in the silent poesy of form.⁴⁹

These lines seem to be the product of a rush of emotion from the speaker’s memory of the *Decameron*. They have so much of the tone of familiar reminiscence that the reader is excluded if his reaction to a mention of the *Decameron* is less enthusiastic. The awe inspired by the painting is ultimately aimed at the soul of Boccaccio: “With old Boccaccio’s soul I stand possest, / and breathe an air like life, that swells my chest.”⁵⁰

Nearer the end of the poem, after the poet has been drawn out of his dull ache, he is moved to describe for the reader several images in

Stothard’s illustration:

Praise the green arches, on the fountain clear
See fragment shadows of the crossing deer;
And with that serviceable nymph I stoop,
The crystal, from its restless pool, to scoop.⁵¹

In the illustration, a series of arched hedges forms a backdrop for a central fountain near which some deer are grazing. Twelve people stand or sit near the fountain, and a woman is stooping to touch the water.⁵² Obviously, the meaning of the lines is clearer if the reader also views Stothard’s illustration (or, indeed, Boccaccio’s description of the garden in the introduction to *Decameron*, Day 3). Like Keats’ “Ode on a Grecian Urn,” the horizon of the speaker is consumed by a single work of art. And, as in *The Book of the Duchess*, its summary or description of that art excludes the reader precisely because it is less perfect than duplication. Like the sweet music the *Duchess* narrator hears, Stothard’s visual art fails to translate accurately into poetry, but the poet persists in attempting the impossible. This rift between the speaker’s experience of the original artwork and his reader’s experience of it is a constant of ekphrastic poetry, and that claim stands *a priori*. This “constant” is significant because it characterizes the cyclic nature of wonder in original and subsequent artists/readers. Any degree of ineffability between the speaker of the intermediate poem and the subject art begets wonder from ignorance in the final reader. Reading Coleridge’s poem about Stothard’s illustration and Boccaccio’s *Decameron*, one is struck by novelty and reminded about one’s own ignorance of Boccaccio and Stothard, desiring to know more but kept from doing so as long as one is a reader of the poem at hand and not of another.

To contextualize this argument, it would be best to consider two philosophers who wrote about “wonder” between the times of Chaucer and Coleridge: Hobbes and Descartes. Hobbes suggests that wonder is a “hope and expectation of future knowledge from anything that happeneth new and strange.”⁵³ He further divides the word into two quasi-synonyms: the “passion which we commonly call *admiration*” and the “appetite . . . *curiosity*.”⁵⁴ Note that this dual sense corresponds somewhat to the two pre-modern sources of wonder, esteem (admiration) and awe or the awareness of ignorance (curiosity). Descartes writes that wonder is a “sudden surprise of the soul”⁵⁵: “Admiration est une subite surprise de l’âme qui fait qu’elle se porte à considérer avec attention les objets qui lui semblent rares et extraordinaires.”⁵⁶ For both Hobbes and Descartes, wonder ends with the arrival of full and complete knowledge.⁵⁷ We might therefore say that for the modern era, wonder no longer means an emotion that is inspired by “esteem.” (This contrasts starkly with Boethius: “It is clear in Boethius . . . that knowledge does not quench wonder at all. Indeed, the wonder of Boethius increases as the dialogue proceeds.”⁵⁸) Awe of the unknown is thus more important for Descartes, and indeed for Coleridge, as the source of wonder.

In fact, Descartes helped to pave the way for the Romantic notion of childlike wonder by suggesting that full knowledge ends wonder and that wonder therefore belongs to childhood.⁵⁹ Coleridge intensifies the naivety with which his speaker experiences everything by adopting a childlike mental state. The speaker paradoxically takes on the mental state of a child in order to “know” the experience of Boccaccio’s spirit more deeply and intensely. In this sense his path to knowledge is a deliberate feigning of ignorance. The Wordsworthian preference for childhood in Coleridge’s poem is very clear: the picture brings him “[a]ll spirits of power that had most stirred my thought / In selfless boyhood.”⁶⁰ Equipped with the immense curiosity of a young mind, he can now “wander through the Eden of thy hand.”⁶¹ “Eden” signifies the freshness and novelty of the speaker’s experience, and the phrase,

“of thy hand,” reminds us that it has been crafted. The images in the rest of the poem are renewed knowledge. The old, experienced mind of the speaker pretends he is young, exploring his own memories with all the wonder of new encounters. The Wordsworthian neo-Platonist notion of the immortality of the child increases the speaker’s appetite for wonder.

