



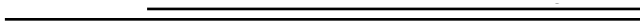


UMKC HONORS PROGRAM \ VOLUME 7 ISSUE 1

# LUCERNA

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*an undergraduate research journal*



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# LETTER *from* // *the* EDITOR

Welcome to the seventh edition of Lucerna! The journal in your hands is the product of yet another year of exemplary work completed by undergraduate students at the University of Missouri-Kansas City. The students featured in this year's edition of the journal have demonstrated outstanding academic achievement and I would like to both congratulate them for their achievements and thank them for making Lucerna possible. Without their efforts, this journal would have no place at UMKC.

I would like to thank the Honors Program for making the publication of this journal possible, especially Dr. Gayle Levy, Dr. Frances Connelly, and Ms. Sally Mason for their patience and guidance this year. Each year, Lucerna expands and improves thanks to their efforts. I would also like to thank my wonderful staff, each of whom has worked very hard to put this journal together. I would especially like to recognize Hye-Won Ham. As our treasurer, she has put forth an outstanding level of work to provide us with the funding necessary to publish Lucerna. Her efforts have been greatly appreciated and I thank her for her time and dedication.

I would also like to thank Egghead Design for their innovative and inspired work with Lucerna this year. Dr. Paul Tosh and his team of talented students have been a pleasure to work with, and I would like to thank them for their patience and cooperation as Lucerna continues to move forward and grow.

It has been an honor to work with the talented students here at UMKC, both on my staff and the authors published within these pages. Their commitment to excellence is a trait I admire deeply, and I am proud to present their work under the Lucerna title. I wish each of the students featured in Lucerna this year a future of success, commitment, ambition, and fulfillment. As Henry David Thoreau wisely said, “Go confidently in the direction of your dreams. Live the life you have imagined.”

Very Sincerely,

**Taylor Barton**

**2012 Editor-In-Chief of Lucerna**

# EDITORIAL

## **EDITOR-IN-CHIEF**

*TAYLOR BARTON*

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Taylor is a senior working on earning a B.S. in Environmental Science and a B.A. in Philosophy. She is hoping to eventually attend graduate school to study environmental philosophy and policy. She is especially interested in pragmatic philosophy and systems theory. Besides attending classes at UMKC and participating in the Honors Program, Taylor is involved in Phi Sigma Tau, the philosophy honors society, and Advanced Law Club. She is also a member of Phi Kappa Phi Honors Society. She works at the U.S. Environmental Protection Agency Region 7 as an intern and also serves as a Supplemental Instructor in Philosophy at UMKC. She enjoys working with Lucerna because providing students with opportunities to showcase their research is an awesome opportunity. Lucerna also provides students with insight into other fields, hopefully sparking interest in subjects they may have never encountered otherwise.

## **MANAGING EDITOR**

*KIRSTEN PETERSON*

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Kirsten came to UMKC in 2010 and is majoring in Communication Studies and Political Science. She plans on graduating in spring 2013 and hopes to either continue her education or engage herself in working in the world of politics. If she could pursue any career and succeed, it would be as a political speechwriter. In her free time, she likes to read, collect antiques, shop online, and practice her Mandarin Chinese. When it comes to Lucerna, Kirsten finds a great deal of value in academic research and thinks that it is an excellent way to engage oneself in his or her field of choice. Not only does it provide more knowledge, it also fosters invaluable streams of thought that may not have occurred otherwise. Putting the mind to work can be quite the exercise, but it is also very rewarding.

## **ASSISTANT MANAGING EDITOR**

*ERYNNE N. DAIGNEAULT*

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# BOARD

## **TREASURER**

*HYE-WON HAM (JENNY)*

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Jenny is pursuing a Chemistry BS/Pre-Pharmacy degree. She is an Alpha Lambda Delta member, Korean Student Association Treasurer, and Lucerna Treasurer. She is currently in the Honors Program and in the pre-pharmacy club. While some of us shy away from the sciences, Jenny really enjoys studying chemistry. She has also enjoyed working with Lucerna, which involves responsibility and teamwork. If teamwork is not established, the journal would never get done in time. Working on Lucerna has also taught her how to work with other student organizations like the Student Government Association.

## **SECRETARY**

*MIKAYLA GREEN*

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Mikayla is a sophomore majoring in English and Secondary Education (doubling in English: Language and Literature). Besides acting as the Secretary of Lucerna, she is involved in the Undergraduate English Council (UEC) and the UMKC Peer Coaching Program. Her interests include reading, volunteering and shopping. Lucerna has given her experience in what it takes to publish a journal, as she would like to publish books and articles during her teaching career.

## **ESSAY REVIEWER**

*PARIS CLARK*

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Paris is a sophomore pursuing a double major in Psychology and English Literature, and a minor in Spanish. She has worked as an office assistant in the Student Union for the last two years, and will be returning as a New Student Orientation Leader for the Summer 2012. She is also a Resident Assistant in the Department of Residential Life and a proud member of the UMKC Honors Program. Her involvement with Lucerna aligns with her interests in research and hopefully publishing her own original work in the future. She plans to pursue a Ph.D. in Psychology, focusing on psychological disorders and family dynamics as well as language and literature in English and Spanish within the constructs of classic psychological theories.

# EDITORIAL // BOARD

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## ESSAY REVIEWER

*AMY G. JOHNSON*

Amy is a second-year junior majoring in Biology and interested in everything from public health and advocacy work to bodybuilding and reptiles. She has enjoyed working as an essay-reader for Lucerna because it gives her an outlet to read creative compositions and enjoy the talent of the students here at UMKC. Eventually, she'd love to sit on a research review board for a nonprofit organization, examining medical publications much in the way she does with student work for Lucerna.

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## ESSAY REVIEWER

*CHELSEA SCOTT*

Chelsea is a resident assistant in the Oak Street Residence Hall, and has been for the past two years. She enjoys being a student at UMKC and is a member of Impact Ministries on campus. She has been an essay-reader for Lucerna since she was a freshman and enjoys reading all the articles. Chelsea finds it very interesting to read papers written by her peers who have different passions than her. It really takes learning that extra step outside the classroom.

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## ESSAY REVIEW BOARD

AMY G. JOHNSON  
CHELSEA SCOTT  
PARIS CLARK  
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## GRAPHIC DESIGNERS

*PROFESSOR PAUL TOSH*  
*CHELSEA COOPER*

## **GREGORY STEEL**

---

is in the final stages of his career at UMKC. His interests range from environmental sustainability to animal wellbeing. These interests are reflected in his chosen fields of study: biology, chemistry, and environmental studies. He has chosen to write about the parasite-host interaction because to him, these are some of the most derived and most interesting relationships in the animal kingdom. His future goal is to work to help both the animal kingdom and the environment in which we all live. He is currently the president of the Student Environmental Coalition. The main focus of this organization is to foster student and community involvement to sustainably care and protect the environment.

## **MAX SHOCKLEY**

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is not a career-oriented person. He prefers to see his life as an exploding firework. At the heart of this explosion there are a few main guiding or motivating forces from which other less important things stream. One of these forces is the idea of Christian Hedonism. It is a rejoicing in the heart about something in the mind, something like the gospel. He loves it. Critical understanding developed in Economics helps him to see what is really important in a system. In the system of life, it is critical that his heart not be overly critical of others given what he knows and rejoices in about who God has shown himself to be.

## **ALEX KARANEVICH**

---

is a mathematics major at the University of Missouri-Kansas City who completed his undergraduate degree in May 2012. He has accepted an offer from the University of Wyoming to pursue a Ph.D. in mathematics with a focus on applied mathematics.

## **JESSE HAMER**

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is pursuing a B.A. in mathematics with two minors, French and Computer Science. He plans on graduating from UMKC in Spring 2013 and going directly into graduate school for pure mathematics the following fall. He is not yet certain as to where he will go for graduate school, but would like to pursue a Ph.D. As far as career goals are concerned, Jesse aspires to become a pure mathematician, teaching at the university level and doing research. He finds pure math fascinating but also has a strong interest in philosophy, although that's more of a hobby than anything at the moment. He enjoys reading, especially about the philosophy of mathematics and logic, and would not mind doing some work in either of those areas. Jesse enjoys playing the guitar in his free time and going to the movies. He would like to thank Dr. Richard Delaware for providing lots of constructive feedback during the development of his paper.

## **RACHEL KAUFFMAN**

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is graduating this year with a in psychology and sociology and a minor in family studies. She was a member of Phi Theta Kappa and in the Honors Program, and a member of Psi Chi, the International Honors Society in Psychology. She served in various leadership positions in UMKC's Sociology Club. She was a research assistant in Dr. Tamera Murdock's psychology lab. She has presented her research on adolescent fathers' young adult outcomes at the Great Plains Psychology Conference (2012), the Great Plains Honors Conference (2012), and Midwestern Psychological Association in Chicago (May 2012). She has received a SEARCH (Students Engaged in Artistic and Academic Research) grant and a Psi Chi travel grant to conduct and present her research. Her main research interests include close relationships, community prevention and intervention, gender issues, and social psychology. She would like to thank Professor Wade Elmore for his assistance with the successful publication of her essay.

## **MELISSA CHILDRESS**

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is graduating this year with a bachelors degree in psychology. Her research interests include child, parent and provider perceptions of treatment in chronic illness and how this affects adherence and treatment course, specifically in ADHD and chronic pain. She plans on pursuing a Ph.D. in clinical psychology after finishing her degree at UMKC.

## **JULIETTE BATES**

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will graduate with a double major in German and Studio Art and a minor in Philosophy this spring. In the fall, she plans on travelling to Germany for a year as a Fulbright English Teaching Assistant. She cannot predict her future beyond that, but is very excited for it nonetheless. This paper was inspired by Juliette's junior year abroad in Salzburg, Austria. She would like to thank Dr. Scott Baker for being a patient and encouraging mentor, not only on this project but throughout her entire German-speaking career.

## **JEREMIAH SHULER**

---

is a senior at UMKC majoring in Urban Studies-Community Development and Housing Tract. He chose UMKC because of the urban campus and the ability to study cities through social sciences and urban planning. He hopes to continue his education at UMKC and obtain a master's degree in Public Administration. Before UMKC, Jeremiah served eight years in the Marine Corps. He is married and has four children. He would like to thank Professor Sookhee Oh for encouraging him to submit this paper.

## **LAWRENCE STITT**

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is a junior history major emphasizing in the study of the history of Kansas City and the surrounding region. In addition to local studies, Lawrence is interested in the intersections of philosophy, history and politics and the relationship between local and global historical events. He originally wrote the paper "The Necessity of Choice: Reflections on Film and History in Occupied East-Central Europe" for his fall 2011 course in East-Central European History with UMKC professors Dr. Andrew Bergerson and Dr. Larson Powell. Outside of the classroom, Lawrence recently completed research for the Kansas City 1912: Everything is Up to Date! exhibit at Union Station. He lives in Midtown, Kansas City and in his free time raises chickens, ducks and vegetables with his roommates.

## **ERIN YORK**

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is a 22-year-old writer and editor. In summer of 2012, she will graduate with a B.A. in Creative Writing and a minor in Manuscript, Print Culture, and Editing. Next, she plans to attend graduate school where she will pursue a Master in Fine Arts. Her writing has received both numerous publications and awards that include national acclaim. She has pieces forthcoming in *The Whistling Fire* and *Dossier*. Aside from writing, Erin has worked on several literary magazines and continues to work as a freelance copyeditor. For more information, visit her website: [www.wix.com/eywritereditor/erinyork](http://www.wix.com/eywritereditor/erinyork).

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## THE DUALITY OF THE PARASITE-HOST NEXUS

BIOLOGY 498WI:

CRITICAL ANALYSIS OF BIOLOGICAL ISSUES WITH DR. AARON REED

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### ABSTRACT:

*The large majority of biotic interactions stem from the concept of the parasite-host relationship. This relationship is immensely diverse and convoluted, ranging from one host and one parasite to multiple hosts and one parasite. The immensity of this interaction can be seen in the fact that parasites inhabit both terrestrial and aquatic organisms. Through the course of many years, parasites have evolved in order to adapt to their host. The evolution of genetics has allowed the parasite to gain the ability to manipulate its environment to increase its fitness. There are several methods that the parasite can employ to attain maximum survival. One such method is behavioral modification in either the intermediate or definitive host. The parasite can also induce forced castration in its host in order to enhance parasite survival and propagation. As result of parasitic load, the host is able to modify its own behavior and sexual reproduction as a means for evasion. The study of these diverse interactions will shed more light on the complexity of parasite-host interactions.*

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Many different types of biological interactions exist in the natural world. Some of the most thoroughly studied interactions include predation, commensalism, and symbiosis. However, possibly the most derived interaction is that of a parasite and its host. Over the course of millions of years, the parasite-host relationship has led to some amazing and unique behaviors. Some behaviors are controlled by the parasite while others are controlled by the host. The resulting behaviors are as diverse as there are species of hosts and parasites.

Parasite-host interactions can result in host behavioral changes that range from incredibly simple to extremely complex. The simplest of these behavior changes is seen in *Bombus impatiens* (the common bumble bee), which is infected with the parasite *Crithidia bombi*. This parasite interferes

with the bee's vision, making it hard to arrive at the correct flower. A far more derived behavior change is seen in cockroaches infested with wasp larvae. As the larva grow up they devour the cockroach from the inside out. In the subsequent paragraphs these behaviors will be extrapolated to shed light on the parasite-host duality.

## **EVOLUTION OF DUALITY**

Chloroplasts and mitochondria can shed light on the evolution of parasites. These cellular organelles have arisen by way of symbiotic relationships between viruses, microbes and higher-order organisms. Chloroplasts and mitochondria share a similarity with parasites in the fact that all of these organisms started their existence as free living and mobile organisms. However, their uniqueness lies in the fact that there must have been other organisms that were exploited by the parasites, which ultimately led to parasite-host interactions.<sup>1</sup> To become a successful species of parasite, the parasite must first find a suitable host. This is naturally accomplished by trial and error; if the host's immune system was too strong, the invader would be killed, however, if the host's immune system was suitable, the invader was able to colonize and create a new species of parasite. Furthermore, genetic components must have preceded this initial relationship to arrive at a successful parasite-host relationship.<sup>2</sup>

Two bits of information have now been identified; parasites were free living before host colonization and genetics plays a role in parasite-host relationships. To fully understand parasitism in an evolutionary context, the evolution of the host must also be taken into account. "The entire life cycle of a parasite with all closely associated organisms, including the host, is a unit in evolutionary development. This evolution of a parasitological system is as important as evolution of individual parasites."<sup>2</sup> With this understanding, the next few paragraphs shed light on the intense interplay that is exhibited between the host and the parasite. These behaviors are possible because both parties have evolved side by side for millions of years. The few behaviors that will be discussed in this paper are only a handful of the actual number of behaviors that are seen in parasite-host communities.

Parasite-host interactions are very complicated in nature but one way to explain the foundation of the interaction is to consider a ball in water. The ball is sitting in a body of water, free from weight, and able to float freely. Now, if a light weight is placed on the ball, it will still be able to remain buoyant. However, as heavier and heavier weight is placed on the



ball, it will cause the ball and subsequently the weight to sink. This situation is analogous to a virulent parasitic infection. As the parasite kills off its host, the parasite will also die but if the parasite is not too virulent the host stays alive and the evolution of parasite-host relations can persist in the population.<sup>5</sup> The parasite-host relationship must remain in equilibrium for the parasite to propagate its own species.

### **PARASITE-INDUCED BEHAVIORAL MODIFICATIONS AS SEEN IN THE INTERMEDIATE HOST**

A little background information must be presented to clarify the preceding paragraphs; an intermediate host is considered a vector that the parasite uses to arrive at the definitive host. This host is where the parasites are able to sexually reproduce and propagate the species. A common behavioral modification is seen in intermediate hosts that are used as vectors to infect their definitive hosts; these behaviors primarily serve to increase the chances of the intermediate hosts to be preyed upon by the definitive hosts.<sup>4</sup> Behavioral changes are also seen in paratenic (accidental) hosts, where immature parasites wreak havoc on the internal organs instead of maturing in a suitable location.<sup>5</sup> The parasite can elicit behavioral modifications in the host via chemical signals that make the host a better place to raise the parasite's offspring. However, the host can fight back by increasing its opportunity for sexual reproduction.<sup>6</sup> Sexual reproduction can increase fitness and the population's adaptation efficiency to different environmental conditions by facilitating genetic diversification of its lineages.<sup>7</sup> Consequently, the parasite responds by decreasing its host's chances of sexual reproduction by forced castration of its host. A castrated host has the ability to provide the parasite with more resources and will be less aggressive.<sup>8,9</sup> As a result of parasite-induced castration, the host will inevitably increase in body size so as to fulfill the needs of the parasite.

Parasites can have a profound effect on the behavior of their chosen host. Three theories persist to explain why parasites modify their hosts' behavior: enhanced transmission effectiveness, accidental or pathological side effects of parasitic infection, and host behavior based on the act of trying to rid itself of the parasite.<sup>10</sup> The concept of enhanced transmission is exemplified in adaptive behavioral modifications of the host by its coevolving parasite.<sup>7</sup> This is likely to be seen in parasites that require different hosts to complete their life cycles. The parasite Hyme-

nolepis diminuta, a rat tapeworm, requires the use of an intermediate host, Tribolium confusum, the flour beetle as a vector to get the parasite to its definitive host, the rat, Rattus norvegicus. The parasite's eggs are released in the feces of the infected rat and eaten by the flour beetle. During eight days from initial ingestion, the parasite will mature to an infective cysticeroid (immature parasite) within the beetles' hemocoel. Once a rat ingests an infected beetle, the cysticeroid will then develop into a mature parasite, thus completing its life cycle.<sup>11</sup> The goal of rat tapeworm is to gain access into its definitive host by way of an intermediate host. This is accomplished by means of the behavioral modifications of the flour beetle.

The rat tapeworm changes the normal behavior of the flour beetle in two ways: by decreasing its activity and by causing it to exhibit behaviors in order for it to avoid concealment.<sup>12</sup> Both of the above behaviors will modify the behavior of flour beetle in order to increase the chances of it to be preyed upon by the definitive host, the rat. This relationship will fulfill two of the parasite's needs; not only does the parasite have a readily available source of food, but it also has a way of reaching its definitive host. Both behaviors are extremely beneficial to the parasite and detrimental to the flour beetle. The hypothesis surrounding this parasite's life cycle alludes to the fact that the parasite needs to increase the probability of its transmission to the definitive host in order to evolve and propagate its species.<sup>13</sup>

Parasites are generally successful at finding and infecting their target hosts. However, when the parasite is unable to find its correct host, the parasite will alter its behavior in very drastic and irreversible ways. A good example of this infection pattern is seen in the canine roundworm, *Toxocara canis*. This parasite's life cycle is direct in nature and consists of increased tissue migration with the end goal of maturation in the intestines.<sup>14</sup> The first phase of the parasite's life cycle consists of unembryonated eggs that are shed in the feces of the definitive host, the canine, which are then embryonated in the soil.<sup>15</sup> Once in the soil, young canines, less than three months, ingest these embryonated eggs, which hatch and penetrate the intestinal mucosa. Eventually these eggs get to the canine's lungs by the way of the bloodstream and liver. The parasite is then coughed up, swallowed, and matured in the small intestine. Conversely, when embryonated eggs are ingested by older canines greater than three months of age, the larvae hatch in the

intestines, penetrate the intestinal mucosa and find their way to the liver, lungs, muscles, connective tissues, kidneys, and many other tissues. These are the sites in the host in which the larvae's development is arrested to a point where the parasite does not harm the host.<sup>16</sup> If the parasitic roundworm is ingested by a paratenic host in the environment as an embryonated organism, it will undergo a somatic migration through bodily organs but fail to reach maturity in the intestines.<sup>17 18</sup>

A behavioral hallmark of the canine roundworm is that it is able to infect many paratenic hosts, all of which behave in very different ways. One example of a paratenic host for the parasite is the common house mouse, *Mus musculus*. The parasite is unable to complete a full lifecycle in the body cavity of the mouse; this results in the larval forms of the parasite being encysted in the brain of mouse. Heavily infected mice will have impaired brain activity to the extent of extremely retarded levels of activity, exploratory behavior, and aggressiveness. Consequently, it is known that the canine roundworm can infect various types of hosts, which make it unlikely that it could select the same behavior that would have the same repercussions for all of the different types of hosts.<sup>17</sup> Canine roundworm infection does induce behavioral changes in its paratenic host but the observed changes are likely to be a consequence of parasite-induced pathology rather than an adaptive mechanism of parasite-altered host behavior.<sup>17</sup>

## **PARASITE-INDUCED BEHAVIOR MODIFICATIONS AS SEEN IN THE DEFINITIVE HOST**

The above examples solidify the notion that parasites do in fact change the behavior of the intermediate and paratenic hosts, however, they also modify the behavior of the definitive hosts in ways unlike what is seen elsewhere. Parasite modification of definitive host behavior is usually seen in direct systems that involve one host. A few examples that better explain this characteristic is that of *Sacculina carcini*, a crab parasite, *Crithidia beombi*, a bee parasite and the parasitoid Jewel Wasp, *Ampulex compressa*.

*Sacculina carcini* is of the cirripedia family or barnacle phylogeny and when mature, looks nothing like a classic barnacle. The parasite starts its simple lifecycle as a free swimming nauplius, which after a few molts will morph into a cypris larva. It is this larva that will find and infect a crab. The female larva will be first to colonize the crab. She is drawn to the crab by scent organs located on her legs and will swim through the water until she lands on the crab's body. She will then walk up the arm/leg, and an-

chor herself on exposed hairs around a body joint where she will begin to insert herself into the crab's body.<sup>19</sup> She then extends a long root-like filament into the crab and injects a 'blob' made up of a few cells. This process is just another way of molting for the crustaceans, enabling them to grow. This behavior produces a hard exoskeleton, or husk, that is left behind. In this case, most of parasite is left behind as a husk and the part that lives on looks nothing like a barnacle but more like a slug.<sup>19</sup> The crab parasite will then burrow into the body of the crab, finally occupying the brood pouch of the crab. From this position, the parasite is now able to shoot out rhizoids (root-like filaments) throughout the crab's body, including areas like the eye stalks.<sup>19</sup> The purpose of this behavior is to gain nourishment at the expense of the host. Shockingly, the parasite does not trigger an immune or physical response from the crab. In fact, the crab continues to eat and walk as if nothing is out of the ordinary. In other words, the barnacle produces its own 'zombie' so to speak.

Once large enough, the crab parasite will form a brood chamber, equipped with an entrance hole to the outside. If this female is lucky enough, a male will find his way into her. Once the male has found her, he will then molt, and inject himself into her. The male, now able to produce sperm, will venture down a long canal, ending up at the female's visceral sac. The female parasite has two of these canals, allowing her to carry two males for her whole life span. The male will ceaselessly fertilize her eggs, creating thousands of offspring every few weeks. Consequently, the female parasite has created a living food source that will take her wherever she needs to go. In other words the "crab" has been changed into a servant of the parasite, providing the parasite with an endless supply of food, protection, and mobility; the crab even stops molting and growing, funneling all of its energy to the parasite. The crabs are able to escape from predation by severing a claw that regrows later. However, crabs that are infected with *Sacculina* are able to sever a claw but it will not be regrown. Parasitized crabs will also forgo mating to care for the parasite.<sup>20</sup>

As a result of parasitism, *S. carcini*, has castrated the host crab. The reason for this is that the parasite has chosen to colonize the brood pouch of the crab. In doing so, the crab has not lost the ability to nurture. This is exemplified when parasite cypris larvae are ready to come out; the male or female crab finds a rock or hill to which it lifts up its abdomen and begins to spray the parasites into the surf. This behavior has been seen in both males and females and is another great example of the ways in which

parasites can control their hosts. Another striking example of this can be seen in parasitized bumble bees.

*Crithidia bombi* is a flagellated trypanosome who is the primary parasite of the common bumble bee, *Bombus impatiens*. The lifecycle of this parasite is remarkably simple in relation to the damage it can cause on a single bumble bee and its colony. A host is infected when it comes into contact with feces laden with the parasite cells and once ingested, the cells will attach to the gut wall where they proliferate.<sup>21</sup> This cycle of infection and cell growth will continue until the entire hive has been infected. "Because *B. impatiens* and other bumblebees lack any ability to transfer food among members of the hive, trophallaxis, infectious pathogens like *C. bombi* cannot be transmitted directly but are picked up from surfaces of the nest." <sup>21</sup>

Parasites of many different families are able to alter their host's behavior in drastically different ways and the *B. impatiens* and *C. bombi* system is no different. The parasite is able to induce central nervous system changes that are seen when compared to wild, un-parasitized bumblebees. Parasites like *C. bombi* are able to accomplish this task in two ways; directly, where the parasite is able to physically and chemically destroy central nervous system functioning and indirectly through the action of the host's immune system reaction to infection. The parasite is an example of indirect control, where the host's responses to the parasite are produced by its own immune system. This is accomplished in the fact that parasitized bumblebees show a drastically declined ability to utilize floral assets, which in turn stresses the hive and decreases the abundance of the available floral assets. The parasite is able to stress the body of the bumblebee enough that it is unable to correctly distinguish good flowers from bad flowers. Infected bees are able to acquire floral cues but lose the ability to retain this information.<sup>22</sup> The parasitized bees, in turn, would be responsible for total colony decline to the point of decreased survivorship. In social bees, the reproductive success of the colony is directly related to the acquisition of floral resources by foragers. Given that plant species vary tremendously in the quality of floral rewards offered, bees that are better able to recognize and discriminate profitable species will acquire more resources and increase colony success.<sup>25</sup> Not only would the health of the colony and the individual bees be at risk but the health of the surrounding plants will also be at risk.

Another parasite-host interaction involves parasitoid wasps, more

specifically the Jewel Wasp, *Ampulex compressa*, which hunts *Periplaneta americana*, American cockroaches, which serve as a food source and housing structure for its growing offspring. This behavior modification in the host is: once the parasite finds a suitable host, it will sting the cockroach twice. The first sting is in the thorax and will induce transient paralysis of the legs. The second sting is aimed at the head, which is responsible for certain cognitive behavioral changes. The first notable behavior that the cockroach exhibits is excessive grooming for thirty minutes. After the grooming behavior ceases the cockroach will lose the ability of self-initiated motility. Rendered completely docile, the wasp will guide its host by the antenna and lead it back into the nest that the wasp created. The wasp will then lay one egg on the exoskeleton of the cockroach and then seal the nest off. After two days, the larvae will hatch inside the host and begin to feed for another three days. The larvae will then pupate and eat the cockroach from the inside out, ultimately killing it. After a month, adults emerge ready to reproduce.<sup>24</sup>

The wasp controls its victim by the use of neurotoxins that interfere with the functioning of the central nervous system.<sup>24</sup> The chemistry of the neurotoxin is able work in such a way as to decrease the cockroach's fitness and increase the wasp's fitness. The way in which the wasp has adapted to brood offspring will allow more mating attempts in the natural world due to the fact that immediately after mating has occurred, female wasps can find a suitable host in which to deposit eggs allowing her to go out and breed again. This behavior will increase the females' and males' fitness, while giving the offspring a better chance at life. The parasitic wasp has evolved a pattern of parasitic infection that benefits its own fitness by allowing an optimal place to rear its offspring.

The above examples show that a parasite is not exclusionary, meaning it is not affected by what type of host it uses; rather its focus is on growing and propagating. The notion that only parasites modify the behavior of the intermediate or paratenic hosts has been destroyed. The crab and bee systems were highlighted to shed light on this fact, but there are many more examples that are around us every day. We looked at what the parasite does to the host, but there are also ways in which the host is able to fight back.

## RESPONSES TO PARASITE VIRULENCE AS SEEN IN THE HOST

Parasite-host interactions are able to shed light on the hypothesis that certain host behaviors are a result of parasitism; one such behavior is the result of fighting off the parasite. *Chaetodon capistratus*, the four-eye butterfly fish, is the host for an isopod parasite, *Anilocra chaetodontis*, which is a sexual reproducing ectoparasite of marine fishes. The females have a pouch where embryonated eggs hatch and undergo two or more molts to form the manca or pullus II stage. After a short free-swimming life stage, the juvenile larvae are parasitic and need to find a suitable host for each of the separate stages of juvenile molts.<sup>25</sup> Once infected with the parasite the four-eye butterfly fish will begin to move away from the pack and stay motionless in areas of low light or underneath rocks.<sup>25</sup> The energy that butterfly fish would normally expend actively moving about its environment is now shifted into energy to fight off the parasite. This type of behavior is a way in which the host can decrease the spread of the parasite.<sup>26</sup>

### SEXUAL REPRODUCTION AS A MEANS TO ELUDE PARASITES

Behavior modifications are just one of the examples of the parasite-host interaction. The examples stated above explain how the parasite controls the host to increase the parasite's fitness and how the behavior of the host tries to thwart the virulence of the parasite. The way in which *C. capistratus* can negatively impact the spread of *A. chaetodontis* is a good behavior in this particular situation to try and ward off the parasite; however, a better behavior is seen where the host can use the act of sexual reproduction to elude parasitic genetic fixation.

The modest explanation is that sexual reproduction, in host and non-host animals, evolved alongside virulent parasites. Sexual reproduction allows for new combinations of genes that are better adapted for life in a parasitic world. Consequently, it has been hypothesized that parasites could be the driving agents in the long-term preservation of sexual reproduction in host populations.<sup>27</sup> The Red Queen hypothesis, proposed in 1973 by evolutionary biologist Leigh Van Valen, attempts to understand the 'give and take' that is seen in parasitic relationships. The Red Queen hypothesis proposes that what one species gains from the interaction the other will lose.<sup>28</sup>

Red Queen dynamics can provide a structural framework for the comprehension of sex, why sex exists, and what benefits it offers. The first question is, why is there sexual reproduction in the first place? While

asexual reproduction is in fact less resource dependent, it does not allow for genetic variation. The Red Queen conundrum, some researchers have argued, may give an evolutionary edge to sex. Asexual strains can never out-compete sexual strains because whenever they get too successful, parasites build up and devastate the strain. Sexual organisms, meanwhile, can avoid these dramatic booms and busts because they can shuffle their genes into new combinations that are harder for parasites to adapt to.<sup>29</sup> A nematode by the name of *Caenorhabditius elegans* provides a practical explanation of the Red Queen and the benefits of sexual reproduction.

