Feature Articles

Unlocking the Mystery of the Sistine Chapel Ceiling: A New Interpretation of Michelangelo’s Design

Lauren J. Staub

Keeping up Appearances: A Pattern of Degeneration in Plato’s Republic

Caroline Wekselbaum

Quantitative Estimation of Channeling in the Glycolytic Pathway in Intact Escherichia coli

Jennifer C. Lee

Finding Adoptive Homes for Waiting Foster Children: An Exploratory Study of Adoption

Jennifer T. Beach

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WUURD, the Washington University Undergraduate Research Digest, is published by the Office of Undergraduate Research once a semester each academic year.

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The logo for the Office of Undergraduate Research, on the front cover of this publication, consists of an “impossible triangle” within a starburst. To some, the triangle evokes the challenge of puzzles to be solved or the eternal research question “How does that work?” To others, the triangle represents the Greek letter Δ, the mathematical symbol for change.
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This edition of the Washington University Undergraduate Research Digest (WUURD) is testimony to many things, but perhaps particularly to the deepening ties that have developed over the past three years between the Office of Undergraduate Research and the many departments it serves. For in this edition three of the four feature articles are actually senior honors theses, brought to our attention by faculty who were familiar with our office and alerted us to the excellent undergraduate research taking place in their departments.

Thanks are also due to Kathryn B. Hoopes, as this third edition of the WUURD would not exist without her extraordinary generosity. Her contributions to undergraduate research not only endow 40-50 undergraduates for summer research and other activities, but also endow the promotion of that research in vehicles such as this one.

I would be remiss if I did not also alert you to the tremendous work of Dean Joy Kiefer in putting this edition together. Not only did she pay meticulous attention to the tailoring of articles to fit into this format, but you will see that it is particularly her work on the little things that make this edition sparkle: from the short biographies of authors and mentors, to abstracts, to acknowledgements, Dean Kiefer has taken great pains to make sure every piece is both informative and accurate.

Finally, it is important to thank the additional proofing of two new stars to our office. Aline Holtz, PhD and Kristin Sobotka read through each article for errors and readability. While the excellence of this work should primarily redound to the undergraduates, these editors also deserve no small measure of credit for how well this third edition holds together.

Respectfully,

HENRY BIGGS
Associate Dean
Director, Undergraduate Research
The Washington University Office of Undergraduate Research is proud to present the fall 2006 edition of the Washington University Undergraduate Research Digest or WUURD. This edition of the Digest showcases the quality undergraduate research that comes from the capstone experience of the senior honors thesis. Lauren Staub, in her senior honors thesis which earned the History Department’s J. Walter Goldstein Prize for the Most Outstanding Senior Honors Thesis, explores a groundbreaking interpretation of Michelangelo’s Sistine chapel ceiling painting based on Dante’s *Divine Comedy*. This interpretation challenges current understandings founded on the story of Genesis and solves the need to prove or postulate the existence of a theological advisor to Michelangelo. Caroline Wekselbaum, in her senior honors thesis, identified a pattern of degeneration in Plato’s *Republic* never before illustrated by scholars. Her model makes an important contribution to the understanding of Plato’s account of constitutional degeneration and is further applicable in many historical contexts. Jennifer Lee studied the metabolism of glucose in *E. coli*. She and her colleagues uncovered that channeling exists in the glycolytic pathway and quantified it. In depth knowledge of the process by which metabolism occurs is important to developing an understanding of how a crowded, dynamic cell can carry out the many different functions necessary for survival and contributes significantly to the overall conception of the normal functioning of major metabolic pathways. Finally, Jennifer Beach, in her senior honors thesis, analyzed the problem of foster care children in the United States left waiting to be adopted. Her research uncovered certain factors that seem to prevent adoptive parents from adopting waiting children and can further an understanding of the necessary components that make the adoption process smooth for both waiting children and potential adoptive parents.

The significance of an undergraduate research capstone experience for both the intellectual development of the student and the advancement of a discipline is clearly represented in this edition of the Digest. The impacts and depth of analyses speak to the commitment not only of our undergraduates, but also the faculty who mentor them. We here in the Office of Undergraduate Research hope that you enjoy the fall 2006 edition of the WUURD and look forward to supporting many more undergraduate research efforts in the future.

JOY ZALIS KIEFER
Assistant Dean, Editor
Office of Undergraduate Research
Unlocking the Mystery of the Sistine Chapel Ceiling:
A New Interpretation of Michelangelo’s Design

Author
Lauren J. Staub

Lauren Staub graduated from Washington University with the distinction of Summa Cum Laude in May 2006 with a degree in History. Lauren’s research began as a semester-long research paper in an Advanced Seminar on Michelangelo during the spring semester of her junior year. It then became the topic of her senior honors thesis in the Department of History. Lauren’s thesis was awarded the J. Walter Goldstein Prize for the Most Outstanding Senior Honors Thesis in the Department of History. The present article is an adaptation of her senior honors thesis. Lauren is considering the possibility of attending law school and pursuing a career in the field of Art Law.

ABSTRACT
In 1508 Pope Julius II summoned Michelangelo to Rome to paint the ceiling of the Sistine chapel. The artist most likely arrived with the hordes of pilgrims streaming into the ‘Eternal City’ on the Via Cassia, trampling the vineyards and sheep pastures into pathways on their journey to the civitas Dei. As the day began to fade and the “darkening air was releasing all the creatures” on the earth from “their daily tasks,” another native Florentine had been preparing to “endure the battle of the journey” two centuries prior. Weaving through the streets of the decrepit city on his way to the Sistine chapel, perhaps it was Dante’s cammino of the body and soul that Michelangelo recalled. “Who would doubt that in painting the Judgment in the chapel in Rome,” Benedetto Varchi rhetorically questioned in 1546, “that it was the work of Dante, which he had memorized completely, that was always before his eyes?” While scholars have long acknowledged Michelangelo’s references to La Commedia in his Last Judgment on the altar wall of the Sistine chapel, in the nearly five-hundred years of debate surrounding his program for the ceiling, none have ever proposed the poem as a plausible solution. Even the most common interpretation of the Sistine chapel ceiling, the story of Genesis, is inherently flawed. This study suggests that it was not the bible, but Dante Alighieri’s La Commedia—the vernacular form of the bible in sixteenth century Italy—that served as Michelangelo’s inspiration for the Sistine chapel ceiling. The theory that Dante’s La Commedia guided Michelangelo in his design for the Sistine chapel ceiling is significant because it removes the necessity of proving, or even postulating that a theological advisor assisted Michelangelo in developing his program for the ceiling.

ACKNOWLEDGEMENTS
I offer my deepest gratitude to Mark G. Pegg, Associate Professor of History, and William E. Wallace, Barbara Murphy Bryant Distinguished Professor of Art History, for the extraordinary guidance, encouragement, and inspiration that they have provided me during this study and throughout my undergraduate education at Washington University in St. Louis. I am also greatly indebted to Dean Henry Biggs and the Office of Undergraduate Research for providing me with the funds to travel to Rome for research. Further thanks are extended to the Vatican Library for granting me access to its invaluable collection. Finally, thank you to my mom, dad, and little sister, Allie, for both enabling and daring me to dream.

KEY TERMS
• La Commedia (The Divine Comedy)
• Fresco
• Intonaco
• Lunette
• Spandrel

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FACULTY MENTOR: MARK GREGORY PEGG, PH.D., ASSOCIATE PROFESSOR OF HISTORY
Professor Pegg specializes in the history of Medieval Europe. His recent research includes an examination of the history of heresy and the history of holiness. He teaches courses on the early Medieval world and an advanced seminar in history about heresy and war.
In 1508, Pope Julius II summoned Michelangelo Buonarroti to Rome to paint the ceiling of the Sistine chapel. Julius had hoped that the artist would replace the traditional blue canopy, dotted with golden stars, with twelve apostles. However, “[a]fter the work was begun, it seemed” to Michelangelo “that it would turn out a poor affair.” Michelangelo convinced the Pope to give him a “new commission to do what” he “liked and [the Pope] said he would content” him, and that he “should paint down to the Histories below.” Nearly five-hundred years after Michelangelo painted the Sistine chapel ceiling, his artistic license continues to instill viewers with awe and bewilderment. Scholars have generated countless theories to explain the program behind the artists’ masterpiece, yet none have arrived at a convincing explanation. While many theories rely upon evidence impossible to prove, namely, the assistance of a theological advisor, even the most widely accepted interpretation of the ceiling—the Genesis theory—is inherently flawed.

The Genesis interpretation is based upon the central narrative’s progression in Biblical chronology, proceeding from The Separation of Light from Darkness painted above the altar, towards the scene from The Drunkenness of Noah, over the exit/entrance of the chapel. According to the story of Genesis, Noah’s sacrifice preceded the deluge. On the Sistine chapel ceiling, however, Michelangelo painted these two scenes in the reverse order [Fig. 6]. Even Michelangelo’s contemporaries, quick to point to Genesis as the model for the artist’s design, grappled to find a solution to explain this apparent inconsistency. This study postulates that perhaps it was not the Bible, but Dante Alighieri’s La Commedia— the vernacular form of the Bible in sixteenth century Italy, that served as Michelangelo’s inspiration for his design on the Sistine chapel ceiling. For the ceiling—the upper limit of mortality of not just a chapel, but the Papal Chapel, built to the exact dimensions of King Solomon’s Temple, Michelangelo imagined a design that would lead all pilgrims on their journey through life towards salvation.

This study did not begin with the intent of developing a theory for Michelangelo’s program on the Sistine chapel ceiling. What led me to the Vatican Library, carefully sifting through the pages of a 1481 edition of La Commedia, stemmed from a single question about a much narrower aspect of Michelangelo’s design: What is a Sibyl [Fig. 4]? Taken at face value, any dictionary provides a concise answer: Sibyls were women from antiquity believed to possess powers of prophecy and divination. However, when examined within the context of the Sistine chapel ceiling, the Sibyls’ presence assumes tremendous implications: Why did Michelangelo depict pagan Prophetesses within a Christian narrative, on the ceiling—presumably the closest space to God—within a Christian chapel? Interested in developing an understanding for Michelangelo’s artwork within the context of his own conceptual framework, I looked first to what he read. While presumably I could have examined any number of texts, Dante Alighieri’s La Commedia seemed especially pertinent to this investigation. The very premise of Dante’s poem suggested a clue towards understanding Michelangelo’s inclusion of these pagan figures; in La Commedia, Dante powerfully demonstrated the notion that the domain of Christianity encompassed all of time and space—both secular and ecclesiastical. Ultimately, I found in Dante’s poem not only an explanation for the Sibyl’s presence on the ceiling; I saw in La Commedia the model that Michelangelo used for his design on the Sistine chapel ceiling.
MICHELANGELO AND DANTE: THE CONNECTION BETWEEN THE ARTIST AND POET

“The eye,” the philosopher Nelson Goodman once wrote, “comes always ancient to its work, obsessed by its own past.” Dante’s influence on Michelangelo began at the very inception of his career as an artist. While helping Domenico del Ghirlandaio complete a series of frescoes in the choir of the church of Santa Maria Novella, the young apprentice encountered the works of Dante through the lens of an artist who had painted more than a century prior. Perhaps as he waited for layers of intonaco to dry or for the next set of instructions from his master, Michelangelo found himself standing before Nardo di Cione’s Last Judgment with Paradise and Hell. Painted in the Strozzi Chapel in Santa Maria Novella, Hell was regarded as the first detailed illustration of the punishments described by Dante in the Inferno. While this fresco may have triggered Michelangelo’s curiosity in the works of Dante, it would mark only the beginning of an enduring passion for the poet and his works; throughout his life, Michelangelo would continually return to Dante’s words for both guidance and inspiration.

Less than a year into his apprenticeship with Domenico del Ghirlandaio, Michelangelo left and moved in with the Medici, the great ruling family of Florence. Undoubtedly, it was in this household, where Michelangelo lived and studied for four years—immersed in the circle of humanistic thinkers, scholars, and artists surrounding Lorenzo ‘the Magnificent’—that his fascination with Dante was nourished. Only eight years prior to Michelangelo’s arrival, this same group around Lorenzo had conceived of a new edition of La Commedia. The learned and elegant edition was also a fierce polemic to reclaim Dante for the Florentine republic—poised on the brink of war with Naples and Milan and fractured by the turmoil of the Pazzi conspiracy—after nearly two-hundred years in exile. In this grand bravado of nationalistic pride, the fragile republic targeted the 1481 edition against all non-Florentine cities that had produced the poem. The publishers went to great lengths to distinguish this first Florentine edition from all previous versions printed, in both content and form. In this edition, Cristoforo Landino would offer the most extensive examination of Dante’s language until that time—carefully discriminating between Florentine and non-native dialects. The edition would also represent the first illustrated version of the poem, for which the great Florentine artist, Sandro Botticelli would provide the illustrations. Ultimately, the bound copy presented to the Signoria on the thirtieth of August, however, did not contain Botticelli’s illustrations; Botticelli had been called to Rome to paint the walls of the Sistine Chapel, and unable to supervise the publication, his engravings met “inferior” results. Despite its disastrous conclusion, the 1481 edition attained widespread popularity. Three years following its release, Ottaviano Scoto purchased another illustrated edition and alas, Bonino de’ Bonino, still using Botticelli’s designs, finally succeeded in producing the first fully illustrated version of La Commedia. Constantly surrounded by the great minds that had conceived of the 1481 edition, the excitement over the release of this polemical work undoubtedly made a strong impression on the young Michelangelo.

Dante’s words would continue to resonate in Michelangelo’s mind long after leaving the Medici household. Shortly before the Medici’s exile, Michelangelo fled Florence for Bologna to work for Gianfrancesco Aldovrandi. While living in this city
for a little over a year, Michelangelo read something “from Dante or Petrarch and now and then from Boccaccio” to his master every evening “until he fell asleep.” So “delighted by the marvelous genius of that man,” Ascanio Condivi, Michelangelo’s close friend, pupil, and biographer commented, Michelangelo knew Dante’s work “almost all by heart.” A long-standing myth suggests that Michelangelo, like Botticelli—with whom he was in contact—illustrated a version of La Commedia. Tragically, the version was reputedly lost in a shipwreck in the sea of Civitavecchia. While this legend may remain forever unsubstantiated, it offers insight into a long-acknowledged truth about the artist and his passion for Dante.

Although scholars have unduly labeled Michelangelo ‘un gran dantista,’ perhaps the most convincing support for the artist’s fascination with Dante and his works appears in Michelangelo’s own poetry, sculpture, and painting. Michelangelo’s companion, Donato Giannotti, writing on Michelangelo’s depth of knowledge of Landino’s commentary and his firm understanding—and negative opinion of Velutello’s 1544 Venetian edition of La Commedia—indicated the artist’s desire to make both the Poet and the Commedia the subjects of his own work. Giannotti explained that Michelangelo had begun arranging to have his poetry published in a volume that included two poems on Dante. While the death of Michelangelo’s friend Luigi del Riccio, who had taken on the task of seeing the book to print, prematurely terminated his plans, at least one of the poems survives today. Benedetto Varchi, writing in 1546, had “no doubt at all” that just as Michelangelo had “imitated Dante in his poetry, so he too had imitated him in his works [of art]. Not only giving them that grandeur and majesty that is seen in the conceits of Dante, but also contriving to make, either in marble or with colors, that which Dante has made with sentences and words.” It is widely accepted that the two allegorical figures that Michelangelo carved on the tomb of Julius II, Rachel and Leah, represent the active and contemplative lives as they appear in Paradiso. And “[w]ho would doubt that in painting the Judgment in the chapel in Rome, that it was the work of Dante, which [Michelangelo] had memorized completely, that was always before his eyes?” Varchi rhetorically questioned. Varchi’s confident statement points to Michelangelo’s references to the Inferno in his Last Judgment on the altar wall of the Sistine chapel, a fact long-acknowledged by both historians and contemporaries of the artist alike. Surprisingly, in the nearly five centuries spanning the time since Michelangelo painted the ceiling of the same chapel, the rest of La Commedia has never been proposed as a solution to his design.

The theory that Dante’s La Commedia guided Michelangelo in his design for the Sistine chapel ceiling is significant because it removes the necessity of proving—or even postulating—that a theological advisor assisted Michelangelo in developing his program for the ceiling. However, in order to understand what relevance a poem, written two centuries prior, had to a design painted on a chapel ceiling requires an understanding for the relationship between poetry and art, the conceptualization of time and space, and the notion of holiness itself in fifteenth and sixteenth century Italy. When Pope Julius II summoned Michelangelo to the ‘Eternal City’ in 1508, Rome bore little resemblance to its former grandeur in antiquity. Ransacked, looted, re-buried, and even more commonly, fed to lime-kilns for use as fertilizer, antiquities languished...
on the barren landscape, bereft of context and meaning. Initially, legends and fantasies grew up around these ancient remnants. However, as myth converged with the critical approach of humanism in the fifteenth and sixteenth centuries and a broader inquiry into the past developed, people began to consider these seemingly innocuous objects in a new light. What once had existed as disparate fragments dotting the periphery of their consciousnesses gradually became evidence for a bygone world. The past became alive in the present. Incorporating ancient Rome into their own paradigm of the universe, however, meant extending the doctrine of Christianity to a time before Christ existed—to both pagan and Jewish peoples. As new evidence overturned the manner in which fifteenth and sixteenth century denizens and travelers to Rome conceptualized time and space, Dante's *La Commedia* offered a powerful model for how they might assimilate these objects of the past into their own world. Dante demonstrated to his Renaissance readers how to re-imagine the ancient remnants surrounding them not as disparate, disjointed parts, but as a pre-figuration and part of their own Christian world.

Dante's *La Commedia* is the story of a Pilgrim's (Dante's) journey towards salvation. In this journey through the Christian afterlife, all of time and space had collapsed; as the Pilgrim traveled through the depths of Inferno, scaled the mountain of Purgatory, and flew through the Empyrean until finally reaching Paradise, he walked simultaneously through the Old Testament and navigated the streets of the 'Eternal City.' Like Dante's Rome, Michelangelo's Rome was at once the Rome of the present, the New Jerusalem, the ancient Rome of the pagans, and a gateway to the spiritual world. The visitor to the chapel was not merely a viewer; he or she was a pilgrim, whose feet navigated the same streets on which Dante walked. As a pilgrim traveled through the city of the Vicar of Christ and the successor of Peter, their eyes served as the vehicle for a spiritual journey, releasing their soul to the space beyond space and a time at once temporal, historical, and eternal.

The attainment of a vision of God represented the Pilgrim's ultimate goal in his journey through *La Commedia*. However, in order for the Pilgrim to see through his internal eyes and ultimately arrive at a vision of the Trinity, he had to first be made to see through his physical eyes. In *La Commedia*, Dante sought to demonstrate that God's presence is revealed through miracles seen in the world—like the miracle of Christ—who was God’s living semblance on earth. The poem unfolds like a painting in the eye of the reader's mind—an intentional stylistic technique meant to mimic Dante’s notion of attaining holiness. Through writing, however, Dante could never fully realize the fundamental concept that he sought to convey; as a poet, he had only words and the imaginations of his readers at his disposal. The paradox that Dante encountered epitomized the argument for the superiority of painting over poetry during the Renaissance; as Leonardo da Vinci explained, while painting is interpreted directly through the eye, poetry must pass through the ear first and then project an image on the mind. Through painting, Michelangelo could place Dante's theory within the very material of its substance; the visual world. Thus, simply by looking at the Sistine ceiling, Pilgrims could mimic the first step towards salvation and the imitation of Christ by looking at, and not merely imagining, the narrative that would lead them towards finding salvation.
INTERPRETING THE SISTINE CHAPEL CEILING
ACCORDING TO LA COMMEDIA

Interpreting the ceiling of the Sistine chapel using *La Commedia* as the model requires no re-ordering or justification; it demands only a reading of the text and a consideration of a viewer’s proximity and orientation to the ceiling. Michelangelo’s design on the Sistine chapel ceiling is meant to direct the viewer’s gaze upwards—towards God—orienting them within a divine hierarchy. The only thing lower than the viewer—standing approximately twenty meters below the ceiling—is the ground beneath their feet that reminds them of their mortality. The highest points in the chapel are the altar, where one might surpass their physical station, and the vault; the ceiling of earthly divinity, the closest point to God. One might then imagine everything in between as stages; levels, “zones,” ascending towards the highest point [Fig. 1].