This preference for a childlike state becomes abundantly clear in Coleridge’s personification of Philosophy and Poesy as the same “matron.” He writes,

And last, a matron now, of sober mien,
Yet radiant still and with no earthly sheen,
Whom as a faery child my childhood wo’ld
Even in my dawn of thought—Philosophy;
Though then unconscious of herself, pardie,
She bore no other name than Poesy.⁶²

In this passage there is an intriguing reversal of the normal order of the states of mental maturity. The poem even implies at the beginning that adulthood brings along with it a state of “vacancy”⁶³ and “dull continuous ache”⁶⁴ since the only time at which the speaker operates out of his adult consciousness is before the painting strikes him with wonder. Though he treats Philosophy and Poesy as two sides of the same entity, he associates Poesy with childhood, the preferred mental state of the poem. The implication is that he leaves Philosophy behind, unlearning his knowledge, but to do so is not possible. The speaker’s action, rather, is akin to adopting the wisdom of knowing how little one knows. His mental transformation, spurred by an intense connection with Stothard’s illustration, reaches several successive levels of completeness. First, his visual faculties are freed: “Thanks, gentle artist! now I can descry / Thy fair creation with a mastering eye, / And all awake!”⁶⁵ Then, several lines later, he ceases viewing and begins to inhabit the imagined garden: “I see no longer! I myself am there, / sit on the ground-sward, and the banquet share.”⁶⁶ His intense inward focus and a Spenserian sense of a distant medieval past together cultivate wonder in the mind of the speaker. While he loses himself in his imagination, however, the reader of *his* poem is excluded from the exchange of ideas. The aforementioned lack of verbs and broken syntax further indicate the reflexivity of his conversation, as though he is in dialogue with his own memory of Boccaccio and the reader is an eavesdropper. Unlike Chaucer’s narrator, it may be possible for Coleridge’s speaker to relate to the reader his own experience with the art, but his Spenserian interiority precludes it. The reader is thus left, as before, with the paradox of a poem not fully expressed - a paradox that I see as the germ of new wonder.

Both of the poems in this study inspire wonder precisely because they take part in the rhetoric of ineffability. Because the poet expresses his reaction to the previous artwork instead of duplicating that artwork, he expresses wonder; wonder is necessarily inexpressible because it is a state before knowledge. Also, the writer of poetry containing translation wrestles with “the resistance which any good poem sets up against all attempts to paraphrase it”⁶⁷ and the writer of ekphrasis struggles with the barriers between media. The art on which a poem focuses is not and cannot be expressed in it (only paraphrased, referenced, described, or compared), and thus our experience of the poem is necessarily somewhat ignorant of the total utterance that is its subject. The ekphrastic poem or translation does not and cannot reproduce the art exactly, and therefore, by itself, it lacks total knowledge of its source. In signifying another work of art imperfectly, it reminds us that we do not at that moment “know” that other work of art (i.e., we have not finished reading it a moment ago or have not memorized it) and thereby prompts wonder in us.

Wonder in Chaucer’s *The Book of the Duchess* follows the Boethian tradition closely. The narrator’s awe combines with esteem to inspire wonder and frees the narrator from eight years of insomnia. But despite his newfound track toward knowledge, his attempts to recount his experience through translation and ekphrasis fail because his reader cannot have experienced the artworks as he has. In Coleridge’s poem also, the speaker is saved from mental apathy by a work of art, but he, too, is plagued by the void between his subject art and his reader. Furthermore, the intense and introverted conversation with his own memory that ensues cripples the poem which his experience prompts him to write. Despite their significant differences and disparate chronological moments, these two poems unite powerfully in generating awe for the mysterious process of reading and wondering at a poem by rendering that process impossible to comprehend within another poem. Furthermore, if not for the complex and unique force of wonder during ekphrasis and translation, the protestations of expressibility which these poems contain would challenge the validity of poetic expression and comprehension so much that they would undercut themselves. Wonder is the only positive presence that can fill the void left by the crisis of the inexpressible and is therefore the best creator of meaning among works which interrogate the possibility of poetic meaning and comprehension.

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Shades of color

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Courtney joined me in the lounge and settled into the chair across from my own. Right away I was captivated by her story. "When I hear music, I see colors," she said. "When I smell certain smells, I see colors. Or even when I think of a person, there is a very strong color association with that person."