The nematode can either be male or hermaphrodite. The hermaphrodites are able to reproduce asexually or seek out a male to reproduce sexually. “Although usually low, outcrossing rates can be genetically manipulated to produce either obligate selfing (asexual reproduction) or obligate outcrossing (sexual reproduction) individuals.”<sup>50</sup> Astonishingly, the nematode can be home to many pathogens. The soil pathogen, *Serratia marcescens* “is highly virulent and capable of exerting strong selection on *C. elegans*.”<sup>50</sup> Once ingested, the parasite can kill the nematode; however if exposed over a long period of time, the host is able to evolve resistance against the parasite while *S. marcescens* is able to evolve increase virulence. This system is also an example of Red Queen dynamics. In one study, *C. elegans* and *S. marcescens* revealed some astonishing results. The sexual worms that faced co-evolving germs were annihilated in just twenty generations. If the germs could not evolve, however, the asexual worms did fine. The *S. marcescens* that was allowed to co-evolve with the asexual *C. elegans* became much deadlier. The co-evolving sexual *C. elegans*, on the other hand, suffered far lower mortality rates from their germs.<sup>51</sup>

This study shows that the interplay between parasites and hosts is far deeper than behavior modification, but that “the ability of antagonistic co-evolution to continually generate novel environmental conditions under which outcrossing is favored and populations persist when interacting with a virulent pathogen.”<sup>52</sup> The overall theme is that sexual reproduction can expedite adaptation to the surrounding environment, but long term sexual reproduction must persist in the population to hold to the Red Queen dynamics.

The life cycle of *Toxoplasma gondii* consists of both sexual and asexual stages. The definitive hosts are member of the cat family, *Felidae*. In this case, *Ratus Norvegicus*, the brown rat, serves as the intermediate host. Members of the cat family will shed unsporulated oocytes in their feces,



where they will sporulate in the environment leading to their infectivity. The brown rat will then ingest infected soil or plant material. Shortly after the oocysts will transform into tachyzoites, which will then encyst in nervous or skeletal muscular tissue forming bradyzoites. Members of *Felidae* will then ingest infected rats, thereby, allowing the parasite to complete its life cycle.<sup>35</sup>

Female brown rats are able to sense that a male has been infected and avoid them in most situations. Aversion behavior seen in females is likely driven by the need to seek out healthy males avoiding sexually transmitted infections.<sup>34</sup> Female aversion behavior to parasitic infection is seen as a negative to the parasite's fitness when transmitted by sexual contact.<sup>34</sup> The parasite is able to manipulate the male brown rat to be more appealing to the female brown rat. Since the parasite has evolved so closely with the brown rat, it is able to manipulate its host to increase its chances of sexual transmission.

## **RESULTS OF PARASITE-HOST RELATIONSHIP**

Another consequence of this interaction is the forced castration and sterilization of the host as achieved by the parasite. Since the growth of the parasite and its reproduction efforts are severely limited by the host resources, these limited resources decrease the fertility of the host and the transmission of the parasite. Reproduction draws precious energy away from the parasite and into the host's offspring; however, if the parasite can keep this from happening, it will gain increased fitness while the host will be at a detriment.<sup>35</sup>

Another hypothesis for parasite castration involves the host's reproductive tissue as a readily available source of high quality nutrients.<sup>35</sup> To better examine parasitic castration the interactions of a plant-ant community is examined. *Crematogaster nigriceps*, an ant, resides in the Acacia tree, *Acacia greggii*, and manipulates the trees to better suit its needs. The Acacia tree serves as shelter for the colony of parasitic ants, providing nutrition and protection from predators. On the other hand, the parasite protects the Acacia tree from consumption and overgrowth by the surrounding vegetation. This relationship is not symbiotic but more closely related to parasitism because the action of the ant sterilizing the Acacia tree is a way of protecting their colony. While the parasite prunes the tree, it inadvertently kills most growing apical meristems. This pruning behavior creates unique canopy architecture and causes the sterilization of the tree.<sup>36</sup> The pruning behavior seen in the parasite increases its fitness while

decreasing the fitness of the Acacia tree. As a result of castration, the host will experience two unique phenomena: gigantism and early-infection fertility compensation occurrence.<sup>57</sup> Gigantism is the physical increase of body mass driven by the parasite by increasing parasitic lifetime reproductive success and it may allow for more resources to be available to the parasite.<sup>58</sup> A gigantic host allows for more room for the parasites to grow to maturity, which is why gigantism is seen in parasitized Acacia trees.

The early-infection fertility compensation occurrence allows for a reproduction race between the host and the parasite. The infected host has only a finite amount of time to reproduce until the parasite castrates the host and uses the remaining host energy to complete its lifecycle. The early-infection fertility compensation occurrence principle could be applied to the *C. nigriceps*-*A. greggii* relationship. It is advantageous for the parasitic ants to sterilize the Acacia trees as soon as possible to stop new tree branches from growing, which will decrease the amount of territoriality disputes between colonies of ants.

## CONCLUSION

The above parasite-host interactions are just a representative sampling of the unique relationships that exist between the parasite and the host. If nothing more, these interactions should shed light on the fact that parasites have a complex interaction with their host species. The examples presented here allude to the fact that the parasite-host relationship is a very dynamic and specialized relationship that formed from a lifetime of interactions between parasites and their hosts. Specialization is the way in which parasites and host have evolved to be members of this interaction, however, it is important for a balance be achieved to allow for successful parasites and successful host defenses.

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# MAXWELL SHOCKLEY

## SOME HISTORY OF ECONOMIC THOUGHT ON USURY: ARISTOTLE, AQUINAS, AND CALVIN

*ECONOMICS 406:*

*HISTORY OF ECONOMIC THOUGHT WITH DR. JOHN HENRY*

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### ABSTRACT:

*What is usury? This historical, evolutionary inquiry into usury shows that usury is like a villain, a shifty, adaptable, and mysterious villain. Although usury is actually an idea and not a person, personifying usury provides a greater appreciation for the idea of usury and how it has changed in thought and definition through time. This inquiry features thoughts on usury from a few key historical figures including Aristotle, Thomas Aquinas, and John Calvin.*

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If at a dinner party one were to run into a man by the name of Murder, one should be wary of his behavior. If also at this party one were to see a man by the name of Usury, one should tell him that we miss him since he departed from historical relevance. Most are under the impression that he was not the choicest fellow, though it is strange that scarcely two can agree on what makes him such a poor soul. It is hard to get to know him. He rises to the surface like a sea monster and then is gone. Sea monsters have been depicted differently by different societies throughout time. Some saw them as seven-headed dragons, or some as giant squids; likewise, as it relates to the beast of usury, there has not been unanimous consent either on its manifest form or nature. He has been an elusive serpent, adapting to the times with different incarnations; he might as easily have been mistaken for the devil.

Despite their differences, all come to agreement on one point: Usury is a villain. I will argue that he is one of the most savvy, crafty, and adaptive villains. He is continually reinventing himself, and, like the best of villains, Usury is complicated and messy. But his most admirable quality has been, if one could admire a villain, his ability to keep us confused, concealing his mysterious character even to the present day. If

one is not at least a little bit confused at the end of this reading, then shame on me. The purpose here is not to get rid of confusion; it is to show the evolution of an idea: usury. But ideas do not evolve with voluntary spontaneity. The minds of people change and these changes are expressed through people's opinions. This is why we will look at people's opinions in this paper. I am treating this idea as though it were a person at times in order to help breathe it to life.

The villainous evolution of Usury can be traced through history by studying the scholars and theologians who have battled with him. Aristotle, Thomas Aquinas, and John Calvin are three such individuals who have commented on usury in their respective times. Neither of these three is primarily known as an economic thinker, but that's okay because usury is not solely an economic issue. Aristotle was a philosopher, and Aquinas and Calvin were both theologians. Before the special treatment of usury should be granted to our representative gladiators, a more general introduction to the idea of usury will prove valuable.

Usury is villainous, and tied to the idea of evil. It is a word that describes a particular type of evil relationship between a creditor and debtor in which money is loaned at interest. This is a working, basic (and I would argue, commonly agreed upon) definition. Because the inquiry here is largely into the evolution of what usury means and why some have categorized it as evil, the contention will revolve around its definition to a significant degree. Aristotle, Aquinas, and Calvin will differ on what qualifies as "usury." However, among these three it will be unanimously accepted that usury is an evil kind of debt relationship. David Graeber, in his book *Debt: The First 5,000 Years*, explains how the conversation on debt as it relates to morality is muddled. According to Graeber, the anthropological record shows mankind's tradition to widely hold that any party to a loan is involved in something sinful, regardless whether one is taking the loan or giving the loan.<sup>1</sup> Whether any particular debt relationship is sinful or not, calling debt relationships "usury" is an implicit way people indicate that they are evil; that is, "usury" has a negative connotation. Intellectual leaders largely agree upon the idea that usury is evil or sinful, but they do not agree on its definition.

Defining usury is not a simple problem. It involves multiple spheres of society that are variable to change, simultaneously involving theological, legal, and economic aspects of life.<sup>2</sup> Gunnar Myrdal, in his paper "Institutional Economics," understands that problems are not confined to one sphere of society.<sup>3</sup> Instead, circular causation exists



between interdependent spheres of society. For instance, what the philosophical and theological leaders say in educational and religious spheres of society concerning usury has an effect on what laws jurists determine in the political sphere. For example, in the political sphere, laws could be made that would inhibit or prohibit the charging of interest on loans. This could have the effect of reducing or multiplying the availability of loans for philosophical and theological leaders in the economic and religious spheres. Also, conflicts of interest existing between people within these interdependent spheres of society have played large roles in the process of defining usury. If in the economic sphere of life merchants and traders say that usury is necessary for society to function, while in the religious sphere the Church simultaneously denounces usury as meriting excommunication and keeping one from receiving a Christian burial, there arises a need for intellectual leaders to rectify, or at least clarify, what usury is and how it relates to theology, business, and law. As foreshadowed earlier, we will now allow our intellectual leaders Aristotle, Thomas Aquinas, and John Calvin, to battle gladiatorially over the definition of this villain. This will help to provide a historical evolution of opinions about the definition of usury, which will address these concerns about the stakes at hand in defining usury.

Aristotle is one of the earliest figures in the historical analysis of usury. Scott Meikle notes in his book *Aristotle's Economic Thought* that “the object of Aristotle’s inquiry is to discover the nature of a property, [and its] exchange value, and an inquiry with that kind of aim is a metaphysical inquiry.”<sup>4</sup> Aristotle was not making an economic inquiry but rather an inquiry into the nature of things. Before Aristotle gets to usury, he introduces a few foundational assumptions about money. Let us remember that money is what is loaned in the evil credit/debt relationship in which usury is believed to be committed. Aristotle believes that money is legally determined and “has been instituted as the measure by which the values of diverse real goods may be equated with each other.”<sup>5</sup> Aristotle lays another foundational idea about money by saying that there are two types of commercial actions: the economic and the acquisitive. “The economic is part of the management of a household” (46). It is undertaken out of the need to survive and different from the “acquisitive,” which is a behavior that arose once money was introduced. Instead of using money as a means of exchange to meet the needs of life, people began to engage in exchanges for the purpose of making money (46). In other words, money began to be used for something other than its natural purpose as a means of exchange.

For Aristotle, money was a means to an end, but in commercialized societies, money is an end in itself.<sup>6</sup> To Aristotle this would not have been natural. Aristotle's treatment on usury came out of a general sort of natural law argument against commercial society and trade as a whole. Usury was therefore the most unnatural type of trade because it "not only [sought] an unnatural end, but [misused] money itself."<sup>7</sup> Money was supposed to be used as a means of exchange, but Aristotle said that when usury happened there was an "unnatural breeding of money from money."<sup>6</sup> For Aristotle, Usury became a villain because he was unnatural. He was the nine-headed monster that originated from the unnatural inbreeding of money. The unnaturalness of usury was also an important characterization that Thomas Aquinas, despite living in a radically different time and place, also built upon in his discussions of usury. For Aquinas, however, usury was more than a monster. As we will see, he was an unholy bookie too.

Major historical events that effected societal change took place between the time of Aristotle and the time of Aquinas, including the fall of Rome and the controversial life of the god-man, Jesus Christ. Power structures undoubtedly changed as the Catholic Church increased its great influence on society. It comes as no surprise that Aquinas, an intellectual of the Catholic tradition, should have been the one to address the problem of usury in his time. To note, there had been other intellectuals who battled with usury during the time between Aristotle and Aquinas, but they were lesser in prominence. The perspectives of Aristotle, Aquinas, and Calvin will give us a mere outline of the history of economic thought on usury; a book-length treatise would be necessary for the full story of the history of economic thought on usury. However, we will briefly discuss some of the other significant players that took stands and provided thoughts on usury, as will be seen interspersed throughout this paper.

By the time Aquinas enters the stage, there had formed a strong tradition against usury. St. Augustine, the famous Catholic theologian, argued that usury should be considered a sin against justice, like stealing.<sup>9</sup> Other Church Fathers and Councils attacked usury with biblical texts, such as Christ's statement, "Lend freely, hoping nothing thereby,"<sup>10</sup> and King David's verse of psalm, "Lord, who shall abide in thy tabernacle? He that hath putteth not out his money to usury."<sup>11</sup> The tradition preceeding Aquinas had well established that usury was a deathly, serious sin. Pope Alexander III would not see it fit for the Church to commit usury even if it was in order to ransom a Christian's life from a Saracen.<sup>12</sup> The thrust of the arguments suggesting that usury was evil, espoused leading up to the

time period of Aquinas, were—it should be apparent—dominated by theology. Aristotle’s natural law argument had been replaced with scriptural arguments.

Thomas Aquinas, aka Thomas of Aquino, writing in the medieval period, made a full attack on usury that at once kept the tradition against usury set before him in the work of Aristotle and in the decisions of the Church Fathers, and used his own new forceful arguments. Aristotle was of the opinion that money had a particular natural purpose of being a means of exchange. Usury was wrong because money, as a means of exchange between goods with utility value, was used to get more money. Money thence became, unnaturally, the end itself. Although Aquinas seemed to believe that he was in concurrence with Aristotle, he actually formed an argument that was foundationally different than Aristotle’s.

Aquinas argued that money was a measure. Noonan elaborates on Aquinas’ position: “Like other measures, money [was] considered independently from the things it [measured], and as fixed and stable in its measurement” (52). He explains, “If money is a measure, with a fixed value, deliberately to value it differently at different times is to distort unnaturally its formal character” (52). This argument for why usury was evil was different than Aristotle’s. Aristotle argued against usury from the standpoint of money’s purpose. Aquinas argued against usury from the standpoint of what money was formally: usury was wrong because it was the selling of money, which as a measurement, cannot be sold. “To sell money would be to give simultaneously two different evaluations to the same measure” (53). Besides arguing that money was a fixed legal standard of measurement that could not be sold, Aquinas made another argument. He thought, since money was consumed in its use (one cannot use money without spending it), it could not be allowed to charge two prices—for its use and for its substance—since its substance and use were one. Meaning, when a person committed usury as a lender charging interest, he or she essentially charged for the same thing twice, which was an infraction of justice (54). Aquinas was in agreement with Aristotle that usury could be objectively understood as anything collected beyond the initial loaned principal. For Aquinas, Usury was not the unnatural monster that Aristotle portrayed; he was instead, a two-timing bookie.

Though he did make a significant contribution, it is clear that Aquinas did not finish the discussion on usury with his arguments. Scholars after him took exception that Aquinas’s arguments were only valid in rare circumstances because of his assumptions<sup>13</sup>. As the subsequent

scholars were also Catholic, they did not throw out Aquinas's arguments. They aligned themselves in the same tradition of Aquinas though they had a list of exceptions that effectively undid his general prohibition. They argued that certain circumstances make the value of present money more valuable than its value in the future because creditors who loan forgo their security against emergencies, their opportunity to invest in other businesses, etc., in order to loan. Usury changed from being "whatever [was] added to the principal" to a more friendly concession that usury only happened when interest was collected as profit and no "just title" to this profit existed.<sup>14</sup> There were so many "just titles" to profit from a loan that by the year 1750, "it would be perhaps impossible to think of a transaction involving the extension of credit at a moderate profit which could not have been justified in terms of the revised scholastic analysis".<sup>15</sup>

By 1750, Usury was not a "big time" villain anymore. Though his operations were once rampant and he had many agents, most of his activities by this time had become allowable exceptions endorsed by the legal, theological, and economic world; he mostly was regarded as a good guy. Usury, that is the collecting of interest as profit on a loan, became, for the most part, allowable in the Catholic tradition after many exceptions to the general prohibition were permitted. John Calvin, in the Protestant tradition, took a different route but came to the same effectual conclusion that collecting interest as profit on loans was mostly acceptable.

John Calvin of France, a Protestant Reformer, was an outlier in the discussion on usury, a sort of crack in the homogeneity of Catholic tradition against usury, which started to take form way back when Thomas Aquinas attempted to explain what the nature of usury was in its essence. To situate Calvin's contribution to the historical evolution and definitional dispute about usury, let us consider some contextual information.

Though Aquinas's successors built on what Aquinas had set out about usury, albeit taking occasional exception to his ideas, Calvin did not follow the Catholic tradition that dominated the usury discussion leading up to his time. In Calvin's time the power structures of society were beginning to change. The Church had had a monopoly on scholarship up to this point because they had been one of the few institutions that could protect and provide the supporting infrastructure needed by the profession. Moreover, in the wake of the fall of the Roman Empire, the medieval world was too dangerous to possibly have the need or means to accommodate a large scholarly class. Therefore, the Church took the role of the great preserver of scholarly work and tradition.

This became less the case as the blasphemous Protestant Reformation took hold. The Catholic Church, while having its earthly throne of power usurped by Protestantism, was also losing headway in the battle for ideas. This new Protestant movement tended to throw away the historical scholarly tradition because this tradition was deeply biased in the Catholic persuasion—most of the scholars had been exclusively Catholic. For the Catholic Church to have been dead wrong about something so fundamental to the faith—about the idea of salvation—established Catholic credibility issues for the Protestants. It spoiled their appetites to hear any other theological points put forth by the Catholic Church, not to mention such a non-essential position as usury.

A Protestant at this time would probably guess that if the Catholic Church had an official position on usury, it was wrong or at least misguided, or perhaps overly complicated with a hundred needless legalistic rules associated with it that had no basis in scripture. “Salvation is not complicated,” thought the Protestants. “It does not require works. It requires one thing: faith.” Now that we have reviewed some of the historical, cultural, and theological context, the position of John Calvin on usury can be examined in a qualified light.

John Calvin’s position on usury was not complicated. There was only one governing rule in Calvin’s argument on usury: charity.<sup>16</sup> If a loan hurt someone then it was uncharitable and therefore usurious. Conscience, for Calvin, was what determined the charitability of a contract. Usury was not emphasized as a sin against justice but rather as a sin against conscience. For Calvin, profit on a loan was not a sin as long as one intended to act charitably and with a clear conscience. For Aquinas, if one intended to profit from a loan, he or she had already sinned, because it was a sin of injustice, though also probably of conscience. This was different from other earlier views expressed, in that usury was subjectively determined, not objectively determined. This view, taken with the others, lends support to the characterization of Usury as a shape-shifting or chameleon-type villain capable of reinventing himself over time with the changing environment. It would seem that this villain has not only been capable of changing in order to suit a given historical era or economic system, but that he has even been capable of appearing differently to two people at the same time, that is if Calvin’s understanding that usury was subjective and determined by conscience was correct.

The one consensus on Usury, the singularly held opinion, is that he is a villain. In terms of the gladiatorial bouts over the definition of usury,

it turns out that the actual bouts were always between Usury and his next opponent, be him Aristotle, Thomas Aquinas and the Catholic scholars, John Calvin, or someone else. And Usury always gets back up as the undefeated champ. Although he was not an option for the judges—the winner was supposed to be Aristotle, Aquinas, or Calvin—Usury is the clear choice. His historical evolution is proof of his craftiness. Aristotle tried to pin him down as an unnatural monster. Aquinas painted him as a two-timing bookie of injustice. Later, Catholic scholars took exception to him as mostly a nice guy, and Calvin, with his charitable conscience rule, ultimately left it up to the people to decide, allowing Usury to exist in different forms at different places simultaneously, a shape-shifter that can bend space and time.

Usury is a notorious villain. He has managed to draw the attention of multiple spheres of society including the religious, political, and economic. He is also a complicated villain, an intricate mess that humankind cannot disentangle. If villains can be admired, I admire Usury for his ability to confuse mankind, for he seems to have been able to preserve an aura of mystery about him. I doubt that I will find even ten people in my entire life who have a good understanding of Usury's villainous, nebulous, and shape-shifting character. That is why, in my book, I am putting Usury on the A-list of villains .

## ENDNOTES

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<sup>1</sup>Graeber, David. *Debt: The First 5,000 Years*. Brooklyn: Melville House, 2011. Print.

<sup>2</sup>Noonan, John Thomas. *The Scholastic Analysis of Usury*. Cambridge: Harvard UP, 1957. Print

<sup>3</sup>Myrdal, Gunnar. "Institutional Economics." *Journal of Economic Issues* 12.4 (1978): 771-83. Print.

<sup>4</sup>Meikle, Scott. *Aristotle's Economic Thought*. Oxford: Clarendon, 1995. Print.

<sup>5</sup>Noonan, John Thomas.

<sup>6</sup>Trever, Albert Augustus. *A History of Greek Economic Thought*. Philadelphia: Porcupine, 1978. Print. Pg 105.

<sup>7</sup>Noonan. Pg 47.

<sup>8</sup>Noonan. Pg 47.

<sup>9</sup>Noonan. Pg 18.

<sup>10</sup>Holy Bible King James Version. Luke: 6.35.

Nashville, TN: Thomas Nelson, 1984. Print.

<sup>11</sup>Holy Bible King James Version. Psalm 15.1,5.

<sup>12</sup>Noonan. Pg 19.

<sup>13</sup>Noonan. Pg 360.

<sup>14</sup>Noonan. Pg 365.

<sup>15</sup>Noonan. Pg 362.

<sup>16</sup>Noonan. Pg 366.

## TRIGONOMETRY DEVELOPMENT IN ANCIENT AND MEDIEVAL INDIA

MATH 464WI:  
HISTORY OF MATHEMATICS WITH DR. RICHARD DELAWARE

### ABSTRACT:

*This paper explores the history and possible mathematical methods behind the development of trigonometry in ancient and medieval India. Specifically, it describes possible methods for the construction of the Sine tables, as well as methods of interpolating sine values from these tables.*

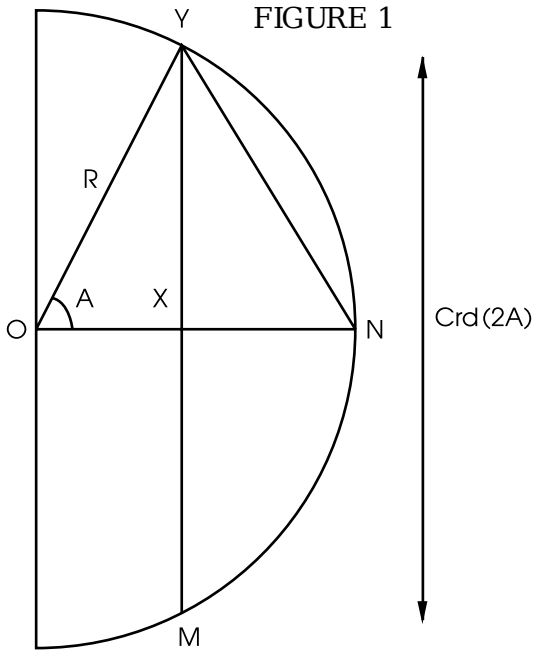
Trigonometry developed in India for the same reason that it did in the rest of the ancient world: to solve astronomy problems. The earliest reference to trigonometry in India occurs in the text “Suryasidhanta” (c. 400) (1 p.229). Indian knowledge of trigonometry most likely first derived from the ancient Greeks, as the Indian standard radius of a circle was 3438, which is the same radius  $R$  as was used by the ancient Greek astronomer Hipparchus (5 p.252). While it may be that ancient Indian astronomers simply inherited this standard radius from Hipparchus (c. 190 BC - 120 BC), another conjecture, based on several different Indian texts, is that the value of  $R$  was found by the equation  $2\pi R = C$  where  $C$  is a circle’s circumference and  $R$  is the circle’s radius. As Indian astronomers had an astonishingly accurate value of  $\pi$  (3.1416) as early as 499, and  $C$  was expressed in minutes ( $360^\circ = 21600$  minutes, which is written 21600’), we obtain:

$$R = \frac{C}{2\pi} \approx \frac{21600'}{2(3.1416)} \approx (3437' + \frac{967'}{1309}) \approx 3438'$$

This diffusion of knowledge from ancient Greece is thought to have possibly occurred along Roman trade routes (5 p.253), but regardless of how trigonometry first came to India, its mathematicians were quick to make vast improvements. Indian mathematicians are credited with not only being the first to use sine and cosine functions (As well as the lesser-known versed-sine or “versine”, see Figure 1) (5 p.252), but also produced accurate sine tables, developed multiple algorithms for approximating sine, and thus

cosine, and eventually discovered approximations for sine and cosine that are equivalent to today's Maclaurin series expansions for sine and cosine.

The following figure shows the definition of the different trigonometric functions, specifically cosine, sine, chord, and versine:



- $OY = ON = R$ , where  $R$  is the radius of the circle, typically 3438
- $OX = R \cos(A)$ : We will refer to this “Indian cosine” as the capitalized  $Cos(A)$
- $XY = R \sin(A)$ : Again, we will refer to this as the capitalized  $Sin(A)$
- $YM = Crd(2A) = 2Sin(A)$ , where “crd” is the chord of the circle
- $XN = R \text{versine}(A) = R - R \cos(A)$ : The “versed-sine” or “versine” of  $A$ , referred to as  $Vers(A)$

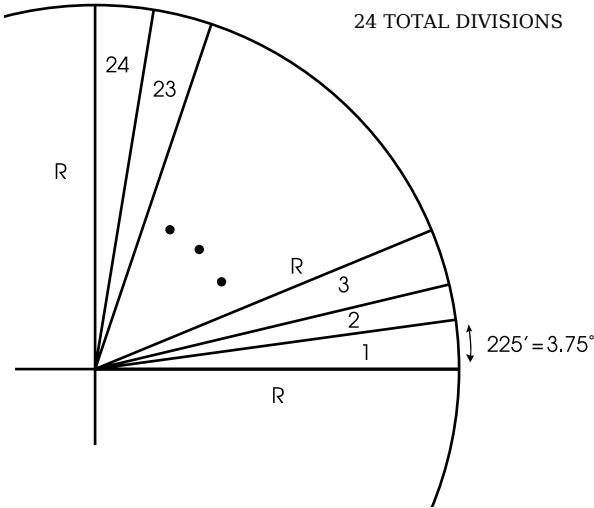


Many ancient astronomy problems involved solving triangles by using a table of chords, rather than sines and cosines (Recall that chords are line segments that connect two points on a circle). Often, an astronomer would have to make calculations with the half-chord of double the angle [ $\frac{1}{2}Crd(2A) = Sin(A)$  for a circle of radius  $R$ ; see figure 1](5 p.252), and one of the first Indian improvements to trigonometry was to tabulate values as not a table of chords, but a table of half-chords. These “half-chords” are known today as sines (2 p.7).

An interesting note is that, in Sanskrit, “jya-ardha” means chord-half, and this was frequently abbreviated to just “jya”. Indian works were eventually translated to Arabic, and when an Arabic work was translated to Latin, the term was mistranslated to mean “bosom or breast”, and thus was written as the Latin word “sinus”. This is how we get our term “sine” (5 p.253).

**CONSTRUCTION OF SINE TABLES**

As mentioned above, one of the first improvements by Indian mathematicians to trigonometry was that of constructing tables of half-chords, or sines. The tables split a quarter-circle of radius  $R$  into 24 equivalent arcs (see below), which increased in increments of  $225'$  ( $225'$ , or 225 minutes, is equivalent to  $3\frac{3}{4}^\circ$ , and  $24 \times 3\frac{3}{4}^\circ = 90^\circ$ ).



From these tabulated sine values, other important values could be derived using [Recall that we are using capital trigonometric functions to represent  $R \times$  (Function), e.g.  $R \cos(A) = \cos(A)$ ]:

$$\cos(A) = \sqrt{R^2 - \sin^2(A)}$$

$$\text{Vers}(A) = R - \cos(A)$$

The first sine table to show up in India appeared in the early 5th century in the text “Paitamahāsiddhanta” (5 p.252). The first well-preserved text containing a somewhat accurate sine table is in the work of Aryabhata I’s “Aryabhatiya”, written in 499. Here are the first nine values of Aryabhata I’s table of sines (As found in 1, p.247), and each Sine is given a number.

SINE NUMBER	ANGLE (MINUTES)	SIN(ANGLE)	SINE DIFFERENCE
1	225'	225'	225'
2	450'	449'	224'
3	675'	671'	222'
4	900'	890'	219'
5	1125'	1105'	215'
6	1350'	1315'	210'
7	1575'	1520'	205'
8	1800'	1719'	199'
9	2025'	1910'	191'

In the last column, the difference between the current Sine and the one before it is given (e.g. the Sine difference of the fifth Sine and the sixth Sine is  $\sin(1350') - \sin(1125') = 1315' - 1105' = 210'$ ). Note: Even though Sine number 1 is the “first sine”, it is still known that  $\sin(0') = 0'$ , and thus the Sine difference between Sine 1 and Sine 0 is simply

$$\sin(225') - \sin(0') = 225' - 0' = 225'$$

Aryabhata I also gave a rule for calculating the sine values. The translation of this rule is as follows: [Notes in brackets are mine.]

STANZA II, 12: “By what number the second Sine [difference] is less than the first Sine [Sine number 1 from above table], and by the quotient obtained by dividing the sum of the preceding Sine [differences] by the first Sine, by the sum of these two quantities the following Sine [difference] [is] less than the first Sine.”

The “second Sine [difference]” is the Sine difference of the previously calculated Sine. For example, when calculating  $Sin(675')$  (see above table), the “second Sine [difference]” would be  $224'$ , the Sine difference associated with previous Sine,  $Sin(450')$ . The “first Sine” is Sine number 1, or  $Sin(225')$  which always equals  $225'$ . The “sum of the preceding Sine [differences]” is simply the sum of all the previously calculated Sine differences, so to continue our example of calculating  $Sin(675')$ , the “sum of the preceding Sine [differences]” is  $(225' + 224')$ .