Structurally, the Sistine chapel itself evoked the terrain of *La Commedia* [see Fig. 1]. After descending through Hell, the topography in *La Commedia* changed and the Pilgrim arrived at the base of the mountain of Purgatory, above which the heavens encircled [Fig. 1]. The journey through Michelangelo’s design begins on the highest part of the walls—the lunettes just before the ceiling, and in the antechamber before the mountain of Purgatory—ante-Purgatory [see Fig. 2]. Dante invented the space of ante-Purgatory in order to penalize those who saved their repentance until the last moment. By forcing the souls to wait in ante-Purgatory before embarking on the path of purgation, the poet delayed their possibility of attaining salvation. After death and above the earth, yet before Purgation and below the ceiling, the souls waited without the possibility of transformation. Like the ancestors of Christ on lunettes in the Sistine chapel ceiling—reading, writing, admiring themselves in the mirror, combing their hair—the repetition of the earthly tasks that had prevented them from seeking salvation in life constituted their punishment after death [see Fig. 2]. Unable to remove their sins through purgation, in ante-Purgatory, the souls’ sole responsibility was to imitate these mundane habits and reflect on the habits that contributed to their negligence.

In the space of Purgatory and on the lowest tier of the Sistine chapel ceiling—the spandrels, the souls would begin their ascent towards God [see Fig. 3]. The Pilgrim, like all pilgrims peering up at the spandrels, watched the slothful shades, “unequally tormented by their loads,” moving “slowly beneath their weights.” The souls, like those on the spandrels, were “hunched over more or less, depending on the burdens on their backs.” The “grievous nature of their punishment” had afflicted them physically, bending their bodies towards the ground. The Pilgrim, like all pilgrims standing in the Sistine chapel, looked ahead of himself, “straining” his eyes, and saw a “mass of spirits wrapped in cloaks the color of the stone they leaned against.” Their cloaks “seemed to be made of the coarsest cloth, and one’s head on another’s shoulder lay, the inner cliff supporting all of them. They brought to mind blind beggars at church doors during Indulgences begging their bread: the one leaning his head upon the next.” Like the defective souls on Michelangelo’s ceiling, the shades would repent their sins and through bodily punishment, feel the pain that led to salvation—the pain that demonstrated to themselves, as it would to all pilgrims observing them, the way towards God. As the souls purged themselves of the “fifth of worldliness” to regain their original purity, all pilgrims contemplating their deformation would transform from “worm” into “the angelic butterfly,” rising nearer to their original and final perfection.
Fig. 1: A Re-Orientation of the Sistine Ceiling: the Ceiling as the Terrain of La Commedia
Fig. 2: Detail of the Lunettes on the Highest Part of the Walls in the Sistine Chapel: Ante-Purgatory

Fig. 3: Detail of the Spandrels of the Sistine ceiling: Purgatory
Architectural framework: The Earthly Paradise/ Sphere of the Fixed Stars
(Contemplatives: Prophets and Sibyls)

Fig. 4: The Architectural Framework: The Contemplatives (Prophets and Sibyls) on the Sistine Ceiling

Fig. 5: Vision of a Golden Ladder on the spine of the Sistine ceiling
A Dante Interpretation of the Ceiling: Paradise

1. Examination of Faith: The Drunkenness of Noah
2. Examination of Hope: The Deluge
3. Examination of Charity/Love: The Sacrifice of Noah
4. Temptation and Expulsion from the Garden of Eden
5. Creation of Man and Woman
6. Inability to reach God, Vision of the Souls of the Blest in the Rose of Paradise
7. The Rose of Paradise; God, omnipotent, flying in the shape of a cross

Arrival at the altar and like Jonah, penetrated and transformed by the ray of the exalted Light of Truth

A Genesis Interpretation of the Ceiling: The Story of Creation

1. Separation of light from darkness
2. Creation of the sun and moon
3. Separation of sky and water
4. Creation of Man
5. Creation of Woman
6. The Garden of Eden/the fall
7. The Sacrifice of Noah
8. The Deluge
9. The Drunkenness of Noah

Fig. 6: The Central Narrative
Fig. 7: Transformed by the Light of God and Reborn in Holiness
After his arduous climb up the mountain of Purgatory, the Pilgrim had arrived at its summit, stripped of sin, in the Garden of Eden. Beneath a “brilliant light,” a heavenly pageant, containing all of humanity—from Genesis to the Apocalypse—processed before him, all marching in relation to Christ. Gazing at the seven Prophets and five Sibyls in their monumental thrones on the perimeter of the Sistine ceiling (see Fig. 4) and the central narrative that would lead to Christ’s salvation—which these contemplatives had predicted—on the spine (see Fig. 6), all pilgrims would observe this vibrant pageant as the pagan and Christian worlds collided to reenact the fall of man, His redemption, and the changing history of the Church in a brilliant profusion of light and color. The intuitive knowledge of the Prophets and Sibyls (Fig. 4)—their Faith for God—that they could see Him even before His time, distinguished them from the more mediated knowledge of the theologians in the spheres below. Tilting his head upwards, the Pilgrim saw, as all pilgrims in the Sistine chapel would witness on the spine of the ceiling, the ladder that Jacob saw in his dream; the ladder who was Christ, that united Heaven to Earth and humankind to the Divine (see Fig. 5):

I saw—color of gold as it reflects the sun—a ladder gleaming in the sky, stretching beyond the reaches of my sight.

di color d’oro in che raggio traluce
vid’io uno scaleo eretto in suso
tanto, che nol seguiva la ia luce.36

The only way to Heaven for all pilgrims was through Faith in Christ, for He was the ladder that came down from Heaven to humankind, providing the pathway towards God.37

The Pilgrim’s “mortal eyes,” like those of all pilgrims’ standing beneath the ceiling, however, could not rise higher.38 Beatrice implored St. Peter, the beholder of the keys to Heaven, to provide the Pilgrim with a glimpse of what he might see after passing through the gates of Paradise.39 In order to receive the privilege of such a vision, the Pilgrim, like all pilgrims, would first have to undergo three examinations.40 In the poem, the metaphors to water begin to increase, evoking the story of Noah.41 As a pilgrim walked from the entrance towards the altar of the chapel, he or she underwent three examinations in the same order that the Pilgrim did: the examination of Faith—The Drunkenness of Noah,42 the examination of Hope—The Deluge,43 and finally, the examination of Charity or Love—The Sacrifice of Noah [Fig. 6].44 The Genesis interpretation of the Sistine chapel ceiling reads the panels in the opposite direction, beginning at the altar and placing The Drunkenness of Noah as the last, rather than the first, of nine panels. As indicated previously, the problem with the Genesis interpretation is that the Biblical chronology—the very premise that the theory rests on—lapses out of order, placing The Sacrifice of Noah before, rather than after The Deluge [Fig. 6]. Following the ceiling in the opposite direction (from the entrance of the chapel towards the altar), in accordance with the Pilgrim’s journey in La Commedia, avoids this problem.

After passing the three examinations in the same order as the Pilgrim, the viewers in the chapel arrive at the fourth panel on the ceiling and watch as the Pilgrim learns of Adam’s stay in the Earthly Paradise and man’s fall in the original sin (The Temptation and Expulsion from the Garden of Eden) [Fig. 6].45 As the lecture on the expulsion and temptation subsides, the Pilgrim and all witnessing The Creation of Man and Woman on the Sistine ceiling, learn that from “the blossom shall good fruit.
come forth” [Fig. 6].46 Alas, Beatrice leads the Pilgrim “[i]nto the gold of the eternal Rose, whose ranks of petals fragrantly unfold[ed]” and shows him how few seats are left.47 In the rose, the Pilgrim, like all pilgrims standing beneath the ceiling, saw the souls of the Blest, the saints of the Church Triumphant, and the angels who had “descended all at once on that great bloom of precious petals” [Fig. 6].48 The Pilgrim described “the glow of living flame” on the angels’ faces—the same flame that transformed the faces of those surrounding God on the ceiling.49 The Pilgrim’s journey, however, had not ended—like all pilgrims, he remained unable to see that which he had come so far for. Reaching up to the highest, there remained still a small space yet to bridge, like the gap separating man from reaching God on the Sistine ceiling [Fig. 6]. In order for the Pilgrim to reach his “journey’s perfect consummation,” he had to “fly through this heavenly garden” with his “eyes.”50 Only in “gazing it” would he “prepare” his sight, as Michelangelo’s design would prepare the sight for all pilgrims, “to rise into the vision of God’s Ray.”51 As all pilgrims’ vision grew clearer, it penetrated “more and more the Ray of that exalted Light of Truth Itself,” like God, omnipotent, flying in the shape of a cross, in the last three panels of the Sistine ceiling [Fig. 6].52

In the last three panels of the ceiling, God’s Robe grows increasingly rosier [Fig. 6]. This overwhelmingly rose color (the red of Christ’s passion) envelops the viewer in the chapel just as it encompassed the Pilgrim as he neared the summation of his journey in La Commedia [Fig. 6]. Reaching the altar and arriving at the “Rose of Paradise,” a pilgrim would be reborn, like Jonah on the ceiling, “penetrated” by the “ray of the exalted Light of Truth itself” and “so transformed within that Light that it would be impossible to think of ever turning” his or her eyes [Fig. 6 and Fig. 7].53 “[T]hree colors bound in one same space; the first” seeming to “reflect the next like rainbow on rainbow,” and the third “like a flame equally breathed forth by the other two” both would witness a vision of the trinity.54 As a “geometer who tries so hard to square the circle,” yet remains unable to “discover, think as he may, the principle involved,” Dante had sought to understand this “new mystery.”55 The Pilgrim’s “own wings,” however, could not take him that high.56 Only after Virgil and Beatrice had guided the Pilgrim’s vision, as Dante had led the reader through La Commedia, and Michelangelo led all pilgrims through the heights of the ceiling, would “a great flash of understanding” strike his mind.57 From an image described only in words, Michelangelo made appear in paint a vision “higher than words.”58 What had been fleeting for the Pilgrim, like something one sees “in a dream and wakes to feel the passion of the dream still there although no part of it remains in mind,” Michelangelo rendered eternal for all pilgrims.59

Ironically, the pervasive mystery of the Sistine chapel ceiling itself represents the very key to unraveling Michelangelo’s design. Only through looking and contemplating, as Michelangelo’s ceiling was meant to direct all who stood beneath it towards holiness, could one apprehend his creation. As Dante had demonstrated to Michelangelo, in the ‘Eternal City’ of Rome, time and space had no boundaries; no separation between the past and the present, holiness and the mundane, or the celestial and the terrestrial existed. The remnants of ages past dug up daily represented not pagan or Old Testament relics, but evidence—signs—that pointed towards God’s presence on earth. The downward direction into the past was but another way upward. God reflected Himself, La Commedia explained, in all things on earth; so in Michelangelo’s Rome, what the artist unveiled through looking, finding, and contem-
plating the objects surrounding him, was not merely a fragmented piece of marble or deteriorating sculpture, but a sign of the Faith that led His ancestors, as it would lead the artist himself, towards salvation.

Michelangelo’s painting in the Sistine chapel does not represent an illustration of La Commedia or an imitation of Dante, but rather a model, just as the Poet had created, that would guide all pilgrims, as Dante’s Pilgrim had guided Michelangelo, on the path towards seeking salvation. The poet had sought to demonstrate that the mystery of God was made accessible to all of humankind through the incarnation of Christ; to show, through exempla, as Christ was the exempla Himself, that God existed within man, and within themselves, so that one could find the path that led to salvation simply by looking at the world around them. However, through writing, Dante could never fully demonstrate the path towards seeking the Word made flesh, for he had only the word at his disposal. While the images that the Poet created could reside only within the mind, the artist could make what could not be seen visible. Michelangelo could show, not merely teach, that like the riddle to the mystery of his ceiling itself, the answer for all who seek it lies right before their eyes, for He existed among us. The artist had finally revealed in what the poet remains concealed, and painted a vision for all pilgrims through life that rose to “heights higher than words.”

Notes

1 Michelangelo Buonarroti, “Letter to Fattucci” in Letters. Translated from the Original Tuscan, trans. and ed. E.H. Ramsden, vol. 1. (Stanford: Stanford University Press, 1963), p.149: In a letter to Fattucci in 1523, Michelangelo wrote: “After the work was begun it seemed to me that it would turn out a poor affair, and I told the Pope that if the Apostles alone were put there it seemed to me it would turn out a poor affair. He asked me why. I said, ‘because they themselves were poor.’ Then he gave me a new commission to do what I liked, and said he would content me and that I should paint down to the Histories below.”

2 Ibid.


4 La Commedia (The Divine Comedy)- An epic poem written by Dante Alighieri in the early fourteenth century. Regarded as the last great work of literature in the Middle- Ages and the first great work of the Renaissance. The poem describes Dante’s journey through the Christian afterlife. It is composed of three parts: Inferno (Hell), Purgatorio (Purgatory), and Paradiso (Paradise). Dante wrote The Divine Comedy with the name La Commedia. The word “Divine” was not added to the title until two and a half centuries later, in Dolce di Venezia’s 1555 edition of the Commedia.


6 fresco- A technique or method of painting on wet plaster with pigments dissolved in water. The plaster is made of lime, fine sand, and marble dust. It is applied in small sections each day. This
type of fresco was referred to as **buon fresco** during the Italian Renaissance to distinguish it from **fresco secco**, the technique of using pigments with a glue or casein base on dry plaster.

7 intonaco- On a fresco, the final, smoothest layer of plaster on which the painter works before it dries and hardens.


9 “...into the hands of that magistrate which is most high in the Florentine Republic,” Landino proclaimed to the Lords of Florence in his *proem*, “he [Dante] should be restored to his homeland after long exile and not recognized as romagnolo or lombardo nor any of the languages of those who have glossed him, but simple Florentine, a language which is greater than any other Italian idiom.”


See also Cristoforo Landino, *Orazione di Messere Cristophoro Landino Fiorentino havuta alla illustriissima S. Fiorentina quando presento el comento suo di Danthe* (Venice: Francisci Barocil Patriti, 1560): “In che qua tu proficto habbi facto a piu docti di me la facio el giudico: questo solo afferrom havere liberato elustro cictadimo dalla barbare di molti externi idiomi ne quail da comentatore era stato corrupo: et al presente così puro et semplice fiorentino et mio officio a presentarlo a voi illustri signor nostri accioche per le mani di quell magistrato: el quale e sommo nella fiorentina republica si a dopo lungo exilio restituto nella sua patria: et riconosciuto nella sua lingua: la qua e quato tutte laltrctaliche auãzi manifesto testimonio ne fia: che nessuno nel quale aparifica ingegno o doctrina ne collegata in verti ne absoluto improsa mai oratone scrip se che non si forzasssi u fare el fiorentino idioma.”

10 Landino’s edition was especially directed against the Venetian and Milanese editions of 1477 and 1478, respectively. The Venetian edition of 1477, edited by Cristoforo Berardi da Pesaro, was the first edition of the *Commedia* produced with commentary. [For more information, see Theodore Cachey and Louis Jordan, “1481, Florence: Nicolo di Lorenzo della Magna,” and “1477, Venice: Windelens of Speyer” in *Renaissance Dante in Print* (1772-1629). See also Deborah Parker, *Commentary and Ideology: Dante in the Renaissance*, esp. pp. 94-95].

11 Deborah Parker, *Commentary and Ideology: Dante in the Renaissance*, p. 95.


13 Most likely, it was the disastrous conclusion of the 1481 edition which prompted Giorgio Vasari’s criticism for Botticelli’s engagement in the project: “Botticelli was generously paid by the Pope; but living in his usual haphazard fashion he spent and squandered all he earned during his stay in Rome. Then, when he had finished and unveiled the work he had been commissioned, he immediately returned to Florence where, being a man of inquiring mind, he completed and printed a commentary on a part of Dante, illustrating the *Inferno*. He wasted a great deal of time on this, neglecting his work and thoroughly disrupting his life. He also printed
many of his other drawings, but the results were inferior because the plates were badly engraved.” [Giorgio Vasari, Lives of the Artists, trans. George Bull (New York: Penguin Books, 1965), vol. 1, p. 227].

Baccio Baldini was responsible for the engraving of Botticelli’s illustrations. Kenneth Clark suggests that Baldini engraved only the first two illustrations himself, and attributes the poor engravings to his two unskilled assistants. While the first two images were printed on the page, Clark explains that the rest were “tipped in” haphazardly—some even appearing upside down. Still, in other parts of the Commedia, the spaces where the illustrations should have appeared in the cantos were left blank [Kenneth Clark, The Drawings by Sandro Botticelli for Dante’s Divine Comedy (New York: Harper & Row Publishers, 1976), p. 9].

Deborah Parker explains that the poor results also stemmed from the printer’s (Niccolò della Magna) inability to smoothly combine the two printing processes required for text and imagery (relief printing for the text and intaglio for the engravings), resulting in twelve- hundred partially illustrated versions. [Deborah Parker, Commentary and Ideology: Dante in the Renaissance, p. 136].

Deborah Parker, Commentary and Ideology: Dante in the Renaissance, p. 136].


Ascanio Condive, Life of Michelangelo Buonarroti, p. 68: “And just as he has delighted in the conversation of learned men, so he has found pleasure in studying the writers of prose, and equally so verse, among whom he has especially admired Dante, delighted by the marvelous genius of that man, whose work he knows almost all by heart.”

Botticelli and Michelangelo both worked within the small circle surrounding the Medici. Ironically, the same patron for whom Botticelli had illustrated yet another version of La Commedia (“un Dante in carte pecora” – a “cosa meravigliosa”), Lorenzo (“Lorenzino”) di Pierfrancesco de’ Medici, used Botticelli as an intermediary to correspond with Michelangelo while he was working in Rome in 1496 [Anonimo Gaddiano, who wrote about Florentine art in the tradition that would be continued by Giorgio Vasari, noted that Botticelli “Dipinse et storio un Dante in carte pecora a Lorenzo di Pierfrancesco de’ Medici cosa meravigliosa temuta.” Kenneth Clark, The Drawings by Sandro Botticelli for Dante’s Divine Comedy, pp. 7-8, identifies this inscription as the earliest reference to another set of illustrations of Dante by Botticelli. Ninety- two of these drawings survive today.


Giannotti indicates that this occurred in the mid 1540’s. Ibid [See also Paul Barolsky, The Faun in the Garden: Michelangelo and the Poetic Origins of Italian Renaissance Art (University Park, PA: The Pennsylvania State University Press, 1994), p. 3].

Ibid.

Justly to speak his praise all speech must fail,/ For Dante’s splendid beams our vision blind:/ Language shall sooner reach the guilt of those/ Who wrong him, than his smallest merit tell./ The realms beneath, of sin, he viewed, and then/ To God ascended, to instruct mankind;/ Nor heaven her lofty gates opposed him./ Whose country’s gates were closed to every prayer./ Yet to be like him welcome were his fate!/ His virtue and his banishment to share/ The happiest state on
earth I would exchange./ Ungrateful country! Of his glory nurse/ When ruin was they aim. And
well he shows/ That men most perfect most abound in woe;/ Proof strong as thousands singly he
affords,/ For exile so unjust on earth ne'er fell,/ And nobler mind than his the world ne'er saw.

Michelangelo Buonarroti, cited in E. Vale Smith, “Comparative Analysis of Dante and Milton
[Reprinted from a copy in collections of Brooklyn Public Library], p. 287.]

I first discovered this poem, written by Michelangelo and dedicated to Dante while researching
the art market during the American Civil War for Eleanor J. Harvey, Chief Curator of the
Smithsonian American Art Museum. The poem appeared in The Crayon, an art periodical that
ceased publication at the onset of the war, and represented the concluding section of a compar-
ison between Dante and Milton that spanned five volumes of the periodical. “No poet has
probably inspired so many works of art as Dante,” the author commented; “Among the painters
and sculptors who have sought subjects from him may be named Giotto, Orcagne, Massacio,
Zucari, Flaxman, and particularly Michael Angelo Buonarroti, who made sketches illustrating
every canto in the book, but all of which were unfortunately lost by shipwreck. Michael Angelo
was an intense admirer of Dante, and we cannot better conclude this sketch than by transcrib-
ing one of the great artist’s sonnets upon the great poet.”