Courtney Van Evera is a charismatic, 24-year-old woman with a giggly personality and a curiosity toward her environment and everyone in it. What she experiences is called synaesthesia. The Greek root *syn* means "together," and *aisthesis* means "sensation."¹ This phenomenon is best explained as a cross-wiring in the brain causing the onset of one sense to trigger another.²

Her face lit up and she did her best to contain her giggling. It looked as if she had a secret that had to be told. "What I experience is – with every sense like hearing, taste, touch, smell –" she counted off on her fingers, "I see colors...All my senses are involved with it, so it's kinda like they all get crossed into sight with colors."

Many cases of synaesthesia have been documented starting as early as 1880 when a paper was published in *Nature* on this condition by Francis Galton, a cousin of Charles Darwin.¹ However, it wasn't until recently in 1999 that scientists started to explore synaesthesia as a "genuine sensory experience."¹ Before then, it was just assumed that these experiences were either being made up or that they were a prod-

uct of the use of drugs such as LSD.¹

The senses of a person who experiences synaesthesia can become intertwined in many different ways. Because synaesthesia occurs with any combination of intersecting senses, psychologists have counted more than 100 different existing combinations.¹ The most common of which are colored-hearing synaesthesia, where a sound triggers the perception of color, and letter/number to color synaesthesia, where numbers and letters are perceived to be in assigned colors no matter the coloring of the ink on the page.³ Courtney experiences both of these, as well as color synaesthesia triggered by tastes, smells, and even concepts of people's personalities. Studies show that people who have one type of synaesthesia are likely to have another type as well.¹

Courtney explained that she used the colors that she sees associated with numbers and letters to help her through elementary school. Through Courtney's eyes, numbers and letters are not seen as the black print on a page but instead appear slightly different in colors and shades. She said that this was how she learned to spell – by memorizing the color patterns of the letters in words. As for math, Courtney memorized what colors equal other colors. She said it is her own personal internal categorizing system. "Colors help me memorize things. I did well in spelling and vocabulary and I very easily memorized math and multiplication tables...I mostly memorize things that

I need to, by categorization. I think I tend to do that in my life anyway. But it's all color coded in my head, so it makes it a little bit easier for me to memorize."

Upon hearing that, I shared that I use an external system of six different colored pens and colored note cards; one color of pen with one color of card is one category. Courtney must have seen this as an opportunity to show me her math skills. "Well," she exclaimed, "that's 36 different categories."

Of course, it is. But I couldn't find the words to confirm that she was correct. I was amazed at the effortless speed with which she was able to answer. Not more than two seconds after telling her that I mix and match six different colored pens with six different colored cards did she have the answer of just how many categories are in my system. She giggled and explained to me that "purple times purple equals green and purple." The number six is purple while the number three is a green hue.

Viewing numbers and letters in color is one thing, but what about objects or concepts more complex than numbers and letters? Courtney explained that more complicated concepts, such as peoples' personalities and the concept of time, can have many different colors "wrapped up in them." This makes sense; we see an individual letter on this page as flat and just simply a letter. However, we see complicated concepts, such as people, as changing and inconsistent; less reliable than a simple letter. Courtney went on to say that "the first impression of someone might be one color and then a different part of their personality might be a different color or a memory might be a different color."

"The first letter of the person's name is always a big indicator to what the color will be," Courtney explained. "The first thing I learn about you is your name and then the first letter is capital, so it's bigger." It is not uncommon to have the first letter or the capitalized letter of a word to bleed or blend its color over to the next letters of the word.¹ The capital "J" in my name is purple. Courtney explained to me that because of this, parts of my personality are "mostly associated with purple."

"It's the same with music." Courtney explained that music can be as complicated as people are. "Notes will be different colors. So, maybe that's why I like music so much; it's like this color show in my mind. Or different instruments can bring different colors into my head." She stated that overlaps in color are common with complex concepts. Courtney's ability to visualize colors brought on by sound is known as higher synaesthesia whereas colors seen simultaneously with physical objects (such as actually being able to see a number or a letter on a piece of paper) is known as lower synaesthesia.^{3,4}

Psychologists have put together a test, known as the pop-out test or the segregation test, to use when trying to determine if a person experiences synaesthesia.^{1,5} The most common example of this test is forming a hidden pattern, such as a triangle, using 2s among a scattered placement of 5s.