For  $Sin(675')$  subtracting the “second Sine [difference]”,  $224'$ , from the “first Sine”,  $225'$ , is  $225' - 224' = 1'$ . The “sum of the preceding Sine [differences]”,  $225' + 224'$ , divided by the “first Sine”,  $225'$ , is  $\frac{225' + 224'}{225'}$ . Summing these two quantities yields  $1' + \frac{225' + 224'}{225'} \approx 3'$ . This gives us what “the following Sine [difference] [is] less than the first Sine” meaning that the Sine difference of  $Sin(675')$  is  $3'$  less than the first Sine, which is  $225' - 3' = 222'$ . Since we already know the preceding Sine,  $Sin(450') = 449'$ :

$$Sin(675') = Sin(450') + 222' = 449' + 222' = 671'.$$

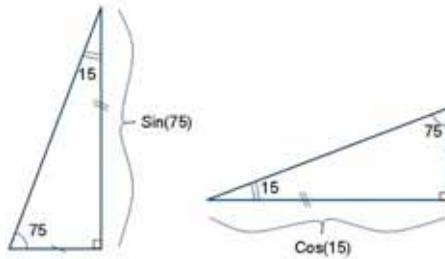
Aryabhata I’s rule uses cumulative Sine differences to calculate Sine values. Starting at  $Sin(225') = 225'$ , it is possible to determine all 24 values of the Sine table, as each new Sine value depends only on the preceding Sine values and their differences. However, as is noted by (5, p.253) and (1, p.254), this rule leads to several discrepancies from Aryabhata I’s actual sine table as the *Sine* of larger values is taken. In fact, differences occur as early as calculating the 8th Sine,  $Sin(1800')$ . This value, when approximated with Aryabhata I’s rule, is  $1717'$ , yet Aryabhata I reports  $Sin(1800') = 1719'$ . As the angle of the arc gets larger and larger, the Sine values obtained from this approximation method get more and more inaccurate.

This leads many scholars to believe that this was not the actual way that mathematicians such as Aryabhata I calculated their sine tables. Instead, it is thought that the sine tables were calculated by manipulating the already-known values of  $Sin(30^\circ)$ ,  $Sin(45^\circ)$ ,  $Sin(60^\circ)$  and  $Sin(90^\circ)$  with the following identities:

- Pythagorean identity:  $Sin^2(A) + Cos^2(A) = R^2$  in modern notation this is  $sin^2(A) + cos^2(A) = 1$ , as  $R = 1$  ].
- Indian half-angle identity:  $Sin(\frac{A}{2}) = \frac{1}{2} \sqrt{Sin^2(A) + Vers^2(A)}$  [Note this is equivalent to our half-angle identity  $Rsin(\frac{A}{2}) = R\sqrt{\frac{1-cosA}{2}}$  .]

For example, to calculate the 10th tabulated Sine,

$\text{Sin}(2250') = \text{Sin}(37.5^\circ)$  [we will use degrees in this example for convenience], we would first use the Indian half-angle identity to calculate  $\text{Sin}(\frac{30^\circ}{2}) = \text{Sin}(15^\circ)$ , since  $\text{Sin}(30^\circ)$  is already known. Next we can use the Pythagorean identity to calculate  $\text{Cos}(15^\circ)$ . By similar triangles,  $\text{Cos}(15^\circ)$  is equivalent to the Sine of its complement,  $\text{Sin}(75^\circ)$  [See below]:



Applying the Indian half-angle identity once more to  $\text{Sin}(75^\circ)$  gives us  $\text{Sin}(\frac{75^\circ}{2}) = \text{Sin}(37.5^\circ)$ . All of the 24 tabulated values of Sine and Cosine can be found in this fashion, and the values that result match that of Aryabhata I's.

### **Approximations for non-tabulated values: Second-Order Interpolations**

Although many astronomical problems required values not found in the 24 sections of the Sine table, the first table which had Sines for arcs closer together than  $3\frac{3}{4}^\circ$  was not printed until the time of Bhaskara II, around 1150 (5 p.254). As a result, Indian astronomers relied on methods of interpolating, or estimating, Sine values in between the tabulated values. For example, in order to find  $\text{Sin}(301')$ , a value not in the table of 24 Sine values, Indian mathematicians could find a line that passes through the known values of  $\text{Sin}(225')$  and  $\text{Sin}(450')$  and then use that line to approximate  $\text{Sin}(301')$ . This linear approximation is a first-order interpolation, and while it is a good start, it is not very accurate for Sine values.

By 628, Indian mathematician Brahmagupta (598 - 668) developed a method for approximating second-order interpolations of general equations. From this general method, one can find a second-order interpolation for Sine, effectively allowing Indian mathematicians to more accurately find  $\text{Sin}(A+x)$ , where  $\text{Sin}(A)$  is a known, tabulated value, and  $x$

is some value such that  $0' < x < 225'$  (3 p.87).

Brahmagupta's general rule first appeared in Sanskrit:

गत भोग्य खण्डकान्तर दल विकल वधात् शतैर्नवभिराप्तैः ।  
तद्युति दलं युतौर्न भोग्यादूनाधिकं भोग्यम् ॥

While this rule applies to general functions and not just Sines, we will treat it as it applies to the Sine function, specifically  $\text{Sin}(A + x)$ . The rule translates as follows (3 p.88): [Notes in brackets are mine.]

"Multiply half the difference of the tabular differences crossed over [ $\text{Sin}(A) - \text{Sin}(A - 225')$ ] and to be crossed over [ $\text{Sin}(A + 225') - \text{Sin}(A)$ ] by the residual arc [ $x$ ] and divide by (the common [tabulated] interval [ $225'$ ]). By the result (so obtained) increase or decrease half the sum of the same (two) differences, according as this [average] is less or greater than the difference to be crossed over. We get the true functional differences to be crossed over [the difference between  $\text{Sin}(A)$  and  $\text{Sin}(A + x)$ ]"

Consider the following Sine table:

Sine Number	Angle (minutes)	Sin(Angle)	Sine difference
1	225'	225'	225'
2	450'	449'	224'
...	...	...	...
n-1	A-225'	Sin(A-225')	
n	A	Sin(A)	Sin(A)-Sin(A-225')
n+1	A+225'	Sin(A+225')	Sin(A+225')-Sin(A)

The “tabular difference crossed over” is  $\text{Sin}(A) - \text{Sin}(A - 225')$ , where  $\text{Sin}(A - 225')$  is the tabulated value preceding  $\text{Sin}(A)$ , meaning we have already passed, or “crossed over” this Sine difference on our table of Sines. The tabular difference “to be crossed over” refers to  $\text{Sin}(A + 225') - \text{Sin}(A)$ , where  $\text{Sin}(A + 225')$  is the next tabulated Sine value after  $\text{Sin}(A)$ , so we have not “crossed over” this Sine difference yet. The “residual arc” is  $x$ , which is  $0' < x < 225'$ , and the “common [tabulated] interval” is the constant value by which our Sine table increases,  $225'$ .

Now, “multiply half the difference of the tabular differences crossed over [ $\text{Sin}(A) - \text{Sin}(A - 225')$ ] and to be crossed over [ $\text{Sin}(A + 225') - \text{Sin}(A)$ ] by the residual arc [ $x$ ] and divide by (the common [tabulated] interval [ $225'$ ])”. Since in quadrant I,  $\text{Sin}(A) - \text{Sin}(A - 225') > \text{Sin}(A + 225') - \text{Sin}(A)$ , in order to stay with positive numbers the order in which we subtract matters:

$$\begin{aligned} & \frac{x}{225'} \left[ \frac{\text{Sin}(A) - \text{Sin}(A - 225') - [\text{Sin}(A + 225') - \text{Sin}(A)]}{2} \right] \\ &= \frac{x}{2(225')} [2\text{Sin}(A) - \text{Sin}(A + 225') - \text{Sin}(A - 225')] \end{aligned} \quad (2.1)$$

Next, “by the result (so obtained), [the above (expression 2.1)], increase or decrease half the sum of the same (two) [“crossed over ” and “to be crossed over”] differences”. Thus we increase or decrease (expression 2.1) by

$$\begin{aligned} & \frac{1}{2} [\text{Sin}(A + 225') - \text{Sin}(A) + \text{Sin}(A) - \text{Sin}(A - 225')] = \frac{1}{2} [\text{Sin}(A + 225') - \text{Sin}(A - 225')]; \\ & \frac{x}{2(225')} [2\text{Sin}(A) - \text{Sin}(A + 225') - \text{Sin}(A - 225')] \pm \frac{1}{2} [\text{Sin}(A + 225') - \text{Sin}(A - 225')] \end{aligned}$$

Dealing with the  $\pm$ : “increase or decrease...according as this (average,  $\frac{1}{2}[\text{Sin}(A + 225') - \text{Sin}(A - 225')]$ ) is less or greater than the difference to be crossed over  $\text{Sin}(A + 225') - \text{Sin}(A)$ ”. Recall, in quadrant I,  $\text{Sin}(A) - \text{Sin}(A - 225') > \text{Sin}(A + 225') - \text{Sin}(A)$ . Thus the average of the left side and the right side will always be greater than the right side, namely the difference to be crossed over (If  $x > y$ , then always  $x > \frac{x+y}{2} > y$ ), so we will use a “-” rather than a “ $\pm$ ”:

$$\frac{x}{2(225')} [2\text{Sin}(A) - \text{Sin}(A + 225') - \text{Sin}(A - 225')] - \frac{1}{2} [\text{Sin}(A + 225') - \text{Sin}(A - 225')]$$

This gives us “the true functional differences to be crossed over”.

Multiplying this by  $\frac{x}{225'}$  and adding it to  $\text{Sin}(A)$  gives us our second order interpolation for  $\text{Sin}(A - x)$ :

$$\begin{aligned} & \text{Sin}(A) + \frac{x}{225'} \left( \frac{1}{2} [\text{Sin}(A + 225') - \text{Sin}(A - 225')] + \frac{x}{225'} \left[ \frac{\text{Sin}(A + 225') - 2\text{Sin}(A) + \text{Sin}(A - 225')}{2} \right] \right) \\ &= \text{Sin}(A) + x \frac{\text{Sin}(A + 225') - 2\text{Sin}(A - 225')}{2(225')} + \left[ \frac{x^2}{2} \right] \frac{\text{Sin}(A + 225') - 2\text{Sin}(A) + \text{Sin}(A - 225')}{(225')^2} \end{aligned}$$

Thus we get our end result:

$$\text{Sin}(A+x) \approx \text{Sin}(A) + x \frac{\text{Sin}(A + 225') - \text{Sin}(A - 225')}{2(225')} + \left[ \frac{x^2}{2} \right] \frac{\text{Sin}(A + 225') - 2\text{Sin}(A) + \text{Sin}(A - 225')}{(225')^2}$$

It is interesting to note that Brahmagupta's 2nd-order interpolation method relies on the differences of tabulated values, as did the Aryabhata I method for calculating Sines based on Sine differences.

225' is the common difference in our tabulated values. But, if we replace that with some variable  $\alpha$ , measured in radians, and take the limit of Brahmagupta's approximation as  $\alpha \rightarrow 0$ , then we get the second-order Taylor polynomial for  $\text{Sin}(A + x)$  [The proof is omitted here]:

$$\text{Sin}(A + x) \approx \text{Sin}(A) + (x)\text{Cos}(A) - \left[\frac{x^2}{2}\right] \text{Sin}(A).$$

### Approximations for non-tabulated values: Third-Order Interpolations

This second-order interpolation for  $\text{Sin}(A + x)$  was a definite stepping stone towards Indian mathematicians finding the Taylor series expansion for sine and cosine. The most probable next step was discovered in Paramsevara's "Siddhanta-dipika". Paramsevara was a student of Madhava's, and this work, which was a commentary of a commentary of the early seventh-century text "Mahabhaskariya", gives a more accurate approximation for  $\text{Sin}(A + x)$  than Brahamagupta's. Paramsevara's approximation formula is nearly equivalent to the function's third-order Taylor series approximation; there is a divisor of 4 in the fourth term of his approximation, rather than a 6 (4 p.289).

Again, we are calculating  $\text{Sin}(A + x)$ , where  $\text{Sin}(A)$  is a known tabulated value, and the residual arc  $x$  is such that  $0' < x < 225'$ . The explication of Paramsevara's rule is as follows (4 p.288): [Notes in brackets are mine.]

"The semi-diameter [the radius  $R$ ] divided by the residual arc [ $x$ ] becomes the divisor  $[\frac{R}{x}]$ . Put down [write down for later use] the Sine and again the Cosine at the end of the arc traversed".

[The "arc traversed" is  $A$ , so "put down"  $\text{Sin}(A)$  and  $\text{Cos}(A)$  for later use.]

"From the Cosine, subtract half the quotient obtained from the divisor-divided Sine [which is] increased by half the quotient obtained from the Cosine by the divisor  $[\frac{R}{x}]$ ".

[First, find "half the quotient obtained from the Cosine by the divisor" =  $\frac{1}{2} \frac{\text{Cos}(A)}{\frac{R}{x}}$ , then add this to  $\text{Sin}(A)$  giving  $\text{Sin}(A) + \frac{\text{Cos}(A)}{2\frac{R}{x}}$  which is the "Sine [which is] increased...". Next we divide this by "the divisor"  $\frac{R}{x}$  to obtain the "divisor-divided Sine", and subtract half of that quotient from  $\text{Cos}(A)$ ]:

$$\text{Cos}(A) - \frac{1}{2} \left[ \frac{\text{Sin}(A) + \frac{\text{Cos}(A)}{2\frac{R}{x}}}{\frac{R}{x}} \right]$$

"Again, [the quotient] obtained from that [above difference] by dividing by the divisor  $[\frac{R}{x}]$  becomes the true Sine-difference".

$$\frac{1}{\frac{R}{x}} \left( \text{Cos}(A) - \frac{1}{2} \left[ \frac{\text{Sin}(A) + \frac{\text{Cos}(A)}{2\frac{R}{x}}}{\frac{R}{x}} \right] \right)$$

“The Sine at the end of the arc traversed [ $\text{Sin}(A)$ ] increased by that [true Sine-difference] becomes the desired Sine for a [given] arc [ $\text{Sin}(A + x)$ ].”

$$\begin{aligned} \text{Sin}(A + x) &\approx \text{Sin}(A) + \frac{1}{\frac{R}{x}} \left( \text{Cos}(A) - \frac{1}{2} \left[ \frac{\text{Sin}(A) + \frac{\text{Cos}(A)}{2\frac{R}{x}}}{\frac{R}{x}} \right] \right) \\ &= \text{Sin}(A) + \frac{\text{Cos}(A)}{\frac{R}{x}} - \frac{\text{Sin}(A)}{2(\frac{R}{x})^2} - \frac{\text{Cos}(A)}{4(\frac{R}{x})^3} \end{aligned}$$

Recalling  $\text{Sin}(A) = R\text{sin}(A)$ , and  $\text{Cos}(A) = R\text{cos}(A)$ :

$$\begin{aligned} R\text{sin}(A + x) &\approx R\text{sin}(A) + \frac{R\text{cos}(A)}{\frac{R}{x}} - \frac{R\text{cos}(A)}{2(\frac{R}{x})^2} - \frac{R\text{cos}(A)}{4(\frac{R}{x})^3} \\ &= R\text{sin}(A) + x\text{cos}(A) - x^2 \frac{\text{sin}(A)}{2R} - x^3 \frac{\text{cos}(A)}{4(R^2)} \end{aligned}$$

If we now let  $R = 1$ , we see that

$$\text{sin}(A + x) \approx \text{sin}(A) + x\text{cos}(A) - x^2 \frac{\text{sin}(A)}{2} - x^3 \frac{\text{cos}(A)}{4}$$

This is nearly equivalent to the third-order Taylor series approximation for  $\text{sin}(A + x)$ , which is

$$\text{sin}(A + x) \approx \text{sin}(A) + x\text{cos}(A) - x^2 \frac{\text{sin}(A)}{2} - x^3 \frac{\text{cos}(A)}{3!}$$

The only difference between the two equations is in the denominator of the fourth term, which is 4 as opposed to  $3! = 6$ .

When working with radians, this third-order approximation for Sine is accurate up to four decimal places. Yet, as nautical navigation required more and more accurate Sine values, better approximations were derived. Indian mathematicians, specifically Madhava, eventually found approximations for Sine and Cosine which are equivalent to today’s Taylor series expansions. Although none of Madhava’s own works on the subject remain intact, we know of this through the work of his students. From their commentaries and works, we know these Sine and Cosine expansions allowed Madhava to find remarkably accurate values of Sine, Cosine, and  $\pi$  (5 p.256).



## TIMELINE

- *c. 400*: The earliest reference to trigonometry in India occurs in the text “Suryasidhanta” (1 p.229)
- *c. 400*: The first sine table, appears in the text “Paitamahasiddhanta” (5 p.252)
- *499*: Arybahata writes “Aryabhatiya”, which introduces sines and versed sines, as well as a Sine table (1 p.15)
- *505*: Varahamihira gives the Pythagorean identity and Indian half-angle identity, as well as values for  $\text{Sin}(30^\circ)$ ,  $\text{Sin}(45^\circ)$ ,  $\text{Sin}(60^\circ)$ , and  $\text{Sin}(90^\circ)$  (1 p.255)
- *665*: Brahmagupta discovers a formula for second-order interpolations, which allows  $\text{Sin}(x + e)$  to be computed with an equation that is equivalent to the second-order Taylor series approximation of  $\text{Sin}(x + e)$  (3 p.87)
- *1150*: The first sine table which had Sines for arcs closer together than  $3\frac{3}{4}^\circ$  is printed (5 p.254)
- *c. 1400*: Madhava develops an approximation for  $\text{Sin}\theta$  which is equivalent to its Taylor series expansion (2 p.9)
- *c. 1400*: Paramsevara, a student of Madhava’s, writes “Siddhanta-dipika” in which he discusses an approximation for  $\text{Sin}(x + e)$  which is nearly equal to its third-order Taylor series approximation (4 p.287)
- *c. 1550*: Jyesthadeva writes “Yuktibhasa” including an approximation for  $\text{Sin}\theta$  that is equivalent to its Maclaurin series, which is credited to Madhava (2 p.8)

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# JESSE HAMER

## INDIVISIBLES AND THE CYCLOID IN THE EARLY 17TH CENTURY

MATH 464WI:  
HISTORY OF MATHEMATICS WITH DR. RICHARD DELAWARE

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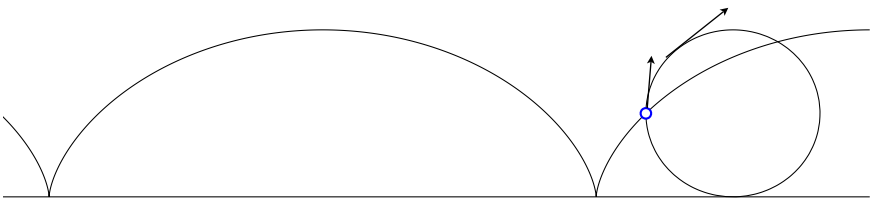
### ABSTRACT:

*We observe the application of Bonaventura Cavalieri's (1598 - 1647) method of "indivisibles," a mathematical method popular in the early 17th century for finding the area contained by curvilinear spaces, to the problem of finding the area under one arch of the so-called "cycloid" curve, that is, the curve traced by a point fixed upon the circumference of a circle which rolls along a horizontal line. We first briefly discuss the method itself, as well as what is understood by the notion of "indivisible." Next, we explicate two different solutions to the stated problem of finding the area under one arch of the cycloid curve, one from Gilles Personne de Roberval (1602 - 1675), the other from Pierre de Fermat (1601 - 1665). Attention is paid to the ways in which these solutions utilize the method of "indivisibles." Emphasis is placed throughout on the relationship between the notion of "indivisible" and the notion of the infinite.*

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At the heart of the differential and integral calculus lie the notions of the infinite and the infinitely small. Whether characterized by the continuous, the instantaneous, or the infinite in quantity, whether described vaguely in the 17th century [2, 200-202] or rigorously in the 19th, one will seldom see a concept in the calculus which fails to invoke these fundamental notions. Although the historical development of ideas of the infinite was plagued with skepticism and doubts about mathematical arguments which utilized them, owing to the seeming incomprehensibility inherent to the meaning of "infinite," there have nevertheless been a few mathematicians who momentarily withheld their suspicions and applied their intellect to the massive concept. Archimedes, for example, considered the infinite and the infinitesimal "as suggestive heuristic devices, to be used in the investigation of problems concerning areas and volumes which were

preliminary to the intuitively clear and logically rigorous proofs given in the classical geometrical method of exhaustion” [2, 96]. Indeed, it was perhaps Archimedes’ relatively lax views towards the infinite (along with his genius) which allowed him to exploit so well the method of exhaustion (a classical technique developed by Eudoxus which determined areas of non-polygonal regions by inscribing in them polygons with an ever-increasing number of sides, thus finding their areas by “exhausting” the space of that region [8, 84-85]) in determining curvilinear areas, volumes, surfaces, and arcs—works of his which have “frequently been referred to as genuine integration” [1, 34] (“integration” in this context refers to techniques for finding areas of curved regions). As Carl B. Boyer describes in [2], the infinite, and related concepts such as the continuum, began to be discussed and used more freely during the later Middle Ages, albeit in a much more metaphysical and scientific setting. However, mathematicians of the late 15th and 16th centuries rejected these Scholastic and Aristotelian views and instead attempted to reconcile them with the views of Archimedes. This attempt at reconciliation during the 16th century, mixed with influences from Hindu and Arabic algebra, as well as a gradual acceptance of new kinds of numbers (irrational, negative, imaginary), allowed for and helped to lead to the eventual development of various methods of “indivisibles” [2, 96-98], with which this paper will concern itself. In particular, I want to pay special attention to the application of methods of indivisibles to finding the area under one arch of a curve known as the “cycloid”—the curve traced by a point fixed on the circumference of a circle which rolls on a horizontal line (figure 1).



*FIGURE 1: generation of the cycloid curve*

The mathematicians whose solutions to this problem we will observe in depth are Gilles Personne de Roberval (1602-1675) and Pierre de Fermat (1601-1665), but it will first be necessary to introduce the mathematician who popularized indivisibles in the early 17th century, Bonaventura Cavalieri (1598-1647), and briefly explain his method for using them.

*Geometria indivisibilibus continuorum nova quadam ratione promota* (1635) and *Exercitationes geometricae sex* (1647), both by Cavalieri, rapidly became the most quoted sources on geometric integration (again, “integration” refers to techniques for finding areas under curved regions) in the 17th century [1, 122-123], and it is in these two texts in which Cavalieri develops and applies his method of indivisibles. It should be noted that Cavalieri never explains precisely what he understands by the word “indivisible,” but he conceives of a surface as being composed of an indefinite number of parallel equidistant lines, and a solid as being composed of an indefinite number of parallel equidistant planes (figure 2), and it is these lines and planes which he called the “indivisibles” of the surface and of the volume, respectively [2, 117].



FIGURE 2: Cavalieri's conception of "indivisibles" [1,124]

Cavalieri held a view towards the infinite which could be described as “agnostic” [2, 117], and in fact he held that his use of the infinite and the indivisible was purely auxiliary, similar to the “sophistic” quantities used by Cardano in his solving of the cubic equation; “inasmuch as it did not appear in the conclusion, its nature need not be made clear” [2, 118]. This is to say that, although he could not precisely explain their nature, the “indivisibles” of Cavalieri’s arguments played the role of a useful tool or “black box,” and his conclusions were not concerned with “indivisible” facts, but rather with geometrical facts. Cavalieri’s method worked by establishing ratios between the individual indivisibles of one figure to those of another, and then from

these ratios he developed relations between the areas (or volumes) of the figures (figure 3).

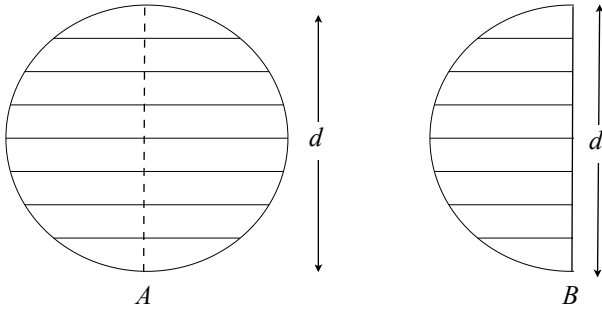


FIGURE 3: at any given height, the “indivisibles” of circle  $A$  are twice the length of those of semicircle  $B$ , and we conclude that  $\text{area}(\text{circle}(A)) = 2 \text{ area}(\text{semicircle}(B))$

The foundation of Cavalieri’s method of indivisibles rests upon two complimentary notions: the *collective* and the *distributive*. In the first notion, the *collective* sums,  $\Sigma l_1$  and  $\Sigma l_2$  of line (or surface) indivisibles (note: ‘ $\Sigma$ ’ is used here to denote a collection of indivisibles; it does *not* refer to a numeric sum), of two figures  $P_1$  and  $P_2$  are obtained separately and then used to obtain ratios of the areas (or volumes) of the figures themselves [1, 125]. The second, *distributive*, notion was a concept which Cavalieri developed primarily to defend against anticipated philosophic objections to the comparison of indefinite numbers of lines and planes [2, 126]. It is used to tell us *in what way* we may compare this collection of indivisibles. The two concepts are best summarized in what is commonly known as *Cavalieri’s Theorem* (for solids), which essentially states:

“If two solids have equal altitudes, and if sections made by planes parallel to the bases and at equal distances from them are always in a given ratio, then the volumes of the solids are also in this ratio” [2, 118].

I have mentioned Cavalieri’s method because it plays a large underlying role in the following arguments from Roberval and Fermat in determining the area under one arch of the cycloid curve.

Let us first introduce the cycloid curve itself. As I have mentioned, and as can be seen in figure 1, the cycloid is that curve which is traced by a point fixed upon a circle which itself rolls along a horizontal line. The cycloid possesses many peculiar properties, but here we will only demonstrate that the area under one arch of the curve is equal to three times that of the circle which generated it.

The cycloid was first referred to Roberval by Marin Mersenne (1588-1648) in a letter from 1628 [10, 167]. In it, Mersenne suggested that the curve might look like a semi-ellipse. It would not be until a letter dated January 6th, 1637, almost 9 years later, that Roberval would provide Mersenne with a sample, but not a full dossier, of his long-awaited work on the cycloid (Roberval was extremely secretive with his methods and results, which he attributed to an examination held every three years to retain his position of the Chair of Ramus at the Collège Royal [2, 140]). This letter to Mersenne was expanded in Roberval's *Traité des indivisibles*, which he seems to have written sometime between 1634 and the end of 1636, though it was not published until 1693 in *Divers ouvrages de mathématiques et de physiques*, by the French Académie des Sciences. In it, Roberval explains how to construct the curve, how to find tangents to the curve, how to find the area under one arch of the curve, and how to find the volume of the solid produced by rotating one arch of the curve about the horizontal line of its base.

As a preliminary in *Traité des indivisibles*, Roberval outlines his conception of indivisibles, which is very similar to that of Cavalieri, except for the fact that Roberval considered a line as being made up not of an infinity of points, but of an infinity of little lines; likewise he held the surface to be composed not of an infinity of lines, but of an infinity of little surfaces, and so on in any given dimension [9, 190-191]. Notice that in Roberval's conception of indivisibles, he supplies "the essential element found in our conception of the definite integral, in that, after dividing a figure into small sections, he allowed these continually to decrease in magnitude, ... the result being obtained by summing an infinite series" [2, 142]. Thus, even though he does not rigorously define this concept, Roberval avoids the logical hole of considering a line as being made up of elements which have no length (for then, how could such a line have length?), a surface as being made up of elements which have no width (likewise, how could such a surface have area?), etc., which is an inconsistency of Cavalieri's conception of indivisibles. That being said, however, their two methods are actually very similar.

## ROBERVAL'S SOLUTION TO FINDING THE AREA UNDER ONE ARCH OF THE CYCLOID CURVE.

[This text is taken from the original *Traité des indivisibles*, found in the 1695 *Divers ouvrages...*, and translated from the French by me; all comments in [square brackets] are mine.]

We pose that the diameter AB of the circle AEFGB is driven in parallel to itself, as if it were carried by some other body, until arriving at CD to complete the semi-circle or half-turn.

[See figure 4. He imagines diameter AB moving right to a line segment CD equal and parallel to AB such that the rectangle ABCD is formed, where sides AC and BD are each of length equal to “the semi-circle or half-turn,” meaning one half of the circumference of the circle AEFGB. So, if our circle AEFGB is of radius  $r$ , then AC is of length  $\pi r$ , and AB and CD are each of length  $2r$ . Let circle AEFGB have center X.]

While it [AB] walks on [as AB moves along AC towards CD], the point A at the extremity of the said diameter [AB] goes through the circumference of the circle AEFGB, and makes its way as

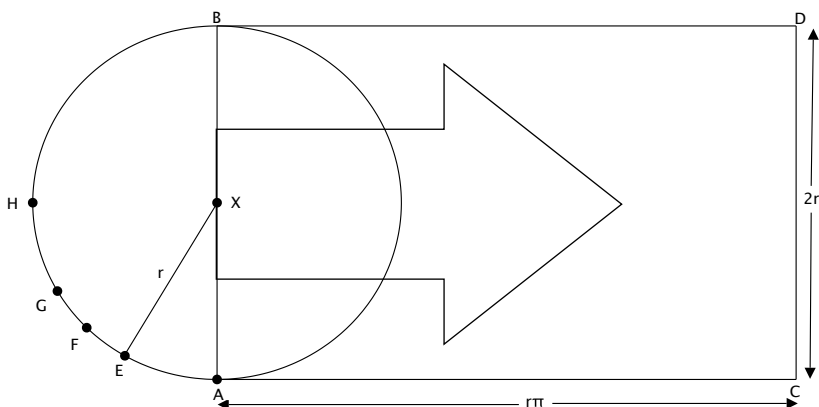


FIGURE 4: preliminary diagram

much as the diameter [makes its way], so that when the diameter is on CD, the point A has come to [rolled up to] B, and the line AC finds itself equal to the [semi-]circumference AGHB.



[So, Roberval begins his construction of one half of one arch of the actual cycloid curve by supposing that, as diameter AB moves towards CD and the circle rolls towards the right, the point A also moves around the circumference of the circle AEFGB (clockwise), a distance equal to that travelled by the diameter AB in its horizontal movement towards CD. Notice that Roberval does not yet let the point A make its horizontal movement towards CD. This relationship is given as follows: as A moves through an angle of  $\theta$  along the circumference of AEFGB while the circle moves rightward, A moves a distance of (arc length)  $r\theta$ , and AB simultaneously moves a distance of  $r\theta$  along AC towards CD (figure 5), so that the arc length traversed by A and the horizontal movement of AB towards CD are each  $r\theta$  from the original position of A.]