I later learned of the Dante revival between the 1820’s and 1860’s, which climaxed during a
three- day festival in May of 1865. 1865 marked both the sixth centenary of Dante’s birth as
well as the height of nationalistic sentiment in Italy. If anything, the inclusion of
Michelangelo’s poem in this mid nineteenth- century American periodical is a testament to the
pervasive connection between Michelangelo and Dante— one that has spanned two continents
and nearly five- centuries between the artist’s life and today. For information about the recep-
tion of Dante in the mid- nineteenth century, as well as studies on Dante reception in general,
see Deborah Parker, Commentary and Ideology: Dante in the Renaissance (Durham: Duke

21 Benedetto Varchi, Lezione nella quale si dispute della maggioranza delle arte e qual sia più
nobile, la scultura o la pittura [1546], I: 57 in Paola Barocchi, ed., Trattati d’arte del Cinquecento

22 Ibid.

apertenente a quella” in Parte Prima di Libro di Pittura di M. Lionardo da Vinci Pittore et scutore
fiorentino: “L’occhio, che si dice finestra de l’anima, è la principal via donde il comune senso
pò più coppiosa et magnificamente considerare le infinite opere de natura, et l’orecchio è il sec-
ondo, il quale si fa nobbile per le cose raconte le quali ha veduto l’occhio,” [cited in Claire J.
Farago, Leonardo da Vinci’s Paragone: A Critical Interpretation with a New Edition of the Text in

24 Charles de Tolnay describes the Sistine chapel ceiling as composed of “three superimposed
zones,” divided “topographically and stylistically” and corresponding to “a triple gradation of
subject matter.” Though I draw on his conceptualization of the architectural space, I separate
the lunettes and spandrels, dividing the ceiling into four, rather than three, separate and reced-
University Press, 1969), pp. 22-23].

25 lunette- The arch- shaped panels on the highest part of the chapel wall.

26 For example, in Purg 8: 13- 17, the souls sang Te Lucis Ante, a prayer for protection from temp-
tation, especially from evil dreams that might tempt them at night. In ante-Purgatory, just as
on the lunettes, this hymn evoked the irony that these souls did not sleep, dream, nor sin;
before beginning the process of purgation, their only role was to imitate the daily lives of a liv-
ing Christian community. [For more information on this song, see “Note 5” in The Divine
Comedy of Dante Alighieri, Volume 2: Purgatorio, ed. and trans. Robert M. Durling (New York:
spandrel - The triangular spaces between two arches and the horizontal cornice above them.


Dante continually repeats the metaphor of a worm turning into a butterfly to help demonstrate the process of purgation. The image enables him to demonstrate the weight of sin that ties a soul to the ground, preventing them from seeing God. For example, in Canto X, Dante writes “do you not understand that we are worms,/ each born to form the angelic butterfly,/ that flies defenseless to the final judge? Why do your souls’ pretensions rise so high,/ since you are but defective insects still,/ worms as yet imperfectly evolved?” [see Purg. X: 124-129, trans. Mark Musa, p. 111].


John 14:6: “I am the way; I am truth, and the life; nobody can come to the Father, except through me.”


Par. XXIV: 37-42: “tenta costui di punti lievi e gravi,/ come ti piace, intorno de la fede,/ per la qual tu su per o mare andavi./ S’elli ama bene e bene spera e crede,/ non t’è occulto, perché ’lviso hai quivi/ dov’ogni cosa dipinta si vede,” [Ibid, p. 268], Ibid, p. 284.

For the metaphors to water in La Commedia, see for example an excerpt from the Pilgrim’s examination of Faith: “[F]rom the depths of that light’s radiance [p]oured the words” of the Pilgrim’s answer to Peter: he attained Faith from “[t]he bountiful rain of the Holy Spirit showering the parchments, Old and New,” and the proof of his Faith was not purely logical— it was composed “not only of physics and metaphysics,” “but of “the truth which rains down” through “Moses, through the Prophets, through the Psalms, and through the Gospel and through you [St. Peter] once kindled by the Holy Spirit’s tongue” [Par. XXIV: 87-138, [Ibid, pp. 272, 274], Ibid, pp. 286-287].

The Drunkenness of Noah: The brazen nakedness and drunkenness of Noah on the Sistine chapel ceiling immediately confronts and penetrates the eyes of the viewer. It was Noah who built the ark, not knowing, yet blindly accepting God’s word, just as he intuitively knew of
Christ’s redemption. Even in his despicable state on the Sistine ceiling, Michelangelo painted the vessels of the before Noah and the wine of His blood in the bucket behind. Just as the ark that Noah had built through Faith had saved him from the flood that ravaged the earth, even in his inebriated state, Noah would remain beneath it; Michelangelo had painted the wooden roof passing over his head, protecting him from harm even in sin. For the examination of Faith in *La Commedia*, see Par. XXIV: 52- 138 [Ibid, pp. 270- 274], Ibid, pp. 285- 287.

43 In *La Commedia*, St. James administered the examination of Hope. As St. James’ epistle had reminded the Pilgrim, and as Michelangelo reminded all pilgrims, to attain salvation—to see the light who was Christ at the end of the storm—action, too, was necessary; Faith in God alone would not save pilgrims from calamity. Michelangelo’s *Deluge* did not represent foreboding or destruction itself, but rather a demonstration that the Hope of salvation would be realized through the humanity that lifted Him up—He who was reflected in all believers. See, for example, James 1:22-26: “One who listens to the word without living by it is like a man who sees, in a mirror, the face he was born with; he looks at himself, and away he goes, never giving another thought to the man he saw there. Whereas one who gazes into that perfect law, which is the law of freedom, and dwells on the sight of it, does not forget its message; he finds something to do, and does it, and his doing of it wins him a blessing.” For the examination of Hope in *La Commedia*, see Par. XXV: 46- 78, [Italian cited in Singleton, pp. 280- 282], trans, Mark Musa, pp. 296– 297.

44 The Sacrifice of Noah: Just as Noah’s sacrifice sealed the covenant with God so that He would never bring another flood to destroy mankind again, so St. John, the administer of this third examination, had written himself in *The Book of Revelation*: Christ was the lamb slain for the salvation of the world, whose blood would cleanse all sin. Standing beneath the Sistine ceiling, all pilgrims would witness this promise of redemption in *The Sacrifice of Noah*. For the examination of Charity/Love in *La Commedia*, see Par. XXVI: 58- 63, [Italian cited in Singleton, p. 292], trans. Mark Musa, p. 308.

46 Par. XXVII: 139- 141 [Ibid, p. 310], Ibid, p. 322.
51 Ibid.
54 Par. XXXIII: 115- 120, [Ibid, p. 378], Ibid.
56 Par. XXXIII: 139- 141, [Italian cited in Singleton, p. 380], Ibid.
57 Ibid.
60 Par. XXXIII: 52-60, [Ibid], Ibid: “ché la mia vista,/ venendo sincera,/ e più e più intrava per lo raggio/ de l’alta luce che da sé è vera./ Da quinci innanzi il mio veder fu maggio/ che ’l parlar mostra, ch’a tal vista cede,/ e cede la memoria a tanto oltrag
This study identifies a pattern in Plato’s account of psychological and political degeneration in Books VIII and IX of the Republic. Following his discussion of the perfectly just city and its correspondingly just ruler, the philosopher-king, Plato proceeds to explain how *kallipolis* could degenerate in Books VIII and IX with his account of the four unjust constitutions: timocracy, oligarchy, democracy, and tyranny. Although scholars allude to the psychological significance of this account, none have yet identified any patterns in how the unjust constitutions degenerate. The pattern of degeneration identified tracks the psychological degeneration of the rulers to the political degeneration of the *polis*. The exception to this pattern is the first degeneration, from *kallipolis* to timocracy. The explanation for this exception hinges upon the fact that philosophers are not corruptible while the rulers of the unjust constitutions (who are non-philosophers) can always become worse. This study argues that the pattern of degeneration is important for two main reasons: First, the exception to the pattern highlights the psychological perfection of philosophers and the political perfection of *kallipolis*. Second, the model is an important step towards deconstructing Plato’s account of degeneration and understanding what motivates the events Plato describes. Consequently, the pattern of degeneration identified can help explain certain kinds of historical change.

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Caroline was a transfer student from Wesleyan University and graduated from Washington University in May 2006 with her degree in Philosophy. The present article is an adaptation of her senior honors thesis in Philosophy. Caroline was inspired to research the topic of this study from a course taught by Mary-Hannah Jones at Wesleyan University. Professor Jones encouraged Caroline to pursue this topic since it was a unique way of interpreting the *Republic*.

**KEY TERMS**

- Democracy
- Forms
- *Kallipolis*
- Oligarchy
- *Polis*
- Timocracy
- Tyranny

**ACKNOWLEDGEMENTS**

I owe an enormous debt of gratitude to so many people who helped me along the way with this project. Without their academic and emotional support, this project would still be an idea. To Mary-Hannah Jones for inspiring this project. To my advisor, Eric Brown, for his guidance, time, understanding and patience with me. To my wonderful friends for being there for me, and especially to Beth Wolfson who proofread this paper for me. To my little brother Charles for his encouragement. To my dad for his unequivocal love and absolute unwavering support in everything. And of course, to the man himself: Plato, I couldn’t have done it without you. Thank you from the bottom of my heart.

**FACULTY MENTOR: ERIC BROWN, PH.D., ASSISTANT PROFESSOR OF PHILOSOPHY**

Professor Brown’s expertise is in ancient Greek and Roman philosophy, and is especially interested in how ancient approaches to philosophical ethics fare in comparison with modern moral philosophy. Professor Brown also teaches courses in Plato and Ancient Philosophy.
“If the guardians of our laws and city are merely believed to be guardians but are not, you surely see that they’ll destroy the city utterly, just as they alone have the opportunity to govern it well and make it happy”

(421a, Grube).

The central objective of the Republic is to show that it is always better to be just than unjust. Plato begins his defense of justice in Book II following the speeches of Glaucön and Adeimantus, who argue that appearing just, more than actually being just, is sufficient for garnering the rewards of justice. Plato suggests that justice in the city is a larger-scale version of justice in the individual (368e-369a), and he subsequently articulates his vision of a perfectly just city, kallipolis, ruled by the correspondingly just individual, the philosopher-king. After interrupting this discussion at the end of Book IV, Plato presents a lengthy proof defending the just life in Books VIII and IX through his account of how the four unjust constitutions—timocracy (547c-550c), oligarchy (550c-555b), democracy (555b-562a), and tyranny (562a-580a)—degenerate from one into the next. This account begins with how kallipolis degenerates into timocracy, and concludes with the account of tyranny, which epitomizes injustice for Plato. By locating justice in his ideal city and individual, and then contrasting the ideal with the unjust constitutions and their corresponding individuals, Plato attempts to show that it is always better to be just than unjust.

There is a respectable body of scholarship analyzing the degenerate constitutions in Books VIII and IX, although little scholarship exists regarding any patterns in how each society degenerates. Some scholars suggest a consistency embedded in the psychological aspect of this account, where each transition increasingly exhibits the subjugation of reason to the non-rational parts (spirit and appetite) of the tripartite psyche. The degradation of reason and the rise of the non-rational parts denigrates the psychic and political harmony which characterizes kallipolis. This psychological aspect of the degenerations is enormously significant, in large part because it illuminates why Plato’s ideal city (kallipolis) must not be ruled by anyone except philosophers, but no scholar has yet identified a pattern in how this decline in reason manifests itself through each transition.

This research identifies such a pattern that applies to each transition except the one from kallipolis to timocracy. Within the model of degeneration, each degeneration between unjust constitutions proceeds in three stages that track the progression from the psychological degeneration of the rulers to the political degeneration of the constitution. Essentially, the rulers become psychologically corrupt in the first stage and they conceal their corrupt impulses to remain in power in the second. In the third stage, the revelation of this deception leads to civil strife that ends with political degeneration. The difference between the model and its exception hinges upon Plato’s assumption that philosophers are not corruptible.
The pattern of degeneration identified here is important for two main reasons: First, the exception to this pattern (in the transition from *kallipolis* to timocracy) highlights the psychological perfection of philosophers and the political perfection of *kallipolis*. Second, the pattern is an important step towards deconstructing Plato’s account of degeneration, which should be viewed as a theoretical account of historical decay. Consequently, the pattern of degeneration extracted here can help explain historical change in certain circumstances. This paper is organized as follows: First, an explanation is offered about how the model helps explain each degeneration and how the degeneration from *kallipolis* to timocracy is an exception. Second, the exception to this model is explained. Lastly, the practical applications of the model are examined.

I. THE MODEL AND ITS EXCEPTION

This section explains how the three-stage model of degeneration lends structure and order to Plato’s seemingly chaotic account of the unjust constitutions in Book VIII. In the first stage, the rulers become psychologically corrupt. This internal degeneration occurs due to a poor education, a natural pre-disposition towards inferior psychological attitudes, and the possession of political power which gives rulers abundant opportunities to serve their inferior impulses at the expense of others. Second, the corrupt rulers manipulate others and conceal their degenerate impulses to preserve their political power. In the third stage, the rest of society discovers this deception, which leads to civil strife and subsequently to political degeneration.

Before a more detailed explanation of the model and its exception can be given, *corruption*, which is the foundational concept of this model, must be defined. While Plato offers no explicit definition of corruption, his numerous references to it are sufficient for deducing what he meant. Broadly speaking for Plato, corruption is a worsening, a decline from a higher state of being to a lower state. A primary cause of corruption is the decline of reason and the rise in the inferior psychological attitudes, particularly appetite. This is usually a result of a poor education which does not properly train the rational part of the psyche. Plato explains that since reason exercises the best control over appetite (441e-442a), when reason is degraded, humans will act increasingly upon their appetitive impulses until the lawless appetites control all human motivations (as in the tyrant). Political power can serve as an important facilitator of this process because it can enable a corruptible ruler to serve unnecessary appetites without abatement. Such a psychological decline is clearly exhibited in the constitutional degenerations Plato describes where the rulers are increasingly dominated by appetites, and they exploit their political power to serve those appetites. Political power in the hands of such persons leads to further corruption because they lack discipline in using their power.

TIMOCRACY TO OLIGARCHY

Plato describes the timocratic constitution as “a sort of midpoint between aristocracy and oligarchy” (547c, Grube). The primary value of timocracy is honor, and when money-loving oligarchic values replace these honor-loving values, the timocracy transforms into oligarchy.
The first stage in the degeneration from timocracy to oligarchy marks the psychological degeneration of the rulers, where they become more internally corrupt as their souls shift from honor-loving to money-loving. This decline occurs because of a natural pre-disposition towards inferior psychological attitudes, an inferior education and opportunities to serve money-loving appetites (which come with political power). Since the timocrat already “shares in the money-loving nature and isn’t pure in his attitude to virtue” (549a, Grube) and degenerate timocrats “haven’t been educated by persuasion but by force” (548b, Grube), reason, which is their best safeguard against the lure of appetites, is not properly trained. The degenerate rulers seize opportunities to serve their appetites, enabling these impulses to flourish. Hence, souls initially dominated by spirit quickly degenerate into souls dominated by money-loving appetites (553a-c). Eventually, “…the rational and spirited parts sit on the ground beneath appetite, reducing them to slaves” (553d, Grube). These money-loving appetites spread amongst the rulers when other rulers “see” (see 550d-e) and emulate one another in their engagement of wealth-maximizing activities, until those dominated by their money-loving appetites “make the majority of others like themselves” (550e, Grube, italics added by author). Plato describes a “snowball effect” as money-loving appetites take over, at the expense of virtue:

From there they proceed further into money-making, and the more they value it, the less they value virtue...Then, in the end, victory-loving and honor-loving men become lovers of making money, or money-lovers (550e-551a, Grube).

The money-lovers are able to corrupt others with relative ease since the soul of a timocrat is not ruled by the best part, reason. The psychological decline (from honor- to money-loving) of the timocrats occurs even as the city externally appears to be a timocracy.

In the second stage, the corrupt rulers project an honorable appearance to conceal their acquisition of private property from the many in an effort to satisfy their money-loving appetites and maintain their political power in a society that favors honor over wealth. Since the rulers in a timocracy “are not allowed to acquire [wealth] openly” (548b, Grube), the psychologically degenerate rulers must project an honorable appearance to retain their political power and simultaneously satisfy their money-loving appetites. Plato states, Such people will desire money just as those in oligarchies do, passionately adoring gold and silver in secret. They will possess private treasuries and storehouses, where they can keep it hidden, and have houses to enclose them, like private nests, where they can spend lavishly either on women or on anyone else they wish...They’ll enjoy their pleasures in secret, running away from the law like boys from their father... (548a-b, Grube, italics added by author)

The language of “secretiveness” which Plato employs here suggests that the rulers conceal their participation in this prohibited activity (acquiring wealth) to appear better than they are because the rest of the society would not approve. This passage also reinforces the rise of the money-loving appetites in its expression of the lengths to which the rulers will go to acquire wealth (“private treasuries” and “houses to enclose them”).

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In the third stage, the psychological degeneration of the rulers leads to political decline when the new values of the rulers are promulgated for the entire city, although it is possible that some citizens will fail to acquiesce to the new value system. The rulers ...pass a law that is characteristic of an oligarchic constitution, one that establishes a wealth qualification...and proclaims that those whose property doesn’t reach a stated amount aren’t qualified to rule...And they either put this through by force of arms, or else, before it comes to that, they terrorize the people and establish their constitution that way (551a-b, Grube).

This legislation effectively “publicizes” and reveals the importance of wealth in the society and this revelation is the origin of civil strife. Since a majority of the ruling class has already become oligarchic, however, they possess sufficient power to force the rest of society to accept this change. By this stage, Plato suggests it is too late for those who oppose the change to prevent it, and so, with the new legislation (the “revelation” of the new oligarchic values), the society becomes a full-fledged oligarchy.

OLIGARCHY TO DEMOCRACY

Before the steps of this transition can be explained, it is necessary to discuss Plato’s account of oligarchy itself in which he suggests the ease with which one can appear virtuous in this constitution, but actually be psychologically degenerate. This explanation motivates his account of degeneration from oligarchy to democracy, which is complete when equality of appetites replaces wealth as the highest value in the society.

In this transition, Plato makes an important psychological distinction between unnecessary appetites, which are excessive and wasteful, and necessary appetites, which are those physical necessities one requires for well-being, such as food, drink, and shelter (see 558c-559c). He categorizes money-making as a necessary appetite because it is a practical means of fulfilling one’s basic needs (559c), and genuine oligarchs are psychologically ruled by these sorts of appetites.

But, under the new oligarchic system in which “they praise and admire wealthy people and appoint them as rulers, while they dishonor poor ones” (551a, Grube), as long as one is wealthy, one can appear positively to society despite lacking genuine goodness and virtue. Plato’s analogy between ship captains and rulers of the city emphasizes this important problem: “...what would happen if someone were to choose the captains of ships by their wealth, refusing to entrust the ship to a poor person even if he was the better captain?” (551c, Grube). Plato suggests that the foundation of oligarchy is unstable since wealth is a “blind” measure of virtue and leadership ability. In this environment, where virtue is attributed to anyone who is wealthy, degeneration follows easily.

In the first stage of degeneration, the oligarchs become psychologically corrupt when there develops a tension between their necessary and unnecessary appetitive desires. This tension stems from a poor education which fosters the oligarch’s natural predisposition towards appetitive psychological attitudes (see 559d-561a). Plato states:
...because of his [the oligarch’s] lack of education, the dronish appetites—some beggarly and others evil—exist in him, but they are forcibly held in check by his carefulness...in those other contractual obligations, where he has a good reputation and is thought to be just, he’s forcibly holding his other evil impulses in check by means of some decent part of himself...someone like that wouldn’t be entirely free from internal civil war and wouldn’t be one but in some ways two…” (554b; 554c; 554d, Grube, italics added by author).

But the oligarch’s apparent discipline with his unnecessary appetites is misleading because the possession of political power enables him to serve his necessary appetites without abatement. Essentially, the oligarch’s money-making activities become excessive and harmful to the rest of society. The oligarchs might not directly serve their unnecessary appetites, but when their desire for wealth becomes “insatiable” (555b, Grube), the excessive desire is unnecessary. The degenerate oligarchs merely re-direct their service to unnecessary appetites by “over-serving” the necessary appetites which expresses the tension between these two sorts of appetite.

The second stage of degeneration also follows easily: In their insatiable desire for money, the oligarchs conceal the extent of their commitment to their own wealth to exploit the many by administering deceptive high-interest loans to unsuspecting young people. Hence, the wealthy oligarchs do not themselves go for “unnecessaries,” but with great discipline, they encourage the young to go for them. The oligarchic rulers use their political power to foster extravagance in the young, “who’ve had no discipline from spending and wasting their wealth” (555c, Grube), by tempting them with loans to feed their appetites. Since the oligarchs have a “good reputation” and are “thought to be just” (554c), they can easily display a veneer of integrity in their business transactions to exploit the many. This parallels the way in which the timocrats conceal their acquisition of private property and project an appearance of honor, the value of timocracy. The oligarchs do not caution the young people against the risk they incur, which is particularly harmful since the loans are secured by the young person’s property. The oligarchs are certainly aware of the risks incurred by the young people because the oligarchs understand how lucrative these loans are for their own interests, which is why calling in these loans is “their favorite thing to do” (555c, Grube). But since they conceal this important information, the oligarchs demonstrate their cunning and lack of virtue.