All the print is in black and the 2s and 5s are exact mirror images of each other. For non-synaesthetes finding the pattern of 2s among the 5s would take more than a few minutes. Synaesthetes should – being able to perceive the 2s as a different color than the 5s – pick out the pattern almost instantaneously. A study conducted by scientists Vilayanur Ramachandran and Edward Hubbard showed that synaesthetes found the shape that the 2s created up to 90% of the time which is how well non-synaesthetes did in finding the triangle shape constructed out of the 2s when all the numbers actually were shown to them in color.¹

Some synaesthetes participating in the pop-out test would, how-

ever, need to be informed that it is 2s and 5s that they are looking at. Because the test is done using mirror images of the those numbers, the 2s and 5s appear in the form that we see with digital numbers, and it may be hard to interpret numbers out of what is being seen. Courtney explained that if she is not able to tell what a number or letter is, then it wouldn't appear in the assigned colors. This holds true with not being able to read somebody's handwriting: "The style of handwriting itself might have its own color in my mind," Courtney explained. "I'd have to know what the word was for it to have the color it should have."

Until the point when synaesthetes discover that the majority of other people do not share this same crossing of senses, it isn't uncommon for those who experience synaesthesia not to realize that these occurrences are unusual.⁶

Courtney shared what it was like for her when she discovered that not everyone viewed the world as she did. "So at college, I was 20 years old and I did not – I had *no idea* – that this wasn't normal until this time." Courtney cleared her throat and continued, "I was sitting at this table with a bunch of people, and I was like 'Hey! What color do you guys see when you think of three?' And *no one* knew what I was talking about. Everyone was just like 'I...I...I don't. I just see the number three.' She sat up straight, raised her eyebrows, "And," she started dramatically, "the guy sitting next to me told me, 'You see colors because a nerve never grew apart in your brain.'" Courtney giggled as she imitated the voice of the person who told her this. "And I was like 'Oh my gosh!' and, so," she shrugged, "that's when I knew." Courtney went on to tell me that the guy explained to her how children have really strong color association, but that in most people, the nerve that is responsible for this grows apart and loses that ability.

In truth, it's not a matter of a nerve never growing apart but really several nerve connections never having been severed. At infancy, up to 100% more neuronal connections exist within the brain than in adulthood.⁷ At about the age of five, a large amount of these neuron connections start to disappear; this includes parts of the cortical areas which aid in our visual perception.⁷ The severing of those connections is called pruning.⁷ The body seems to prune off pre-marked connections as most everyone's connections are about of the same consistency by adulthood. Because the connections to be pruned are pre-marked, it is suspected that the risk for synaesthesia is genetic.^{5,8}

Even though it is estimated that as many as one person in 200 experience synaesthesia, an answer as to how this occurs in the first place has yet to be found.¹ However, the theory that is most agreed upon, the persevered neural connectivity theory, lines up the closest to what Courtney's friend explained to her the day she discovered the uniqueness of her experiences. The persevered neural connectivity theory suggests that the pruning process is incomplete. This is known as the hyperconnectivity hypothesis.⁹⁻¹¹

Why is it that some senses are so separate in the first place while others are not *completely* separate. For example, taste and smell are so closely connected that when the sense of smell is lost, one's ability to taste is hampered.¹² So why is it, for example, we can only *see* a painting hanging on a wall but not *hear* it?

Our brains do not have a connection between the auditory and the visual areas, although those connections did exist before the pruning process.⁸ The parts of the brain that translate sight, sound, and color – the temporal lobe, the parietal lobe, and the occipital lobe – all meet in one place of the brain known as the TPO junction (temporal, parietal, occipital).¹ If the connections tying these receptors together were never severed, the translation of sound in one lobe would then bounce into the translators of the other two lobes creating a cross-wiring of senses.¹ This would account for color-hearing synaesthesia.

Yet another explanation known as the disinhibition-unmasking hypothesis also exists.¹³⁻¹⁶ This suggestion credits synaesthesia not to inefficient pruning but to a possible imbalance of chemicals traveling around the different regions of the TPO junction and causing a miscommunication between a person's senses.¹ In spite of the research completed on this hypothesis, psychologists favor the hyperconnectivity explanation due to the same pruning process having been observed in other mammals.⁷

Synaesthesia, even though considered a neural condition, does not appear in the Diagnostic and Statistical Manual of Mental Disorder (DSM) for psychology. According to the manual, a diagnosis for a disorder is not made unless what the person is feeling is causing what they would consider to be an "interference in life."¹⁷ Only a few cases of synaesthetes have reported feeling a sensory overload, whereas a high number of reports state that synaesthetes are not bothered by their experiences, and most of them feel that it's like a gift of having "hidden sense."¹⁸

Courtney is not bothered by her experiences. On the contrary, she said, "It makes me feel special." She sat back and sipped her peppermint steamer. "I feel like it's like a little present from God," she smiled, "like I have a little something extra."