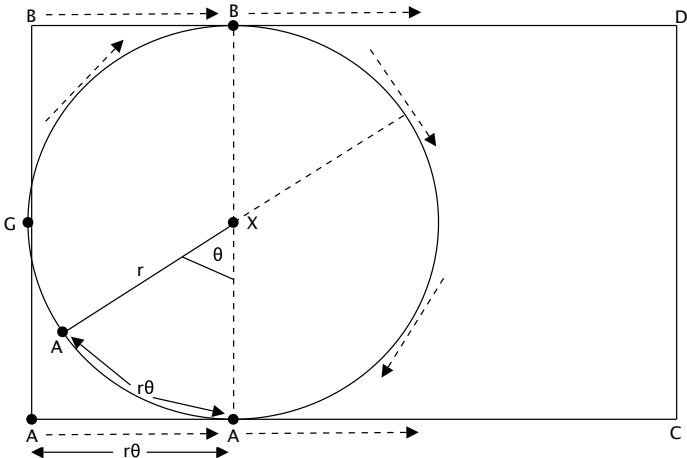


FIGURE 5: the relationship between the different movements of the point a

Thus this course [AC] of the diameter is divided into parts infinite and equal as well between them as to each part of the circumference AGB, which is divided also into infinite parts each equal between them and to the parts of AC traversed by the diameter, as has been said.

[Roberval characterizes “continuous” movement by saying that as AB travels towards CD, the “course of the diameter” AC is divided into tiny, “indivisible” segments which are equal to one another as well as equal to similar tiny, “indivisible” segments of the semi-circumference AGB (Figure 6). Roberval makes this observation so that later in the solution we may make comparisons between the “indivisibles” of the circumference AGB with those of the line AC.]

In afterwards I consider the path which the aforementioned point A made carried by two movements, the one from the diameter in front, the other from its own on the circumference.

[Now he begins to describe the actual cycloid curve.]

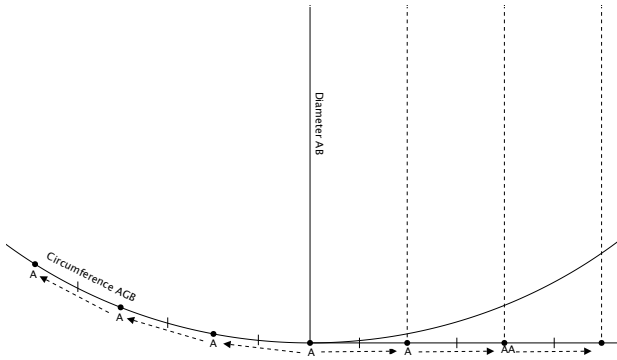


FIGURE 6: the horizontal movement of AB towards C, as well as the movement of A along the semi-circumference AGB (see figure 4), are characterized by infinitely small (“indivisible”) segments of the line AC and of the semicircumference AGB which are described by A at equal intervals, so that the segments are all equal

To find the said path, I see that when it [the point A] has come to E [a point on the semicircle; see figure 7] it is lifted above its first place from which it left; this height is marked drawing from the point E [perpendicular] to the diameter AB a [distance] sine  $E_1$ , and the sinus verse  $A_1$  is the height of A when it has come to E.

[See figure 7. Here “sine  $E_1$ ” is the length of the half-chord from E at angle  $E_1$  on the circle to a point labeled “1” (Roberval’s notation) on the circle’s diameter AB. In modern trigonometry, we call this distance “ $r \sin(E_1)$ .” Also, “sinus verse  $A_1$ ” is given today by  $r - r \cos(E_1)$ .]

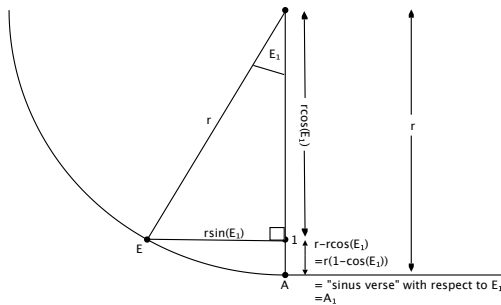


FIGURE 7 how to find the height of the cycloid curve

The same when it has come to F, from the point F on AB I draw the sine F<sub>2</sub>, and A<sub>2</sub> will be the height of A when it has done two portions of the circumference, and drawing the sine G<sub>3</sub>, the sinus verse A<sub>3</sub> will be the height of A when it has arrived at G; and doing thus from all places of the circumference that A traverses, I find all its heights and elevations over the extremity of the diameter A [AB], which are A<sub>1</sub>, A<sub>2</sub>, A<sub>3</sub>, A<sub>4</sub>, A<sub>5</sub>, A<sub>6</sub>, A<sub>7</sub> [see figure 8];

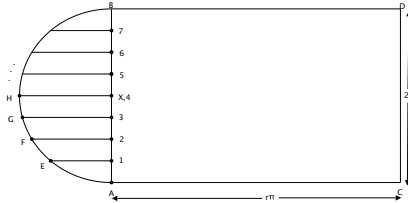


Figure 8: heights of the cycloid curve; each of the points “2,” “3,” ... , and each of the heights A<sub>2</sub>, A<sub>3</sub>, ... is determined in the same way as the point “1” and the height A<sub>1</sub> (see figure 7); note: the points X and “4” are not necessarily the same.

thus, in order to have places whereby pass [both] the said point A, and to wit the line that it forms during its two movements [the cycloid], I carry all of its heights on each of the diameters M, N, O, P, Q, R, S, T, and I find that M<sub>1</sub>, N<sub>2</sub>, O<sub>3</sub>, P<sub>4</sub>, Q<sub>5</sub>, R<sub>6</sub>, S<sub>7</sub> are the same [heights] as those taken on AB.

[See figure 9. Roberval is actually describing the curve which he elsewhere called the *Companion* curve to the cycloid [1, 157]. The “diameters M, N, ..., T,” are the line segments parallel and equal in length (2r) to the diameter AB which intersect AC at the points M, N, ..., T. Roberval does not express it explicitly here, but it should be noted that the points M, N, ..., T are chosen so that the line segments AM, AN, ..., AT are equal in length to the arcs AE, AF, ... . So, on the “diameters M, N, ... S,” we mark respectively the heights 1, 2, ..., 7 corresponding to those marked on the diameter AB. He refers to these later as “M<sub>1</sub>, N<sub>2</sub>, ... , S<sub>7</sub>.”]

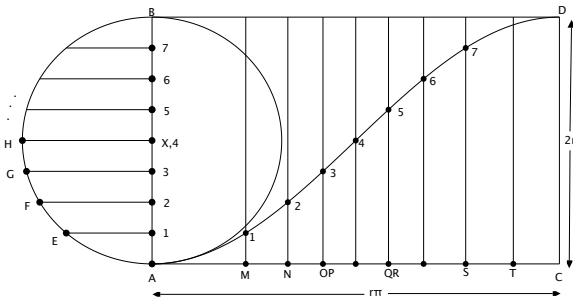


Figure 9; the “companion” curve to the cycloid

Then I take the same sines  $E_1, F_2, G_3$ , etc. and I carry them on each height found on each diameter, and I draw them towards the circle [from the companion curve], and from the [two] ends of these sines are formed two lines [curves], of which one is A 8 9 10 11 12 13 14 D [the cycloid], and the other A 1 2 3 4 5 6 7 D [the companion curve of the cycloid].

[See figure 10. So, on each “diameter M, N, O, ...,” we translate rightward the corresponding half-chords from the semicircle with lengths  $r\sin(E_1), r\sin(F_2), r\sin(G_3), \dots$  so that the point 1 coincides with height M1 (which Roberval calls  $M_1$ ), 2 coincides with N2 ( $N_2$ ), 3 coincides with O3 ( $O_3$ ), and so on. Once again, Roberval’s indivisibles are implicitly invoked, since constructing the complete curves A 8 9 ... D and A 1 2 ... D in this manner requires an infinity of “diameters,” of “sines,” and of heights, so that the curves A 8 9 ... D and A 1 2 ... D are indeed continuous, and not sets of discrete points. The curve A 8 9 ... D is half of one arch of the cycloid curve.]

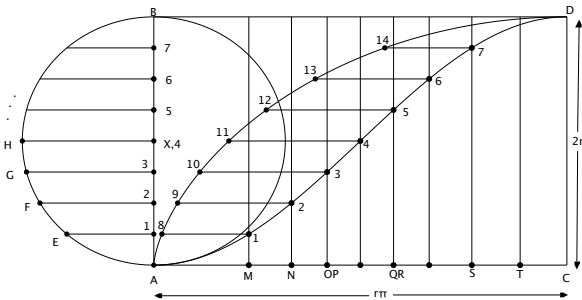


Figure 10; the cycloid curve and its companion curve; similar to Roberval’s original diagram [9, 192]

I know how the line A 8 9 D [the cycloid] is made; but to know what movements have produced the other [the companion curve], I say that while AB traversed the line AC, the point A had climbed the line AB, and marked each of the points 1, 2, 3, 4, 5, 6, 7, the first space [from A to 1] while AB has come to M, the second [from 1 to 2] while AB has come to N, and thusly always equally from one space to the other until the diameter has arrived at CD; so the point A has climbed to B. And that is how the line A 1 2 3 D is formed.

[Suppose, in general, that, instead of using the notations  $E_1, F_2, G_3$ , etc., we let  $\theta$  be the angle of the arc which A traverses at a given time during its movement along the circumference of the circle. As A passes through such an angle, as we have seen, the circle moves a distance of  $r\theta$  towards the line CD. Observe that, as in figure 11, if we take the point A to be the origin, then, with

$u = (x,y)$  representing an arbitrary point on it, the cycloid curve has been parameterized as

$$x = r(\theta - \sin\theta), y = r(1 - \cos\theta).$$

We also see that likewise with  $v = (x,y)$  representing an arbitrary point on it, the companion curve has been parameterized as

$$x = r\theta, y = r(1 - \cos\theta).$$

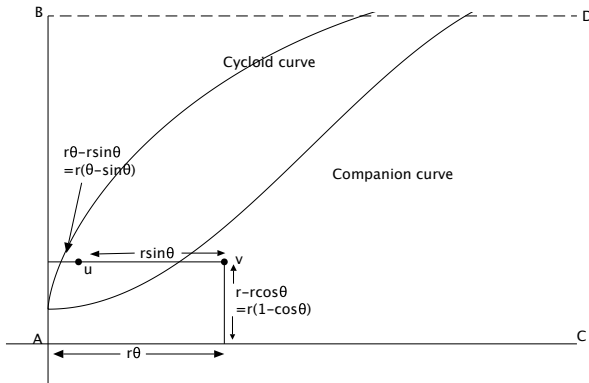


Figure 11; parameterizing the cycloid curve and its companion curve

Thus these two lines [curves] enclose a space, being separated from one another [horizontally] by each sine and rejoining together at the two ends of AD. Thus each part [line segment = “indivisible”] contained between these two lines [curves] is equal to each part [line segment = “indivisible”] of the area of circle AEB contained in the circumference of this one [semi-circle]; knowing the heights  $A_1, A_2$ , etc., and the sines  $E_1, F_2$ , etc., which are the same as those of the diameters M, N, O, etc., thus the figure A 4 D 12 [see figure 10; the area enclosed by the cycloid and its companion curve] is equal to the [area of the] semi-circle AHB.

[Hence, we conclude, using Cavalieri’s method of indivisibles, that the area between the cycloid and its companion curve is equal to the area of the semicircle, namely  $\frac{1}{2}\pi r^2$ .]

Thus the line A 1 2 3 D [the companion curve] divides the parallelogram ABCD in two [in half] equally, because the lines of one half are equal to the lines of the other half, and the line AC to the line BD;

[See figure 12. We show congruence between the spaces APDC and APDB, the spaces inside the rectangle below and above the companion curve, respectively [1, 157]. Recall from figure 11 that if P lies on the companion curve with horizontal distance from A of  $r\theta$ , then the length of the vertical line segment PQ is  $r(1 - \cos\theta)$ . Now consider the point P' on the companion curve with horizontal distance from A of  $r\pi - r\theta = r(\pi - \theta)$ . Notice that the length of the vertical line segment P'Q' is

$$2r - r(1 - \cos(\pi - \theta)) = 2r - r + r\cos(\pi - \theta) = r(1 - \cos\theta),$$

since  $\cos(\pi - \theta) = -\cos\theta$ . So  $PQ \cong P'Q'$ . This means that for every vertical line segment like PQ contained in the space APDC at a distance of  $r\theta$  from AB, there is a corresponding and congruent line segment like P'Q' in the space APDB at a distance of  $r\pi - r(\pi - \theta) = r\theta$  from CD, and so the two spaces have equal areas, according to Cavalieri's method of indivisibles.]

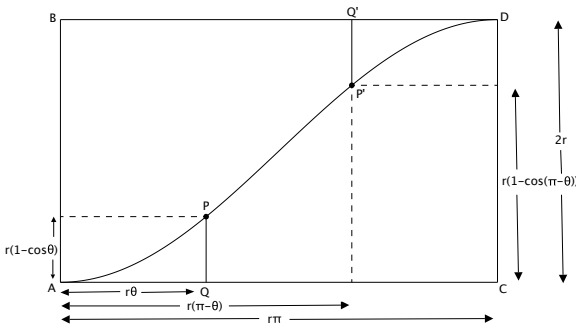


Figure 12; equating the areas above and below the companion curve

and therefore, according to Archimedes, the half is equal to the circle, to which adding the semicircle, knowing the space understood between the two curved lines, one will have a circle and a half for the space A 8 9 D C [see figure 10; the space under the half-arch of the cycloid]; and doing the same for the other half, all of the figure of the cycloid is worth three times the circle.

[The reference to Archimedes is to his determination of the area of the circle [4, 92-95], which states that the area of a circle is equal to the area of a triangle which has a base equal to the length of the circle's circumference and a height equal to the length of the circle's radius. Since the side CD is length  $2r$  (the diameter of the circle), and side AC is length  $r\pi$  (half of the circumference of the circle), and according to Archimedes the area of the whole circle centered at X with radius  $r$  is  $\frac{1}{2}r(2\pi r) = \frac{1}{2}(2r)(\pi r) = \pi r^2$ , one half of the area of the rectangle ABCD is  $\pi r^2$ . But as we have shown, the area under the companion curve is also one half that of the rectangle ABCD. Thus, the area under the half-arch of the cycloid is given by

$$\begin{aligned} & \text{[Area under companion curve]} + \text{[Area between the companion} \\ & \text{curve and the cycloid]} \\ & = \pi r^2 + \frac{1}{2}\pi r^2 = \frac{3}{2}\pi r^2. \end{aligned}$$

and doubling this, we see that the area under one arch of the cycloid is given by  $3\pi r^2$ , meaning three times the area of its generating circle.]

One can see that the above argument is at its heart a geometrical one: we establish relationships between known areas (i.e. the semicircle and the rectangle) and our principal unknown area: the area under a half-arch of the cycloid curve. However, the argument is not pure geometry in its method of establishing these relationships, which is a Cavalierian “indivisible” method, albeit tempered by Roberval’s own conception of what an “indivisible” actually is. Hence we see in this argument a kind of segue between geometry and calculus: its core form is that of geometry, while its core mathematical utensil is that of the integral calculus— the notion of measuring an area using infinitely small rectangles or “surfaces.”

After having solved this problem, Roberval notified Mersenne of his success in his 1637 letter, but as we have said, without providing any kind of actual solution. Mersenne, excited by Roberval’s letter and curious as to whether his results were actually correct, notified his correspondents of the news in an effort to verify whether the secretive mathematician had actually discovered the area under one arch of the cycloid or not [5, 57]. One such correspondent was Toulouse lawyer Pierre de Fermat, who in his first reply in February of 1638 to Mersenne expressed doubt over the validity of Roberval’s solution. Not knowing anything of Roberval’s method, Fermat responded to Mersenne in another letter from July 1638 which begins: “You remember that I had at another time written you that I had found the proposition of M. de Roberval doubtful and that I had apprehended that he had ambiguity in his research. Here is the confirmation.” [6, 377]. Indeed, Fermat’s solution to the area under one arch of the cycloid is framed in his letter to Mersenne as a “confirmation” of Roberval’s mistake. This claim is, of course, not true: Roberval and Fermat both provide differing yet correct arguments. In fact, Fermat retracted his doubts in a letter sent to Mersenne roughly one week after the letter from which we obtain the following solution; we will consider the follow-up letter after having explored the present work.

#### **Fermat’s solution to finding the area under one arch of the cycloid curve.**

[This text is taken from a letter appearing in *Correspondance du P. Marin Mersenne*, vol. VII, pp. 376-380. Again, the work has been translated from the French by me, and all comments in [square brackets] are mine.]

Note in the following figure [The figure to which Fermat refers is given below as figure 14; figure 13 is a preliminary diagram created by me.] the description of the curve described by a point upon a circle which rolls.

[Note the difference between this construction of the cycloid and Roberval's construction; Fermat simply tells us how this curve came about, whereas Roberval went through the work of defining the movement of the point on the circle by relating it to other movements. The difference in rigor is most likely due to the fact that Mersenne, to whom Fermat was writing, was already aware from Roberval's letter of how to construct the cycloid curve, and so Fermat found it unnecessary to go through such labors again.]

Its base [the base of the cycloidal arch] is PR, cut equally [bisected] at the point F: its summit is A [that is, the highest point on the cycloidal arch]; the line AF, perpendicular on PR, is the diameter of the rolling circle; AIGF is half of the said circle; PLAR is the curved line [the cycloid curve]; PS is a rectangular parallelogram [Fermat defines this rectangle by its opposite vertices P and S, but we use here the convention "rectangle(PQSR)" to avoid confusion with the diagonal line PS.]

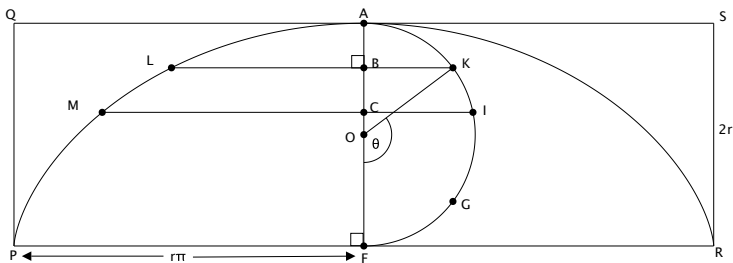


Figure 13; preliminary diagram

The principal property of the curve, which it is very easy to demonstrate, is that, if you take a point on this one [i.e., on the cycloid curve] like L, from which you draw LBK perpendicular on AF [see figure 13], the line LB is equal to the line BK and to [i.e. added to [6, note 2, p. 378]] the portion of the semi-circumference AK;

[This is to say, for any line LBK such that L is on the cycloid, B is on the diameter AF of the circle, and K is on the semi-circumference of the circle, where  $LBK \perp AF$ , we have that  $LB = BK + \text{arc}(AK)$ . Let us demonstrate this fact. Remember from Roberval's solution we derived that the horizontal distance of a point L on the cycloid from the line QP is given by  $r(\theta - \sin\theta)$ , where  $\theta$  is as shown in figure 13, and  $r$  is the radius of the circle AIGF. Since PF has length  $r\pi$ , then LB must have length

$$r\pi - r(\theta - \sin\theta) = r(\pi - \theta) + r\sin(\theta) = r(\pi - \theta) + r\sin(\pi - \theta),$$

since  $\sin\theta = \sin(\pi - \theta)$  from a trigonometric identity. Notice that the length of  $\text{arc}(AK)$  is given by  $r(\pi - \theta)$  and the length of BK is given by  $r\sin(\pi - \theta)$ , from which it follows that  $LB = BK + \text{arc}(AK)$ . In particular, this gives us that  $PF = 0 + \text{arc}(AF) = \text{AIGF}$ , the semi-circumference of the circle.]



all the same the line MC is equal to the line CI and to [added to] the portion of the semicircumference IA, and thusly of the others until the line PF finds itself equal to the entire semicircumference [AIGF; so PR is thus equal to the circumference of the rolling circle].

If the base PR is double the circumference of the rolling circle, then in this case the line LB is equal to the line BK and to double the portion of the circle AK, and thusly the line MC is equal to the line CI and to double the portion of the circle IA. And if the line PR is triple the circumference of the rolling circle, all the same, etc.

[It is somewhat unclear what Fermat is trying to say here (“Que sy la base PR est double de la circonferonce du cercle qui roule, en ce cas la ligne LB est esgale à la ligne BK et au double de la portion du cercle AK, ...”[6, 377-378]) We ignore these remarks, as they have little bearing on his argument as a whole.]

That thus supposed, to find the proportion of the rectangle PA [i.e. rectangle (PQAF) from figure 13] to the half-figure APF [the space under one half-arch of the cycloid, we will call it space(ALPF) to avoid confusion with the triangle(APF)], let us divide AF in as many equal parts as we will like, as AB, BC, CD, DE, EF. And next from points B, C, etc., let us draw the lines BLT, CMV, DNX, EOY parallel to PF.

[See figure 14. As with Roberval’s solution, here when dividing AF into equal parts, the number of equal parts is arbitrary, “as many equal parts as we will like”; the choice of five parts is merely for convenience.]

To find the proportion that we are looking for [that of rectangle(PQAF) to space(ALPF)], it is necessary to compare every line PF, EY, DX, CV, BT, AQ to the lines PF, EO, DN, CM, BL.

[So, Fermat’s strategy in finding the area of space(ALPF) is to first compare all the lines of the larger rectangle(PQAF) (PF, EY, DX, ...) to the lines of the space (ALPF) (PF, EO, DN, ...) so as to find a ratio between the areas of the two spaces. In fact, when Fermat says, “all the lines,” he is implying that we must compare the *sum* of the lines of the rectangle to the *sum* of the lines of the space(ALPF) [6, note 1, pp. 378]; this implies, once again, that we use a Cavalierian method of indivisibles in proceeding, where the “sum of lines” of one space refers to the collectivity of indivisibles which comprise the area of that space.]

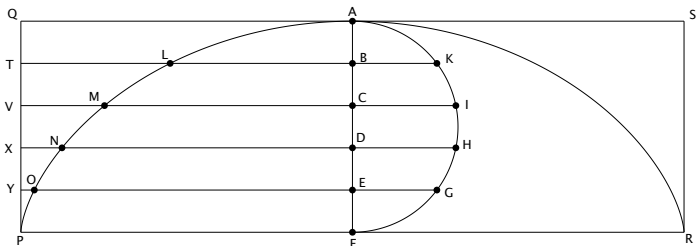


Figure 14; Fermat's original diagram

Thus the lines PF, EO, DN, CM, BL [those of space(ALPF)] are equal, as we have said, to portions of the circle FA, GA, HA, IA, KA, and to [added to] straight lines [half-chords] EG, DH, CI, BK. It is thus necessary to compare every line PF, EY, DH, CV, BT, AQ [of the rectangle(PQAF)] with the portions [arcs] of the circle FA, GA, HA, IA, KA and with [added to] the straight-lines EG, DH, CI, BK.

[From Fermat's preliminary remark earlier ("The principal property of the curve..."), each line of the area under the cycloid is equal to a corresponding half-chord plus a corresponding arc-length. For example,  $EO = EG + \text{arc}(GA)$ . So, we recast the problem to finding a proportion between "the lines of the rectangle(PQAF)" and "half-chords of the circle plus arcs of the circle."]

Let us make this comparison separately. In comparing firstly every line PF, EY, DX, CV, BT, AQ, [the lines of the rectangle(PQAF)] with the straight lines BK, CI, DH, EG, etc., [those of the semicircle AGF] it is obvious that all of these lines [that is, the "sum" of all of these lines] PF, EY, etc., to infinity, will have the same proportion to [the "sum" of all of] BK, CI, etc., than the one which is from the rectangle AP [rectangle (PQAF)] to the semi-circle FGA (because the lines AB, BC, CD, etc. are equal between them). And the aforementioned proportion [the proportion of area(rectangle(PQAF) to area(semicircle(AGF))] is of 4 to 1 in the first revolution (of 8 to 1 in the second, of 12 to 1 in the third, etc., to infinity) of which alone we will speak, the consequences for the others being too easy and the demonstration too obvious.

[Here we see that Fermat's conception of the "indivisible" is decidedly more Cavalierian than Roberval's. Fermat does not state that the infinity of lines represent an infinity of "little surfaces," and in fact he does not seem to concern himself with their nature at all; he uses indivisibles only to allow himself to make comparisons between individual line segments of one space and another, and deduce ratios between the areas of the two. This conception carries with it some logical difficulties, since as we have said, the line having only a length, it would be impossible for any multitude of lines, no matter how compactly placed, to comprise a two-

dimensional area. But, logical inconsistencies aside, Fermat's observation is correct; the area of the semicircle is  $\frac{1}{2}\pi r^2$ , and the area of the rectangle is  $\pi r \cdot 2r = 2\pi r^2$ , and so

$$\text{area}(\text{rectangle(PQAF)}) = 4 \cdot \text{area}(\text{semicircle(AGF)}).$$

After the second revolution of the circle, we have that

$$\text{area}(\text{rectangle(PQAF)}) = 2r \cdot 2\pi r = 4\pi r^2 = 8 \cdot \text{area}(\text{semicircle(AGF)}),$$

and after the  $n^{\text{th}}$  revolution of the circle,

$$\text{area}(\text{rectangle(PQAF)}) = 2r \cdot n\pi r = n\pi r^2 = 2n \cdot \text{area}(\text{semicircle(AGF)}).$$

However, the consideration of multiple revolutions is unnecessary in solving the problem at hand.]

Let us now compare every line [of rectangle(PQAF)] PF, EY, DX, CV, BT, AQ with portions [arcs] of the circle FA, GA, HA, IA, KA. If the portions AK, KI, IH, etc. were equal between them [that is, if the differences in length (AK, KI, IH, ...) between each of the successive arcs (AK, AI, AH, ...) were all equal to one another], we could say that every line PF, YE, XD, VC, BT, AQ [that is, the sum of the lines of the rectangle] would be double the portions FA, GA, HA, IA, KA [the sum of the arcs of the semicircle], because each one of the lines PF, YE, etc. is equal to the semi-circumference FA, which would consequently be the greatest of the arithmetic progression, in which the difference of the progression is equal to the smallest term [which is AK].

[Fermat assumes that the lengths AK, KI, IH, ... are all equal, call this length  $d$ . Thus, the arcs AF, AG, AH, ... have lengths which form an arithmetic progression, with the common difference between lengths of consecutive arcs being  $d$ . Observe that, in figure 15, we may arrange the arc lengths into a right-triangle [1, pp. 158] with base AF, where the points K, I, H, ... lie on the hypotenuse, each a horizontal distance of  $d$  from one another, because for each arc length, there is a corresponding point on the diameter (see figure 14), meaning, if we "stack" each of the arc lengths on top of one another such that the vertical distance between each is equal to the common length  $c$  of segments of the diameter AB, BC, ..., then the endpoints of the arc lengths actually align along a line of slope  $-c/d$  (figure 15). The triangle must then have a height of  $2r$ , so the area of the triangle, i.e., the "sum" of all of the arcs AF, AG, AH, ... is equal to  $\frac{1}{2} \cdot 2r \cdot \pi r = \pi r^2$ . So the area comprised of all of these arc lengths is in fact the area of the circle which they partly describe, and is actually  $\frac{1}{2}$  area(rectangle(PQAF)), which is the "sum" of the lines PF, YE, XD, ..., each having length equal to AF (see figure 14), and so we conclude as Fermat says, that

$$\Sigma(\text{arc lengths of semi circle AGF}) = \frac{1}{2}\Sigma(\text{lines of rectangle (PQAF)}) = \frac{1}{2} \text{area}(\text{rectangle(PQAF)}).]$$

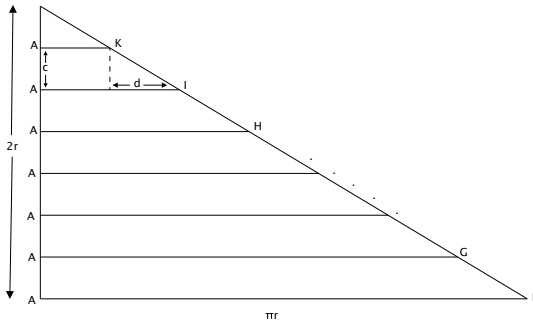


Figure 15; determining the relationship between arcs of the circle and lines of the rectangle

But we cannot without paralogism [fallacious reasoning] determine this double proportion, because the straight lines AB, BC, etc., [on the diameter AF of the semicircle] being equal between them, it manifestly follows that the portions AK, KI, IH, etc. are unequal between them. And therefore we cannot say that all lines PF, EY to infinity, are double the portions FA, GA, etc. to infinity, which nevertheless I estimate that M. Roberval will have believed, not being himself amused to consider the inequality of the portions AK, KI, etc.

[Fermat thus concludes that we cannot assume that there exists an arithmetic progression between the arc lengths AK, AI, ..., since we have previously assumed that AB, BC, ..., which lie on the diameter, are each equal to one another, hence that Roberval must have erred at some point in his solution, despite Fermat having no knowledge of the route Roberval had taken in deducing his solution. As has been said, this mistake is one which Fermat retracts almost a week later in another letter to Mersenne, having discovered that it is irrelevant whether the arc lengths are in arithmetic progression or not; we cover this correction shortly. But, in the letter from which the current solution is taken, Fermat assumes anyway an arithmetic progression between the arc lengths and arrives at Roberval's conclusion.]

And in fact, if this double proportion were true, the proposition of M. Roberval would be as well. Because if all of [the “sum” of] the lines PF, EY, etc. [those of the rectangle] were double the [sum of] portions FA, GA, etc. [the arcs], since we have proven that the same lines PF, EY, etc. are quadruple the lines EG, DH, etc. [those of the semicircle (AGF)] it would follow that the aforementioned lines PF, EY, etc. would be to the sum of the portions AF, GA, and the straight lines EG, DH, etc. as 4 to 3.

[We have shown that, since

$$\text{area}(\text{rectangle}(\text{PQAF})) = 2 \cdot \Sigma(\text{arcs of semicircle}(\text{AGF})), \text{ and}$$

$$\text{area}(\text{rectangle}(\text{PQAF})) = 4 \cdot \text{area}(\text{semicircle}(\text{AGF})), \text{ then}$$

$$\text{area}(\text{rectangle}(\text{PQAF})) = 4/3[\text{area}(\text{semicircle}(\text{AGF})) + \Sigma(\text{arcs of semicircle}(\text{AGF}))], \text{ so}$$

$$\text{area}(\text{semicircle}(\text{AGF})) + \Sigma(\text{arcs of semicircle}(\text{AGF})) = \frac{3}{4}\text{area}(\text{rectangle}(\text{PQAF})) = \frac{3}{4} \cdot 2\pi r^2 = \frac{3}{2} \cdot \pi r^2.]$$

Thus the sum of portions AF, GA, and the straight lines EG, DH, etc. is equal to the straight lines PF, EO, DN, etc. [see figure 14; the lines of the space under half of the cycloidal arch]. Thus the lines PF, EY, etc. would be to the lines PF, OE, etc. as 4 to 3. And therefore, the rectangle AP [rectangle(PQAF)] would be to the semi-figure PAF [space(PLAF)] as 4 to 3 and the entire rectangle PS [rectangle(PQSR)] would be to the figure PAR [the full cycloid arch] as 4 to 3. Thus the rectangle PS is quadruple the rolling circle, thus the figure PAR would be triple the circle in the first revolution [meaning the area under one arch of the cycloid is three times that of the circle which generated it.], and in the second quintuple, etc. as it would be easy to extend the demonstration.