This veneer of integrity is unmasked in the third stage. When the oligarchs call in the loans, they “become even richer and more honored” (555c, Grube), while the young people lose their property and become destitute, “…hating those who’ve acquired their property…” (555d, Grube). Thus, the many become aware of the deception by the oligarchs, who have effectively secured their own demise by creating “a considerable number of drones and beggars in the city” (555e, Grube). Just as the legislation stipulating a wealth qualification for rulers led people to realize the deception by the degenerate timocratic rulers, the destitution produced by the underhand-ed loans of the degenerate oligarchs leads people to realize their deception in this degeneration. This revelation motivates civil strife between the wealthy oligarchs and
the poor masses. Since the oligarchs are few in number relative to the many, and they neglect their physiques, the masses easily overthrow them, and establish democracy where everyone (rich and poor) are equal.

**DEMOCRACY TO TYRANNY**

The degeneration from democracy to tyranny is complete when the constitution is enslaved by unnecessary appetites. The end result is full-fledged tyranny in which the ruler is exactly what he appears. Following this discussion, an explanation of tyranny as the terminal link in the degeneration chain is offered.

The primary value of democracy is freedom or equality, and Plato explains that on the surface, democracy “...looks as though this is the finest or most beautiful of the constitutions, for...this city, embroidered with every kind of character type, would seem to be the most beautiful” (557c, Grube, italics added by author). But “the insatiable desire for freedom and the neglect of other things” (562c, Grube) renders this society a form of anarchy and enables it to give birth to tyranny since anyone can rule “...if only he tells them that he wishes the majority well...” (558b, Grube). If a person with the ambition for leadership appears to identify with the majority, he is seen as qualified for the position.

Plato identifies three groups of people who make up the greater part of a democracy. First, there are the workers, who make up the largest group and consequently have the most power when assembled (565a), even if they have little property. The second group is the wealthy people, who are not oligarchs, but are well-organized so they have amassed a degree of wealth. Third are the “idlers,“ or drones, who cannot become leaders in an oligarchy, but comprise the primary leadership in a democracy. As leaders, the drones preserve their authority by artificially creating civil strife between the workers and wealthy people. The drones appear to have the peoples’ best interests in mind when they distribute money taken from the wealthy, but they actually keep most of it for themselves (565a). When the wealthy protest against the drones, the drones lie to the masses, claiming that the wealthy persons are oligarchs attempting to initiate an oligarchic revolution (565b). The drones manipulate the workers and the wealthy to initiate civil strife between them, but

...neither group does these things willingly. Rather the people act as they do because they are ignorant and are deceived by the drones and the rich act as they do because they are driven to it by the stinging of those same drones (565c, Grube).

The people look to the drones for leadership, and their ignorance prevents them from seeing the drones’ deceptive natures. Eventually, the masses appoint a “popular leader” (565c) to lead them against the alleged oligarchs, and it is the drones who facilitate his psychological corruption by deceiving him, transforming him into the tyrant. In this environment, founded upon deception and corruption, degeneration follows easily.

In the first stage of degeneration, the drones facilitate the popular leader’s psychological corruption, leading him to become the tyrant. Since the democratic character is being pulled by both necessary and unnecessary appetites, in a “battle between the
two parts of himself” (560a, Grube), the drones can easily cultivate his unnecessary appetites by deceiving him. Under the guise of liberty, the drones instill lawlessness (572e, Grube) and eventually a “master passion” (573a, Lee), or madness, into the future tyrant. Plato states,

...the master passion runs wild and takes madness into its service; any opinions or desires with a decent reputation and any feelings of shame still left are killed or thrown out, until all discipline is swept away, and madness usurps its place (573a-b, Lee). 26

The “master passion,” the ultimate unnecessary appetite and a foil to the Good, takes hold of the tyrant, compelling him to shamelessly do whatever he desires. Like the timocratic and oligarch before him, the “popular leader” experiences internal psychological degeneration even as the degenerating political constitution seems to remain intact.

The second stage of decline reflects the tyrant’s corruption as he secretly works to consolidate his power. To protect their “defender” (566b, Grube), the people grant the tyrant’s request for a bodyguard, but he actually uses this new power to overthrow all political opposition and cease absolute power (566d), marking the transition to tyranny. 27 Initially, however, the masses do not perceive their society as a tyranny because the tyrant claims he is not a tyrant and behaves nicely to everyone:

During the first days of his reign and for some time after, won’t he smile in welcome at anyone he meets, saying that he’s no tyrant, making all sorts of promises both in public and in private, freeing the people from debt, redistributing the land to them and to his followers, and pretending to be gracious and gentle to all? (566d-e, Grube, italics added by author)

With his kind and generous disguise firmly in place, the tyrant proceeds to engage in unnecessary wars, attempting to make them appear necessary when in reality, he merely wishes to create a need for his leadership and shift the focus of the people to their own destitution (as a result of war taxes) and not on conspiring against him (566e-567a).

In the third stage, the population realizes that their leader is untrustworthy since “the longer he remains a tyrant, the more like the nightmare he becomes” (576b, Grube). The constant state of war and the destitution it produces for the masses depopularizes the tyrant. As people observe the tyrant’s unjust actions, such as wrongful executions and unjust wars, they begin to understand the tyrant’s evil nature. The many grow to hate him with such fervor that the only people the tyrant can entrust as his bodyguards are slaves he frees and elevates to the status of citizens (and even to the status of surrogate rulers) (568a).

Ironically, it was the popular support from the many which initially empowered the tyrant and enabled his power to increase (see 575b-c). But this initial popular support was a product of the tyrant’s careful concealment of his true nature and their own susceptibility to deception (569a-b). Unlike in the other unjust constitutions where there is a disparity between what rulers are and what they appear to be, tyranny closes the gap and marks the terminal link in the degenerative chain. Plato explains that
everyone has awful desires, but they emerge only in dreams: “Our dreams make it clear that there is a dangerous, wild, and lawless form of desire in everyone, even in those of us who seem to be entirely moderate or measured” (572b, Grube). But, for the tyrannical character, the dreams converge with his waking life (576b) and he “omits no act of folly or shamelessness” (571d, Grube) to maintain his power because, although the people fear their oppressor, the tyrant fears that those he oppresses will one day rise up against him.

THE EXCEPTION: KALLIPOLIS TO TIMOCRACY

The degeneration from kallipolis to timocracy is complete when honor replaces philosophy as the primary value of the rulers. The model of degeneration described thus far depends heavily upon its first stage where the rulers of the degenerating constitution become psychologically corrupt. Without this first step, there will be no concealment of the corruption and there will be no revelation of this deception. This crucial first step is the one missing in Plato’s account of the transition from kallipolis to timocracy, and it serves as a starting point for explaining how this transition is different from the rest. This initial transition can be divided into three stages: In the first stage, the ruling class falls from psychological perfection, but the manner of decline is different from that in the transitions between unjust constitutions. In the second stage, there is civil strife amongst the rulers. In the third phase, these tensions are resolved by a compromise between the philosopher and nonphilosopher-rulers, marking the political degeneration of kallipolis into timocracy.

At the end of Book III, Plato presents “the noble lie” or “myth of metals” (415a-c), which explains his belief that biological factors determine a person’s potential according to four hierarchical classifications: gold, silver, bronze, and iron. Plato says that the souls of the new guardians are mixtures between the metals rather than purely gold, which Plato views as required for philosopher-rulers. Speaking in the language of his myth of metals, Plato emphasizes the importance of maintaining the biological purity of the ruling classes when he states that “the city will be ruined if it ever has an iron or bronze guardian” (415c, Grube). To produce these “gold” types, who possess innate philosophical capacities, Plato maintains that selective breeding of the ruling classes is essential, although it must be kept secret from the rest of the population. The rulers are the only class aware of the selective breeding practices and they have told the “marriage lie” to their subjects. This lie purports that the selection of breeding partners is random when in fact it is meticulously calculated (460a). Plato believes there is a mathematical formula (coupled with sense perception) which the rulers can use to calculate when breeding should take place and who should breed with whom. Since Plato believes there is a biological component to becoming a philosopher (a philosopher must possess an innate philosophical capacity), this calculation is essential to maintaining the philosophical purity of the ruling class.29

In the first stage of the degeneration from kallipolis to timocracy, the biological perfection of the ruling class is destroyed when the philosopher-rulers make mistakes in the selective breeding of the guardian class, which produce inferior rulers in the next generation:
And when your rulers, through ignorance of these births, join brides and grooms at the wrong time, the children will be neither good natured nor fortunate. The older generation will choose the best of these children but they are unworthy nevertheless, and when they acquire their fathers’ powers, they will begin, as guardians, to neglect us Muses” (546c-d, Grube).

It is not the original philosopher-rulers who become psychologically corrupt, but the improperly bred next generation, who cannot develop to full psychological perfection. In the other degenerations, it is the psychological corruption of the original rulers of a political constitution which leads to the decline. In the degeneration from kallipolis, however, the original rulers themselves do not become psychologically corrupt; rather, they fail to raise a uniformly perfect next generation of rulers. Members of the new generation are biologically inferior, and thus, Plato claims they cannot properly absorb the education necessary for philosopher-rulers:

First they will have less consideration for music and poetry than they ought, then they will neglect physical training, so that your young people will become less well-educated in music and poetry. Hence, rulers chosen from among them won’t be able to guard well the testing of the golden, silver, bronze, and iron races (546d-e, Grube).

The new rulers’ natural disregard for a proper philosophical education means that they will be unable to correctly determine the proper calculations in the selective breeding process to restore the next generation to philosophy. Hence, future generations are doomed to imperfection once a mistake is made in selective breeding.

The second stage in the degeneration from kallipolis is marked by civil strife between philosophers and non-philosophers within the ruling class. Once biological and psychological imperfection enters the ruling class, there is bound to be conflict amongst the rulers:

The intermixing of iron with silver and bronze with gold that results will engender lack of likeness and unharm.onious inequality, and these always breed war and hostility wherever they arise. Civil war, we declare, is always and everywhere ‘of this lineage’ (546e-547a, Grube).

The new inferior guardians pull the constitution towards money-making values, while the proper guardians “lead the constitution towards virtue and the old order” (547b, Grube). In the third stage of degeneration from kallipolis, these tensions are resolved with a compromise in the values of the philosophers and non-philosophers. Plato states,

And thus striving and struggling with one another, they compromise on a middle way: They distribute the land and houses as private property, enslave and hold as serfs and servants those whom they previously regarded as free friends and providers of upkeep, and occupy themselves with war and with guarding against those whom they’ve enslaved” (547b, Grube).

This marks the end of kallipolis and the beginning of timocracy.31
II. WHY IS THERE A DIFFERENCE?

At the outset of Book VIII, Plato explains that one factor common to all the degenerations (including the degeneration from *kallipolis*) is that discord amongst the ruling class triggers the degeneration: Without civil strife amongst the rulers, “the constitution cannot be changed” (545c-d, Grube). If all the degenerations originate with a breakdown in unity of the ruling class, then by understanding how the ruling class differs between just and unjust constitutions, we can grasp why the degeneration from *kallipolis* is different from the rest. Already we know that the primary difference is that philosophers rule in the just *polis* while non-philosophers rule in the unjust societies. But, this basic distinction is relevant because the primary difference between philosophers and non-philosophers is that philosophers cannot become corrupt whereas non-philosophers can always become worse. Since the degenerations between unjust constitutions always begin with the corruption of the non-philosopher rulers, if philosophers are incorruptible, then the degeneration from *kallipolis* must differ from the rest.

This section explains why philosophers are not corruptible. The explanation proceeds in three steps: First, the philosophical nature is explained. Second, it is shown that the philosophical education is the primary instrument preventing corruption of the philosophical nature since it instills good motivations and it is the instrument by which philosophers can grasp the Forms. Third, it is argued that the ability to access the Forms is the ultimate safeguard against corruption because philosophers are happiest and aware that they exist in the best state, which stabilizes them. Finally, two potential objections are addressed.

PHILOSOPHICAL NATURE

The term “philosopher” means ‘lover of wisdom,’ which captures the essence of this character. To become a genuine philosopher, one must possess an innate philosophical capacity and cultivate this capacity with a proper philosophical education. The philosopher appreciates the pleasures of the soul over those of the body (485d) and loves all wisdom (474c), knowledge, and learning. Plato makes a crucial epistemological distinction between philosophers and non-philosophers. This difference hinges upon their disparate cognitive capacities, that is, their different states of mind and the corresponding objects of those states. Essentially, there are two states of mind, knowledge and belief, whose corresponding objects are Forms and sensibles, respectively. Knowledge encapsulates reality and is infallible, whereas belief captures appearances, and is changeable. Non-philosophers can have nothing more than beliefs (opinions) (see 476b). Only philosophers possess the cognitive capacity for knowledge (truth, *episteme*) through which they can grasp the Forms, although this does not come until after the philosopher undergoes the final stages of a philosophical education.

The enormous cognitive capacity of the philosopher is what enables him to be either incorruptible or the most corruptible depending upon his educational environment. In Book VI, after describing the philosophical nature, Plato explains that this nature is the most corruptible if it is not exposed to a proper environment to cultivate
its capacities (491d-e, 492a). Since a person with a philosophical nature possesses the greatest cognitive capacity and is therefore the cleverest, he will learn more quickly and effectively than his peers (494b). In the proper educational environment (i.e., *kallipolis*), this cognitive capacity will enable him to grasp the Forms, but in an improper environment where vice is called virtue and the majority’s appetites are called wisdom (493b-c), this same capacity will lead him to become the worst of those with this upbringing. Thus, for the production of a proper philosopher, a philosophical nature requires a proper philosophical education to realize his capacity to access the Forms.

**PHILOSOPHICAL EDUCATION**

The corruptibility of the philosophical nature renders a philosophical education and upbringing the primary instrument in preventing corruption. This education prevents corruption because it actualizes the philosopher by enabling him to access the Forms (especially the Form of the Good), which motivate him. Plato emphasizes that “…those in charge must cling to education and see that it isn’t corrupted without their noticing it, guarding it against everything” (424b, Grube). Additionally, Plato repeatedly emphasizes the importance of testing and selection to weed out guardians unfit for philosophical leadership. Instead of encouraging the acquisition of factual knowledge, Plato’s educational theory advocates instilling a method of analysis in its pupils. In Book VII, Plato explains the crux of his educational theory. He claims that the role of education is not to put “sight into the soul. Education takes for granted that sight is there but that it isn’t turned the right way or looking where it ought to look, and it tries to redirect it appropriately…” (518d, Grube). For Plato, a meticulous philosophical education cannot reverse the effect of inferior breeding, but a proper philosophical education is essential for realizing one’s natural capacity to rule. Plato divides his account of education into two parts: an earlier part in Books II-IV in which he discusses the early childhood education of all guardians and a later part in Book VII in which he focuses solely on the education and selection of philosopher-rulers. The former instills intuitively good motivations in its pupils and the latter instills new motivations and a basis for understanding the pre-philosophical motivations, deepening one’s commitment to them. It is after the second stage that a pupil becomes a full-fledged incorruptible philosopher, although the earlier education is an imperative prerequisite for the later stage.

Early childhood education is administered to all guardians and includes music and poetry (for the soul) and physical education (for the body). Although not all persons receiving this early education go on to become full philosophers, it contains important components which explain the origin of how and why the philosophical education as a whole prevents corruption. Since Plato assumes children’s souls are enormously impressionable because “the opinions they absorb at that age are hard to erase and apt to become unalterable” (378d, Grube), it is crucial that they only be exposed at first to good things and not evil. To accomplish this, Plato advocates telling of false stories that contain underlying truths (377a) and censoring evil or blasphemous stories. These methods help orient the souls of children towards virtue and reason:
[The child will] rightly object to what is shameful, hating it while he's still young and unable to grasp reason, but, having been educated in this way, he will welcome the reason when it comes and recognize it easily because of its kinship with himself (402a, Grube).42

Although they do not have a capacity for moral judgment (yet), Plato is trying to integrate virtue into the nature of these children so that, even if they cannot explain why they make certain judgments, they are still intuitively motivated to do what is morally right. But, this early education does not ensure incorruptibility since it does not enable its pupils to understand these pre-philosophical motivations which come with transcending the world of sensible experience. This comes in the second stage.

Those who possess the best natures after the early education will proceed to the later philosophical education described in Book VII. This education includes ten years of mathematics (537c-d, 522c-531d), five years of dialectic (537d-540a), fifteen years of practical political training (539e-540a), and the ascent to the Good itself (540a). In this stage, the philosophers' commitment to their pre-philosophical motivations deepens as they are able to understand why these motivations are good. The path towards understanding begins with the study of mathematics which enables one to ascend from mere sense perception to pure thought.43 This enables pupils to study the dialectic, which is a method of analysis enabling access to the Forms, and ultimately the Form of the Good. Once a pupil can access the Good, he or she is incorruptible.

One might object that pupils who complete the first stage of education are already incorruptible because they possess an intuitive notion of the good and act according to these virtuous motivations, even if they cannot explain what is good about them.44 Textually, the objection could draw upon 378d and 377a (both cited above) as evidence for this claim. But, as Plato explains, the pre-philosophers' inability to understand their own motivations leaves them vulnerable to corruption by dialectic “as it is currently practiced” (537d, Grube) since “those who practice it are filled with lawlessness” (537e, Grube). In his discussion of the dangers of dialectic (537d-539a), Plato explains that even those who hold firm convictions from early childhood could be shaken of those values by arguments which seem to refute them. Consequently, as Plato states, “…from being law-abiding he becomes lawless” (539a, Grube). Plato emphasizes that no one should begin dialectical training until he is thirty years old, and has successfully completed ten years of requisite mathematical training which has presumably instilled extensive mental discipline since it enables ascension from the realm of sensible experience to that of pure thought. Without such training, one will not possess sufficient discipline to resist the temptation of arguing for the sake of contradiction rather than for the sake of truth. Hence, dialectic threatens to corrupt those who have completed the pre-philosophical education. But once pupils are trained in dialectic, they can resist its dangers and use it as a vehicle to access the Forms.
FORMS

Once the philosopher grasps the Forms, he is not corruptible. Inferior psychological attitudes could never tempt him away from pursuing these ultimate objects of knowledge. The ability to grasp Forms renders philosophers happiest and fully aware that they exist in the best state of being. This awareness, coupled with the fact that the Forms are unchanging motivations, stabilizes the philosophers and prevents corruption.

Plato maintains that because philosophers can grasp the Forms, they are happiest since only they can experience genuine pleasure, while non-philosophers are less happy since they cannot experience genuine pleasure. In Plato’s second pleasure proof in Book IX, he explains that genuine pleasure corresponds only with the rational part of the soul, not with the non-rational parts (spirit and appetite). On this view, the only genuine pleasure is the acquisition of knowledge and the objects of knowledge are Forms. Corporeal pleasures are not true pleasures (586b). Since non-philosophers can only have beliefs about sensible particulars, their objects of pleasure exist in the sensible world and are not lasting; thus, their pleasures are less real than those of the philosopher. But, since only philosophers can grasp the Forms, only they can experience genuine pleasure, which are permanent, and so they are happiest of all persons.

Part of what keeps the philosopher stable in this highest state of being is his self-awareness, while non-philosophers lack the extent of the philosopher’s self-awareness. Plato suggests the philosopher is self-aware at the end of Book IX when he discusses how the philosopher guards his soul: “he’ll [the philosopher] look to the constitution within him and guard against disturbing anything in it” (591e, Grube). Since he can grasp the Forms, and, thus, know what the best human life is, the philosopher understands he exists in the happiest state of all human beings, and so nothing could tempt him to deviate from this state. Appetitive and spirited desires are powerless against the philosopher’s rational desires. The philosopher is even willing to make sacrifices for the sake of pursuing philosophy, which can be seen by his compulsion to rule over kallipolis (540). Philosophers understand that their way of life can only be perpetuated if they themselves are rulers. Hence, they will rule for a time so as to one day return to their lives of philosophy with the knowledge that they will live in a place where this life is possible. In this way, serving the political constitution is harmonious with serving themselves. The extent of self-awareness for non-philosophers varies based on the extent of their rational capacity and education. Non-philosophers might be fully aware of what they are, although since they cannot access the Forms, they lack the necessary judgment to determine if what they are living is the best human life. This is the case with the unjust rulers who deceive others in pursuit of what they perceive as the best life, not what actually is the best life.