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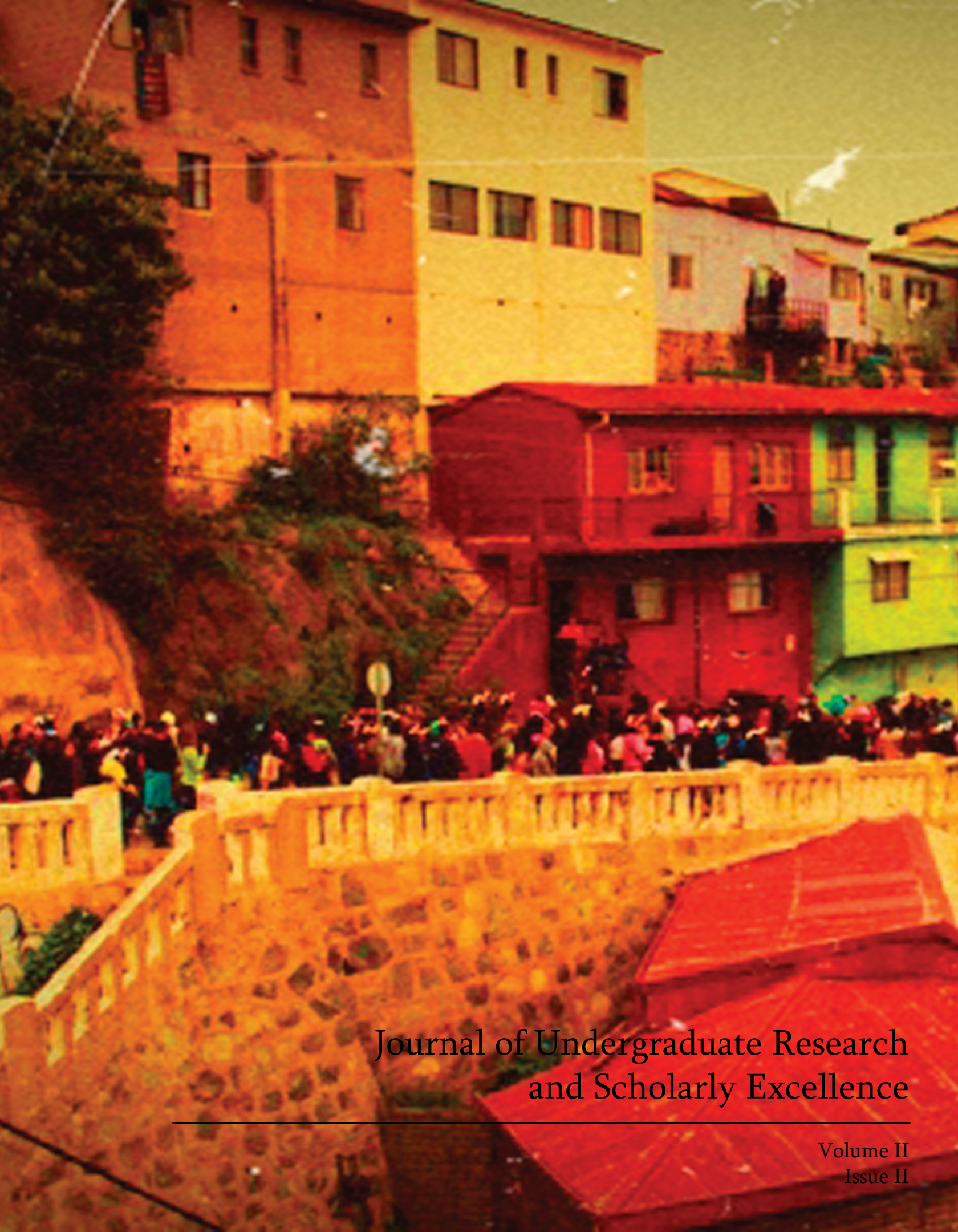
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An aerial view of the Front Range and Colorado State University
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