[Since the arches formed by multiple revolutions of the generating circle do not overlap, then the area under the cycloid curve after  $n$  revolutions would be  $3n$  times that of its generating circle. It is unclear as to why Fermat claims that after two revolutions the area under the cycloid curve is only quintuple that of the generating circle.]

But I believe the proposition is false. And perhaps I have made and guessed the path which M. Roberval has held.

Returning to the problem roughly a week later [7, 397-399], Fermat tells Mersenne, “I take the feather to this stroke to justify M. Roberval against the all-too-hasty censure that I had made of his proposition about the Cycloid...” [7, 397], and he proceeds to argue that it does not matter whether the arcs of the semicircle are in arithmetic progression or not.

René Descartes was also among those contacted by Mersenne for verification of Roberval’s result, and, accordingly, he too provided a solution in July 1638 [3, 407-412]. I do not present it here, but Descartes, in similar fashion to Fermat and Roberval, used an argument consisting of geometry and indivisibles. He too compared the “lines” or “indivisibles” of one space with those of another; where he differed from Fermat and Roberval was in the particular comparisons which he made.

The above examples illustrate the popular mathematical attitudes towards the infinite in the early 17th century, and give a good indication as to the atmosphere surrounding one of the fundamental concepts of the calculus in an era which barely preceded its official development in the works of Newton and Leibniz. They are also a testament to the richness of certain mathematical problems and concepts which allow for a variety of solutions and contain an abundance of interesting properties

awaiting discovery. Of course, since we earlier parameterized the cycloid curve by  $y = r(1 - \cos\theta)$ ,  $x = r(\theta - \sin\theta)$ , today the determination of the area under one of its arches becomes the simple task of evaluating the definite integral

$$\int_0^{2\pi} r(1 - \cos\theta)d(r(\theta - \sin\theta)) = r^2 \int_0^{2\pi} (1 - \cos\theta)^2 d\theta$$

which yields our desired result of  $3\pi r^2$ . As intriguing as the inner-workings of the definite integral are, however, its evaluation above somewhat pales in comparison to the clever interweaving of geometry and the method of “indivisibles” which Roberval and Fermat each exhibited in solving the same problem. For Roberval to have conceived of a “companion” curve to the cycloid to assist him in his calculations, or for Fermat to have realized that a line under the cycloid curve is equal in length to the sum of a corresponding half-chord and arc from its generating circle, lends a certain uniqueness to either solution, as well as insight into the minds of either great mathematician; on the other hand, it also makes us appreciate the efficiency with which the integral calculus allows us to solve problems which at one point required significantly more exhausting arguments. This striking efficiency marks a turning point in the conception of the infinite, which certainly lies corollary to Cavalieri and his method of indivisibles, as well as to the mathematicians who used and refined this method in the solving of numerous problems throughout the 17th century.

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## **OLFACTORY ASSOCIATIVE LEARNING: AN EXAMINATION OF THE RELATIONSHIP BETWEEN OLFACTION, MEMORY, AND EMOTION**

*PSYCHOLOGY 308:  
SENSATION AND PERCEPTION WITH WADE ELMORE*

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### **ABSTRACT:**

*My research examines the relationship between olfaction, memory, and emotion and its practical and clinical implications. Our sense of smell is often taken for granted, but its ability to trigger powerful emotions and memories has been widely documented in the literature. Olfactory associative learning has been studied in a wide range of areas, including rats, school children, dental patients, and soldiers with PTSD.*

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There is a close and complex relationship between olfaction, memory, and emotion. This paper will examine this relationship, and its possible real life implications. The relationship between olfaction, memory, and emotion has been described in the literature as the Proust effect. The Proust effect maintains that odor-evoked memories of meaningful autobiographical experiences are powerful and emotional.<sup>1</sup>

Marcel Proust (1913), the phenomenon's namesake wrote the following in his novel *Swann's Way*:

When from a long-distant past nothing subsists, after the people are dead, after the things are broken and scattered, still, alone, more fragile, but with more vitality, more unsubstantial, more persistent, more faithful, the smell and taste of things remain poised a long time, like souls, ready to remind us, waiting and hoping for their moment, amid the ruins of all the rest; and bear unfaltering, in the tiny and almost impalpable drop of their essence, the vast structure of recollection.<sup>2</sup>

Many people have an anecdote about an emotional, personal memory triggered by an odor. For example, the smell of a specific perfume, baking cookies, a rose, or burning leaves can cause some to feel pleasant emotions and remember a specific moment in their life. Odors may also trigger negative emotional reactions and memories, depending on personal



experiences. The smell of burning leaves may evoke a warm pleasurable memory of a fall day in the country for one person; it might evoke negative painful memories and emotions for another person who was burned by a bonfire as a child. The Proust effect would account for these strong memories and emotions by the olfactory cues associated with these experiences.

One explanation for the Proust effect may be that olfaction is connected to the amygdala, which is where emotional associative learning takes place in humans.<sup>5</sup> Olfactory processing and the assigning of affective value to stimuli both take place in the orbital frontal cortex, which provides further explanation of the memory aspects of the Proust effect.<sup>4</sup> These close physiological connections help account for the relationship between olfaction, memory, and emotion. Researchers have further studied this relationship in animals as well as humans.

Several studies have shown support for the Proust effect. One conducted by Herz (1996) found that when memories were evoked by odors they were more emotional than verbally cued memories.<sup>5</sup> Researchers have also found that when an individual is exposed to a neutral odorant that is paired with an adverse or pleasant stimuli, the two become associated or conditioned, and that odors can have a profound impact on emotional states, based on past experiences.<sup>6 7 8</sup>

Paschal and Davis (2002) conducted a study of olfactory-associated learning in rats. They measured rats' startle responses when paired with conditioned odorant stimuli. They paired an ambient odor (i.e., the conditioned stimuli) in a petri dish under the cage with foot shocks. For 1-40 days after the conditioning was completed the rats displayed significant potentiated startle responses to a noise paired with the odor compared to rats who were not trained to associate the odor with the foot shocks. The authors note that in most studies the effects of an odor-conditioned stimulus wore off after 40 days.<sup>9</sup> Testing in rats has shown that they are quite susceptible to associative learning through olfactory stimulation, but not auditory or visual stimuli. Olfaction is an important sensory system for rats and other mammals because "it is critical for reproductive and appetitive behavior, as well as for fear and avoidant responses".<sup>10</sup> In this study the rats learned that the odor was associated with an adverse stimulus and were more likely to startle than those who had not been conditioned to the stimulus. Other studies have found similar results for olfactory associated learning in rats.<sup>11</sup>

Researchers have also examined olfactory associated learning with emotion in humans. Having dental work done or even the thought of visiting a dentist can be an emotionally and physically traumatic experience for some individuals. Robin, Alaoui-Ismaïli, Dittmar, and Vernet-Maury (1998), examined the effects of dental office odorants, specifically eugenol (from cements used in restorative dental work), on participants' automatic nervous system (ANS) responses (e.g. heart rate and skin temperature).<sup>12</sup> The ANS response analysis they used has previously been found to be "reliable and efficient at characterizing each individual's emotional reactivity to odorants".<sup>15</sup> The study exposed participants to the odorants and compared the ANS responses of participants who stated that they were fearful of dental care with participants who stated that they were not fearful. The researchers found that participants who were fearful were more likely to report the smell of eugenol as unpleasant and also showed "stronger autonomic reactivity" when the odor was inhaled. The fearful dental patients with higher ANS responses (i.e., more discomfort and fear) associated the smell of eugenol with painful memories of their visits to the dentist.

Many of the human studies have focused on associative learning when a neutral or novel unconditioned odorant stimulus was paired with a negative stimulus. Fewer have focused on learning with positive stimuli. Chu (2008) examined olfactory conditioning in children. The study contained three groups of children who were identified as low-achieving and lacking self-confidence.<sup>14</sup> Each group took three tests: a base line test, an experimental or control test, and a retest of the baseline test. Group A was exposed to an ambient odor and their test (which they believed to be intended for older students) was easy and thus guaranteed success. Group A's test scores showed significant improvement compared to group B, which was exposed to a different odorant than the original odorant at retesting, and group C, which was not exposed to any odorants. The authors describe the improvements in group A as being due to the conditioned stimuli (the odor). The results suggest that group A was more inclined to be successful because they associated the odor during the final testing with the success in the prior test.<sup>15</sup> Essentially the conditioned stimuli (the odorant presented at testing and retesting of baseline) helped improve their scores through associative learning. Studies have found that olfaction can become a conditioned stimulus in animals as well as humans, and that it can induce negative affect as well as positive affect.<sup>16 17</sup>

Researchers have begun to examine olfactory associative learning in patients with post-traumatic stress disorder (PTSD). However, the literature is still extremely limited. Many patients with PTSD report having strong emotional and physiological reactions and often have flashbacks (i.e. vivid emotionally linked memories) that are triggered by specific conditioned odorants.<sup>18</sup> According to Vermetten and Bremner, the mental health community has long acknowledged the phenomenon of trauma-related odorants serving as triggers or cues for flashbacks in patients with PTSD. Patients' odor-cued flashback reports have ranged from mild and transient emotional disturbances to longer lasting and more distressing emotional disturbances.<sup>19</sup> Although the mental health community is aware of the role that olfaction may play in triggering flashbacks in individuals with PTSD, there have been few studies that have investigated this relationship in humans. In fact, the prevalence rate of PTSD patients with olfactory-cued flashbacks is not even known.<sup>20</sup>

Rats have even been found to exhibit PTSD-like symptoms (e.g., heightened muscle tension and diurnal hyper-vigilance) cued by trauma-related olfactory stimuli.<sup>21</sup> Nelson, DeMartini, and Heinrichs (2010) conducted a study that examined the effects of a traumatic experience (i.e., aggressive interaction with another male rat) that was paired with an odor cue. They used male rats (residents) that were each paired in a cage with a female rat, and had established normal reproductive and territorial behaviors.<sup>22</sup> Then they placed another male rat (intruder) in the cage. Within 20-120 seconds the resident rats threatened, chased, and pinned the intruder down. In the experimental group, researchers put a dab of a novel odor (peppermint or coconut) on the residents back before the intruder was placed in the resident's cage. They measured muscle tension and diurnal hyper-vigilance in the experimental and control groups at baseline, and at 1, 2, and 4 weeks after the traumatic experience. They found that when the experimental intruder rats were re-exposed to the conditioned odor they exhibited significant increased muscle tension and an increase in locomotor activity compared to the control group who had not been exposed to the odorant.<sup>23</sup> The rats who experienced a traumatic experience that was paired with an ambient odor exhibited PTSD-like symptoms when re-exposed to the ambient odor.

A collection of three case reports described by Vermetten and Bremner (2005) illustrate the nature in which trauma related odors can trigger flashbacks in symptoms with PTSD. One of the cases was of a

55-year-old Vietnam veteran. He was a paramedic in Vietnam and some of his duties included using diesel fuel to burn the soldiers' excretions when they moved camp, as well as sometimes even bodies or body parts. After his tour was over, he went back home and developed PTSD. Among other symptoms, the smell of diesel and burning rubber, and the memories and emotions that the smells evoked were difficult for the veteran to deal with. The smells would trigger intrusive thoughts and memories that could make "him feel uncomfortable, nauseated, and sometimes guilty".<sup>24</sup> He avoided situations where he would be likely to encounter these smells. The researchers stated that ever since the traumatic events happened in his life, the impact of the related smells was still powerful enough to change his emotional state.<sup>25</sup>

Few empirical studies have looked at the relationship between olfaction and PTSD flashbacks, and there are currently no specific treatments for patients that address olfactory-triggered flashbacks. There are two experimental treatment options for PTSD that involve olfactory associative learning. One alternative treatment created and researched by Abramowitz and Lichtenberg (2010) examined the effects of hypnotherapeutic olfactory conditioning (HOC) on Israeli veterans (n=56) whose symptoms included PTSD olfactory-triggered flashbacks.<sup>26</sup> The HOC treatment included hypnosis, mental imagery, and the use of pleasant smelling essential oils, and consisted of six sessions lasting 90 minutes each.<sup>27</sup> In the first session, the patients thought of pleasant memories while they were exposed to the essential oils. In later sessions hypnosis was used with mental imagery of the traumatic event and exposure to the pleasant essential oils. The study used a small nonrandomized trial and has not been replicated.<sup>28</sup> The treatment was found by the Department of Veterans Affairs-Veterans Health Administration researchers to provide "little evidence of broad potential efficacy in PTSD."<sup>29</sup>

Another example of an experimental treatment program for patients with olfactory-triggered flashbacks is specifically targeted to treat veterans with PTSD who served in the wars in Iraq and Afghanistan.<sup>50</sup> The program is called Virtual Iraq and uses virtual reality exposure therapy with olfactory stimuli (e.g. smells of ethnic cooking, smoke, etc).<sup>51</sup> Empirical studies support the efficacy of exposure therapy as a treatment option for PTSD, especially when combined with cognitive behavioral therapy. The efficacy of the Virtual Iraq program has not been published to date, but the initial trials did show some "positive clinical outcomes" for

participants (n=20).<sup>32</sup> More research is still needed about using virtual reality exposure therapy to treat PTSD.

There are many reasons for examining the relationship between olfaction, memory, and emotion. The studies discussed in this paper show that humans are more susceptible to olfactory associative learning than one may originally believe. Robin et al. (1998) found that patients who were fearful of dentists had strong negative emotional reactions to the smell of dental office odorants. There may be opportunities for future researchers to find ways to use olfaction to make visiting the dentist a potentially less frightening experience for dental patients. Also, researchers could possibly build on Simon Chu's (2008) study and further examine the potential of ambient odors in the classroom as a means to improve students' confidence and scores.

While many people have experienced the Proust effect at some point in their lives, olfactory-triggered flashbacks in individuals with PTSD may be an extreme example of this phenomenon. Two potential treatments for PTSD that incorporate olfaction were also discussed in this paper.<sup>35 34</sup> More empirical research is still needed on the relationship between olfaction and PTSD in humans, and before an olfactory related treatment is developed the mental health community should at least find the prevalence rate of reported odor-triggered flashbacks.<sup>35</sup> Emotional olfactory associative learning is a process that is often taken for granted but is widely documented in animals as well as humans. There is much potential for future research to further our understanding of the relationship between olfaction, memory, and emotion. It has been nearly 100 years since Marcel Proust first wrote about the subtle, yet powerful abilities of our sense of smell and its emotional memory-provoking capacity. It will most likely be many more years before we come to fully understand this relationship.

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# MELISSA CHILDRESS

## **EFFECTS OF MEDICATION ON CHILDREN WITH ADHD: DOES MEDICINE FOR ADHD NEGATIVELY IMPACT CHILDREN DIAGNOSED WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER?**

PSYCHOLOGY 302WI

EXPERIMENTAL PSYCHOLOGY WITH STARLYNN HAWES

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### **ABSTRACT:**

*Attention deficit hyperactivity disorder, more commonly known as ADHD, is highly prevalent in children. Due to the prevalence of this disease, more research is being performed in areas such as practitioner effectiveness, treatment adherence, varieties of treatment, and disease experience. These factors heavily influence the course of the disease and oftentimes the child's life experience. Various studies have found problems with the current handling of the disease and suggest better options for parents, children, and providers.*

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### **OVERVIEW OF ADHD**

Attention Deficit Hyperactivity Disorder is a behavioral condition that makes focusing on everyday requests and routines challenging (APA, 2011). People with ADHD typically have trouble getting organized, staying focused, making realistic plans and thinking before acting. They may be fidgety, noisy and unable to adapt to changing situations (APA, 2011). Approximately 1 in 10 children in the United States is diagnosed with ADHD.<sup>1</sup> This makes ADHD a widespread problem which needs to be treated appropriately.

### **RITALIN DEBATE**

Jadad, Boyle, Cunningham and Schachar (1999) completed a meta analysis and came to the conclusion that stimulant medication tended to reduce behavioral disturbances but not help academically and that short-term side effects were mild. However, the Drug Enforcement Administration (DEA) shows that Ritalin production has increased 650% during 1990-1997, and that amphetamine medication, which is a more recent trend of treatment, i.e., Adderall, increased production 4504% during 1995-2000. These medications account for 42% of the stimulants produced in the United States and mostly are used to treat ADHD.<sup>2</sup> Many express concern



over these high numbers as doctors may be over-diagnosing and the use of such addictive medications could be potentially harmful.<sup>5</sup> With many studies showing behavioral treatment is just as effective as stimulants, and many others showing it might not be, it becomes important that we differentiate between what is actually beneficial.<sup>4</sup>

### **IMPORTANCE OF STUDYING MEDICATION EFFECTS**

If we don't study medication effects, we could be giving those diagnosed a potent and possibly harmful drug that is not required, which is unethical. The purpose of this paper is to review the existing literature to understand the current recommendations and how well they are applied, what parental perceptions of available treatments are, and what children's perceptions of the medication are. This review will show that perceptions of medication have a clinically significant impact on their use, which can result in negative effects on the children who take them.

### **EFFECTS OF MEDICATION ON CHILDREN WITH ADHD CURRENT MEDICATION USE AND TREATMENT RECOMMENDATIONS**

Ambalavanan and Molten (2005) published a guideline for diagnosing and treating ADHD. It was derived from evidence-based clinical practice at Cincinnati Children's Hospital Medical Center and is targeted for children between the ages of 5 and 18 with symptoms of ADHD, excluding autism and other mental disorders.<sup>5</sup> It incorporates the DSM-IV criteria for diagnosis. The current recommendations based on this data are as follows: use comprehensive screening forms to evaluate symptoms, impairment, and co-morbidity; combine medication and behavioral therapy; and use stimulants as the first line medicine because they are safe for up to 24 months. Also use group therapy for 1-6 months, do not try alternative therapies, and communicate with schools for monitoring and follow up.<sup>6</sup> This piece provides a thorough example of what current practices are supposed to look like to eliminate other possible diseases to ensure accurate diagnosis and guidelines for the safety of the patient.

Waschbusch, Carrey, Willoughby, King and Andrade (2007) conducted a quasi-experimental study that looked at how children with conduct problems (CP), like rule-breaking, and children with CP caused by callous/unemotional traits (CU), such as no remorse or empathy, react to various therapies. Children who early on develop both CU/CP have a higher likelihood of significant social problems. The purpose of the study was to see what approach works best for both children with ADHD-CP and children with ADHD-CP/CU, and to discern if the treatments produce

different outcomes. The hypothesis was that children with ADHD-CP/CU would respond less to behavioral therapy alone and that medication would be needed more than for those with only ADHD-CP. There were 37 children involved in the study, 19 of whom had attention deficit hyperactivity disorder with CP-only and 18 who had ADHD-CP/CU. The children attended an eight-week summer treatment program at Dalhousie University. All participants were diagnosed with ADHD-ODD (oppositional defiant disorder) or ADHD-CD (conduct disorder). They were then sorted into their groups by parent and teacher ratings using the Antisocial Process Screening Device (which uses 20 questions to measure narcissism, impulsivity and CU). Only those that specifically referred to CU were used in this study; those with a CU score above 65 were placed in the ADHD-CP/CU group and those below placed in the ADHD-CP group. The children were then given a placebo, a low dose, or a high dose of medication that was changed daily based on random assignment. A child could either be on behavioral only therapy, BT with a low dose, or BT with a high dose. For the behavioral therapy children were awarded points for good behavior in daily activities such as swimming, softball, soccer, art, etc., which they could trade in for rewards or honors. Medication was either .5 mg/kg twice daily or .6 mg/kg twice daily, administered when they arrived at the program and right before lunch. Medication was administered in a double-blind fashion. In the STP basic rules were set to be followed always and teachers/counselors would record rule violations as would an independent observer. Inter-rater reliability was tested by running correlations on both sets of data and ranged from .58-.91 the average being .79, which is high. At the end of the day the students were also rated by the teachers on the IOWA scale measuring impulsivity/inattention/overactivity (IO) and oppositional/defiant (OD) behaviors; these scores were averaged. The independent variable then was the type of therapy received: BT-only, BT-low or BT-high. The dependent variable was the teacher and counselor ratings and the IOWA scores.

BT-only children with ADHD-CP/CU exhibited more anti-social behaviors than those with only ADHD-CP. However, the measures only differed significantly on antisocial behaviors, not on positive behaviors or typical ADHD behaviors, such as interrupting. Both groups responded equally well to the combination of medication and behavioral therapy; researchers needed to modify the hypothesis because medicine-only and BT-only did not produce the desired results. <sup>7</sup> This is concurrent with the

current recommendations provided by Ambalavanan and Molten (2005). It is thought that the children in this study will be a good representation of the ADHD population because they have a severe form of the disease which in turn makes effects more significant when they are found. However, it has also been proposed that perhaps children with CU traits may respond differently to rewards and that a finer study with less broad anti-social definitions may be required.

### **PARENTAL PERCEPTIONS OF TREATMENTS**

In a community-based study, Concannon and Tang (2005) conducted a differential analysis exploring parental perceptions of diagnosis and treatment of their children who were diagnosed with ADHD. 278 children, ages 10-12, with ADHD were identified and their parents completed an anonymous questionnaire covering perceptions of overall treatment, diagnosis, and management. The research was conducted in Sydney, Australia through the public schools. The purpose was to find out information about parental perceptions of treatment. Then the information would be used to assess quality and identify shortcomings in the care of children and then be addressed. The questionnaire asked about the child's gender and age, ADHD status, category of the person that made the diagnosis, methods used to make the diagnosis, treatments used and their perceived usefulness, and parental satisfaction.

The study found that 73% had been diagnosed by pediatricians, 9% by psychologists and 10% by other professionals. Ninety percent of the participants remembered an interview with them and the child, while only 66% remembered a survey. There was also a low incidence of vision and hearing tests which could rule out other disorders.<sup>8</sup> Eighty-two percent had tried medication, 66% were continuing it, and all participants had been offered it as a treatment option. As for non-drug conventional treatments, less than 50% reported being offered any type of therapy. The most helpful of these therapies were academic support, 85-88 %, and counseling, 63%, of the small percentage that were offered them.<sup>9</sup> The use of non-conventional therapies was reported by 71% of the parents with the most common being elimination diet (57%), fatty-acid supplementation (31%), and vitamins (22%). Fifty-five percent of parents were satisfied or very satisfied overall. Two groups were very likely to express high satisfaction, those on medication and those who visit the doctors more frequently than every six months.<sup>10</sup> The major reasons for dissatisfaction were: the doctor only wanted to prescribe medication, health and

educational professionals did not understand the child's problem, and the professionals did not appear interested.<sup>11</sup> This can lead to the conclusion that some parents want to explore options beyond medication but because of the unavailability of other treatments cannot find them. This may also be the reason for the high incidence of non-conventional therapies but more studies would have to be done.

Johnston and Leung (2001) conducted a correlational study to determine how parents' and child's attribute behavior based on the type of therapy the child is receiving (medication, behavioral, both, or none). The researchers had 74 mothers, 41 fathers, and their 6-15-year-old ADHD-diagnosed sons watch videos of children performing symptoms of ADHD, compliance and non-compliance. Then they were told that the child was either not on any therapy, taking medicine, in behavioral therapy or doing both medication and behavioral therapy. Then they asked them to rate using a scale of 1-10 why the child was acting out (casual locus), how likely the behavior was to repeat (stability), the amount of control the child had over the behavior (control), and how intentional the behavior was (intentionality). Additionally, the researchers had the parents rate how they reacted to the behavior. The researchers predicted that medicine would be perceived to increase stability in problem and positive behaviors and also increase perceptions of control in child behaviors. To ensure that behaviors were common across the board, the researchers had children act out ADHD symptoms and behaviors and then the videotape was played for the parents and their sons who were then told what type of therapy the child was receiving (Independent Variable). The gender of the parents was another variable. The reactions to the tapes were the dependent variable, with the group receiving no therapy at all as the control.<sup>12</sup>

The results were true to the predictions. Mothers reacted with favor to compliance, while fathers did less so. Compliance behaviors for the medicine group showed less child control and more stability (behavior was likely to happen again) but were viewed more favorably. Behavioral treatments showed that the locus of the problem was more external and was also more likely to occur again. Both were consistent with predictions. For ADHD behaviors, mothers rated behaviors as less intentional than did fathers. With medication, results showed more child control. Medication also gave more credit to things outside of the child and less intentionality. For noncompliance behaviors, in all three treatment conditions parents rated greater control and less stability. But behavior was still ranked as

slightly more control and stability. Medication and combined treatments also received less intentionality and were reacted to more favorably.

### CHILDREN'S PERCEPTIONS OF TREATMENTS

In the same study as above, Johnston and Leung (2001) also rated children's attributions of ADHD behaviors. Also, as previously mentioned, the boys were 6-15 years old and were the sons of the 71 families which participated. They watched the same videos of the behaviors with their parents. For the boys' reactions, compliance behaviors had no significant effects. ADHD behaviors were attributed to be more controllable whenever there was a behavioral component to the treatment. And with noncompliance, the boys believed that it was more intentional and slightly more controllable with any treatment but significantly more controllable with behavior management.

In another publication, Moline and Frankenberger (2001) completed a differential study that evaluated how middle and high students in grades 6-12 felt about ADHD medication. Six hundred and fifty-one primarily white students, ages 8-11, in the Wisconsin and Minnesota area completed a survey after responding positively or negatively that they had been diagnosed with ADHD and were taking stimulant medication. If they indicated they had ADHD and were taking medication, a group of 50 students, they then answered a Likert-type survey on how they felt about their treatment and the experiences that went along with medication such as social, behavioral, academic, and attention effects on a scale of 1=never to 5=always. If they responded that they did not have ADHD or were not taking medication, they answered different questions about their perceptions of students who did take medication. The surveys were given anonymously and voluntarily. The study had several purposes: whether those diagnosed wanted to continue taking their medication and if they liked it; the students perceptions of academic, social, behavioral and attentional side effects; and their self-reported side effects of the medication itself. The survey itself was clustered to be able to help predict what made a child want to continue or stop a medication. The independent variable was whether or not the students were taking medication; the dependent variable was their attitudes towards themselves and/or other students.<sup>15</sup>

The results for the students who were diagnosed with ADHD and were taking medication were concurrent with expectations. The mean grade was 10th and for those taking medication they had been taking it for

an average of 3.73 years.<sup>14</sup> Thirty-five percent would stop their medication, while 43% would continue it and the remaining 23% were unsure, which means over half or 58% of the sample wanted to discontinue their medication or were unsure if they wanted to continue it<sup>15</sup>. Students stated that they felt medication helped them improve behaviorally, socially with parents and peers, and with attention, but academic achievement was significantly lower than all other categories. Also, social ability with friends was lower than that with parents. Sixty-four percent of students reported feeling side effects from their medication, including headache, sleepiness, restlessness, and stomach aches. Thirty-four percent of students also reported being asked to sell their medication.<sup>16</sup> These findings are significant because although students report positively in many areas, they feel that parents like them better on medication, and that it does not help them academically, and 35% wanted to stop taking their medication which is significantly high. Also the study found that the frequency of doctor's visits positively correlates with dosage, which positively correlates with side effects. Whether or not children liked their medication and if it helped them pay attention in school were both predictors of if the children wanted to continue their medication.

The results for the students who did not take ADHD medication were generally positive and also were concurrent with the experimenters' expectations. Many stated that they act the same as other students, but that the medication had not changed them positively or negatively. Fifty-three percent stated that they had seen some students give away or sell their medication. This is a dangerously high number for students when amphetamines, which are very addicting, is a growing trend in the stimulant medication used, which was another finding of this study.

It is also important to point out that 52% of students diagnosed stated that they never needed the medication to pay attention to tasks they really like to do, while only 9.5 % indicated they always do. This indicates that the desirability of the task is a possible variable that determines attention, not medication.

## **DISCUSSION**

### **SUMMARY AND CONCLUSIONS**

The purpose of this paper is to review the existing literature to understand the current recommendations and how well they are applied, and also what the perceptions of parents and children regarding medication are. The thesis, that perceptions lead to a significant clinical effect and may result in negative effects on children, was supported.

Parents perceive medication as providing more child control and that instances of negative behavior are less likely to happen again in the future, which supports my thesis.<sup>17</sup> Parents also reacted more favorably and rated negative behaviors as less intentional in the children on medication. They also gave more credit to things outside of the child causing the problems.<sup>18</sup> Concannon and Tang (2005) found that perceptions of medication do lead to a higher incidence of use, a higher satisfaction rating in parents and are often the only treatment offered which also support my thesis. Another support to my thesis is the data that showed that the majority of children have a high incidence of negative side effects, are unsure of whether they should continue their medication or not, and believe that their parents like them better on medication. They also believe the medicine does not help them academically and that the attractiveness of the task is a possible variable for whether or not they pay attention.<sup>19</sup> Although combined therapy of medication and behavioral therapy are the current recommendations as given by Ambalavanan and Molten (2005), and have been found to be helpful, the study cited showing its effectiveness did not contain a control group, which makes it hard to make an accurate comparison.<sup>20</sup> Also diagnostic tests are not being fully incorporated before a diagnosis is delivered, meaning other problems could be missed.<sup>21</sup>

### **IMPLICATIONS**

There are several implications to be drawn from the literature. These findings lead to the conclusion that in order to satisfy parents, doctors may prescribe medication, may encourage medication as the main viable option and not follow up with any behavioral help because it may be viewed as unnecessary. They may be over-diagnosing because the instances of using the recommended diagnostic tools to rule out other problems are underused. Children may not speak up about how they feel about their medication because they believe their parents like them better if they continue it. Therefore, children may be taking medication that isn't helping them or that is potentially harmful. Doctors may be over-dosing and over-prescribing. Parents may not understand that the medication is possibly affecting their child negatively and that there are other options to explore.

### **LIMITATIONS**

Although quality research has been done, there are some limitations. Many of the studies include people of mainly European descent, and are in isolated areas, such as the Midwest and Sydney, which could make it hard to generalize to the general public. The sample sizes were small and

concurrent with the 3-4% of those diagnosed with ADHD, but could still be a hard representation of the population as a whole. Doctors' perceptions of medication and knowledge of other diagnostic tools available and why they are used were also not studied. Therefore doctors' perceptions are another possible variable.