An innate philosophical capacity coupled with a philosophical education enables philosophers to access the Forms, which provide the philosopher a stable motivation and an objective measure of happiness. Hence, philosophers realize they exist in the best state of being, which stabilizes them. Thus, philosophers are incorruptible.
OBJECTION ONE: THE MISTAKES OF PHILOSOPHER-RULERS

One objection to the claim that philosophers are incorruptible is that they can make mistakes, which lead to degeneration. The objection might stipulate that if they can make mistakes, they are corruptible by virtue of the fact that they can still harm society, even if unintentionally. But, these mistakes reflect human fallibility, not corruption. Whereas corruption suggests a decline in psychological attitudes and a parallel decline in motivations, fallibility suggests no such psychological decline. With fallibility, psychological attitudes and motivations remain unchanged. Since the rulers must rely not only upon “calculation,” but also upon “sense perception” to determine the births of the next generation, mistakes are inevitable. Since Plato makes clear that sense perception is enormously fallible (“everything that comes into being must decay” (546a, Grube)), the constitution which depends upon sense perception must inevitably degenerate. Although the harm to the society originates with the philosopher-rulers, this harm is not a reflection of their corruption, but of their mortal fallibility.

OBJECTION TWO: THE LIES OF THE PHILOSOPHER-RULERS

This study argues that the lies of the non-philosopher rulers are integral to the degenerations of the unjust constitutions, and that these lies reflect their corruption. Logically, it should follow that philosopher-rulers are also corruptible since, as Plato explicitly states, the “...rulers will have to make considerable use of falsehood and deception for the benefit of those they rule” (459c, Grube). That philosopher-rulers lie seems wholly inconsistent with the philosophical nature, which emphasizes truth above all else. But this is not a viable objection because the lies of the philosopher-rulers are categorically different from the lies of non-philosophers. Plato believes the philosopher-rulers’ lies are constructive (lead society towards the good) while the non-philosopher rulers’ lies are destructive (lead society away from the good). Thus, the lies of non-philosophers reflect their corruption while the lies of philosophers do not.

At the end of Book II, Plato distinguishes between two kinds of falsehoods: “true falsehoods” and “falsehoods in words.” A “true falsehood” is embedded in the soul and deceives the rational part. It is always destructive and leads away from the good because reason cannot properly fulfill its role when deceived by a true falsehood. In contrast, a “verbal falsehood” is external to the soul and does not entail deception there. Instead, Plato believes verbal falsehoods are constructive and useful because they can lead people towards the good itself, but only if those telling them know the good. This is why Plato says that only philosophers can tell lies (but only verbal lies) since they are the only ones who know the good (389b). Since non-philosophers cannot know the good and their motivations to lie cannot be in pursuit of the good, their verbal lies can manifest as true lies and lead kallipolis away from the good.

Plato classifies the lies of the philosopher-rulers, including myths and false stories told in childhood education, as useful verbal lies, not true lies. On Plato’s view, the myth of the metals contains an underlying truth (that biological human capacities are innately different) in Plato’s view and thus promotes the good. Similarly, the marriage lie promotes the good of the city since it prevents dissent in the guardian classes. The
logic behind these lies is that they promote both the individual and collective good: They promote the individual good because they help ensure that everyone’s position in society is harmonious with his or her nature, thereby maximizing one’s potential. The lies promote the collective good because if everyone does what is harmonious with their natures, society as a whole maximizes productivity, fulfillment, and happiness. Thus, the philosopher-rulers’ use of lies in *kallipolis* leads everyone towards the good, and so they do not reflect corruption.

The psychological and epistemological differences between philosophers and non-philosophers explain why the latter are corruptible while the former are not. Reason cultivated by a proper philosophical education enables philosophers to grasp the Forms, which are the ultimate motivations preventing their corruption. Once exposed to the Forms, philosophers experience genuine pleasure from which they will never turn. Because non-philosophers are ruled by inferior psychological attitudes and can only access the world of unstable belief, they are psychologically corruptible. Since degeneration according to the model described here requires rulers to become psychologically corrupt, the degeneration from *kallipolis* must proceed differently since philosophers are not corruptible. Instead of the philosopher-rulers becoming corrupt, Plato explains that the degeneration from *kallipolis* occurs due to the mistakes of the philosophers in the selective breeding of the next generation. This mortal fallibility, not corruption, initiates the events which lead to degeneration.

### III. PRACTICAL APPLICATIONS OF THE MODEL

Because philosophers are the only incorruptible persons, Plato proposes a radical solution for how *kallipolis* might come into being\(^{57}\) (472e-473a). His explanation captures a central problem in the *Republic*: until philosophers become rulers, or rulers become philosophers, *kallipolis* can never fully be realized.\(^{58}\) Plato states,

> Until philosophers rule as kings in cities or those who are now called kings and leading men genuinely and adequately philosophize, that is, until political power and philosophy entirely coincide...cities will have no rest from evils, Glaucon, nor, I think, will the human race. And, until this happens, the constitution we’ve been describing in theory will never be born to the fullest extent possible or see the light of the sun...there can be no happiness, either public or private, in any other city (473c-e, Grube).

Plato is suggesting that political power will corrupt anyone who is not a philosopher and as a result, the city ruled by the non-philosopher will suffer accordingly. But, although we can strive towards the philosophical ideal, even Plato acknowledges that the incorruptible philosopher-ruler could not actually exist;\(^{59}\) hence, *kallipolis* is a practical impossibility.

In contrast to *kallipolis*, the degenerate societies have a basis in reality. Although there is much scholarly debate regarding the historicity versus the extent of idealization of Plato’s account,\(^{60}\) ultimately it should be interpreted as a theoretical examination of psychological and political decay.\(^{61}\) The model outlined by this research
explains what can happen to a society whose leadership acts on their corrupt impulses. This model can also be applied to deepen the understanding of certain historical degenerations. In this section, two cases of historical decay are examined and explained.

**CASE 1: ATHENIAN DEMOCRACY (C. 750 B.C.)**

After 750 B.C., Athens was one of the leading Greek city-states, which developed following the Dark Ages. The model of degeneration will explain how it progressed from oligarchy to democracy. In the first stage of degeneration, the ruler becomes psychologically corrupt. In this case, aristocrats usurped power from hereditary kings and became psychologically worse with their newfound power. Second, the new aristocratic oligarchs abused their political power in their exploitation of poor farmers. The oligarchs administered deceptive loans secured by the poor farmers’ land, and when the farmers could not repay those loans, they lost their land and many were enslaved by the corrupt oligarchs. In the third stage, tensions between the oppressed peasant majority and the self-serving oligarchs led to democratic reforms by a series of leaders, including Solon and Cleisthenes. These changes gave rise to a flourishing democracy which declined only after it was defeated by Sparta following the Peloponnesian War.

**CASE 2: GERMANY, HITLER AND NAZISM**

Adolf Hitler and his National Socialist (Nazi) party exploited the volatile political, social, and economic climate to rise to power in the fledgling German democracy. Following the end of World War I and the revolt against Kaiser William II, democracy took hold in Germany in 1919, but powerful forces on both the left and right lent instability to this new government. Additionally, severe inflation and the Great Depression caused the German economy to suffer and as a result, unemployment skyrocketed in the early 1930’s. In this climate of uncertainty, Adolf Hitler used his power to manipulate public opinion into supporting his own agenda. By the time people in Germany and around the world realized what was happening under the Nazis, extensive damage had already been done.

The model of degeneration outlined in this study can help explain the political change surrounding the rise and fall of Nazism. First, political power and a corrupt leader are brought together. In 1933, Hitler was appointed Chancellor of Germany after he promised President Hindenburg he would abide by the constitution. Hitler immediately broke this promise, called for new elections, and the Nazis gained control of the Reichstag in a vote which was marked by intimidation and deceit. Hitler became a dictator and executed all political opposition. Second, and coupled with this rise to power, was the extensive campaign of deceit which came in the form of propaganda that made the Jews scapegoats for the economic hardships of the German people. Hitler was not yet viewed as an absolute dictator by the millions of Germans who believed in his persuasive messages and impassioned speeches. Soon, Nazism spread and Hitler’s yearn to widen his scope of influence thrust the world into the Second World War. In the third stage, Germans and the world began realizing how Hitler deceived them, and they mobilized to stop him. Political change followed Germany’s defeat by the Allies and Hitler’s suicide.
CONCLUSIONS
This study outlines a model of degeneration which provides a uniform structure to each account of constitutional degeneration in the Republic, except the decline from kallipolis. The model explains how the psychological corruption of the non-philosopher rulers in the unjust societies leads to political decline of the constitution. In the exception to the model (in the decline from kallipolis), however, since philosopher-rulers are not corruptible, this decline must proceed differently. Since philosophers are not corruptible, kallipolis cannot undergo the first stage of decline in which the rulers become psychologically corrupt.

This model has both philosophical and historical significance. First, the Republic, like most of Plato’s dialogues, is a protreptic work and as such, it is primarily concerned with advocating the philosophical life. By differentiating the degeneration from kallipolis from the others (based on his assumption that only philosophers are incorruptible), Plato advocates the philosophical life as the best human life and kallipolis as the only political constitution in which that life is fully possible. Unlike in the degenerations between unjust constitutions, the degeneration from kallipolis does not occur due to the unjust motivations of its rulers. Instead, Plato points to what seems to be the philosopher-rulers’ only flaw: that they are human and as such are subject to the fallibilities of corporeal sense perception. Psychologically, however, philosophers are perfect and they are always motivated by what is good. They are always motivated to act in the best interests of kallipolis because only in this constitution is the protreptic life they love possible. In contrast, non-philosophers have a host of flaws and the political constitutions over which they rule will be unhappy and will inevitably degenerate because they are corruptible and possess imperfect motivations. Hence, by differentiating the degeneration from kallipolis from the others, Plato highlights the psychological perfection of philosophers and the political perfection of kallipolis. Second and beyond this philosophical significance, the model of degeneration outlined in this study has practical historical applications: it suggests how corrupt leadership can lead to political decay in certain instances. With the account of degeneration, Plato shows how deficient the lives of non-philosophers are, and that philosophy is the best way of life because only as a philosopher can one access truth.

NOTES
1 Greek term for “ideal city-state”
2 Rule by military; intermediate between kallipolis and oligarchy
3 Rule by the wealthy
4 Rule by the many
5 Absolute rule by one

7 See Irwin and Nettleship, for example.

For Plato, the soul is comprised of three parts: reason, spirit, and appetite. Hence, it is referred to as “tripartite.” In his defense of justice, Plato makes a sweeping assumption upon which his entire argument depends. He assumes that the *polis* (political constitution) is a citizen enlarged. In this analogy between person and *polis*, Plato identifies the inner workings of an individual’s psyche with the workings of the *polis* itself. According to this analogy, each of the three parts of the soul corresponds to one of the three classes of the city (philosopher-rulers, auxiliaries, and producers). The philosopher rulers are the proper guardians of the city, the auxiliaries comprise the military class, and the producers engage in crafts, farming, and other trades outside government. The rational part is the best part and it corresponds with the wise philosopher-rulers, the spirited part corresponds with the militaristic auxiliaries, and the appetitive part generally corresponds with the producers. When considering this framework, it is important to keep in mind two things: First, these are psychological attitudes, and not physical parts of a literal thing (Brown 5). Second, human souls are comprised of a combination of all three psychological attitudes, although one psychological attitude tends to dominate over the rest in each person. Similarly, each constitution is generally ruled by one character type who is dominated by one of the psychological attitudes.

Although it might seem tedious and inelegant, it is important to rigorously establish that a model can help explain the mechanics of Plato’s account since this is the first paper which proposes that any underlying model exists.

For example, see 421d, 490e-495b, and Books VIII and IX.

That is, their education has emphasized physical training over intellectual training.

Plato does not specify precisely how many rulers must become oligarchic for the society to become oligarchic, although this passage suggests it must be a majority.

In his *Lectures on the Republic of Plato*, R.L. Nettleship anticipates my interpretation in his observation of the psychological tension developing within the Timocrat, of whom he asserts that “…beneath the fair exterior of honour one of the lowest qualities is developing itself” (Nettleship 305). By marking the development of some “low” quality beneath the “fair exterior of honour,” Nettleship suggests that as the Timocrat degenerates into the Oligarch, he projects an appearance of honor (“the fair exterior”), which is highly regarded by the society, while he secretly develops and indulges the more primal appetitive (money-loving) impulses within his soul.

Concealing is important here until the degenerate rulers have sufficient political capital to enforce a change in values (from honor-loving to money-loving), which will enable the wealthy to become wealthier. This is why the exposure in this degeneration is willing, not unwilling, as we will see in subsequent degenerations. In this degeneration, the rulers can become even wealthier and more powerful if the entire society values and respects wealthy people. In subsequent degenerations, however, such revelations of the rulers’ true values are unwilling because these revelations harm the rulers’ pursuit of their degenerate values.

Plato strongly suggests that the new rulers have enough physical power (“force of arms”) to put down the dissenters.

As the societies move farther from *kallipolis* and the rulers are increasingly ruled by appetitive psychological attitudes, the easier it is for them to manipulate the rest of the society for their own ends.
One might object that there is a large segment of the city that hates the rich. Plato says that civil strife between the rich and poor is a prominent characteristic of oligarchy. He states that the rich and poor are “living in the same place and always plotting against one another” (551d).

But we must analyze this hatred, for Plato suggests that the poor do not hate the wealthy because they hate wealth, but merely because they are jealous of the oligarch’s wealth and restraint. Plato even says the frugal oligarch is “the sort the majority admires” (554a). It is likely that, given the choice, poor people would choose to be wealthy like the oligarch, but they lack the moderation and discipline to do so (see 555c-d). Thus, the animosity between the rich and poor arises because everyone desires the “good” of oligarchy (wealth) and the rich are in possession of a majority of that good.

The rich “hate” the poor because the poor represent a potential threat to the oligarchs’ wealth and power. Since the poor constitute a majority and resent the wealthy, they cannot be considered their allies in war or any other matter (see 551d).

According to Plato, the oligarch’s degraded sense of value (wealth) arises because oligarchs are not attentive and meticulous with their education. Consequently, Plato says, they choose a “blind leader,” Plutus, the god of wealth (Grube 224, FN 17), and “honor…him most” (554b). This mention of Plutus dramatizes the concealment of reality by false appearances, or the deception within the oligarchy. Plato suggests that in honoring a blind god most, the oligarchs, due to their lack of a good education, do not possess the components of true virtue and knowledge (or the ability to know it when they see it). They are merely “sight-lovers.” Thus, the oligarchs themselves are a form of “blind leaders,” and the society is suffering from a form of blindness since it values wealth above anything else and mistakes wealth as the best qualification for leadership. The society cannot see the potentially negative reality underlying the “positive” appearance of wealth.

Nettleship again anticipates argument presented (see footnote 4) when he suggests this conscious concealment of dronish appetites by the oligarchs. He asserts, “Externally there is decency, order, and respectability in the life of the oligarchic man, but the ‘dron appetites’ are beginning to make themselves felt, though as yet kept in check by the absorbing appetite for wealth…Ultimately oligarchy is overthrown because the rulers, being set upon wealth only, become degenerate, and the people discover their weakness…” (Nettleship 308, 309).

Plato suggests that the oligarchs would have been wiser to be more straightforward since the masses’ realization of this deception motivates their hatred of the oligarchs and their desire for revolution. But, the oligarchs are entirely “unwilling to enact laws to prevent young people who’ve had no discipline from spending and wasting their wealth” (555c, Grube). Towards the end of his description of the transition from oligarchy to democracy, Plato adds a brief discussion of legislative steps the oligarchs could have taken to curb the rise of the drones. In this section, Plato suggests there be a law

...which compels the citizens to care about virtue by prescribing that the majority of voluntary contracts be entered into at the lender’s own risk, for lenders would be less shameless then in their pursuit of money in the city and fewer of those evils we were mentioning just now would develop (556a-b, Grube, author’s italics).

In other words, Plato suggests that if the oligarchs were more forthcoming about the risks of the loans, they would limit the development of the class of drones.

One might cite 554e-555a as an objection to my claim that the oligarch seeks a positive appearance:

Further, this thrifty man is a poor individual contestant for victory in a city or for any other fine and much-honored thing, for he’s not willing to spend money for the sake of a fine reputation or on contests for such things (554e-555a, Grube).
The objection might be that Plato suggests the oligarch does not care if he is in possession of a “fine reputation.” But, while this could be the case in many instances, it cannot be the case when it comes to his reputation in financial transactions. A good reputation in these matters is essential because it serves the oligarch’s main objective of acquiring as much money as possible. If people did not perceive the oligarch’s “fine reputation” in these business matters, they might not borrow from him.

22 Even at this point, however, the oligarchs still attempt to appear virtuous in the sense that they do not acknowledge their responsibility in the poverty of these people: “The money-makers…with their eyes on the ground, pretend not to see these people, and by lending money they disable any of the remainder who resist, exact as interest many times the principal sum, and so create a considerable number of drones and beggars in the city” (555e, Grube, italics added by author).

23 There was already a certain amount of animosity between the rich and poor in oligarchy. But, the consequences (a large class of drones and beggars) of the oligarch’s deceptive loans tipped the balance so that the poor become stronger than the rich.

24 It is interesting to note that whereas the degeneration from timocracy to oligarchy emerges from the top-down, the degeneration from oligarchy to democracy emerges from the bottom-up. This makes way for democracy, which is ruled by the many, as opposed to oligarchy, which is ruled by a few. Additionally, in the degeneration from timocracy, the revelation is willing, but in the degeneration from oligarchy, the degeneration is unwilling. But these differences do not discount the similarities between the degenerations.

25 The “drone” is like a leech on society and is associated with the unnecessary appetites.

26 Grube translates the same passage as follows: “…this leader of the soul adopts madness as its bodyguard and becomes frenzied. If it finds any beliefs or desires in the man that are thought to be good or that still have some shame, it destroys them and throws them out, until it’s purged of moderation and filled him with imported madness” (573a-b).

27 In the article, “The Rise and Fall of the Platonic Kallipolis,” F.V. Merriman suggests the present argument: “Tyranny is safe so long as its docile and virtuous subjects do not begin to see through the maxims they have learned. After that point the government has to depend on force” (Merriman 14, author’s italics).

28 See 571c-d.

29 This aspect of Plato’s kallipolis is enormously controversial since it opposes the widely accepted belief in self-determination. Plato suggests that humans are psychologically limited by their biological makeup. A number of scholars (most notably Karl Popper) have suggested this aspect of Plato’s kallipolis is totalitarian and dangerous. On these interpretations, Plato anticipates and justifies such philosophies as those underlying Nazism and slavery.

30 As in the other degenerations, these tensions are a crucial step in this transition: without civil strife amongst the rulers, “the constitution cannot be changed” (545c-d, Grube). Unlike in the degenerations between unjust constitutions, however, civil strife in the degeneration from kallipolis is not motivated by others realizing the deception by the rulers. As is shown, Plato’s discussion of the degenerations between unjust constitutions exhibits this moment of revelation of the rulers’ deception, which in turn provokes civil strife, causing the political constitution to degenerate. Plato makes no mention of such concealment and subsequent revelation, or lack thereof, in his discussion of how kallipolis degenerates into timocracy. If one accepts the model of degeneration, Plato’s lack of articulation on this point becomes significant, although he is not explicit as to why. But at least it is known that the shift between the rulers’ concealment and the revelation by others cannot be the impetus for civil strife in the first degeneration.

31 This stage illuminates another contrast between the degeneration from kallipolis and the others. In the others, one of the two parties engaged in the civil strife won out over the other. The oligarchs defeat the timocrats, the many democrats defeat the oligarchs, and the tyrant overpow-
ers the rest of the population. There is no compromise in any of these transitions. In the degeneration from kallipolis, however, compromise between the warring parties marks the final point of degeneration.

32 Plato’s invention of ultimate objects of knowledge or “Forms” suggests that for things in the sensible world (our world), there are perfect Forms of them which ordinary humans can never know. For example, the Form of “chair” is “Chairness,” the perfect idea of a chair.

33 Plato’s invention of ultimate objects of knowledge or “Forms” suggests that for things in the sensible world (our world), there are perfect Forms of them which ordinary humans can never know. For example, the Form of “chair” is “Chairness,” the perfect idea of a chair.


36 To understand this primary distinction between philosophers and non-philosophers, it must be accepted that Plato’s theory of Forms (Cross and Woozley, Plato’s Republic 144). If not, then there can be no qualitative distinction between what philosophers can know and what non-philosophers can know. Furthermore, the theory of Forms must be accepted since the capacity to grasp the Forms renders philosophers incorruptible.

37 Plato explains that the majority can never be philosophic (494a).

38 Plato explains that the only way someone with a philosophical nature exposed to such an environment could become a philosopher is through divine intervention (492e). Otherwise, he or she must be raised in the proper environment (i.e., kallipolis).

39 For Plato, the education of the rulers is so critical to kallipolis that he even states that most legislation in the state should govern this education (534d), which at once suggests the enormous political power the philosopher-rulers possess. Presumably, there need be few actual laws governing kallipolis itself because the judgment of the philosopher-rulers is sufficient for the just governance of the state. Hence, Plato’s expectation must be that the philosophical education renders philosophers incorruptible and so they will always act in the best interests of the polis. This is why they can justifiably possess such extensive political power.