### FUTURE RESEARCH

Future research should focus on doctors' perceptions and knowledge of other diagnostic tools to see if it is a common factor with the findings of this paper. The literature on the effects of ADHD medication is lacking and should be bolstered, specifically the side effects and how many are truly affected, the long-term effects, and what children really think the medication is supposed to do, and what it actually does. Other questions include, why children stay on the medication when they want to quit and what the availability and offering of other treatment options is. All studies concerning ADHD should also try to minimize parental influence since it is shown as a strong reason for staying on medication, even if it is not working for the child.

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## „DAS BEWUßTSEIN DER GESICHTE:“ DER GEBRAUCH UND EINDRUCK VON OSKAR KOKOSCHKAS WELTANSCHAUUNG AUF SEINER FRÜHEN KUNST

GERMAN 499:

SENIOR CAPSTONE/SEMINAR WITH DR. SCOTT BAKER

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### ABSTRACT:

*Oskar Kokoschka was one of the leading artists in the Vienna Secession, or the Austrian Expressionist movement. Already in the early 1900s when he was only in his twenties, Kokoschka's innovative and self-taught technique helped him pioneer the Expressionist style in painting, poetry, and drama. In 1912 he also composed a short philosophical essay entitled "On the Nature of Visions." The essay explains his view that individual minds shape the world by collecting external images and rearranging them into visions; these personal visions then contribute to a collective reality. In this essay I explore how Kokoschka uses the philosophy expressed in "On the Nature of Visions" in his early paintings, his children's book "The Dreaming Youths," and in his play "Murderer, Hope of Women" to show how his world view helped him innovate the now familiar style of Expressionist art.*

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Am Anfang des 20. Jahrhunderts, stand die alte Österreichisch–Ungarische Monarchie kurz vor dem Aus. Die dünnen Faden, die dieses vielfältige Kaiserreich noch zusammenhielten, wurden bald in dem ersten Weltkrieg endlich zerbrochen. Aber in der Mitte des drohenden Sturms war die Hauptstadt Wien ein Zentrum innovativer Gedanken. Künstler, Architekten, Musiker, Psychologen, und Philosophen versammelten sich in Kaffeehäusern und diskutierten Ideen, die die ganze westliche Welt beeinflussten.

Einer von diesen einflussreichen Menschen war Oskar Kokoschka. Er war ein autodidaktischer Maler, dessen Gemälde den Anfang österreichischer Expressionismus markieren. Er war auch produktiv als Schriftsteller, und seine Gedichte und Dramen sind einige der ersten Beispiele expressionistischer Literatur. Sein innovativer Stil konzentriert sich auf die inneren Gefühle und die Erfahrung des Individuums im Gegensatz zu dem

konservativen Stil, der damals in Österreich üblich war, oder dem dekorativen Stil der Wiener Secession.

1912 schrieb der junge Kokoschka den Aufsatz, „Von der Natur der Gesichte.“ Darin beschreibt er seine Philosophie über die Verbindung zwischen dem Bewußtsein und unseren Visionen, und die Macht der eignen Seele auf der Welt. Die Philosophie führt nicht nur seine Absicht der Welt, sondern die Schöpfung seiner Kunst. Freilich, sein Glaube an die Wichtigkeit der eigenen Person half ihm, mit der Tradition zu brechen und den neuen expressionistischen Stil zu bahnen.

Hier werde ich analysieren, wie Kokoschkas frühe Kunst die Philosophie in „Von der Natur der Gesichte“ verkörpert. Ich beginne mit einer Erklärung des Aufsatzes, und dann beschreibe ich, wie diese Ideen in seinen Porträten, in seinem Kinderbuch *Die Träumenden Knaben*, und seinem Drama *Mörder, Hoffnung der Frauen* benutzt werden. Ich benutze nur Werke, die um der gleichen Zeit des Aufsatzes gemacht wurden, von 1907 bis 1912. Das ist nur ein kleiner Schnitt des Werks Kokoschkas, aber ich finde, daß die reine, echte Qualität seines frühen Werks seine Weltanschauung am besten repräsentiert.

Der Aufsatz beginnt so:

*Das Bewußtsein der Gesichte ist kein Zustand, in welchem man die Dinge erkennt oder einsieht, sondern ein Stand desselben, an dem es sich selbst erlebt. [...] Bewußtsein der Gesichte ist [...] Leben selber, welches von Bildungen, die ihm zuströmen, wählt*  
(zitiert in Hanlein 49).

Er macht sofort die starke Äußerung, dass nichts ohne das Bewußtsein existiert.

Die Welt ist kein ruhender Ort, den man beobachten und begreifen muss. Sie ist stattdessen eine Versammlung von Visionen, die er jeden Moment in seinem Bewußtsein wiederherstellt. (Kokoschka benutzt das Wort „Gesicht,“ das zweideutig sein kann. Ich nehme es hier an als „Vision,“ und nicht als die vordere Kopffläche.)

Der Prozess funktioniert so. Man wird ständig mit Abbildungen aus der Aussenwelt zerströmt, die dann das Bewußtsein beeinflussen. Der Mensch ist aber nicht untätig in diesem Prozess. Sein Bewußtsein wählt tätig aus diesen Abbildungen und arrangiert sie, wie es ihm gefällt. So sind seine Visionen eine Äußerung der Seele. Kokoschka vergleicht das

Bewußtsein mit einem ungeborenen Kind, das alle die Abbildungen der Mutter einverleibt, „ohne selber faßbar zu sein“ (Ibid. 49). Das Bewußtsein wird immer ausgestaltet und verändert, auch wenn wir es nicht bemerken.

Aber der Prozess hört in dem Kopf nicht auf. Kokoschka beschreibt, wie das Bewußtsein schrankenlos „in die Dinge aufgegangen, wie eingewirkt in die Gesichte“ lebt (Ibid. 49). Es ist kein Teil des Lebens, sondern Leben selber. Nichts mehr existiert allein, sobald es angeschaut wird. „Sie hauchen ihren Geist aus,“ sagt er, „wie die Lampe leuchtet und läßt vom Docht das Öl ziehen“ (Ibid. 51). Anders gesagt, die Dinge, die wir anschauen, speisen unsere Gesichte. Sie werden dann etwas ganz anders, aber nicht weniger wesenhaft.

Kokoschka führt die Metapher der Lampe bis zur Ende des Aufsatzes weiter. „Mir ist es vollkommen bewußt, gewiß,“ schreibt er, „daß ich es mir einbilde, was dort als Flamme brennt“ (Ibid. 51)! Dann endet er den Aufsatz mit einer Verbindung zwischen der persönlichen Einbildung und dem Leben überall:

*ich ziehe aus der Welt absichtslos etwas als Dinge empor. Dann aber werde ich nichts mehr sein als eine, Ihre, Einbildung. Dann ist die Einbildung in allen Dingen das, was natürlich ist. Dann ist Einbildung Natur, Gesicht, das Leben (Ibid, 51).*

Alles, was wir sehen, ist ein Produkt der Einbildung, ein Aufbau des Bewußtseins. Deswegen ist es aber nicht weniger. Im Gegenteil, die Einbildung wird Realität. Jeder von uns trägt zur kollektiven Einbildung bei, die das Leben ist.

Merkwürdigerweise erwähnt der Künstler in seinem Aufsatz nicht die Kunst selber. Für Kokoschka ist die Kunst nicht etwas Besonderes, etwas höher als das tägliche Leben, sondern eine Äußerung des Lebens. Als er jung war, interessierte er sich für die alltägliche Kunst der Laien im Wiener Naturhistorischen Museum vor der bildenden Kunst der alten Meister im Kunsthistorischen Museum. Und als er an die Uni ging, um Zeichenlehrer zu werden, wählte er die Kunstgewerbeschule, denn er „hätte nie daran gedacht, die Akademie der Bildenden Künste in Wien zu besuchen, in Samtrock und Barett als Künstler zu gelten“ (Kokoschka Mein Leben 49). Leben und Kunst waren eins und dasselbe.

Für Kokoschka ist der Künstler nicht wesentlicher als alle anderen im Prozess, die Welt mit dem Bewußtsein kreativ zu schöpfen. Jeder von uns trägt ständig zu der kollektiven Einbildung bei, die die Welt ist. Das

Leben selbst ist eine Äußerung des Bewußtseins. Der Künstler hat nicht mehr Kontrolle über die Welt als alle anderen. Er darf nur seine eigene Vision als Kunst darstellen. Der Einfluss des Werks hängt von dem Zuschauer ab, und wie sein Bewußtsein es zu benutzen wählt.

Und freilich, die Kunst Kokoschkas bis zu 1912, als „Von der Natur der Gesichte“ geschrieben wurde, folgt den Theorien seines Aufsatzes. Obwohl Kokoschka nur 26 Jahre alt war, war er schon berühmt für sein kühnes Werk, das den dekorativen Stil der Secession ablehnte, und den österreichischen Expressionismus heute definiert. Er wurde als Künstler ausgebildet, aber autodidaktisch als Maler, Dichter, und Dramatiker, und deswegen hatte er die Freiheit, seinen eigenen einflussreichen Weg zu bahnen. Seine Kunst, schrieb er später in seiner Autobiographie, war nichts mehr als „eine Basis zum Verständnis [seiner] Rolle in der Umwelt, die Selbsterkenntnis finden sollte“: eine Äußerung der Bewußtsein der Gesichte (Kokoschka Mein Leben 77).

Kokoschka ist für seine Gemälde am bekanntesten. Er hatte keine Ausbildung als Maler, sondern hatte seit Kindheit eine Begabung dafür, und malte Werke für die 1908 und 1909 internationale Kunstschauen in Wien. Der Architekt Adolf Loos hat das Talent des jungen Künstlers bemerkt, und wurde bald sein guter Freund und Mentor. Für viele Jahre förderte er Kokoschka als Maler mit Vergütungen für Porträten, die er fand. Durch die Vergütungen leistete sich Kokoschka ein Einkommen, und in seiner Kunst konnte er sich auf sein Lieblingssubjekt konzentrieren, die menschliche Gestalt.

In seiner Autobiographie beklagt Kokoschka das Fehlen von der menschlichen Gestalt in zeitgenössischer Kunst. Er wuchs während der Zeit der Maschine auf, und schaute die negativen Eindrücke direkt an, als der Beruf seines Vaters als Goldschmied überholt wurde. Er sah die Rückkehr zur Abstraktion als Furcht vor Abbildungen, und eine Ablehnung der menschlichen Erfahrung. Seine Gemälde konzentrieren sich häufig auf Subjekte, die direkt vor seinen Augen waren, wie Porträten, Stilleben, und Landschaftsbilder. Die persönliche Erfahrung und das Bewußtsein der Gesichte waren für ihn wichtiger zu malen als alles andere, genau wie in „Von der Natur der Gesichte.“

Kokoschkas frühe Gemälde sind am meisten Porträten, die er für Vergütungen malte. Er war aber unkonventionell als Porträtartist. Normalerweise vergütet man ein Porträt, sodass man als erfolgreicher, vortrefflicher, attraktiver Mensch erinnert würde. Das Porträt soll Information über seinen

Beruf, seine Gesellschaftsklasse oder Interessen zeigen. Die Porträten Kokoschkas zeigen aber nichts davon. Seine Sitzenden kommen wie Geister auf einem dunklen, schattenvollen Hintergrund vor, ohne die übliche Information – es gibt nichts zwischen einem Herzog und einem Schneider zu unterscheiden. Die Sitzenden sehen auch nicht ganz schön oder stoisch aus. Viele schauen quälend aus der Leinwand heraus, und bewegen ihre Hände heikel, als ob sie dabei wären, eine Geste zu machen. Alle die Gekünsteltheit der traditionellen Porträtmalerei ist weggelassen, und alles was übrig ist, ist der bloße Geist der Menschen.

Kokoschka hatte auch eine besondere Technik für malen. Der Sitzende, statt ganz ruhig für Stunden zu sitzen, durfte sich unbehindert bewegen und mit dem Maler sprechen, als ob er nicht bemalt würde. Keine gekünstelte Pose. Kokoschka war einer der ersten Künstler so zu malen. „Ein Mensch,“ sagte er, „ist kein Stilleben“ (Kokoschka Mein Leben 72). Seine Gemälde sind also keine Nachahmung einer einzigen Pose, sondern eine Zusammensetzung der Bewegungen, der Konversation, der ganzen Zeit, die Kokoschka mit dem Sitzenden geleistet hat.

In dieser Hinsicht ist die Methode Kokoschkas, Bilder zu malen, eine physische Äußerung des Prozesses, den er in „Von den Natur der Gesichte“ beschreibt. Während er ein Porträt malte, versammelte Kokoschka viele Abbildungen von dem Sitzenden, von denen er freiwillig wählte, was für ihn am wichtigsten war. Dann wie die Öl in einer Lampe, ernährte diese gewählte Gesichte seine Einbildung der Person. Das Porträt, das er dann malte, war eine physische Äußerung seines Bewußtseins, eine Verkörperung seiner Einbildung. Er versuchte nicht die objektive Realität nachzuahmen, denn für ihn gab es keine. Alles was er sah, alles was er malen durfte, war seine persönliche Vision .

Obwohl die Porträten aus dem Bewußtsein Kokoschkas kamen, wurden sie trotzdem ein Teil der Realität. Manchmal haben die Sitzenden ihre Porträten abgelehnt, weil sie ihnen nicht gefielen. Aber ein hundert Jahre später sind diese gleichen Porträten der beste, oder velleicht der einzige Weg, wie wir diese Leute erkennen. Diese Gesichte aus dem Bewußtsein Kokoschkas leben für uns alle fort, wie eingewirkt im Leben.

Ein gutes Beispiel ist Kokoschkas Porträt des berühmten schweizerischen Forschers Auguste Forel aus dem Jahr 1910. Forel war dann 62 Jahre alt und sehr einflussreich als Psychologe, Neuroanatom, und Myrmekologe. Er war noch beschäftigt mit Experimenten über Ameisen und hatte kein Interesse daran, sein Porträt gemalt zu haben, besonders von einem jungen österreichischen Künstler, von dem er nie gehört hatte.

Aber Loos überzeugte ihn, dass Kokoschka ihn abends beim Essen porträtieren durfte.

Kokoschka beschreibt die Erfahrung in seiner Autobiographie. Er wußte auch so wenig über Forel, wie Forel über ihn wußte, und beobachtete neugierig, während der Forscher sein kleines vegetarisches Essen aß und mit seiner Familie sprach. Kokoschka dachte, daß er peinliche Information über die sexuellen Probleme der Familie mithörte, und lernte nur später, daß sie tatsächlich die Experimenten Forels über Ameisen erörtert hatten. Manchmal schlief Forel ein, und dann, schrieb Kokoschka,

“could I really study the way he sat in his chair, and see how the wrinkles on his face increased and deepened. Suddenly he seemed ancient. Myriads of small wrinkles appeared, like the documents of a man’s life, and I felt that I must record them all, decipher them like old parchment and hand them on to posterity”

(zitiert in Hodin 97).

Am Ende lehnte Forel das Porträt ab, und man kann klar sehen, warum. Im Vergleich mit einem Foto Forels, das 14 Jahre später gemacht wurde, würde man denken, daß der Mann im Gemälde viel älter war. Im Foto hat Forel volle, runde Gesichtszüge, und ein Licht in den Augen, die Freundlichkeit oder Interesse zeigen könnte. Obwohl er 76 Jahre alt ist, sieht er gesund und lebendig aus. Aber Kokoschkas Porträt ist sehr anders. Die gleichen Gesichtszüge sind dünn und schleppend, wie die Wange, die Nase, und der Bart. Der Kopf sitzt auf einem leichten, geisterhaften Körper, der fast im dumpfen Hintergrund verschwindet. Nur eine leichte Außenlinie beschreibt seine Form, die fast nicht da ist. Er sieht physisch anfällig und erschöpft aus.

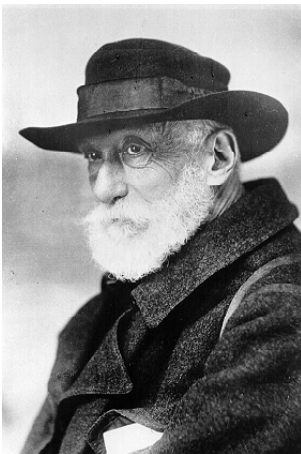


Figure 1: Auguste Forel, 1924



Figure 2: Kokoschkas Porträt Auguste Forels, 1910

Die Schwerpunkte sind aber die Augen und die Hände, die die Bedeutung des Porträts völlig ändern. Die Hände, obwohl arthritisch und misslich, machen eine vorsätzliche Geste. Sie und die großen, dunklen Augen zeigen das aufmerksame Nachdenken einer gesunden Seele. Durch diese kleinen Details, stellte Kokoschka den Genius Forels dar, wovon er nur aus seinen Beobachtungen wusste. Er unterstrich die Wichtigkeit der Seele durch die Hände und Augen im Kontrast mit der Abfälligkeit des alten Körpers.

Das Ziel Kokoschkas war offenbar nicht, eine genaue Kopie des Aussehens zu malen. Das Porträt ist auch keine schmeichelhafte Darstellung des Forschers wie das hübsche Foto links. Es ist stattdessen eine Verkörperung von Kokoschkas Bewußtsein der Gesichte. An den Abenden, die er mit Forel verbrachte, versammelte Kokoschka viele Abbildungen von dem Forscher. Er vergleicht den Prozess mit dem eines Naturforschers, der „Steine, Pflanzen und Fossilien untersucht, um Daten zu sammeln“ (Mein Leben 77). Dann wählte er die Abbildungen, die für ihn am wichtigsten waren, und machte eine Einbildung davon. Er faszinierte sich an den Leuten. Er wollte sie anschauen und begreifen. Dann, „für mich selber,“ beschreibt er, „wußte ich meine Einsichten nur im Malen auszudrücken“ (Ibid. 77). Das Gemälde ist eine Äußerung seiner Einbildung.

Es ist interessant, dass Kokoschka sich mit einem Naturforscher vergleicht. Ein Forscher soll Fakten finden und wissenschaftlich nachweisen, und wir sehen, dass Kokoschka sich um Fakten wie Aussehen und Beruf nicht kümmerte. Aber nach seinen Theorien in „Von der Natur der Gesichte,“ gibt es keine feste Fakten in der Aussenwelt, die wir finden können. Alles ist Einbildung. Man gestaltet selbst die Fakten im Bewußtsein. Sie sind nichts als eine Äußerung der Seele. Es folgt davon, dass alles, was man forschen kann, und alles, was er wissen kann, ist seine eigene Seele.

Und freilich schreibt Kokoschka in seiner Biographie, dass seine Malerei „eine Basis zum Verständnis [seiner] Rolle in der Umwelt“ war, ein Weg zur „Selbsterkenntnis“ (Ibid. 77). Er beschreibt Expressionismus selbst als die „Jugend, die sich in der Umwelt zurechtzufinden sucht“ (Ibid. 78). Seine Porträten sagen also mehr über den Künstler als den Sitzenden. Sie zeigen uns Kokoschkas Wahrnehmung einer Person, und wie sein Bewußtsein ihn einbildete.

Also ist Kokoschka vielleicht zu bescheiden wenn er glaubt, daß der Künstler nicht wichtiger als der Laie für das Bewußtsein der Gesichte ist. Die Kunst muss doch eine besondere Rolle in diesem Prozess spielen.

Wenn man ein Kunstwerk macht, macht er eine neue Abbildung, die



andere Leute dann in ihrer eignen Vision aufnehmen dürfen. Wohl bekannte Werke wie Kokoschkas erreichen mehr Leute, dürfen öfter von einem Bewußtsein benutzt werden, und spielen deswegen eine größere Rolle in der kollektiven Einbildung. Wir alle haben die gleiche kreative Macht, die Welt zu schöpfen, aber die konkrete Darstellung einer Vision, die der Künstler mit seinem Händen produziert, ist machtvoller als eine Vision aus dem Kopf.

Zum Beispiel, etliche Jahre nach dem Tod Auguste Forels, darf man noch sein Porträt aufnehmen und eine Vision von dem Mann formen, ohne Forel selber zu sehen. Aber diese Vision ist sekundär, und auf der Vision Kokoschkas aufgebaut. Dieses Gemälde spielt folglich eine größere Rolle als die Vision jemand anderes, die nicht physisch dargestellt wurde.

In der Zeit bis 1913 hat Kokoschka hauptsächlich Porträten gemalt, und sie haben alle einen verschiedenen Stil, abhängig von dem Sitzenden. Manche wie das Porträt Auguste Forels haben einen

dünnen Anstrich, durch den man die Leinwand sehen kann. Aber die Farbe auf dem Porträt Felix Albrecht Hartas (fig. 3) ist sehr dick mit klar definierten Pinselstrichen. Kokoschka experimentierte auch mit unüblichen Techniken. Manchmal benutzte er seine Hände mehr als einen Pinsel: Frau Forel sagte, dass er fast das ganze Porträt ihres Mannes mit den Händen gemalt hatte (Whitford 51). Er kratzte oft dünne Linien mit seinem Fingernagel in der Farbe, entweder um Haare zu zeichnen oder kleine Formen auf dem Hintergrund zu machen. Und auf dem Porträt Herwarth Waldens (fig. 4)



Figure 3: Felix Albrecht Harta, 1909



Figure 4 : Herwarth Walden, 1910

gibt es klare Fingerabdrücke in den Haaren und auf dem Nacken. Diese Vielfalt von Techniken ist velleicht das vorläufige Experimentieren eines jungen Künstlers. Später erstellte er eine beständige Methode für Malen, in der er viel mehr Farben und Pinselstreiche benutzte, und seine späteren Gemälde sind deswegen sehr laut und chaotisch. Aber seine früheren Techniken sind perfekt für Porträten, weil sie Kokoschka die Freiheit ga ben, die verschiedenen Persönlichkeiten

zu repräsentieren. Er malte nicht nach Routine oder Theorien, sondern durch Gefühl und Empfindlichkeit zu dem Sitzenden. Seine Gemälde sind tatsächlich ein unmittelbarer Bericht seines Bewußtseins der Gesichte.

Kokoschka hat früher in seiner Karriere nicht nur mit Techniken für Malen experimentiert, sondern auch mit verschiedenen Medien, um seine Vision darzustellen. Ein umwerfendes Beispiel ist das 1908 geschriebene Kinderbuch, *Die Träumenden Knaben*. Die Illustrationen darin demonstrieren einen dekorativen Stil, der sehr anders von dem seiner Porträten und anderer Gemälde ist. Der begleitende Text ist auch vielleicht das erste Stück expressionistischer Literatur. Aber trotz der Änderungen in Medien und Stil, behielt Kokoschka sein Bekenntnis zu dem Bewußtsein der Gesichte.

Kokoschka bekam einen Auftrag für das Buch von der Wiener Werkstätte, als er noch ein Student an der Kunstgewerbeschule war. Die



Figure 5: Die Schlafende Frau, 1909

Werkstätte war ein Teil der Wiener Secession, die sich auf die angewandte Kunst konzentrierte, und die eng mit der Kunstgewerbeschule zusammenarbeitete. Viele Werkstätte Mitglieder lehrten an der Schule, einschließlich Kokoschkas Professor Carl Otto Czeschka, der kleine Aufträge für seinen Student für die Werkstätte brachte.

Kokoschka malte Ansichtskarten und Fächer und lernte dadurch die Ästhetik der Secession.

Man kann den Einfluss der Secession in *Die Träumenden Knaben* klar sehen. Diese Bewegung war die österreichische Version des Art Nouveau, der damals in Westeuropa gültig war. Die acht Farbbilder haben die Musterung und die wiederholten floralen Ornamente, die für diese Periode üblich sind. Die dicken schwarzen Außenlinien und Farbenfläche haben auch eine flache, graphische Qualität, die von der angewandten, druckgraphischen Kunst der Zeit beeinflusst wurde.

Die visuellen Aspekte sind nicht nur zeitlich, sondern machen eine wunderliche Märchenstimmung. Obwohl die Drucke Lithographien sind, haben sie das rauhe, abgewinkelte Aussehen des Holztafeldrucks, das sich

völkischer und altmodischer fühlt. Kokoschka stellt eine Welt von bezauberten Wäldern und Meeren dar, in der kleine Walddiere und schöne blonde Mädchen wohnen. Ästhetisch hat er ein schönes Kinderbuch gemacht.

Aber die Stimmung des Buches wird völlig geändert, sobald man den begleitenden Text liest. Das formlose, Bewußtseinsstromgedicht ist nicht nur Kokoschkas erstes Literaturstück, sondern auch eins der ersten Stücke expressionistischer Literatur. Die Themen von Gewalt und Sexualität sind dunkel für so ein Buch, und die verwirrende Geschichte, gefüllt mit Symbolismus, ist schwer auch für Erwachsene zu verstehen. Mit diesem Text übersteigt Kokoschka wirksam die Genres des Märchens und des Kinderbuchs, und schöpft eine ganz neue, einzigartige Buchart.

Das Gedicht ist tatsächlich eine Geschichte über die verwirrenden, manchmal schrecklichen und manchmal schönen Erfahrungen der Pubertät. „nicht die ereignisse der kindheit gehen durch mich und nicht die der mannbarkeit/ aber die knabenhaftigkeit/ ein zögerndes wollen/ das unbegründete schämen vor dem wachsenden/ und die jünglingsschaft,“ schreibt er in der Mitte des Gedichts (Kokoschka Knaben). Der Erzähler beschreibt einmal, wie er ein rotes Fischlein tötet, und einmal, wie er am Abend ein Werwolf wird und ganze Dörfer verzehrt. Er tanzt für den König „die wünsche der geschlechter,“ und liebt ein junges Mädchen, das er auf seiner Silberdecke besucht (Ibid).

Durch Metapher und bildliche Darstellung veräußert Kokoschka alle die verschiedenen und staunenden Fühlungen der Pubertät. Er beschreibt eine Welt, die dunkel und gewältig ist, aber gleichzeitig schön und aufregend. Und die jungen Leute, die diese Erfahrungen haben, begreifen sie nicht. Sie können nur fühlen, obwohl es manchmal schrecklich ist. Kokoschka veräußert diese Fühlungen perfekt durch seinen schriftlichen Stil. Er benutzt keine Großbuchstaben oder Zeichensetzung, und die Sätze sind nicht nach grammatischen Regeln konstruiert. Ohne diese konventionellen grammatischen Grundsätze bringt Kokoschka den Leser in die Unmittelbarkeit der Gefühle, ohne Ordnung und Erwartungen. Der Leser erfährt mit dem Erzähler.

Der Text ist dann noch mächtiger neben den entzückenden Bildern im Buch. Die Bilder allein sind ein kindisches Märchen, aber die Wörter verwandeln sie in einem jugendlichen Alptraum. Es spiegelt die Erfahrung eines pubertierenden Kindes, das eines Tages aufwacht und findet, dass die Welt, die gleiche Welt, die er seit Geburt erkannt hatte, plötzlich etwas ganz anders ist. Obwohl die Bilder den Wörtern nicht genau entsprechen,

erhöhen sie den Text, weil sie eine andere Dimension zulegen.

Der Höhepunkt des Buchs kommt auf der letzten Seite. Statt die verhüllten, urbildlichen Charaktere, die wir in dem Rest des Buches sehen, gibt es hier die zwei nackten, mageren, kindischen Körper eines Mädchens und Knaben. Sie halten ihre

langen, dünnen Glieder heikel und unsicher. Sie sind schwach entgegen einander gedreht, und und obwohl sie separat auf ihren eignen getrennten Plätzen stehen wir, daß sie an einander denken. Neben dem Bild schreibt Kokoschka, „es ist fremd um mich/ jemand sollte antworten.“ Dann endet das Gedicht so: und ich war ein kriechend ding/ als ich die tiere suchte und mich zu ihnen hielt [...] und ich war ein taumelnder/ als ich mein f



Figure 6: Das Mädchen Li und ich, 1909

leisch erkannte/ und ein allesliebender/ als ich mit einem mädchen sprach.“ Die Kindheit ist jetzt vorbei, und der Erzähler akzeptiert sein neues Leben als ein „Allesliebender“ (Ibid.).

Vielleicht wegen des scheinbar persönlichen Inhaltes des Buchs glauben viele Gelehrte, daß *Die Träumenden Knaben* Kokoschkas eigene Erfahrungen der Pubertät und der ersten Liebe erzählt. Kokoschka selber schreibt in seiner Autobiographie, daß Knaben sein erster Liebesbrief an einer Mitschulerin in der Kunstgewerbeschule war. Er beschreibt sie als „eine junge Schwedin, die Lilith hieß,“ und die „einen roten, von Bauernhänden gewebten Rock“ trug (Mein Leben 52). Lilith war aber keine Schwedin. Sie war Österreicherin, und die Schwester Erwin Langs, Kokoschkas guter Freund (Whitford 25).

Gelehrte haben gefunden, daß Kokoschka viele Details in seiner Autobiographie vorsätzlich änderte. Für sie ist es vielleicht ein Problem, aber wir lernen dadurch, daß die Gefühle für Kokoschka viel wichtiger als die Wahrheit sind. Freilich, nach „Von der Natur der Gesichte,“ gibt es keine Wahrheit ohne das Bewußtsein. Wir schöpfen jeden Moment die Welt und unsere Erfahrungen. Kokoschka erkannte diese Freiheit, und benutzte sie dann, seine Erfahrungen wissentlich zu ändern. Er gestaltete einen

persönlichen Mythos, eine Geschichte, die nur halbwahr ist, aber die für ihn nicht weniger wesentlich war.

*Die Träumenden Knaben* ist also ein persönliches Märchen. Wie das Bewußtsein Abbildungen versammelt um eine Vision zu machen, manipuliert Kokoschka Grundsätze wie Ästhetik und Sprache, um eine neue Geschichte zu machen und ein Gefühl zu veräußern. Er benutzt den dekorativen Stil der Secession, aber flößte ihm eine expressive Macht ein, mit den zwei schlaksigen Teenagers auf der letzten Seite. Und er benutzt die traditionelle, wunderliche Ästhetik eines Kinderbuches, aber ändert die Bedeutung mit dem Gedicht. Anders gesagt, versammelt er Abbildungen aus seinem Leben und kombinierte sie so, daß sie etwas ganz anders werden, genau wie das Bewußtsein tut.

Das Gedicht ist auch ein gutes Beispiel dafür, wie Kokoschka Dinge aus dem Alltag benutzt, um etwas ganz anderes zu machen. Es gibt keine klare Geschichte, Zeit, oder Charaktere. Grundsätzlich ist es eine Versammlung von verschiedenen Abbildungen, wie sie dem Bewußtsein zerströmen. Sie kommen eine nach den anderen ohne klare Ordnung. Aber Kokoschka spielt die Rolle des Bewußtseins und wählt die spezifischen Abbildungen. Dann kombiniert und arrangiert er sie so, um etwas anderes zu machen. In seinen Händen wird diese Versammlung von visuellen und sprachlichen Abbildungen ein eindringliches Märchen über die Erfahrungen und Gefühle der Pubertät.

Und wie die Vision des Bewußtseins eine Veräußerung davon ist, ist *Die Träumenden Knaben* eine Veräußerung von Kokoschkas Bewußtsein. Entweder aus seinen eignen Erfahrungen, wie er sagte, oder ganz erfunden, brachte Kokoschka eine neue Vision in die Welt. Die Elemente, die er zu benutzen wählt, und wie er sie arrangiert, sind alle persönliche Entscheidungen. Sie haben ihre Geister ausgehaucht, um Kokoschkas Lampe der Einbildung zu leuchten.

Er wählte und benutzte nur was für ihn wichtig ist. Übliche Elemente wie Zeichensetzungen, Großbuchstaben, und Grammatik sind nicht da oder künstlich manipuliert. Es gibt ästhetische Elemente aus der Secession und Kinderbücher, aber mit überraschenden Wendungen. Kokoschka kümmerte sich nicht um Regeln. Alles, was für ihn wichtig ist, ist die Äußerung seines Bewußtseins, und er manipuliert die Regeln, um das zu tun. Diese visuellen und literarischen Teile verlieren ihre eignen Identitäten und nehmen die, die Kokoschka ihnen angab. Wie das Bewußtsein, wählte er aus den Abbildungen nur, was ihm gefiel.

*Die Träumenden Knaben* wurde an der Kunstschau 1909 verkauft.

Kokoschka hat auch für diese Kunstschau ein kontroverses Drama mit dem Titel *Mörder, Hoffnung der Frauen* geschrieben. Es war sein erstes großes Theaterstück, und er hatte nur wenig Geld und Probezeit, es zu schaffen. Aber trotz dieser Nachteile benutzte Kokoschka die gleichen Theorien wie in seinen Gemälden und seinem Kinderbuch, um eins der ersten und einflußreichsten expressionistischen Dramen der Zeit zu schaffen.

Wie wir schon in Kokoschkas Porträten und seinem Buch gesehen haben, kümmert sich expressionistische Kunst um den Ausdruck der inneren Gefühle. Sie schätzt das Subjektive über das Objektive, Einfühlung über Verstehen. Die Ergebnisse sind oft einsam oder unverständlich. Das ist vielleicht am sichtbarsten im Theater, wenn echte, bewegende Leute sich nur aus der Einfühlung erhalten. Man kann das Fehlen von Grundsätzen und Logik klar sehen, wenn man Leute wie er sieht, die sich so bizarr halten. Aber weil Kokoschka an die höchste Wichtigkeit der inneren Gefühle glaubte, war er der erste, der expressionistisches Theater völlig annahm.

Wie der Aufsatz und das Gedicht, die schon diskutiert wurden, ist dieses Drama ganz kurz aber sehr gehaltvoll. Es ist nur ein Aufzug mit zwei Hauptfiguren, der Mann und die Frau. Sie beide haben eine Gruppe von namenlosen, gleichgeschlechtlichen Gefolgsleuten. Sie alle treffen eines Nachts vor einer Festung, und was folgt ist ein schreiender, blutiger, dramatischer Kampf der Geschlechter.

Die Männer kommen in der Nacht an einem Turm mit einer großen gitternen Eisentür, den Schwerpunkt der Bühne. Sie sind von den Frauen in der Festung gesehen, und die zwei Gruppen beobachten sich neugierig und verlangend, und sprechen nervös und fürchtend mit einander. Dann im Augenblick befiehlt der Mann seinen Männern, die Frau mit seinem Zeichen in ihrem Fleisch zu brennen. Die Frau schreit und sticht den Mann mit einem Messer in die Seite ab.

Der Mann ist tödlich verwundet und fällt nieder. Seine Männer helfen ihm nicht, sondern stecken ihn in den Turm hinter das Gittertor und gehen in den Schatten mit den Frauen. Nur die Hauptfrau bleibt bei ihm. Sie verhöhnt ihn gemein, aber ist gleichzeitig besorgt über ihn. Dann liegt sie auf ihm durch das Gitter. Der Mann wird mächtiger, als die Frau schwächer wird, als ob er ihre Kraft nimmt. Schließlich steht der Mann auf und reißt das Tor auf. Er berührt die Frau, die einmal wieder schreit und im Tod niederfällt. Dann erschlägt er die Männer und Frauen und geht ab.

Das Drama hat keine klare Handlung, und die Charaktere handeln spontan, extrem, und ohne verständliche Begründungen. Der Dialog ist auch verwirrend und erklärt die Handlungen nicht, sondern macht sie unklarer. Kokoschka betont nicht die üblichen Elemente eines Dramas wie Sprache, Geschichte, und Charaktere. Wie in *Die Träumenden Knaben*, ist *Mörder, Hoffnung der Frauen* eine Versammlung verschiedener starker Visionen. Es war eine neue Art von Dramen, in der die auditiven und visuellen Aspekte eine Erfahrung statt eine Geschichte machen.

Und freilich, die Kritiker des ersten Vortrags beschreiben, wie das Drama von der Anschauung eines Malers gemacht wurde. Kokoschka hatte kein Geld für Kostüme und bekleidete die Schauspieler in Haderlumpen, dann malte ihre Haut mit Geäder und Nerven, als ob das Innen nach außen kam. Er lernte sie ihre Zeilen und die Tonhöhen, Rhythmus, und Ausdruckswandel dafür, weil der Ausdruck wichtiger als die Wörter selber war (*Mein Leben* 67). Es gab auch Lichter und ein Orchester mit Hörnern und Schellen. Die Zuschauer wurden mit Geräusch und Chaos überhäuft.

Viele Kritiker der Zeit beklagten, daß *Mörder* ein unverständliches Durcheinander von Schreien und Gewalt war. Die verwirrenden und gellenden Wörter waren nur Untertitel für die starken visuellen Abbildungen (Schvey 35-36). Aber das Drama konnte nicht mit dem konventionellen Durchschnitt verglichen werden. Kokoschka hatte einen neuen Theaterstil begründet, in dem die Wörter nicht so wichtig als die Gefühle, Ausdrücke, und Abbildungen sind.

Wie mit seinen Porträten und seinem Kinderbuch, benutzte Kokoschka seine Theorien über die Weltanschauung um einen ganz neuen Theaterstil zu machen. *Mörder, Hoffnung der Frauen* wird als das erste wahre expressionistische Drama gewürdigt. Er gab traditionelle Theaterelemente wie Struktur, Geschichte, und Charakteraufbau ab, weil sie für ihn die Gefühle nicht gleich ausdrücken könnten. Alles ist stattdessen ein Ausdruck des Inneren. Die Charaktere veräußern ihre Emotionen durch die Stimme und den Körper, nicht mit Wörtern. Ihre Geäder und Nerven kommen auch vom innen nach außen. Wie in Kokoschkas Porträten, fallen die gesellschaftlichen Konventionen weg, um den menschlichen Geist offenzulegen.

Dieser neue Theaterstil passt perfekt mit seinen Theorien in „Von der Natur der Gesichte.“ Im Leben, glaubte Kokoschka, bekommen wir keine Geschichte oder klar motivierte Charaktere. Es gibt nur Abbildungen, die wir sehen und erfahren ohne Verstehen. Alles andere ist ein Produkt

des Bewußtseins. Kokoschka ähnelt dem Leben in seinem Drama. Ohne die üblichen Teile der Erzählungskunst darf der Zuschauer nicht auf seine Erwartungen zählen. Er muss sich der Erfahrung überlassen und sich einfühlen ohne Verstehen.

Kokoschka wollte Leute sehen machen. Als er viel älter war, 1953, begann er eine Schule des Sehens in Salzburg, Österreich. In kurzen Sommerkursen lernte er seine Studenten und Studentinnen—jung und alt, Künstlern oder nicht—wie zu sehen durch Zeichnen und Malen. Aber für ihn war es egal, ob seine Studenten gut zeichnen und malen konnten. Sein Ziel war, daß sie die Welt echt sehen lernten, ohne Erwartung oder Verständnis. Er wollte ihre Weltanschauung ändern (Tate Gallery 40-49).

Sein Drama hat das gleiche Ziel. Ich habe früher gesagt, daß Kokoschka in *Mörder* dem Leben ähnelt. Aber ich habe auch gesagt, daß die Charaktere unrealistisch handeln, und daß der sterbende Mann das Leben aus der Frau saugt, wie mit Zauber. Die Aktionen sind freilich übertrieben und bizarr. Kokoschka hat sie so gemacht, weil er wollte, daß die Zuschauer sich auf Ansehen und Einfühlen konzentrierten. Jeden Moment baut man die Welt neu mit seinem Bewußtsein, aber durch die Jahre gewöhnt man sich an seiner Umgebung. Er verlässt sich auf seine alten Einbildungen und vergisst ehrlich zu sehen. In seinem Drama macht Kokoschka eine ganz unübliche Erfahrung für die Zuschauer, die sie in die Unmittelbarkeit des Moments bringt. Sie haben keine Illusion von Erkennen oder Verständnis. Sie müssen die Abbildungen sehen und aufnehmen ins Bewußtsein. Kokoschka ähnelt dann dem Bewußtsein der Gesichte.

Wie mit *Die Träumenden Knaben*, baute Kokoschka einen persönlichen Mythos um die erste Aufführung *Mörder, Hoffnung der Frauen*. In seiner Autobiographie beschreibt er ausführlich, wie er fast für Ruhestörung arretiert war, als eine Gruppe bosnische Soldaten mit dem Publikum ins Handgemenge während des Spiels geriet (66). Das Drama war anscheinend so kontrovers, daß die Zuschauer eine extreme und gewaltige Reaktion hatten. Der Polizeipräsident selber mußte gerufen werden.

Viele akzeptieren diese Geschichte als die Wahrheit, genau wie seine Beschreibung, daß Lilith Lang Schwedin war. Aber einige Gelehrte haben gefunden, daß es in allen den Kritiken keine Erwähnung von so einem Tumult gibt. Die Zeitungen nannten auch nichts. Vielleicht kam dieser Ablauf direkt aus Kokoschkas Einbildung. Aber für ihn war das kein



Problem, weil er glaubte, daß alles eine Einbildung ist. Bewußtsein ist der Ursprung aller Dinge, und wir wählen immer die Abbildungen, die uns gefallen, um die Einbildung zu fördern. Kokoschka erkannte diese künstliche Freiheit, die wir alle haben, und benutzte sie in seiner Kunst und in seinem Leben.

In allem, was er tut, war das Visuelle für Kokoschka eindeutig am wichtigsten. Es ist verständlich, dann, daß er hauptsächlich als Maler bekannt ist. *Die Träumenden Knaben* und *Mörder; Hoffnung der Frauen* waren seine frühen Experimenten in Literatur, die er später verließ. Aber mit seiner Perspektive als Maler konnte er seine Vorstellung in anderen Medien wie Dichtung und Theater benutzen. Wie in seinen Porträten, beobachtete er die lebende, atmende Welt um ihn, als ob sie eine Person war. Er versammelt seine visuellen Eindrücken und kombiniert sie, um seine persönliche Erfahrung auszudrücken. Im Prozess begründet er neue Arten von diesen Medien, die heute Expressionismus definieren.

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## **SOCIAL AND ECONOMIC EFFECTS OF URBAN RENEWAL IN KANSAS CITY, MO: CENSUS TRACTS 24 AND 33**

*SOCIOLOGY 431:*

*SOCIAL ORGANIZATION OF THE CITY WITH DR. SOOKHEE OH*

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### **ABSTRACT:**

*In an effort to revitalize urban cores, and to maintain competition with rapidly rising suburbs, the federal government equipped cities with new tools in the mid-20th century. But the federal government's redevelopment plans focused primarily on highway development and land clearance and this focus has led to a breakdown of urban districts with vibrant, active neighborhoods and gave rise to concentrated and cyclical poverty, and a concomitant rise in business flight from urban centers. This paper focuses on the outcome of urban renewal projects in Kansas City's census tracts 24 and 33.*

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Slowed growth in urban cores, clamoring property owners, downtown business elites, urban blight and booming suburbs all convinced the federal government that large scale urban renewal was necessary to save the city from obsolescence. The result from urban renewal projects on Kansas City's east side has concentrated poverty, destroyed the urban fabric, reduced density and left a community with less agency than compared to pre-urban renewal.

Communities anchor us to resources and social networks. They provide us the social organization needed to boost individual agency and improve our neighborhoods, lobby for scarce resources, and also empower us to ward off undesirable developments or troublesome vagrants. The residential neighborhoods are where stability, diversity, interaction and healthy living must take place. The city builds a sturdy tax base and houses its educated, marketable workforce in residential neighborhoods. It is because nearly everyone can understand the deep bond we all share with place that makes the local and federal government's urban renewal policies so pernicious. The federal urban renewal policies displaced many, destroyed much and helped few. The government has encouraged

development that is counter beneficial to our urban centers. The federal government's answer to fixing the urban decline, such as dilapidated housing, blight and neglect, was highway development and land clearance, which did little to create a better urban environment and disproportionately affected those who were of a lower socioeconomic class. Furthermore, the government, through its actions, has weakened the resource structure of those in areas affected by urban renewal, thus crippling their social agency to combat damaging urban policy. The end result of urban renewal was the creation of concentrated and perpetual poverty and neighborhoods with little social agency.

This case study will examine census tracts 24 and 33 abutting Kansas City's central business district (CBD), home of several urban renewal projects, to understand how urban renewal policy affected these neighborhoods and residents. Census Tracts 24 and 33 are bound by 9th Street on the north, Prospect Avenue on the west, 23rd Street on the south and Cleveland Avenue on the east. These census tracts have experienced both large and small scale projects that were meant to reverse urban decay and spur reinvestment. The two largest undertakings were the interstate highway (I-70) and the nearby Wayne Minor Court public housing projects. I will provide an overview of federal urban renewal policy and examine the census tracts before, during and after urban renewal programs to understand the influence of federal policies on residents and neighborhoods in census tracts 24 and 33.

### **EFFECTS OF FEDERAL URBAN RENEWAL POLICY**

In response to suburbanization and urban decay, the federal government empowered cities with new tools to combat the dilapidation of housing, spur new development, and appease downtown stakeholders by giving eminent domain powers to municipalities in order to facilitate land clearance and highway building.<sup>1</sup> This was an attempt to level the playing field with suburbia where land clearance and blight were not barriers to development.

The Land Clearance for Redevelopment Authority (LCRA), empowered by the American Housing Act of 1949, was created in 1953 and spearheaded the Kansas City effort to remove blighted properties.<sup>2</sup> Several urban renewal districts around downtown were created and eventually the entire CBD was slated for redevelopment. The city manager advocated using the LCRA in order to speed the construction of highways into downtown and use the urban renewal funds to construct segregated public

housing for the displaced residents.<sup>112</sup> This process would clear large tracts of land and transfer property to new owners for redevelopment. In 1952 Mayor William Kemp proclaimed that the LCRA would create space for parking and city planners saw redevelopment as a way to retrofit the urban core to suburban standards in order to stay competitive.<sup>3</sup> All this was done in the name of financial stabilization with emphasis on the privatization of the urban core.

During the 1940s middle class consumption and social mobility were very high. Growing mobility would continue into the 1950s and 1960s with the government subsidizing sprawl development with FHA loans and municipality-bonded infrastructure on the fringe.<sup>4</sup> As the socially and spatially mobile left the city for suburban living, a cycle was created in which the city and the people who remained in the newly economically drained neighborhoods would be victim. As new roads and highways were created to accommodate the wealthy commuters, even more development would appear on the edge. Soon businesses would follow and previously healthy urban neighborhoods would be in decline without economic capacity to support retail markets or other commercial services. Kansas City, needing to reverse this decline, cleared land for highway construction and built housing projects to relocate the displaced in segregated neighborhoods. This was the fix and it culminated in the development of Wayne Minor Court public housing, Interstate 70 and the South Midtown Expressway (US 71).

### **MAKING OF AN UNDERCLASS: CENSUS TRACTS 24/33**

I start with the 1950 census and gather key economic statistics on residents and the neighborhood. Comparing this data with the 1970 and 2000 census it is obvious that tracts 24 and 33 were not stabilized in the 1950s during urban renewal. In fact the opposite can be said of this area as population, home value, vacancy, unemployment, and income have all fallen in the area when adjusted for inflation to 2011 dollars.

First we examine the loss of population and housing units. This is important for a community, as William Julius Wilson writes, “Lower density makes it harder for a sense of community to develop or for people to feel that they can find safety in numbers.”<sup>5</sup> The area’s increasing joblessness and vacancy have an effect on those residents who remain. Wilson also studied the decline of urban neighborhoods such as tracts 24/33 and found that 71% of residents felt their neighborhood had deteriorated and gotten worse.<sup>6</sup> Wilson also notes the psychological effect joblessness has on a

community and the worry residents have for personal belongings.<sup>7</sup> Joblessness and poverty lead to low levels of social organization. High rates of unemployment lead to community problems that cripple social organization such as crime, gangs, drug trafficking, and broken families.<sup>8</sup> These elements link poverty, the underclass and the culmination of divisive housing policy during urban renewal.

**BY THE NUMBERS:**

Only 31% of 1950 housing units exist today. Since 1950 there has been a 465% decrease in population. Even with fewer housing units, vacancy has soared from 1950 levels to well over the state average of 12%. By comparing the numbers it seems that in 1950, census tracts 24/33 were far more prosperous and stable than in 1970 thru 2000.

The housing vacancy rate of the tracts was very healthy, under one percent, in spite of the fact that the area’s average household income was 66% of the national average. So as time and investment went on, the housing units in the tracts decreased in number and value. This is counter to the belief that the massive slum clearing of the 1960s would elevate the area economically and socially.

<b>Census Tracts 24/33</b>	<b>1940</b>	<b>1950</b>	<b>1970</b>	<b>2000</b>
Population	8563	9311	4550	2003
Housing Units	2731	3051	1980	948
Owner Occupied	28%	45%	43%	38%
Vacant	9% (247)	0.8% (26)	16% (314)	19% (175)
Average Rent: Mean of 24/33	\$ 264.30	\$ 236.00	\$ 240.00	\$ 344.00
Home Value: Mean of 24/33	\$ 23,874.00	\$ 31,725.00	\$ 31,067.00	\$ 22,780.00
Unemployment	16%	4.70%	8.70%	9.2%
Average Household Income		\$ 16,295.00	\$ 27,574.00	\$ 22,142.00

*\*All figures adjusted for inflation to year 2000 dollars. (US Census)*

As those with money left the city, it was only a matter of time before the jobs and other resources would follow. When the income levels of neighborhoods plummet it generally starts a downward spiral that is difficult to reverse. First, the commercial services that made central city neighborhoods so convenient left to be in a more desirable demographic. The mean household income of census tracts 24 and 33 is 43% of the average American household income. As the wealthy corporate decision makers invested in suburban edge nodes it became desirable to relocate

larger commercial offices around their homes and increasingly their suburban workforce. This decentralizes the city, making its core less relevant. The heterodox approach to economics suggests that if one's social structure is weakened then it also adversely affects one's power and the distribution of resources. Douglas Massey and Nancy Denton wrote "in a market such as the United States opportunities, resources, and benefits are not distributed evenly across the urban landscape, certain residential areas have more prestige, greater affluence, higher home values, better services, and safer streets than others."<sup>9</sup> It was, in part, government action that was crippling urban neighborhoods and facilitating the spread of wealth to the fringe, which led to segregating the less socially and spatially mobile class of people in urban cores. The segregation that the Housing Authority of Kansas City used to locate and house residents along with their poverty status created an underclass in census tracts 24 and 33.<sup>10</sup>

As wealth and employment opportunities left the city, neighborhoods were left with less powerful representation and influence to obtain much needed assets. Cities need the middle class tax base to be viable. It is the middle class who have the means to purchase homes, support commercial services and sustain large businesses as well as provide the city with a well educated, able-bodied work force in order to be competitive with competing centers.

By the 1940s the federal government was finally involved in developing public, low-income housing. The government's intentions were to stabilize cities and reverse blight and population loss. However, with the passage of the 1949 Federal Housing Act, the government set new requirements and standards for building.<sup>11</sup> The new housing act mandated that towers be uniform in stories and set generic plans with cost-cutting initiatives. Moreover, the financial management rules imposed by the government stated that rents must cover maintenance and staked the success of these projects on the shoulders of the low-income tenants and their ability to generate income.<sup>12</sup> The government did little to increase the resources available to the lower-class residents and for residents of these large superblock complexes life became challenging. In Kansas City the only high rise development under urban renewal was the Wayne Minor Court housing projects. It was made up of five 10-story towers located between 9th and 11th Streets and Woodland and Brooklyn Avenues. Wayne Minor was built to house the displaced black residents affected by land clearance and highway building. The projects developed a poor reputation of inadequate maintenance, mismanagement, financial difficulties and



neglect.<sup>15</sup> Wayne Minor's reputation was not helped when two buildings were condemned and the other three buildings' top floors were shuttered due to low occupancy.<sup>14</sup> Vandalism and security in the area became a concern and eventually the poor refused to live in them. Occupancy rates in the projects never surpassed 60% and the housing development was destroyed less than 30 years after it was built.<sup>15</sup> The development was created to rid the area of blight but ended up creating new problems. The demolition erased 650 residential units that were never replaced. Instead, the former residents were forced to utilize the Section 8 housing program or fend for themselves in the open market. Today Wayne Minor public housing is a series of townhomes along 11th Street. After the demolition, the Housing Authority of Kansas City conceded that high-rise residential units cannot work for low-income, Kansas City families. Even when faced with the evidence of poor management and inadequate maintenance, the housing agency could not admit to doing the community an injustice by allowing and concentrating substandard housing in the community. Today the Kansas City Housing Authority is in receivership after a federal judge noted that the agency was the worst run in the nation.<sup>16</sup>

Today tract 33 is 92% black and tract 24 is 50% black and the mean income of both tracts is 34% below the national average. The concrete and steel erected through the urban renewal process did little to address the social and economic complexities that hinder the success of black and mixed-race urban communities. Instead of equity and advocacy planning, the government pursued the interests of property owners over those of everyday residents, both black and white. The result is a homogenous concentration of the underclass with little agency for change and without true advocacy. Without investing in social causes and human capital the redevelopment of buildings will never address the root of inequity and basic human civil rights.

### **HIGHWAY POLICY**

When it comes to the government attempting to fix urban issues, one Band-Aid commonly applied was the highway. The highway became a two-pronged answer for urban issues; it permitted the further consumption of houses and land by the middle class as well as a way to destroy perceived blight in cities. Today, one can go to any major American city and see the result of our Interstate system on our cities. Most downtowns are choked off or disconnected by the presence of highways. Neighborhoods have become less pedestrian friendly, marked with dead ends or polluted by their noise

or unsightliness; this is especially true in census tracts 24 and 55. Highways divide communities; they also have become political dividers in that they allow residents to quickly pass through urban communities without any engagement. High priority was given to highway construction in the past to create middle-class jobs and to facilitate the middle-class lifestyle.<sup>17</sup>

The resulting new interstate system, funded 90 percent by federal money, had devastating effects on American cities. The new highways enabled industry and commercial activities to leave the city and build in the suburbs following people and further deepening the problems of the city with abandonment and a declining tax base.<sup>18</sup> The new highway system was developed by supporters of the decentralization of people and jobs. They wanted a way to bypass the urban areas and to create a car-dependent culture. Urban planners of the day such as Robert Moses and others advocated that highways should penetrate the heart of the city and remove blight and improve accessibility to and from the suburbs.<sup>19</sup> The same attitude was present in Kansas City. A large portion of the 1947 Kansas City Master Plan is devoted to highway and arterial street building with seemingly little concern for the area but with great concern for those who needed to bypass it.<sup>20</sup> A 1946 traffic study showed planners that 40% of the traffic in the central business district was passing through the district with a destination beyond downtown. Combined with increasing investment in suburban areas and increasing auto ownership, Kansas City was hedging its bets and positioning itself for federal highway funds.<sup>21</sup> Planners and governments seemed to be disinterested in the effects of the highway system on those remaining in the city.<sup>22</sup>

Suburbanization aided by urban renewal has economically and racially segregated us. Today 86 percent of whites live in a neighborhood where minorities make up less than 1 percent of the population.<sup>23</sup> The federal policies have led to a decline in our cities and less options for those of a lesser economic class.

It is not solely the presence of highways and suburbs that have further disadvantaged urban residents; wealth was been pulled out of urban neighborhoods. Those with strong resource and cultural structures have powerful agency to cause change and influence. And those with weaker resource and cultural structures have little agency to improve things. So it is reasonable to acknowledge that the actions that have weakened the central city have also weakened the agency of those living there. Those of lesser economic status were not aided by the policies or subsidies of the federal government's urban renewal. The government catered to those with

the power of consumption and was not concerned with the effects on the lower class and what future was developing for them or our major cities. The federal government's policies tried to fix major urban issues with massive demolition and highway construction during urban renewal, which has led to creating new and complex problems in the city. These policies contributed to the development of sprawling suburbs and concentrated poverty. It is important that the government strengthen its focus and position on reversing decline in the urban core while moving to strengthen our cities with not just investment in infrastructure but in people as well.

## ENDNOTES

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- <sup>1</sup>Gotham, Kevin. *Constructing the Segregated City*. Lawrence, KS: University of Kansas, 1990. Pg 269.
- <sup>2</sup>Gotham, Kevin. Pg 156.
- <sup>3</sup>Gotham, Kevin. Pg 158.
- <sup>4</sup>Gotham, Kevin. Pg 157-9.
- <sup>5</sup>Gans, Herbert. *The Levittowners: Ways of Life and Politics in a New Suburban Community*. New York: Columbia University Press, 1967. Pg 14.
- <sup>6</sup>Wilson, William Julius. "From Institutional To Jobless Ghettos." 1996: 126-135. Pg 131.
- <sup>7</sup>Wilson, William Julius. Pg 129.
- <sup>8</sup>Wilson, William Julius. Pg 129.
- <sup>9</sup>Wilson, William Julius. Pg 133.
- <sup>10</sup>Massey, Douglas, and Nancy Denton. "Segregation and the Underclass." In *The Urban Sociology Reader*, by Jan Lin and Christopher Mele, 134-143. New York: Routledge, 2005. Pg 139.
- <sup>11</sup>Massey, Douglas & Denton, Nancy. Pg 138.
- <sup>12</sup>Hall, Peter. *Cities of Tomorrow*. Third. Malden, MA: Blackwell, 1988. Pg 257.
- <sup>13</sup>Hall, Peter. Pg 259.
- <sup>14</sup>Gotham, Kevin. Pg 138.
- <sup>15</sup>Mincer, Jilian. *National Notebook*. March 8, 1987. <http://www.nytimes.com/1987/03/08/realestate/national-notebook-kansas-city-mo-failed-project-is-demolished.html> (accessed April 7, 2011).
- <sup>16</sup>Mincer, Jilian.
- <sup>17</sup>Gotham, Kevin. Pg 317.
- <sup>18</sup>—. "Growth Machine Up-links: Urban Renewal and the Rise and Fall of a Pro-Growth Coalition In a U.S. City." n.d.

<sup>19</sup>Phillips, E. Barbara. *City Lights: Urban-Suburban Life in the Global Society*. New York: Oxford, 2010. Pg 451.

<sup>20</sup>Hall, Peter. Pg 317.

<sup>21</sup>City, City of Kansas. 1947 Master Plan. Planning Document, Kansas City: Unknown, 1947.

<sup>22</sup>City of Kansas City.

<sup>25</sup>Hayden, Dolores. *Building Suburbia: Green Fields and Urban Growth 1820-2000*. New York: Vintage Books, 2003.

<sup>24</sup>Phillips, Barbara. Pg 554.

## THE NECESSITY OF CHOICE: REFLECTIONS ON FILM AND HISTORY IN OCCUPIED EAST- CENTRAL EUROPE

HISTORY 400CZ:

THE OTHER EUROPE: HISTORY AND CULTURE FROM THE BALTIC TO THE  
BLACK SEA WITH DR. ANDREW BERGERSON

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### ABSTRACT:

*Using the tragic-heroic archetypes of Achilles and Hamlet, this paper examines the nature of choice in the real and imagined lives of two individuals living in Nazi-and-Soviet-occupied East-Central Europe: Maciek, a fictional character in Andrzej Wajda's celebrated post-war film Ashes and Diamonds, and Rudi, an historical person examined in Andrew Stuart Bergerson and Maria Stehle's "Rudolph Mosaner's 'Wanderjahre.'" An interdisciplinary, comparative analysis of these dramatic figures yields insights into the nature of human agency and the necessity of choice, especially in vital situations. Ultimately, for human agents, acceptance or refusal of choice itself may be equally important to particular decisions between two or more morally weighted options.*

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Philosophy, one will recall, literally means *a love of wisdom*. Wisdom, of course, is not the acquisition of information for its own sake, but knowledge in action—*knowledge applied*. In other words, wisdom is intimately related to choice. While philosophers since Plato have often reflected on choice, they have not been content to merely develop procedures for arriving at the best of two or more options. They have also insisted on the importance of examining the nature of choice itself. While *what* (content) and *how* (method) are irreducible considerations of a problem for all human agents, equally important is the question of *why—why choose at all?* Illustrating the problem of agency through tragedy, philosophers and dramatists have bequeathed to us a wisdom that insists on the *necessity of choice*. The personal successes and failures of tragic heroes like Achilles and Hamlet, as well as real historical persons closer to our own time, are replete with lessons concerning choice. Drawing from both art and life, this paper will use the traditions of philosophy and tragedy to examine the nature of choice in a modern context. Through

interdisciplinary lenses, I will show how issues of choice connect literary figures like Achilles and Hamlet to the 1958 classic Polish film, *Ashes and Diamonds*, and Andrew Stuart Bergerson and Maria Stehle's historical article about a German soldier during World War II, "Rudolph Mosaner's 'Wanderjahre.'"<sup>1</sup> Critical reflection and comparison of these narratives will demonstrate that refusing choice condemns one to an undignified end and a fate worse than death.