40 See 412d, 503a, 503e, and 539e. There is mention of this in the in the early childhood education, but it is especially emphasized in the later education specifically geared towards philosophers.


42 This lack of experience in what is bad is especially important for a judge, who “does rule over other souls with his own soul” (409a, Grube), and should be older before assuming his or her post (409b). It is the opposite for the doctor, who has control over other peoples’ bodies. According to Plato, a good doctor has had much contact with sick people and has preferably had much experience being ill himself (408d-e).

43 See 525b-c and 529d, for example.


45 As it is used in the Republic and other Platonic texts, “happiness” is the translation of the Greek word eudaimonia, which is the “objective state of maximal human flourishing” (Mary-Hannah Jones in a handout for her course entitled “Plato’s Republic.” Wesleyan University, Spring 2003.) Eudaimonia is an ultimate end in itself and, in the Republic, is the effect of living a just life. For an extended discussion of happiness, see Gregory Vlastos, “Happiness and Virtue in Socrates’ Moral Theory,” Plato 2 Ed. Gail Fine, (New York: Oxford U.P., 1999) 105-136.

46 In his book, Plato’s Utopia Recast, Christopher Bobonich takes an extreme approach to this, suggesting that only philosophers can be happy while non-philosophers can never be happy (See Christopher Bobonich, Plato’s Utopia Recast (New York: Oxford U.P., 2002) 7-8.)
For Plato, the world of Forms is more real than the world of sensible experience.

Self-awareness simply refers to one's understanding of one's own state of being. Self-awareness is greater when rational psychological attitudes are stronger. It is strongest for those who can know the Forms since then they will have an objective measure against which they can test their own state of being.

Annas 296.

See 485c, d.

By “destructive,” the author means detracting from one's good, and by “constructive,” the author means contributing to one's good.

This refers to philosophers and never non-philosophers.

The problem here relates to what Plato says preceding his account of the noble falsehood. Plato raises doubts as to how much philosophers can actually know when he states that the “best case” would be that in which the noble falsehood would “persuade even the rulers” (414b-c). Why would Plato have his philosopher-rulers accept a falsehood? Why not merely have them accept the truth underlying the falsehood? Philosophers are supposed to know truth, and not be deceived by falsehoods. Karl Popper, a notable critic of Plato’s, goes so far as to suggest that the lies extend beyond totalitarianism since they are not only for consumption by the ruled, but also by the rulers after several generations (Karl Popper, *The Open Society and Its Enemies*, vol. I (London: Butler & Tanner, 1945) 122. Popper is citing 414b-c). Although Popper might be extreme in his criticisms, he does take issue with a problematic passage. Thus far, no scholar has been able to offer a satisfactory response to the problem raised in this passage, and so it is often overlooked. If this is what Plato meant, it raises a legitimate problem with the philosophers’ ability to know the truth. If this is the case, it also raises problems as to whether or not they should be permitted to tell lies since only those who can fully grasp the good should be permitted to tell lies.

This debate considers whether Plato’s account has any basis in history or whether it is a purely theoretical idealization of historical change. While some scholars argue for the purely historical reading (Karl Popper advocates this view in *The Open Society and Its Enemies*), many others take a more moderate view, suggesting that Plato’s account is a theoretical “philosophy of history” (Walsh 3). The author argues one must accept the latter perspective because Plato himself suggests that the four unjust constitutions are theoretical in that they represent the most distinct forms of constitutions and that all other constitutions are intermediate between them (544c-d). Hence, one can use this account to potentially understand historical change.

Nettleship aptly characterizes how one should view Plato’s account of degeneration: “The question he [Plato] puts before himself is this: The human soul being as we have described it, and having in it a certain capacity for evil as well as for good, what would it come to, and through what stages would it pass, if its capacity for evil were realized gradually but without any abatement? In actual human experience there is always some abatement; there are always countering circumstances which prevent any one tendency working itself out in isolation and unhin-
dered; but the philosopher may, as Plato here does, work out the result of a single tendency logically. These books therefore put before us an ideal history of evil, as the previous books put before us an ideal history of good” (Nettleship 295).

62 For the most part, the model should be used to understand declines which arise from factors internal to the workings of the society itself and not from external influences such as conquests by other societies.

63 The following case studies do not exhaust the historical facts and circumstances, but are merely intended as sketches with sufficient details to illustrate the model.

64 This decline closely resembles Plato’s discussion of the decline from oligarchy to democracy and it is quite plausible that Plato based his account on these historical events.

65 Stage one of the model is difficult to document with full certainty because it depends so heavily upon the internal psychological states of the rulers and this historical information is not always well-documented. This is the case in this example, although we can make certain rough conclusions about the psychological changes the rulers must have undergone based upon their actions and the effects of those actions.

66 Between these two leaders, Athens was ruled by the tyrant Pisistratus, but his support of causes important to peasants further paved the way for democracy.


68 Protreptic is a method of classical rhetoric originally associated with the Sophists. Essentially, it refers to the supremacy of the philosophical life and the methods for practicing philosophy (often through rhetoric). This advocates the philosophical life as the best life.
ABSTRACT

Channeling is the preference of an enzyme for intermediates within a pathway over the same intermediates in the cell’s cytoplasm. The importance of this phenomenon stems from its proposed role in regulating metabolism and in allowing a cell to function with limited cellular resources. This study is a quantitative examination of channeling in vivo using intact Escherichia coli, an often used model bacterium. In E. coli, enzyme interaction was examined in the glycolytic pathway. A high degree of channeling was found in the seven reactions from fructose-1,6-bisphosphate (F1,6P2) to pyruvate and then on to CO2. This contrasts with the non-significant channeling found from fructose-6-phosphate (F6P) to CO2. The F1,6P2 result is surprising, since detection of channeling in this protocol requires each downstream step of the pathway to preserve channeling and not equilibrate with the cell’s cytoplasm.

ACKNOWLEDGEMENTS

Thank you to Danny Kohl and Georgia Shearer for their care, direction, guidance, and support throughout the last four years. Thanks to Jia-an Koo, Dustin Zemel, Lauren Holden, and Maureen Hughes for their assistance and support. This work has been supported by the Howard Hughes Medical Institute Washington University Summer Undergraduate Research Fellowship, Washington University Office of Undergraduate Research, and NSF Grant # MCB-02004900. For a more detailed account of this and related work, see Shearer et al. [18].

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KEY TERMS

- Cellular flux
- Channeling
- Glycolysis
- Metabolic regulation
- Metabolon
INTRODUCTION

The interior of a cell is a crowded, dynamic environment. It has been proposed that some manner of organization within the cytoplasm must exist for vital metabolic processes to be carried out efficiently. A possible candidate for such organization is the phenomenon of channeling (See review by Srere\textsuperscript{1} and also\textsuperscript{2,3}).

Channeling is the preference of an enzyme for an intermediate just produced within a pathway over the same intermediate in the cell’s cytoplasm. The putative mechanism of channeling is the transient interaction of sequential pathway enzymes. Advantages that might result from channeling include localization of reaction intermediates to the catabolic site in which they are used. This would increase the concentration of the intermediates at the catalytic site, prevent degradation of the intermediate elsewhere in the cell, and prevent potentially toxic intermediates from having detrimental effects on the cell\textsuperscript{4}. It also suggests the possibility of improved efficiency by allowing decreased transit time between catabolic sites, preventing other pathways from competing for an intermediate, and contributing to pathway regulation, particularly at metabolic branch points.

Several \textit{in vitro} experiments have been cited as evidence for channeling. These include co-precipitation, co-purification, and isotope dilution using cell extracts\textsuperscript{5,6,7,8}. While promising, such methods do not fully account for the complexity of the intact cell. Since channeling involves the transfer of substrates among interacting proteins in a crowded cell, cell extracts are not accurate proxies\textsuperscript{9}.

Various \textit{in vivo} methods have also been used to investigate channeling. Nuclear magnetic resonance, co-localization, and genetic knock-out studies have established the occurrence of channeling in several different pathways\textsuperscript{10,11,12,13}. In addition, several investigations using radioactive isotopes are consistent with channeling\textsuperscript{14,15,16}. These \textit{in vivo} studies are promising, but all of the studies either damage cells by permeabilization or allow only for a qualitative assessment of channeling.

This study examines quantitatively the channeling in the glycolytic pathway (Figure 1) in intact cells of \textit{E. coli}, since results of earlier \textit{in vitro} experiments\textsuperscript{14,17} were consistent with channeling in this pathway. Incubation of \textit{E. coli} cells with radio-labeled 14C-glucose resulted in the production of 14CO2. The amount of 14CO2 evolved in a thirty minute incubation was measured. An unlabeled challenging glycolytic intermediate, either glucose-6-phosphate (G6P), fructose-6-phosphate (F6P), or

\textbf{Figure 1}

\begin{center}
\begin{tikzpicture}

\begin{scope}[scale=0.8]

\node (glucose) at (0,0) {Glucose};
\node (atp) at (1,0) {ATP};
\node (g6p) at (2,0) {G6P};
\node (adp) at (1,-1) {ADP};
\node (f6p) at (2,-1) {F6P};
\node (adp1) at (1,-2) {ADP};
\node (f1p) at (2,-2) {F1,6 P\textsubscript{2}};
\node (dhap) at (0,-3) {DHAP};
\node (nad) at (1,-3) {NAD}\node (nadp) at (1,-4) {NADH};
\node (g3p) at (2,-3) {G3P};
\node (3pg) at (2,-4) {3PG};
\node (2pg) at (2,-5) {2PG};
\node (adp2) at (1,-6) {ADP};
\node (pep) at (2,-6) {PEP};
\node (atp1) at (1,-7) {ATP};
\node (pyruvate) at (2,-7) {Pyruvate};
\node (mixed) at (0,-8) {Mixed acid fermentation};
\node (acetyl) at (2,-8) {Acetyl Co-A};
\node (tca) at (2,-9) {TCA cycle};
\node (co2) at (2,-10) {CO\textsubscript{2}};
\end{scope}

\end{tikzpicture}
\end{center}

\textbf{Figure 1.} The sources of CO\textsubscript{2} from the glycolytic pathway, followed by mixed acid fermentation or the TCA cycle.
fructose-1,6-bisphosphate (F1,6P2), was also added to some of the incubations. Assuming that the 12C-intermediate was able to enter the cell, this would set up a competition between the 14C-intermediate produced from 14C-glucose and the exogenous 12C-intermediate for the next enzyme in the pathway. If the added intermediate were successful in competing for the next pathway enzyme, the amount of 14CO2 generated during the incubation would be decreased. The degree to which the unlabeled intermediate does not decrease the amount of 14CO2 produced points to channeling. Inverse experiments, incubations using a 14C-intermediate alone and with both 14C-intermediate and 12C-glucose, were also performed.

**MATERIALS AND METHODS**

Radioactive materials and other biochemicals used in growth and incubation experiments were from Sigma (St. Louis, MO). An *E. coli* mutant and parental strain were obtained from the late Robert Kadner (University of Virginia). The *E. coli* mutant line was designed to allow constitutive uptake of sugar phosphates with four, five, or six carbons.

*E. coli* cells were grown in Medium A, a defined growth medium that contained K2HPO4, KH2PO4, (NH4)2SO4, trisodium citrate, MgSO4, CaCl2, thiamine, and glycerol. The glycerol served as the carbon source. Growth medium for cells to be used in some F6P channeling experiments were augmented with 25µM F6P, which resulted in greatly increased F6P utilization when incubated in the presence of glucose. Cells were grown at 37°C on a rotary shaker to an absorbance of 0.8 at 600 nm. At this point, cells were harvested and washed with Medium Aminus (Medium A lacking MgSO4, CaCl2, thiamine, and carbon source) by centrifugation.

Prior to incubation, *E. coli* cells were resuspended with Medium Aminus. An incubation mixture was prepared that contained Medium Aminus and carbon sources, uniformly labeled 14C and 12C as appropriate. Cells were added to 230 µl of incubation medium, which resulted in an optical density of 0.8 at 600 nm. This was placed in a 25 mL glass vial sealed with a rubber septum. Before incubating, a straight pin was inserted into the septum and a strip of filter paper was placed onto the end of the pin. The filter paper was then soaked in 10 µl of 10% NaOH to absorb CO2. Incubations were carried out for 30 minutes in a shaking water bath at 37°C, after which time the incubations were stopped by adding 100 µl of 70% HClO4 to each of the vials. Vials were allowed to stand for at least 30 minutes following incubation so that all CO2 produced would be driven onto the alkaline filter paper. The filter paper was removed from the pin and placed into a scintillation vial for quantification of 14CO2.

**Abbreviations:**

- G6P – Glucose-6-phosphate
- F6P – Fructose-6-phosphate
- F1,6P2 – Fructose-1,6-bisphosphate
- DHAP – Dihydroxyacetone phosphate
- G3P – Glyceraldehyde 3-phosphate
- 1,3PG – 1,3-Bisphosphoglycerate
- 3PG – 3-Phosphoglycerate
- 2PG – 2-Phosphoglycerate
- PEP – Phosphoenolpyruvate
Within each channeling experiment, four treatments were replicated four times. The treatments used were as follows:

14C-glucose
14C-glucose plus 12C-challenging compound (G6P, F6P, or F1,6P2)
14C-challenging compound
14C-challenging compound plus 12C-glucose

Suitable concentrations for all carbon sources—namely 1 mM glucose, 5 mM G6P, 5 mM F6P, or 10 mM F1,6P2—were determined in preliminary experiments. Preliminary time course experiments showed 14CO2 production to be linear for at least 30 minutes, which indicates that steady state concentrations were reached and that incubation for 30 minutes provides a valid measure of CO2 evolution rate.

RESULTS AND DISCUSSION

Data from *E. coli* channeling experiments are shown in Figures 2 and 3. Experiments using F6P as the unlabeled challenger had no significant effect on the 14CO2 evolution from glucose; 5.6 ± 0.6 nmols were produced from 14C-glucose alone, while 5.1 ± 0.5 nmols were produced from 14C-glucose plus 12C-F6P. The same was also true with F1,6P2 (8.8 ± 1.8 versus 7.9 ± 1.2 nmols, respectively). The data from F6P and F1,6P2 experiments are consistent with the presence of channeling, but are not conclusive proof of channeling. In the G6P experiments, unlabeled G6P did decrease the 14CO2 evolution from labeled glucose by 35%, from 8.2 ± 1.0 nmols to 5.3 ± 0.6 nmols. While this is less suggestive of channeling, it is still possible that G6P is partially channeled to F6P.

**Figure 2.** Amount of 14CO2 evolved by *E. coli* cells when incubated with 14C-glc alone (black bars) and incubated with 14C-glc plus 12C-challenging compound (G6P, F6P, or F1,6P2).
However, the above data cannot be interpreted definitively as resulting from channeling since there are two other possible causes of the observed results. One such cause is catabolite repression, the inhibition of substrate transport and/or metabolism in the presence of glucose. If challenging intermediates fail to enter the cell or be metabolized once inside, then absence of effect on 14CO2 production caused by co-incubation (as for F6P in Figure 2) would be expected even in the absence of channeling. In order to rule out this possibility, data from incubations with 14C-challenger alone and 14C-challenger plus 12C-glucose were examined (C and D, respectively). These results showed that enzymes utilized in transport and metabolism of the challenging compound are still functional in the face of glucose (Figure 3). Thus, total catabolite repression did not occur.

A second reason the data of Figure 2 cannot be interpreted definitively is that the expected effect of co-incubation of the two sources is unknown; that is, the dilution of labeled CO2 from one source by unlabeled CO2 from the other is unknown. A method for measuring the expected effect emerged from the data in Figure 3.

Figure 3. Amount of 14CO2 evolved by E. coli cells when incubated with 14C-intermediate, G6P, F6P, or F1,6P2, alone (black bars) and incubated with 14C-intermediate plus 12C-glc.
When two sources to any given intermediate are co-incubated, the intermediate can originate from either of the two sources. Since the amount of $^{14}$CO$_2$ is proportional to the amount of $^{14}$C-intermediate within the cell, the amount of $^{14}$CO$_2$ evolved when cells are co-incubated with $^{14}$C-glucose and unlabeled intermediate is proportional to the amount of $^{14}$C-intermediate that originated as $^{14}$C-glucose; i.e. the amount of $^{14}$CO$_2$ evolved in treatment B. Likewise, the amount of $^{14}$CO$_2$ evolved in treatment D is proportional to the amount of the added $^{14}$C-intermediate within the cell. Thus, the fraction of the intermediate derived from $^{14}$C-glucose when co-incubated with the $^{12}$C-intermediate is equal to $B/(B+D)$. The letters A, B, C, and D, will be used as a shorthand for the amount of $^{14}$CO$_2$ evolved in experiments carried out with the incubation conditions defined earlier.

If no channeling is occurring, the factor by which $^{14}$CO$_2$ from $^{14}$C-glucose is decreased by co-incubation with a $^{12}$C-intermediate is equal to $B/(B+D)$. The observed effect of the unlabeled substrate on the production of $^{14}$CO$_2$ (condition B) versus the rate of $^{14}$CO$_2$ production when $^{14}$C-glucose alone is the carbon source (condition A) is $B/A$. That is, $B/A$ is the ratio by which the unlabeled compound actually affected the evolution of CO$_2$ from the labeled compound. Thus, if $B/A = B/(B+D)$, there is no channeling, and the effect of the unlabeled intermediate is exactly the dilution of $^{14}$CO$_2$ expected absent any other effect. This situation is denoted by fraction channeled equal to zero ($F_{ch} = 0$). In the opposite extreme, $B/A = 1$ implies that the unlabeled intermediate had no effect on the metabolism of the labeled intermediate. When the observed ratio is 1, no dilution is seen; i.e., $F_{ch} = 1$. This implies all flux originating from $^{14}$C-glucose is channeled to CO$_2$. Between these two extremes, $F_{ch}$ can be calculated by interpolation. As depicted in Figure 4, channeling from glucose is calculated by comparing the observed ratio $B/A$ to the expected ratio in the absence of channeling, $B/(B+D)$.

\[ F_{ch} = \frac{B/A - B/(B+D)}{1 - B/(B+D)} \]
Results from the Fch calculations are shown in Table 1. The most remarkable result occurred in the F1,6P2 experiments, which showed significant channeling from F1,6P2 all the way to CO2 (Fch = 0.99 ± 0.16, p = 0.005). In order to observe such strong evidence for channeling using this protocol, each step of the pathway must preserve the channeling in the steps from F1,6P2 to dihydroxyacetone phosphate (DHAP) and glyceraldehyde 3-phosphate (G3P) by not equilibrating with the bulk solution. Equilibration at any step downstream of the conversion of F1,6P2 by aldolase would erase the signature of channeling at the aldolase step.

Table 1. Calculation of the fraction of the channeled flux to total flux (Fch) in E. coli. A, B, C, and D in the table are the nmols of 14CO2 evolved in each of the four treatments. Fch reported was calculated for each experiment and averaged, rather than determined from average values in the table.

<table>
<thead>
<tr>
<th>Number of experiments (n)</th>
<th>G6P</th>
<th>F6P</th>
<th>F1,6P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (14C-glc)</td>
<td>6</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>B (14C-glc+12C-int)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (14C-int)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D (14C-int+12C-glc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B/(B+D)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From glucose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since seven steps exist in the glycolytic pathway between F1,6P2 and pyruvate, and there are more steps from pyruvate to CO2 by way of mixed acid fermentation or the TCA cycle, this result was unexpected. However, this result is similar to that of Mowbray and Moses17, who inferred the existence of a complex of enzymes that releases virtually no intermediate into the cytosol from the time G6P binds to it and pyruvate is finally produced. Srere1 called such complexes “metabolons”. The relevant elements of the complex must stay together long enough for these reactions to take place.
It is worth noting that, even though the channeling at the F1,6P2 step was virtually 100%, there was a very high rate of CO2 production from exogenous F1,6P2 (Table 1, F1,6P2, C and D). An inescapable conclusion from this result is that a large fraction of aldolase present in the cell is free rather than part of the postulated complex of glycolytic enzymes. Since 14CO2 is the measured product in treatment D, that must mean that some fraction of all of the enzymes in the pathway(s) to CO2 is free in the cytoplasm.