In a lecture given in 2005 and later republished as *Philosophy in the Present*, French philosopher Alain Badiou insists that philosophy cannot have something to say about every problem. Because a philosopher is someone who decides what important problems are or invents new problems, a philosopher cannot be asked "on television, night after night, what he thinks about what's going on."<sup>2</sup> In other words, only problems with particular features provide a situation for philosophical intervention. For example, a philosopher might find a situation worthy of reflection or examination if the situation elucidates a choice. Badiou illustrates such a situation by retelling the argument between Socrates and Callicles in Plato's *Gorgias*. In this dialogue, "the thought of Socrates and that of Callicles share no common measure, they are totally foreign to one another."<sup>3</sup> On one hand, Callicles argues that "might is right," that justice is "cunning and violence" and that "the happy man is a tyrant." On the other, Socrates argues that the happy man is the virtuous man, the "true man" and "the Just."<sup>4</sup> Badiou argues that between the two lines of thought, "justice as violence" and "justice as thought," there is no common relation. Thus Plato's dialogue presents not a discussion, but a confrontation. And faced with this situation, the task of philosophy "is to show that we must choose."<sup>5</sup>

Tragedy also emphasizes the necessity of choice, even if human freedom seems limited when confronted with fate. Over time tragedians have developed two tragic-heroic types—those who fail because of a mistaken choice but retain their dignity, and those who fail because of indecision and are condemned to an unsympathetic end. In the Greek tradition, Achilles represents this former kind of hero. During a particularly intimate scene in the *Iliad*, Achilles refuses to fight the Trojans because he has been publicly dishonored by one of his allies, the Greek warrior-king Agamemnon. Idle in camp, the usually fierce Achilles shows a rare moment of existential contemplation and vulnerability. He reflects that there is little glory in war and that death in combat is senseless. Although sincere, Achilles' doubts are short lived. Even though his death was predicted both by oracles and by his enemy, Hector, Achilles refuses to return to his home-

land where he foresees living into old age. After the death of his best friend Patroclus, a newly ennobled Achilles returns to battle and defeats Hector and the Trojans, winning great glory. While the *Iliad* does not recount Achilles' death, Greek tradition holds that he was later killed by Paris, which establishes Achilles as a tragic hero. Juxtaposed with his ultimate fate, an early death, Achilles' earlier moment of introspection and doubt evidences his agency. Confronted with a difficult fate, Achilles chooses a path of courage and glory—important virtues of the Greeks—and is thusly remembered.

The most famous tragic hero of the latter category—the tragic hero embodied by one who *fails to choose*—is not from Greek but rather Shakespearean tragedy. This is Hamlet, Prince of Denmark, the angst-ridden protagonist of the play that bears his name. Faced with the knowledge that his father has been murdered by his uncle, Hamlet becomes erratic, melancholic, and indecisive. He toys with his lover, Ophelia, sometimes approaching her with tenderness, and other times with rage. In one scene he famously screams for her to leave: “Get thee to a nunnery!”<sup>6</sup> Eventually he drives her mad and she takes her own life. Hamlet's soliloquies are notoriously ridden with anxiety and indecision: “to take arms against a sea of troubles” or “to die.”<sup>7</sup> Ultimately, his downfall is the result of his own fence-sitting on whether to avenge his father by killing his uncle, Claudius. Hamlet's indecisiveness allows for his enemies to conspire to kill him, and although he avenges his father's death, he dies needlessly while performing the act, his flesh ripped open by a poisoned rapier. While the deaths of Achilles and Hamlet are both in some ways senseless, Achilles is redeemed because of his decisiveness and embodiment of courage in the face of fate. Hamlet's downfall is unsympathetic—his death by no means inevitable and is effectuated primarily because he repeatedly denies his own power to choose.

In many ways, the protagonist Maciek in Andrzej Wajda's 1958 film *Ashes and Diamonds* is analogous to the tragic-heroic archetype exemplified by Achilles. The film is set in a small town in Poland on the last day of World War II. Maciek, a member of the Polish resistance, has been given an order to kill a local Communist official named Szczuka. The first assassination attempt is botched when Maciek and his partner Andrzej shoot up a car full of cement plant workers they mistake for Szczuka's entourage. Andrzej, Maciek's superior officer, then receives further orders that Maciek is to finish the job while he himself will be transferred elsewhere. At this point the film takes several detours.

Maciek has a brief love affair with Krystyna, the barmaid of the hotel, and the relationship gives him pause to consider his occupation. In a scene reminiscent of Achilles' existential reflection, Maciek expresses doubts about his occupation as a soldier to Andrzej, and he asks what they are fighting for. Andrzej coldly replies that Maciek will be considered a deserter if he does not kill Szczuka and reminds him of the Polish cause. In the end, an emboldened Maciek maintains fidelity to the Polish resistance, killing the Communist official in a dark street while fireworks erupt commemorating the end of the war against the Nazis. The film draws to a close as Maciek is unexpectedly and senselessly shot by Polish soldiers and momentarily wraps himself in a white linen sheet hanging from a clothesline. The image of the blood-soaked cloth evokes the red and white of Poland's flag, cementing Maciek's status as a hero, if a somewhat ironic one. Like Achilles, Maciek represents a man of action caught in a universe of moral confusion and violence. Unable to escape death, he forgoes the chance of love and domestic life for higher virtues and the cause of his nation. The lesson of the tragic hero embodied by Achilles and Maciek is that although we may not be able to choose how we die, we have to opportunity to choose for what we live.

To return to Badiou, the narratives of Achilles and Maciek are philosophical situations because they present the protagonists with choices that bear no relation. Between the call of love and the call of duty there is no common measure. As agents each must choose and as an audience we must also choose. The importance of these stories lies less in the particular content of the choices of their protagonists than in the act of choice itself. In other words, one may not agree with Achilles and Maciek and still respect *that they chose*. The second kind of tragic-hero, Hamlet, however, refuses to choose. He drives his lover mad, causing her to take her own life, and then he loses his life himself. This kind of tragic hero—someone who refuses to choose when confronted with a difficult problem—has historical counterparts, and can be seen as an archetype of many collaborators of genocide and oppression during Nazi and Soviet occupation of East-Central Europe during World War II. Far more prevalent than hard-line, orthodox followers of Nazi or Stalinist ideology were “non-ideological” people who collaborated in oppression or genocide with the occupying regimes—in other words, those who chose neither active participation nor resistance.

An historical example of such a person may be found in Andrew Stuart Bergerson and Maria Stehle's article, “Rudolph Mosaner's



‘Wanderjahre.’” The article recounts the autobiographical testimony of Rudolph Mosaner, or Rudi, on his life in Europe during the Nazi occupation. The central thesis of Bergerson and Stehle’s work is that Rudi, a soldier in the German army, employed irony both during and in the retelling of the events of this period of his life to “negotiate complex ethical-political postures that preserved a sense of moral distance” from the violence in which he was complicit.<sup>8</sup> In his testimony, Rudi consistently downplays the violence for which he was either complicit, participatory, or a beneficiary. In Rudi’s account he breaks rules, mocks his commanders, and depicts himself as a “habitual nonconformist and ironic trickster.”<sup>9</sup> Rudi himself is never at the center of violence. Consider Rudi’s testimony of a period during which he was attached to a motorized unit traveling through Belgrade, Budapest, and Croatia. Although historical evidence suggests his unit was involved in violent encounters, Rudi omits description of any military engagements whatsoever and claims that “the fighting was concluded by the time his unit arrived and that the SS were responsible for most of the destruction.”<sup>10</sup> Bergerson and Stehle note that such rhetorical maneuvering was common in postwar recollections, a “largely untenable distinction between the ideologically committed, genocidal SS units and the politically indifferent, military minded *Wehrmacht*.”<sup>11</sup> Furthermore, Bergerson and Stehle insist that Rudi’s irony was not simply a post-war affectation to hide his complicity with Nazism; rather, Rudi used irony to survive on a daily basis *during the war*. For Rudi, irony was a defense mechanism used to obscure his own refusal to choose—neither active participation nor active resistance to the Nazis. Rudi’s ironic posture and selective omission of particular historical events in his testimony evidences that he felt a sense of guilt over this refusal. While denial of choice drove Hamlet mad, Rudi was able to maintain such denial and his sanity and continue living by cultivating a pathology of ethical avoidance with irony at its heart—behavior in effort to achieve what Bergerson and Stehle dub a form of moral *sovereign impunity*.

All of these characters—Achilles, Hamlet, Maciek and Rudi—were trapped in a fatalistic universe. For each of them death lurked in the shadows, around the corner or just over the next hill. While the fates of Achilles and Maciek are lamentable, their acceptance of personal agency is commendable. Not so for Hamlet and Rudi. Rudi largely fits the Hamlet model of tragic hero, except that he did not die, as many did, on a battlefield in Europe. He survived into old age and dies of natural causes. In a sense, this makes Rudi’s fate even more tragic. Through Rudi’s autobiographical

interviews at the end of his life, upon which Bergerson and Stehle's article is based, we witness a demise worse than death in the usual sense. To borrow from another literary tradition, Rudi had become a *qelipot*, a Kabbalistic term which refers to the husks of the dead—the condition of a body that goes on after the loss of its soul.

Today, many contemporary historians work towards non-ideological or non-metaphysical interpretations of history. Well-intentioned they may be, their insistence on neutrality merely obscures various ideologies operating just under the surface of their work. Historians must aim beyond the construction of factual narratives. Drawing from traditions like philosophy and tragedy, they must understand the relationship of the narratives they construct to the archetypal narratives upon which we humans organize our personal identities and social relations. Truth is important, but no less important is *truth-effect*—history means nothing if it does not compel the transformation of life.

#### ENDNOTES

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<sup>1</sup>Alain Badiou and Slavoj Žižek, *Philosophy in the Present* (Malden, MA: Polity Press, 2009).

<sup>2</sup>Badiou, 2.

<sup>3</sup>Ibid., 5.

<sup>4</sup>Ibid., 4.

<sup>5</sup>Ibid., 5.

<sup>6</sup>Hamlet, Act III, Scene I.

<sup>7</sup>Ibid.

<sup>8</sup>Andrew Bergerson and Maria Stehle, "Rudolph Mosaner's 'Wanderjahre': Irony and Impunity in Nazi Europe," *War, Exile, Justice and Everyday Life, 1936-1946*, ed. Sandra Ott (Reno: Center for Basque Studies, 2011), 288.

<sup>9</sup>Ibid., 291.

<sup>10</sup>Ibid., 295.

<sup>11</sup>Ibid., 294.

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## MARLOVIAN THEORY, VENUS AND ADONIS, AND THE SHAKESPEARE AUTHORSHIP QUESTION

ENGLISH 317:

INTRODUCTION TO BRITISH LITERATURE WITH MICHAEL MCCLLOUD

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### ABSTRACT:

*This project takes a critical look at the existing research for and against the concept of Marlovian Theory and argues for Marlowe's guise as William Shakespeare in later life. This argument is drawn from not only expert, outside scholarship, but also involves a close examination of Marlovian and Shakespearian texts, specifically Venus and Adonis, and strives to prove that it was, in fact, Marlowe who composed this epic poem. This project also acknowledges the fact that despite what some might consider definitive proof in favor of Marlovian Theory, the Shakespearian authorship question will always remain.*

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The same name appears on some of the greatest plays and poems written in the entirety of English history: William Shakespeare. However, was this poor, uneducated man from Stratford-upon-Avon truly the author of these works? Many believe otherwise. Popular Shakespeare-authorship theories state that other men, better educated and well-respected writers, may have produced these works. Names of possible authors include Sir Francis Bacon, Edward de Vere, the seventeenth Earl of Oxford, William Stanley, the sixth Earl of Derby, and Christopher Marlowe. Perhaps the most interesting of these candidates is Christopher Marlowe. Marlowe's secret lives (espionage, alleged homosexuality, and atheism), his untimely death, and his similarities to Shakespeare in writing styles all point to the fact that Marlovian theory may be correct; this young man may have written the plays and poems that today carry the name William Shakespeare. By exploring Marlowe's past one can conclude that Shakespeare's famous poem, *Venus and Adonis*, was actually written by Marlowe, due to the themes, literary devices, style, and symbolism common between Shakespearian and Marlovian works.

To better understand why Christopher Marlowe could be the author of Shakespeare's works, one must examine his childhood and upbringing. He was born in Canterbury, "in the same artisan class and in the same year (1564) as William Shakespeare." His intelligence won him a scholarship where he attended the King's School. From there Marlowe went on to attend the University of Cambridge. His education took a secretive route at this point. Many believe Sir Francis Walsingham recruited Marlowe to serve the Crown as a secret agent.<sup>1</sup> The article, "The Government Agent," states this "was vitally important in this age of Catholic versus Protestant political intrigue, an age of political assassinations, directed against the Heads of States" (para. 1). Because of this, Walsingham was charged with creating an unparalleled espionage network, which probably included young Christopher Marlowe.<sup>2</sup>

Marlowe's secret lives did not stop with his spy work for the Crown. Perhaps his upbringing, his intelligence, or his secretive nature explained his involvement in another covert organization. Marlowe was a part of a group called the Free-Thinkers. Though this group and its School of Night may not sound too terribly dangerous, the information and ideas exchanged at this time were highly controversial. The Free-Thinkers were labeled as atheistic, though whether or not all the members actually denied a belief in a higher power is unknown.<sup>3</sup> Rather, the Free-Thinkers "... discussed a wide range of subjects and were avid in their pursuit of all knowledge," which centered around scientific discovery.<sup>4</sup> These men and their pursuit of knowledge were seen as dangerous, revolutionary, and vile. One of the theories concerning Marlowe's untimely death is based upon his involvement with this group and the Church's discontentment with that fact.

The Church chose to target Christopher Marlowe as an enemy against its teachings not only because of his rumored atheism but also because of a report by Richard Baines on Marlowe's homosexuality, in which he quotes the playwright as saying, "All they that love not Tobacco and Boys are fools."<sup>5</sup> Aside from this testimony, Marlowe's own works included many blatant, homosexual themes and characters. In *Edward II*, Marlowe paints the king as having a relationship with a man named Piers Gaveston. The article, "Marlowe and Homosexuality" states, "This was very new for the time" and recognizes that Marlowe's characterizations and explorations paved the way for other playwrights, including William Shakespeare, to experiment with homosexual innuendo.<sup>6</sup> Many of the young playwright's other works also demonstrate homosexual undercurrents, including *The Passion-*

*ate Shepherd to His Love and Hero and Leander*. Aside from just writing about homosexuality, Marlowe also had a close relationship with a gentleman named Thomas Watson with whom he later lived. Watson introduced Marlowe to Sir Francis Walsingham and was the reason Marlowe became a spy for the Crown.<sup>7</sup> This close relationship between the two males fed Baines' attempt at incriminating, and eventually killing, Marlowe—an attempt that many believe worked.

Christopher Marlowe was only twenty-nine when he was murdered. In the year 1595, Marlowe and others rented rooms from a woman named Dame Eleanor Bull. The irony here is that her house in Deptford was supposedly a safe place for government agents to meet, and it was in this house that the murder of Marlowe allegedly occurred. The three men involved in the murder were also, strangely enough, all men who knew or worked for Walsingham, the same man who hired Marlowe to work as a spy for the Crown. These men were Ingram Frizer, Robert Poley, and Nicholas Skeres. Marlowe was said to have spent the day with the men. An inquisition into Marlowe's death, written by William Danby, states that the jury acquitted Frizer because he killed Marlowe in self-defense. However, the inquisition seems rushed and incomplete. According to the article, "Death in Deptford," "The report leaves many questions unasked and there are many hypotheses as to what really happened that day in Deptford, producing theories that range from a Government-backed assassination to a faked murder".<sup>8</sup> This and the fact that Marlowe's body was strung up and burned directly after the coroner confirmed it was, indeed, the young spy, and that Frizer was released by Queen Elizabeth only fourteen days after the murder, have given fuel to the theory that Marlowe did not die that day. Scholars theorize that perhaps Queen Elizabeth was part of the conspiracy. But was this conspiracy against Marlowe or in his favor? Some believe he lived on in secret and continued to write works now credited to William Shakespeare.<sup>9</sup>

The idea of a faked murder whereby Marlowe was simply exiled by the Crown to save him from the Church has grown in popularity. Scholars have analyzed Marlowe's complete works and compared them to those supposedly written by William Shakespeare. Marlovian theory, still alive and active today in organizations such as the Marlowe Society, states that, based on content and stylistic similarities, Marlowe is the author of Shakespeare's works, which he completed while in exile.<sup>10</sup>

Marlowe's works, which include *Tamburlaine*, *The Tragicall*

*History of Doctor Faustus*, and *Edward II*, arrived on the London stage when "the public theater [was] still in its infancy, several years before Shakespeare [made] his debut".<sup>11</sup> The fact that Marlowe's plays came to the stage before Shakespeare's is key. Shakespeare has always been the imitator, not the other way around because Shakespeare would have had to study and watch Marlowe's productions. His writing style would have mirrored Marlowe's, and his themes and characterizations would have been closely related to his contemporaries, which included none other than Marlowe. The argument that Shakespeare did not imitate but that Marlowe simply continued writing after exile under a different name makes sense. Likewise, Marlowe's prophetic genius, which seemed to allow him to sense the direction the theatre would take, comes out in his prologue to *Tamburlaine*. This famous play, one of many, captured the attention of the English populace like none had before, just as Shakespeare's plays would later do. Indeed, Marlowe's style is similar to that of William Shakespeare, a fact explored by Calvin Hoffman in his book, *The Murder of the Man Who Was "Shakespeare."*

Hoffman spent nineteen years researching the Shakespearian authorship question. He argues that the larger-than-life exploration of humanity that peppers the pages of Shakespeare's texts mirrors the exciting and tragic life of the young spy and playwright. Due to the themes of Marlowe's travels throughout the Western world and the similarities in writing styles, Shakespeare's works should be given to their rightful owner: Christopher Marlowe.<sup>12</sup>

Hoffman compiled many examples of Shakespearian and Marlovian similarities within their respective works. Some include:

Marlowe's *Tamburlaine*:

Holla, ye pampered Jades of Asia.

What, can ye draw but twenty miles a day...

Shakespeare's *Henry IV* (Part II):

And hollow pampered jades of Asia,

Which cannot go but thirty miles a day.

Marlowe's *The Tragical History of Dr. Faustus* (conjuring Helen of Troy):

Was this the face that launched a thousand ships?

Shakespeare's *Troilus and Cressida* (referring to Helen of Troy):

...She is a pearl,

Whose price hath launched above a thousand ships.<sup>15</sup>

Hoffman lists many other similarities and parallelisms between

both the plays and poetry of Shakespeare and Marlowe. He states that after nineteen years of research, he "was ready to prove, beyond any reasonable doubt, that every single play and poem we have been led to believe was written by William Shakespeare had been written by Christopher Marlowe."<sup>14</sup>

Other researchers also agree with the theory that Marlowe was Shakespeare. In a video produced by the Kennedy Center, the narrator explores the possibility that Marlowe "faked his death and continued to write extensively under the name William Shakespeare" (*The Christopher Marlowe Theory*). The video explains how Marlowe feigned his death in order to escape persecution by the Church and was forced to live in other parts of Europe. There he, no doubt, became familiar with other cultures and people and lived in a state of constant inspiration, which led to the production of some of the greatest literary works of all time: those credited to Shakespeare.

The video states that Marlowe supposedly died on May 30th, 1593. Perhaps this death, if it were faked, saved him from the wrath of the Church. It could have allowed him to retire in peace and continue doing what he loved: writing. Indeed, simulating his death would have benefitted several parties including the whole of play-going England and Queen Elizabeth. The queen owed Marlowe money for his service as a spy, but by allowing him to fake his death, she gave him a gift greater than money, his life. Although William Shakespeare is reported to have sought Queen Elizabeth's favor as a patron, perhaps the name William Shakespeare was a simple front. Shakespeare's money could have conceivably gone to Marlowe, who simply used Shakespeare as a cover-up, or even a *nom de plume*. One argument, as explored by The Kennedy Center, states that Marlowe and Shakespeare were the same man and compares a picture of the young Marlowe with a picture of Shakespeare. Minus some hair, the paintings are almost identical.<sup>15</sup>

On June 12th, less than a month after Marlowe's supposed death, the narrative poem *Venus and Adonis* was published in the Stationer's Register.<sup>16</sup> Marlovian theorists believe Marlowe asked his London publishers to release the work under the name William Shakespeare. The video produced by The Kennedy Center states that even if Marlowe was not the author of the plays and poems credited to Shakespeare, the real author would owe a huge debt to Marlowe, as Marlowe's own works heavily influenced the Shakespearian author.<sup>17</sup>

But Marlowe is, in fact, the author of the narrative poem *Venus and Adonis*. The themes found in the play, the style of writing, the coincidence in dates, and analyses by Renaissance scholars leave no room for question. *Venus and Adonis* is a poem about the Greco-Roman goddess Venus who falls in love with a mortal man named Adonis. Adonis is a mortal like no other. He has no equal in looks or in skill. Thus, the goddess is determined to have him. However, Adonis resists her advances. By the end of the narrative poem he has resisted her but at the expense of death. These themes are not new to Marlovian works, nor is the style or word use. The symbolism seen in this work is also highly important to arguing that Marlowe is the true author.

The themes in *Venus and Adonis* and works credited to Marlowe are similar. The theme of passionate love appears in other Marlovian works, including in the poem *The Passionate Shepherd to His Love*. Also, the rural, springtime setting is similar between *Venus and Adonis* and *The Passionate Shepherd to His Love*. The exploration of a world of magic (such as in *The Tragicall History of Dr. Faustus*) where mythical creatures (Mephostophilis as compared with Venus) interact with mortals is commonly seen in Marlovian works. Of course, readers see how the mortals are negatively affected by the immortals. The mortals are manipulated, abused, and damned by the immortals. Often, the mortals even end up dead at the end of the works. In *The Tragicall History of Dr. Faustus*, Faustus' death scene goes on for pages. In *Venus and Adonis*, Adonis is gored to death by a boar, and the author does not spare the reader when he graphically draws out the scene.

The comparisons in subject matter between the poem by Marlowe, *Hero and Leander*, and Shakespeare's *Venus and Adonis* add another clue to the authorship mystery. Both works explore an ancient world, the same ancient world. Both look to the same author of ancient source material: Ovid. The characters and their interactions are similar, as seen in the line from *Hero and Leander*, "For [Adonis'] sake whom their goddess (Venus) held so dear, / Rose-cheeked Adonis" (ln. 92-93). And in the end, the poems conclude tragically for the mortals, which is perhaps reflective of Marlowe's own untimely, faked death.

The similarities between these poems go even deeper. *Venus and Adonis* is actually a portion of *Hero and Leander* that Marlowe decided to flesh out more fully. At the start of *Hero and Leander*, Marlowe writes, "Where Venus in her naked glory strove, / To please the careless and disdainful eyes, / Of proud Adonis that before her lies" (lns. 12-14). This short sequence alludes to the entire story that unfolds within *Venus and*



*Adonis*. The character interactions follow the same path in *Venus and Adonis* as they do in *Hero and Leander*. In both poems, the beautiful, talented, but foolish mortal, Adonis, resists the great goddess, up to the point of his death. Marlovian scholar, Daryl Pinksen, supports this analysis in his article “Who Wrote Venus and Adonis? And Why?” In this article, he writes, “*Hero and Leander*; [is] assumed to have been written before *Venus and Adonis*, but not published until four years later.”<sup>18</sup> He goes on to say:

*Hero and Leander* influenced Shakespeare directly and powerfully when he was writing *Venus and Adonis*...Shakespeare had read *Hero and Leander* since he quotes from it, since his scheme and treatment are essentially similar in *Venus and Adonis*.<sup>19</sup>

From this analysis, it is not a leap but a small step to assume that Marlowe actually wrote *Venus and Adonis* and simply published the work under William Shakespeare’s name.

Just as the themes between *Venus and Adonis* coincide with those in Marlowe’s works, the style of writing and the usage of language are also similar. Both Shakespeare and Marlowe were praised for their writing talents because they used rhyme schemes within their works. They were also praised for their ability to massage and manipulate language. As Pinksen reminds readers, the “scheme and treatment” between Shakespeare’s works and Marlowe’s works are quite similar around the time of Marlowe’s death and Shakespeare’s early publication.<sup>20</sup> The argument against this case states that Shakespeare’s mature writing style differs greatly from Marlowe’s, but nothing less should be expected from a great writer. Of course the writer’s, whether Marlowe in disguise or Shakespeare, style and language usage improved over time; he tackled greater and more complex projects. This is to be expected because historians have seen this pattern of maturation in other great writers, such as Chaucer, Plutarch, and others.

As for language usage, *Venus and Adonis*, *Hero and Leander*, and *The Passionate Shepherd to His Love* all follow an iambic rhyme scheme, though the meters differ. The maturation from a form like iambic tetrameter to iambic pentameter seems a natural progression for one writer to make. Writing consecutive verses in rhyme is a one-of-a-kind talent; for two men born around the same time period to both have such a talent was as unlikely then as it is today (After all, in all of human history, there has been but one Shakespeare).

Like the maturation in iambic meter, readers can see maturation in

the employment of literary devices. In *The Passionate Shepherd to His Love*, the reader can find alliteration in phrases such as “feed their flocks” and “Melodious birds sing madrigals.” Marlowe also employs metaphor and hyperbole, such as in lines nine and ten when he writes, “There will I make... / a thousand fragrant posies.”

In *Venus and Adonis*, which was written four years after *The Passionate Shepherd to His Love*, the reader experiences the author employing techniques like alliteration and metaphor (clearly, the author shows a penchant for these devices, despite a four-year gap between the creation of the two pieces); he also branches out to use anaphora “Still he entreats / Still is he sullen / still he lours and frets” (lms. 73 and 75). The author uses simile on top of metaphor and even uses some ironic phrases when he states lines, such as, “Poor queen of love... / To love a cheek that smiles at thee in scorn” (lms. 251-252). The reader watches the very goddess in charge of love fail at love itself. This use of irony could reflect either Marlowe’s own trials with love, like the backwards courtship where ladies of court fawned over and pursued the young playwright, while he preferred the company of men, or his alleged homosexuality. Even if both of these conclusions are incorrect, the consistencies within the employment of literary devices and the beautiful use of language that develops from them supports the argument that Marlowe wrote the love poem *Venus and Adonis*.

Finally, the symbolism seen in *Venus and Adonis* and its relation to Marlowe’s life alludes that he is the true author of the poem. Adonis is a mortal man of great beauty and skill, much like Marlowe, who excelled at all his endeavors (within writing and his spy work). He, like Adonis, could have married and settled down, perhaps with one of the ladies of court. However, his pursuit of other interests consumed his life; in fact, they led to his death, or the illusion of his death, much like Adonis’ resistance led to his death. Furthermore, resisting a goddess, beautiful beyond compare, and preferring the company of men, echoes the homosexual themes found in other pieces of Marlowe’s writing, such as in *Hero and Leander* when he writes of the god Neptune desiring a young boy.

In *Venus and Adonis*, both Adonis and Venus are symbolic. Perhaps Marlowe used the goddess of love as a representation of the Church. Venus is a goddess (a blatant representation of religion), wields great power (representing the structural confines of religion, as well as the power struggle between common men, Church, and State), and she uses her outward beauty to seduce men into worshiping her. The golden crosses, ruby-

and emerald-studded communion cups, and the stained glass windows adorning churches in the Elizabethan Era were also outwardly beautiful. The fact that Adonis runs from the goddess could be symbolic of Marlowe running from the Church, both figuratively during his days of involvement with the Free-Thinkers and literally during the days surrounding his death. Venus only ceases pursuing Adonis when he is gored to death by a boar. If Venus is the Church, then readers can experience Adonis' death (where he goes to spend fall and winter with Persephone in Hades, according to Greek lore) as not a tragedy but as a release, much like a faked death would have released Marlowe from the threats of the Church. Perhaps Marlowe chose to characterize himself as Adonis because the peerless mortal of mythology lives on in the underworld and in the works that literature students and scholars still study today. Both Adonis and Marlowe continue to outlive their respective time periods, one because of the impact of the stories he was in and the other because of the impact of the stories he wrote.

Due to the life Christopher Marlowe lived—one fraught with peril, adventure, and intrigue—and due to the parallels between Marlowe's writing and the writing of William Shakespeare, scholars have made convincing arguments for Marlovian Theory. Will future generations read *The Complete Works of Christopher Marlowe* instead of *The Complete Works of William Shakespeare*? Such an extreme notion is doubtful, for now, but the Shakespearian authorship question remains. And we will continue to search for its answer.

## ENDNOTES

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<sup>1</sup>Erne, Lukas. "Biography, Mythography, and Criticism: The Life and Works of Christopher Marlowe." *Modern Philosophy* Vol. 103. Issue 1 (2005): 28-50. Print.

<sup>2</sup>"The Government Agent." Marlowe Society. The Marlowe Society. 2002-2011. Web. 23 September 2011.

<sup>3</sup>It is this author's opinion that Marlowe must have, indeed, questioned the idea of a singular higher power. I came to this conclusion because of the groundbreaking and revolutionary themes he explores in the play, *The Tragicall History of Dr. Faustus*, and because of Marlowe's intelligence, which was coupled with worldly travel. This travel, no doubt, exposed him to other belief systems and other "Free-Thinkers."

<sup>4</sup>"The Free Thinkers." Marlowe Society. The Marlowe Society. 2002-2011. Web. 23 Sept. 2011.

<sup>5</sup>“Marlowe and Homosexuality.” Academic Encyclopedia. Academic Kids. Web. 29 Oct. 2011.

<sup>6</sup>“Marlowe and Homosexuality.”

<sup>7</sup>“Marlowe and Homosexuality.”

<sup>8</sup>“Death in Deptford.” Marlowe Society. The Marlowe Society. 2002-2011. Web. 23 Sept. 2011.

<sup>9</sup>“Death in Deptford.”

<sup>10</sup>“Marlowe in Exile?” Marlowe Society. The Marlowe Society. 2002-2011. Web. 23 Sept. 2011.

<sup>11</sup>Erne, Lukas. Pg 38.

<sup>12</sup>Hoffman, Calvin. *The Murder of the Man Who Was "Shakespeare."* New York: Julian Messner, 1955. Print.

<sup>13</sup>Hoffman, Calvin. Pg 54.

<sup>14</sup>Hoffman, Calvin. Pg 51.

<sup>15</sup>“The Christopher Marlowe Theory”. John F. Kennedy Center for the Performing Arts, 2007. Web. Video. 24 Sept. 2011.

<sup>16</sup>Pinksen, Daryl. “Who Wrote *Venus and Adonis*? And Why?” The Marlowe-Shakespeare Connection. 17 Aug. 2009. Web. 22 Oct. 2011.

<sup>17</sup>“The Christopher Marlowe Theory”.

<sup>18</sup>Pinksen, Daryl.

<sup>19</sup>Pinksen, Daryl.

<sup>20</sup>Pinksen, Daryl.