Channeling from F6P was found to be non-significant. Originally, when E. coli was grown without supplementing growth medium with F6P, experiments suggested that channeling might be significant (Figure 2). However, in these experiments, very little F6P entered the cell (Figure 3, F6P open bar), so the unlabeled challenger (F6P) obviously could not decrease the amount of 14CO2 evolved from glucose. The absence of an impact of the unlabeled exogenous compound on the amount of 14CO2 evolved from 14C-glucose is a necessary, but not sufficient, condition for concluding that the intermediate just made in the pathway was channeled to the next intermediate. Clearly, if little F6P entered the cell, then B/(B+D) would be close to 1 since D would be approximately 0. In that case, channeling cannot be adequately assessed because the observed value is very close to the value that is consistent with both Fch = 0 and Fch = 1. That is, very little room for interpolation exists between the poles of zero channeling versus complete channeling; thus, the F6P experimental results shown in Figure 2 are indeterminate. Data from the inverse experiment were necessary to calculate the value of B/(B+D). By contrast, in growth medium supplemented with 25 µM F6P, substantial F6P was converted to CO2 (Table 1, F6P, C and D). Still only negligible channeling was observed, Fch = 0.04 ± 0.01 (Table 1, F6P, From glucose Fch), since B/A was very close to B/(B+D).

The G6P experiments also resulted in non-significant apparent channeling (from 14C-G6P made from 14C-glucose, 0.10 ± 0.26; from 14C-exogenous G6P, 0.07 ± 0.22). However, this result was expected because no significant channeling was identified from F6P to CO2. The detection of channeling depends on non-equilibration in all steps leading to CO2. Thus, channeling from G6P could not be observed in this protocol since a downstream intermediate, F6P, was not channeled.

Major elements of the glycolytic pathway have been known for more than 60 years. As one of nature’s fundamental pathways for energy metabolism, it is important to discover the details that provide cells, and in turn organisms, the molecular fuel to function. Studying the putative interaction of pathway enzymes, or channeling, adds another dimension to our understanding of glycolysis. No channeling was observed from F6P to CO2, and consequently no apparent channeling was observed from G6P to CO2. However, the Fch = 0.99 ± 0.16 from F1,6P2 to CO2 was significant indicating a high degree of channeling. The data reported here differ from other reports in two important respects: namely, (i) intact cells were used and (ii) the degree of channeling, rather than its presence or absence, was calculated. Our results are consistent with channeling being a highly important mechanism resulting from sub-cellular organization.
NOTES

Finding Adoptive Homes for Waiting Foster Children:
An Exploratory Study of Adoption

Author:
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Jennifer graduated in May 2006 with a degree in Social Thought and Analysis. She came to do undergraduate research because it was a requirement for the Social Thought and Analysis major. The present article is an adaptation of her senior honors thesis. Jennifer is currently a graduate student here at Washington University, pursuing a joint degree in law and social work (a J.D./M.S.W.). While she was planning on pursuing this joint degree before she began her research, the experience confirmed that she wanted to study child welfare, specifically, adoption and foster care. Her undergraduate research experience also helped her decide that she wanted to continue her graduate studies here at Washington University.

ABSTRACT
This project was designed to analyze the problem of foster care children in the United States left waiting for adoptive homes. Research was conducted in order to uncover the factors preventing adoptive parents from adopting waiting children, as well as to understand the demographics of people who adopt available children. This study surveyed adoption services providers in private adoption agencies (including workers that handle the three types of adoption: Domestic Public/Special Needs, International and Domestic-Private) about the important characteristics of adoptive children and the adoptive process. The survey also collected adoptive parent demographic information. Findings from this study indicated that there are certain characteristics that make children less appealing to adoptive parents, specifically, if a child is older than age five, has a moderate to high level of disabilities, or is the member of a sibling group of three or more children. As for the adoption process, adoption service providers indicated that parents are very concerned with the ease and cost of the process. There were also certain adoptive parent characteristics that made them significantly more likely to work with Domestic-Public/Special Needs adoption workers, and consequently more likely to adopt waiting foster children.

ACKNOWLEDGEMENTS
First and foremost, I would like to recognize all the adoption service providers and adoptive parents that took time to participate in my research. Many thanks to Dr. Melissa Jonson-Reid for her advice and expertise during this project, as well as Dr. Margaret Perkinson for her encouragement. And finally, a special thanks to my parents.

KEY TERMS
• Special Needs adoption
• Termination of Parental Rights (TPR)
• Domestic-Public/Special Needs adoption
• Domestic-Private adoption
• International adoption

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Professor Jonson-Reid studies child and adolescent outcomes related to services provided in the child welfare and public school systems. She is particularly interested in the interrelationship between child abuse and neglect, exposure to community risk factors, school and child welfare service provision, and later delinquent outcomes. She also has interests in the impact of cumulative family violence (e.g., child abuse and domestic violence), interagency coordination of services, school social work services, and the integration of theory with research.
INTRODUCTION

The most recent data on adoption suggest that there are 123,249 children waiting for adoption in the United States.¹ To illustrate, imagine 1,812 school buses full of children arriving at your doorstep. This is the number of children without homes. To aggravate the problem, these children wait a long time before they are adopted, if they are adopted at all. Once parental rights are terminated, the average child has already been in foster care for three and a half years. Upon termination of parental rights, foster children usually wait another year and a half before they are adopted. One-fifth of these children will wait over two years before an adoption is finalized.² Despite the long wait, these children are the lucky ones. Many children never find a permanent family. Between 18,500 and 25,000 children leave the foster care system each year because they have “aged out,” meaning they are no longer entitled to the services provided by the state because they have reached the age of legal adulthood.

Obviously something needs to be done to improve these statistics. If it is not reasonable to return children to their biological families, how can they be provided with loving and secure adoptive families in a timely manner? Why are foster children not being adopted? The public policy surrounding adoption is one reason but it is not the only one. (Adoption law and public policy is discussed in depth in the full length version of this study, but was omitted here for the sake of brevity.)

Another possible explanation could be that there are not enough families willing to adopt. This, however, seems not to be the case given the length of adoption wait lists and the thousands of dollars people pay to adopt children internationally³–⁴. A more likely issue is that people are not willing to adopt children who are available through the foster care system. For the sake of adoption, children are considered “special needs” if they have a disability, are of a minority race, if they are older than age five, if they are in a sibling group (meaning the adoptive parent will have to commit to adopting a group of siblings rather than just one child), or if they are “at-risk” (meaning that some event has occurred in the past which could produce negative consequences in the future, such as prenatal exposure to drugs or alcohol, abuse or neglect, or genetic disorders).⁵ According to the 2003 Adoption and Foster Care Analysis Reporting System, of the 123,249 waiting children, 64% are over age five. African-American children are also disproportionately represented in this group relative to their proportions in the general population. African-American children make up 40.6% of children waiting for adoption.⁶ Furthermore, children often come in sibling groups, and/or have medical, behavioral, or emotional needs.⁷ Research is necessary to determine which factors contribute the greatest to children left in the foster care system. Such research can provide insight into how to increase the number of adoptions of foster children and decrease the time they spend waiting for adoption.

BACKGROUND

Research studies on Americans’ attitudes and behaviors surrounding adoption have only recently been conducted. The first study that examined Americans’ views on adoption was the 1997 “Benchmark Adoption Survey.” The methodology for this study involved 1,554 phone interviews of randomly selected Americans. The interviews
asked general demographic and lifestyle questions of the participants, as well as respondents’ attitudes towards adoption and issues surrounding adoption. In analyzing the results, the Evan B. Donaldson Adoption Institute put each respondent into one of three categories, “full supporter,” “qualified supporter,” or “marginal supporter” of adoption. Findings showed that 32% of Americans are full supporters of adoption, 37% are qualified supporters of adoptions, and 31% are marginal supporters of adoption. The research also discovered that certain demographic characteristics of the respondents could help predict how supportive they would be of adoption. Those with a college degree, women, Whites, people living in the western part of the country, and married couples were more supportive of adoption than their equivalent counterparts. This research, however, focused on general adoption attitudes and provided little information about why Americans were not adopting waiting foster children.

In 2002, the “Benchmark Adoption Survey” was advanced and expanded upon by the “National Adoption Attitudes Survey.” Similar in methodology to the “Benchmark Adoption Survey,” the “National Adoption Attitudes Survey” was conducted by telephone and included interviews of 1,416 adult Americans. The interviews consisted of questions on attitudes about adoption with a focus on attitudes about the adoption of foster children. Questions about opinions on adopting children available through the foster care system (e.g. minority children, sibling groups) were asked. The majority (over 70%) of those surveyed said they would be very or somewhat likely to adopt a sibling group (“brother and sister age 2 & 4”), a child of a different race than themselves, and a child who has been in the foster care system for several years. For children with medical or behavior problems, the willingness of Americans to consider adopting such children decreased. Only about 50% said they would be very or somewhat likely to consider adopting these children.

The “National Adoption Attitudes Survey” began the process of discovering why so many children linger in the foster care system. Not surprisingly, special needs, such as medical and behavioral problems, seem to be a large barrier in the willingness of Americans to adopt these children. A child’s race, their membership in a sibling group, and the time they have spent in foster care, while still creating concern in some respondents, did not seem to be a major barrier to adoption. This research is problematic in some ways, mostly because the sample involved the general U.S. population with phones in their homes. Asking the general population what type of child they would be willing to adopt is much different from asking those who have actually considered adoption, or even taken steps toward completing the adoption process. Peoples’ ideas about what type of child they would actually consider raising might drastically change after they had contemplated the issue and done some investigating. While these respondents may have been able to hypothesize about what sort of child they would be willing to adopt, it is impossible to generalize these statistics to those Americans who are actually committed to adopting and becoming legally and emotionally attached to a child.

By studying private adoption service providers, the present study was designed to look more closely at adoption preferences among people who have taken steps towards adoption. It also examines several other issues surrounding the adoption of foster children. This research seeks to uncover (1) who elects to adopt foster children, and (2) what aspects of the adoption process are important to potential adoptive parents. Specifically, what types of children are prospective adoptive parents, who actually take steps to adopt, willing to consider (according to workers in private adoption agen-
cies)? What characteristics of the adoption process are important to parents (e.g. money, waiting time for a child)? Finally, is there a relationship between the demographics of adoptive parents and the type of adoption they choose? Knowing the characteristics of the adoption process and adoptive children that are important to prospective adoptive parents, and who is more likely to adopt foster children will allow adoption agencies and national, state, and local governments to alter their policies and practices to recruit and retain more parents who are willing to adopt waiting children.

METHODS

Data for the present study came from a survey of adoption service providers in private adoption agencies. Eighty workers in private adoption agencies in the states of Missouri and Wisconsin were surveyed. Only two states were surveyed because of project funding limitations. Wisconsin and Missouri were chosen because of their convenience to the researcher. Listings of private adoption agencies in both Wisconsin and Missouri were obtained from the National Adoption Information Clearinghouse (NAIC). A list of adoption agencies published by the Missouri Religious Coalition for Reproductive Choice was also utilized. Only two agencies, however, that were not listed by the NAIC were listed by the Missouri Religious Coalition for Reproductive Choice and used in this research. The National Adoption Information Clearinghouse divided its lists into three sections: (1) Licensed Public Adoption Agencies that handle domestic adoptions, (2) Licensed Private Adoption Agencies that handle domestic adoptions and (3) Licensed Private Adoption Agencies that handle intercountry adoptions. All agencies on the two latter lists were contacted in both states. Unfortunately, due to necessary IRB approval and time constraints, public adoption agencies in Wisconsin and Missouri were not able to participate in the present research. However, in both Missouri and Wisconsin, private adoption agencies are contracted by the public sector to handle the adoptions of foster children and many of the surveyed adoption service providers handled the adoption of foster children.

An attempt was made to contact 87 agencies, 58 in Missouri and 30 in Wisconsin. Agencies were contacted via both e-mail and phone. Of the 87 agencies, 5 did not provide adoption services, 5 had their numbers disconnected and were presumably no longer in business, and 2 did not provide adoption services in Wisconsin or Missouri. Of the remaining 75 agencies, surveys were sent to 38 agencies. The remaining 37 agencies did not participate in this research for various reasons.

Surveys were provided for all agency workers unless the agency requested that only one person respond (n=3; 7.9% of agencies). 115 surveys in total were sent out to the agencies. 61 were sent to agencies in Wisconsin and 54 were sent to agencies in Missouri. Using the National Adoption Information Clearinghouse definitions, the three types of adoption for the purpose of this survey where defined as International Adoption (the adoption of children abroad), Domestic-Public/Special Needs Adoptions (the adoption of children in the foster care system), and Domestic-Private Adoption (the adoption of an infant in the United States whose biological parents have made an adoption plan and the child has not spent time in the state foster care system). Surveys were sent to adoption service providers who handle both International and Domestic-Private adoptions, International Adoptions alone, Domestic-Private adoptions, Domestic-Public/Special Needs adoptions, and all three types of adoptions.
The survey instrument used in this research was designed specifically for this project. Most questions were based on questions asked of the general public in the 2002 “National Adoption Attitudes Survey”. These questions focused on willingness to adopt children of various characteristics, and adoptive parent complaints about the foster care adoption system. Following the “National Adoptions Attitudes Survey”, this survey asked adoption service providers to respond to questions about basic demographic characteristics and their educational background, characteristics of the prospective adoptive parents with whom they work, the requests and desires of the prospective adoptive parents as they apply to adoptable children and the adoption process, the experience of adopting a child at the worker’s agency, the worker’s experiences as an adoption service provider, and why prospective parents chose the particular type of adoption the adoption worker handles. The questions about the prospective adoptive parents’ requests and desires as they apply to adoptable children and the adoption process, as well as the questions regarding an adoption service provider’s experience in the job were measured using a Likert scale ranging between strongly disagrees to strongly agrees. The majority of the other questions were fill in or multiple choice. There were also several free response questions at the end of the survey. Survey participants were asked to answer the questions using only the requests and desires of the adoptive parents with whom they currently work. Therefore, the responses of workers who work with Domestic-Public/Special Needs adoptions should indicate the perceptions of only prospective adoptive parents who are trying to adopt Domestic-Public/Special Needs children.

The survey was designed to be filled out in hard copy, and all transactions took place via USPS. This survey was reviewed for face validity by a professor with a child welfare background, and for methodological issues, by a professor with a background in methodology and empirical research. The study was approved by the HHSC at Washington University in St. Louis, #X05-74. Recruitment took place in December 2005 and January 2006 and the surveys were sent out in January 2006.

RESULTS

Of the 115 surveys sent out, 44 of the surveys sent to agencies in Missouri were returned and 39 of the surveys sent to agencies in Wisconsin were returned, yielding a response rate of 72.2%. There were five types of adoption workers studied, and the number of surveys received by each type is presented in Table 1.

Table 1: Surveys Received by Type of Adoption Handled

<table>
<thead>
<tr>
<th>TYPE OF ADOPTIONS HANDLED</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both International and Domestic-Private Adoptions</td>
<td>19; 23.6%</td>
</tr>
<tr>
<td>International Adoption Alone</td>
<td>14; 17.5%</td>
</tr>
<tr>
<td>Domestic-Private Adoption</td>
<td>13; 16.3%</td>
</tr>
<tr>
<td>Domestic-Public/Special Needs Adoptions</td>
<td>18; 22.5%</td>
</tr>
<tr>
<td>All three types of adoptions</td>
<td>16; 20%</td>
</tr>
</tbody>
</table>

Total=99.9%
Adoption service providers indicated that there were several child characteristics that deter the adoptive parents. When adoption service providers were asked to indicate if parents are willing to adopt children with low level disabilities, 67.5% of workers agreed that the parents are willing to adopt such children, but when asked about children with a moderate level of disabilities, only 12.5% of workers agreed that parents are willing to adopt such children. For children with high levels of disabilities, the number decreased to 1.3%. As expected, the older the child, the less willing parents are to adopt. After a child reaches age five, there was a dramatic decrease in the percent of willing adoptive parents. Furthermore, the more children in a sibling group, the less likely parents are to consider adopting the children. Approximately eighty-three percent of workers agreed that prospective adoptive parents are willing to adopt children in a two child sibling group, but only 23.8% and 7.5%, agreed that parents are willing to adopt sibling groups of three and four children, respectively. About half (47-52% depending on the race specified) of adoption service providers thought that the race of the child, specifically that the child is the same race as the parents, is important to the adoptive parent. A significant minority (25-35%, depending on the race specified) thought that the race of the child is unimportant.

Usually, the characteristics of the adoptive child’s biological parents do not deter an adoptive parent from adopting a child. A large majority of workers agreed that parents are willing to adopt children whose biological parents are under eighteen years of age, have a low level of education, or have a history of drug abuse. For children whose biological parents have a mental handicap, the number decreased, and only 43.7% of workers believed that parents are willing to adopt such children.

As for the adoption process, adoption service providers indicated that parents are most concerned with the cost and “cleanliness” of the process. “Cleanliness” was defined as no complications, for example, being able to adopt without biological relatives fighting for the child or experiencing a slow adoption process.

It is also interesting to note that adoption service providers working with Special Needs/Foster Care adoptions were significantly more likely to indicate that parents are likely to consider adopting children who have characteristics that make them harder to place in adoptive homes. Specifically, workers working with Special Needs/Foster Care adoptions indicated that parents are more likely to consider children of a different race, children older than age 5, children with a moderate to high level of disabilities, and children whose biological parent(s) have a drug abuse problem or mental handicap. Furthermore, adoption service providers working with Special Needs/Foster Care adoptions were also significantly more likely to indicate that parents are less concerned with the “cleanliness” of the adoption process.

Adoption service providers were also asked to approximate the percentage of parents who fall into various categories based on age, level of education, race, income level, and reasons for adoption. One-way ANOVA analyses and the Kruskal-Wallis test indicated the demographic characteristics of adoptive parents. Results indicated that Domestic-Public/Special Needs workers were significantly more likely to work with parents aged 41-50 (F=3.939; p=.006), as well as those over age 51 (x?=16.927, p=.002). Results also indicated that Domestic-Public/Special Needs workers were significantly more likely to work with African-American parents (x?= 9.673; p=.037), parents who were classified as “low income/state assistance” (x?=15.710; p=.003) and
“middle income” (F = 3.028; p = .023). Results indicated that Domestic-Public/Special Needs workers were significantly more likely to work with adoptive parents with a lower level of education (F = 4.73, p = .002). Finally, Domestic-Public/Special Needs adoption workers were also more likely to work with parents who are adopting a relative child (F = 3.166, p = .019) or adopting because they felt a desire to help a child in need (χ² = 23.657, p = .000).

Results of the free response questions suggest that adoption workers believe in the necessity of educating the general public about children available for adoption, the adoption process, and the rewards of adopting. They also noted the necessity of dispelling myths put forth by the media about the hardships of adopting foster children. Many service providers suggested decreasing the cost of adoption and increasing financial incentives. Although foster care adoptions are typically state subsidized (making them free), post adoption financial support is also necessary. When Private and International adoption workers were asked why parents choose Private or International adoption instead of Domestic Public/Special Needs adoption, the most common answers were that adoptive parents want to avoid birth parent contact or other complications. They also want a faster time frame and do not want to deal with the state department of social service. Adoptive parents feel Private and International adoptions are more guaranteed ways of obtaining an infant or younger child, and they have a perception that international/privately adopted children do not have special needs and are healthy. When Domestic-Public/Special Needs workers were asked why parents choose Domestic-Public/Special Needs adoptions instead of International/Private adoptions, the main answer was that it is cheaper or free.

CONCLUSIONS

The results of this study reveal some of the important characteristics and demographics of prospective adoptive parents and the categories of children they are willing to adopt. The results show that children with moderate and high level disabilities, children over age five, and children in sibling groups greater than two children are less attractive to adoptive parents.

Efforts could be made to expedite the process to make children available for adoption at a younger age. Clearly this is difficult because of the importance of family preservation and the necessity of giving biological parents enough time and assistance to recover from whatever event caused the child to be placed for adoption. Furthermore, because a significant minority of workers indicated that adopting a same-race child is still important to prospective adoptive parents, further acceptance of mixed race families, both in individuals and communities, might improve the willingness of parents to adopt children of a different race.

Cost and “cleanliness” of the adoption process were also indicated by adoption workers as important factors in the adoption process. Any action taken to decrease the cost or increase incentives would also likely increase the number of parents willing to adopt. Moreover, adoptive parents need the support of skilled social service workers and education about the adoption process. Education of the general public about the foster care adoption process, as well as dismissing myths put forth by the media are ways many adoption workers believe adoptions could be increased. Because adoption
service providers working with Domestic-Public/Special Needs adoptions were significantly more likely to indicate that their adoptive parents are willing to adopt harder to place children (i.e. older children, children with disabilities), actively recruiting these families may be a promising tactic for increasing adoptions.

In America, the concept of family is a basic aspect of life that so many take for granted. This research suggests ways of improving the outcomes for children in the foster care system. Further research needs to be conducted not only with adoption service providers, but also with the parents who have adopted or are at some point in the process of adopting in order to understand if adoption worker perspectives are similar to those of prospective adoptive parents. Adoption attitude research began only nine years ago with the “Benchmark Adoption Survey,” and there is still more work to be done.

NOTES


9 Dave Thomas Foundation for Adoption and the Evan B. Donaldson Adoption Institute, note 8.

Previous research in cognitive psychology has shown that tests can be used as a learning tool instead of strictly a means of assessment. Giving feedback after a test helps to promote learning by allowing test-takers to correct errors. However, a debate exists in the literature about the optimal timing of feedback. This debate partially stems from the fact that studies that directly compare immediate and delayed feedback have often confused timing and type of feedback. The goal of this experiment was to separate these two variables in order to examine the unique effect of each on retention.

Participants read passages and took an initial multiple-choice test. Timing of feedback was manipulated within-participants: for some of the questions they received immediate feedback and for other questions they received delayed feedback the next day. In addition, feedback was not provided for some questions. Type of feedback was manipulated between-participants: one group of participants received “correct answer” feedback in which they saw the question and the correct answer, and the other group received “answer-until-correct” feedback in which they had to keep answering the question until they discovered the correct response. Participants returned one week later to take a final cued recall test that included the questions previously presented on the multiple-choice test, as well as, new questions (no test condition / control).

The results of the final cued recall test indicate that delayed feedback led to better retention of the material than immediate feedback. However, type of feedback (correct answer vs. answer-until-correct) did not have a differential effect on retention. In addition, both feedback conditions produced better performance than the no feedback condition. Finally, all three testing conditions (delayed feedback, immediate feedback, and no feedback) out performed the no test condition. This result indicates that taking an initial test helps people learn.
Osteolytic (pathologic) bone loss typically results from improper activation of osteoclasts, the multinucleated mononuclear-derived cells responsible for bone resorption. Through the secretion of acidic and lytic enzymes in an extracellular compartment formed between themselves and bone surfaces, osteoclasts function to counterbalance the forces of bone synthesis, thus preventing excessive bone mass increase. As such, they play an important role in the skeletal renewal process of bone remodeling. When properly regulated, bone formation (by osteoblasts) and bone resorption (by osteoclasts) work in concert to maintain the appropriate physiological bone mass density. An imbalance in this process—either through overproduction of osteoclasts or underproduction of osteoblasts—results in a recognizable loss of bone mass most notably characteristic of osteoporosis, a debilitating condition that affects over 50% of elderly populations. In order to effectively understand and treat conditions such as osteoporosis, it becomes imperative to first study normal development and function of these resorptive cells. This study explores details of the NF-κB transcriptional pathway, a set of transcription factors responsible for, among other functions, the generation of osteoclasts from macrophage precursors. Specifically, Imani and her colleagues seek to determine the subunit-specific domain functions of two key NF-κB transcriptional factors: p65/RelA and RelB. Preliminary data have established that though homologous, p65/RelA and RelB have distinct mechanisms and serve unique functions in the NF-κB pathway. However, to date, an understanding of the actual domains within these proteins responsible for their unique roles has been uninvestigated. This type of research will lead to a more in-depth understanding of the NF-κB pathway, the regulation imbalances that occur in bone diseases such as osteoporosis, and may serve as a foundation for future specific drug targets for osteoporosis.
Justin's research describes the development of the Special Forces medic and its ties to the physician assistant (PA) program. It also covers the broader social implications regarding the professionalization of medical care. While military historians have written extensively on the Special Forces in general, no one has formally studied these highly-trained, quasi-professional medical caregivers. The absence of historical literature covering this topic is surprising for two reasons. Firstly, Special Forces medics are the most highly trained enlisted men in the United States military, whose presence with the Green Berets makes the teams unique. Secondly, the medics in Vietnam have evolved into the modern physician assistant position. Using the medics as a model, the PA program provided an opportunity for ‘non-professional’ physician extenders, like the Special Forces medics, to continue working in the medical profession. Thus, this project not only fills a historiographic void on the Special Forces medics themselves, but it also elucidates the connection between the medics and the PA program and contributes to the growing field on professionalization.

To complete this project, Justin made extensive use of the archives at the Marquette Library at Fort Bragg, North Carolina. The boxes of memoranda, curriculums, and official army documents, and more than sixty oral histories became a rich primary source for groundbreaking historical research. He also took an oral history from the command surgeon of the Special Forces, Col. Warner Farr. The information gathered at Ft. Bragg allowed Justin to write a true piece of historical scholarship that not only traces the history of Special Forces medics, but also examines the wider ranging implications for the medical profession and society at large.
During a three and a half week field school at the La Suerte Biological Field Station in northeastern Costa Rica, Katherine studied two groups of mantled howler monkeys in the rainforest. This research analyzed the prehensile tail positions during various activities and on various sizes of substrates. Howler monkeys belong to the family, Cebidae, which includes several species with prehensile tails (including Alouatta palliata). This grasping tail is a unique adaptation of certain New World monkeys that enables interesting locomotor and postural behaviors.

Twenty-four hours of observational data were collected during focal animal scans every minute. Seven distinct tail positions were defined (body wrap, loose wrap, full wrap, end wrap, hang, free tail, and resting tail). Substrate size was divided into terminal, small, medium, and large branches. The activity budget of the howler monkeys was divided into movement, feeding, and resting. A typical activity budget was found for this group of howler monkeys. Feeding was primarily done on terminal branches although a fairly large percentage of feeding behavior was also recorded on small branches. Movement was typically done on small branches, although medium and large substrates were also used often. While moving, the tail was only recorded in the free position (not attached to any substrate) or end wrapped (with the lower third gripping a substrate). During resting, howler monkeys exhibited the widest repertoire of tail positions and a more equal distribution of various substrate sizes. While resting, the tail was predominantly body wrapped (wrapped around the individual’s body and not any substrate). Three other tail positions (end, full, and loose wrap) were also used frequently while resting. The majority of resting activity was done on small and medium substrates.

These data indicate that there is a definite pattern to the use of tail positions on certain substrate sizes and during particular activities. This pattern most supports the idea that the prehensile tail evolved as a means of extra support and balance while resting or moving in the trees and as a means to expand food resource availability in the precarious terminal branches. This topic can be further explored in future research which analyzes the factors contributing to choice of specific substrates such as angle and canopy height. Additionally, future research may focus more specifically on the use of limb-tail combinations in locomotor behavior to help further understand the postural behavior of howler monkeys.
Toward a Better Understanding of…

**Famil y Caregivers’ Perspectives on a Home-Based Exercise Program for Persons with Mild Dementia**

*Christine Dang-Vu and Ming-Ming Xu,*

Mentor(s): Margaret A. Perkinson, Ph.D.

This research was supported by the Washington University Office of Undergraduate Research through a Hoopes Undergraduate Research Award.

Because of their unique insights and perspectives into the needs and motivations of their older relatives, and also because they often are asked to implement programs developed for older adults, family caregivers represent potentially significant collaborators in program development, implementation, and evaluation. This study describes the contributions of family caregivers to the refinement of a physical activity program developed for persons with dementia. In an attempt to provide exercise options for community-dwelling persons with mild dementia, individualized home-based exercise programs supervised by family members were developed, implemented, and evaluated. Thirty persons with dementia and their family exercise supervisors (N=60) participated in the three month program. Family members provided information on which the individualized programs were based, received intensive training, and maintained telephone contact with the research team throughout the program. As they supervised the exercises, family members exercised along with their relative and afterwards recorded reactions to the session. During in-depth interviews and focus groups, family exercise supervisors reported their general reactions and those of their relative to the program. These data included: the barriers to exercise that they encountered and ways they dealt with those problems, their reactions to the training sessions and monitoring process, the modifications or innovations that they made to the program on their own, their perceptions of the impact of the program on their relative and themselves, and their plans for future exercise. Family caregivers proved to be significant resources in the development, implementation, evaluation, and further refinement of this home-based exercise program.
The spread of exotic weeds has caused significant economical and ecological problems. The focus of much research is to predict which exotic plants will become pests, and to control existing pests. While there has been much work done on the role of plant enemies, the role of mutualists, such as pollinators on seed production, and the spread of exotic species, has been virtually ignored. Many non-native plants require pollinators for sexual reproduction, but occur without their co-evolved pollinators in their introduced range. Thus, this study hypothesizes that species able to colonize new habitats may be able to reproduce without pollinators. Alternatively, it hypothesizes that non-native plants that require pollinators for reproduction will be more limited by pollinators than the reproduction of native plants. To test these hypotheses, native and non-native species in the same plant family were paired. Using pairs of species with similar phylogenetic histories means that species will be similar in many aspects except for their native/non-native status. To test if each species was autogamous, that is, capable of producing seeds without pollinators, small mesh bags were placed over five individuals of each species and then the seeds were collected and counted. The researchers also conducted 5 twenty minute observations of the pollinators that visited each species. To determine pollen limitation, the researchers hand supplemented twenty individuals of each species and marked twenty species for control. The number of seeds from the supplementation were counted and compared to the number of seeds collected for the control individuals. The study found that only one family showed significant effects of autogamy. Of the outcrossing species tested, three families showed significant effects of pollen limitation. These results suggest that autogamy is not a significant requirement of invasion and that non-native species could be more detrimental if their co-evolved pollinators are introduced into the area.
When stories end with death, often the reader is left to imagine grief and mourning. In the canon of African-American literature, however, death is not the end. How authors define the grief and mourning of their characters often defines the characters themselves. This research explores fundamental questions surrounding death in African-American literature from 1760-present. How does Zora Neale Hurston’s depiction of grief compare with Phillis Wheatley’s, Richard Wright’s, Toni Morrison’s, James Baldwin’s, or Gwendolyn Brooks’s? What common themes run through scenes surrounding death, and where is there divergence? How can one begin to categorize and understand the vast expanse of death in African-American literature? What does the abundance of death in African-American literature say about the greater American society? How does the prevalence of death shape the formation of a black cultural identity? Through an analysis of scenes surrounding death in some of the most common African-American literature of the past two and a half centuries, this research seeks to answer many of these questions while exploring examples of how authors utilize death to further expand upon the notion of African-American existence.
The polarized debate about the mental and social position of women in Italy was a distinct subject of discussion during the early parts of the 16th century. This is seen in many aspects of society, and our most lucid depiction lies in the popular works of the time. While general analysis has been done discussing the subject of women in early modern Italian literature, one that is specifically designed around different genres and representations is rare. Using the Courtier of Baldassare Castiglione and Niccolò Machiavelli’s play Clizia, Jessica has analyzed the similarities and differences in the ways women are represented, as well as the types of women who are presented in the works. She uncovered two different types of women in each work. There exist the intelligent and witty women who are seen throughout each work, upholding moral order and deliberate understanding, and the ideal perfect women who do not exist, either because they have been created by a group of courtiers in a Platonic dialogue, or because they, as virtuous innocents, are always spoken of but never seen.
The Middle English poem *Erthe upon Erthe* enjoyed a wide popularity, both geographically and over time. It was written during the fourteenth century, peaked in popularity a century later, and was widely circulated for hundreds of years thereafter throughout most of England. Although *Erthe upon Erthe* ("Earth upon Earth") has faded almost entirely from popular consciousness, its message of eschewing material wealth for spiritual reward is of interest today.

The goal of this project was to transcribe an inedited manuscript of *Erthe upon Erthe*, and to identify its relationship to other variants of the poem. Thirty-nine manuscripts contain versions of *Erthe upon Erthe* at present. A small number of these variants share unique stanzas, indicating that these manuscripts share a special relationship in terms of source material and transcription. Two of these variants—manuscripts (MSS) Laud Miscellaneous 23 and Lambeth 853—are nearly identical and have been edited previously. A third, British Library Additional (BL Add.) 37788, appeared to match these two variants but had never been edited thoroughly.

Transcription required familiarity with fifteenth-century handwriting, abbreviations, and regional variations in diction and spelling. A line-by-line comparison between the three manuscripts established their strong relationships to one another. Once these relationships had been determined, extensive research provided a date, description, and list of contents for each of the three manuscripts.

Transcription and research confirmed that the manuscripts were either derived from a common manuscript, or from one another. Over the course of this research, Laura also uncovered records that grouped the poem incorrectly, either through omission, repetition, or mislabeling. The results of this project will help to streamline research for future scholars of the poem, and may have larger implications for the origin and circulation of *Erthe upon Erthe* in the Middle Ages and after.
Based on the filming of his senior honors thesis in Film and Media Studies entitled, “Et Tu, Jesus?”, Jeff Stepp explored the use of a camera called the Panasonic AJ-SDX900. Jeff’s film is a short, running about 12 minutes. The story centers on Dick, a college student, who is picked on by Jesus all day. The main concept he wished to explore in this film was a “what if?” concept: what if Jesus was a naturalized, everyday man who is tired of always being the nice guy and just needs some time to goof off?

This research demonstrated in depth, the features and possibilities of the Panasonic AJ-SDX900, and how it can help a film studies program advance to the next level. The SDX is a unique video camera in that it is able to acquire images at 24 progressive frames per second (true film speed) on a high-resolution standard definition format, DVCPro50. In short, the SDX allows video to “look” like a film you would see in the theaters, as opposed to looking like video footage one might see on a reality TV show. This film-look was a crucial element in developing Jeff’s project, as he was very interested in showing this short at film festivals across the country. As the prices of video equipment continue to drop and access to this equipment continues to rise, it is important for any serious filmmaker or institution like Washington University to stay at the leading edge of technology.
The Sifrei Evronot, roughly translated as “Books of Intercalation,” emerged in the 13th century as guides to Jewish calendar reckoning. The Jewish calendar is primarily lunar based, but retains elements of the solar cycle. Intercalating the Jewish calendar requires a complex and sophisticated system that merges the lunar and solar year, ensuring the occurrence of festivals during their mandated times. Jewish community leaders, merchants and travelers used these manuals to construct calendars, intercalate leap years, and determine the dates of trade fairs and Christian festivals. Although some 200 extant Sifrei Evronot manuscripts reside in rare book and private collections around the world, a comprehensive examination of the genre has yet to be conducted. Through a study of Sifrei Evronot manuscripts from collections in the United States and Israel, including a late 16th century example from Washington University, Josh attempted to answer some of the many questions that surround this elusive genre: Who authored the first Sefer Evronot? Which charts, diagrams and illustrations are universal to the genre? Why did scribes continue to produce manuscript copies for some 200 years after the first printed edition appeared in 1560? Finally, how do the illustrations contribute to one’s understanding of the calendar, and what is their relationship to the iconographic traditions of Hebrew manuscript illumination? Rather than focus on a single aspect, Josh’s research introduces the salient features of printed and manuscript Sifrei Evronot which include, placing the genre in the socio-historical context of early Modern European history, traditions of manuscript production, the development of the Jewish calendar, and cross-cultural exchange among Christians and Jews.
Newborn Resistance to Malaria

Craig Wilen

Mentor(s): Daniel Goldberg, Ph.D.

This research was supported by the Washington University Office of Undergraduate Research through a Hoopes Undergraduate Research Award.

Plasmodium falciparum, the most lethal of the four human malaria-causing parasites, affects over 300 million people and causes one to three million deaths per year, 90% of which occur in sub-Saharan Africa. In addition to its profound public health concerns, the disease has a substantial economic burden with approximately $12 billion spent annually on endemic developing countries. The severity of the global disease burden is augmented by the increasing chemotherapeutic resistance to readily affordable drugs. Thus, new drugs and drug targets are desperately needed to mitigate the malaria epidemic. It has long been known that newborns exhibit partial resistance to malaria particularly in the first few months of life. However, the mechanism that confers such resistance remains unclear. Elucidating this mechanism may prove beneficial in drug target refinement and subsequent drug design. One possible reason for newborn resistance to malaria is that a newborn’s red blood cells contain two types of the oxygen-carrying protein hemoglobin called fetal and adult hemoglobin. In older children and adults, only adult hemoglobin is present in the red blood cells. Hemoglobin serves as the malarial parasite’s primary nutrient source, and it is thought that preventing the parasite from degrading hemoglobin may starve it to death. The fact that the parasites can not utilize fetal hemoglobin as well as adult hemoglobin may explain why newborns are resistant to malaria.

To evaluate this hypothesis, several forms of fetal and adult hemoglobin were grown in bacteria, and then purified. It was then determined how well the parasite could degrade them. By comparing the difference in degradation between various hemoglobin, the factors influencing degradation were determined. Surprisingly, the results suggest that the amino acid sequence of fetal hemoglobin has an important role in conferring its resistance to degradation which may explain newborn resistance to malaria.
The Florida manatee (*Trichechus manatus laterostris*) is listed as an endangered species. A large number of manatees die every year off the coast of Florida due to injuries sustained from collisions with boats. It is unclear whether the manatee has difficulty hearing oncoming boats or simply moving out of the boat’s path. Learning about the way manatees move, balance, and hear in their three-dimensional, often lightless habitat in the ocean may help save the species. Their ability to navigate successfully in this environment is likely to depend largely on the vestibular system. This special sensory system contributes to the coordination of eye movements, posture and balance, and perceptions of motion and orientation. Previous research has shown that both the size and shape of the vestibular systems of cetaceans (obligate marine mammals including whales and dolphins) are significantly different from the vestibular system of terrestrial mammals. While the reason for these differences is unknown, they have been hypothesized to decrease the sensitivity of the labyrinth as an adaptation to the aquatic environment of cetaceans. It is unknown to what extent other fully aquatic mammals, such as manatees, share these adaptations and how they may relate to their ability to orient and navigate safely.

In this study, one skull and four isolated temporal bones from Florida manatees were examined using conventional computerized tomography (CT) and high-voltage computerized tomography (microCT). Images were then analyzed using software custom written in MATLAB (www.themathworks.com) and visualized using VideoMach (www.gromada.com). The semicircular canals were identified in scanned images and traced using MATLAB from the dilated ampulla region until they re-entered the vestibule. The radius of curvature and planarity of the canals, the angles formed between ipsilateral and synergistic canal pairs, and the overall sensitivity of the vestibular system were determined from conventional CT scans. In addition, the cross-sectional area of the vestibular aqueduct was calculated from microCT data. The size and shape of the manatee vestibular system were found to share more similarities to those of terrestrial mammals than of cetaceans. There is no evidence to suggest that an obligate aquatic habitat alone predisposes marine mammals to vestibular adaptations documented in cetaceans including decreased canal radii and non-orthogonal canal orientations.
Toward a Better Understanding of…

Synthesis, Structure, Spectroscopy and Reactivity of Thiapentadienyl-Rhodium-Phosphine Complexes

Eric S. Wise

Mentor(s): John R. Bleeke, Ph.D.

This research was supported by the Washington University Office of Undergraduate Research through a Hoopes Undergraduate Research Award.

Catalysts are compounds that are added to chemical reactions for the sole purpose of speeding up the reaction rate. These compounds are found in many forms. Some are simple organic molecules containing carbon, hydrogen and oxygen. Others are metallic surfaces, such as nickel. Organometallic catalysts are of great interest in the manufacturing of plastics, fabrics and other materials. These catalytic compounds consist of “organic” molecules or fragments chemically bonded to a metal atom. In fact, the 2006 Nobel Prize in Chemistry was won by Dr. Robert Grubbs at CalTech for the development of an organometallic catalyst used to make large polymers and cyclic molecules. Eric’s research has centered on constructing organometallic compounds which are designed to have catalytic properties.

Since the summer of 2003, Eric has synthesized and characterized compounds consisting of rhodium metal attached to both 5-atom long “thiapentadienyl” chains and phosphorous compounds. The strength of bonds in these compounds can be altered so that other molecules can join the metal center, react, and leave the metal-this is the catalytic potential of these compounds. In conducting this chemistry, many laboratory techniques were employed. Most importantly, almost all the reaction chemistry was conducted in a “dry box,” that is, a sealed bench top under an inert nitrogen atmosphere. The structures of new compounds were discerned using Nuclear Magnetic Resonance spectroscopy and X-Ray Crystallography techniques, both of which provide valuable, conclusive insight into a probed molecule’s identity, shape and bond distances. Many new compounds were discovered and fully characterized.

In several reaction systems, one product formed initially, but over time, a process called “isomerization” occurred in which the first compound converted to a second compound where the difference between the two is the nature of bonding. Thus, a challenge posed itself toward handling both compounds in a given system. On the synthesized compounds, further reactions with different chemicals were conducted. For example, one rhodium compound was allowed to react with oxygen, which bonded to the metal center to form a novel rhodium-oxygen compound. These data provide necessary preliminary studies for eventual application to catalysis and perhaps, the manifestation of utility of these compounds in manufacturing.
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The Office of Undergraduate Research is funded by the College of Arts & Sciences.