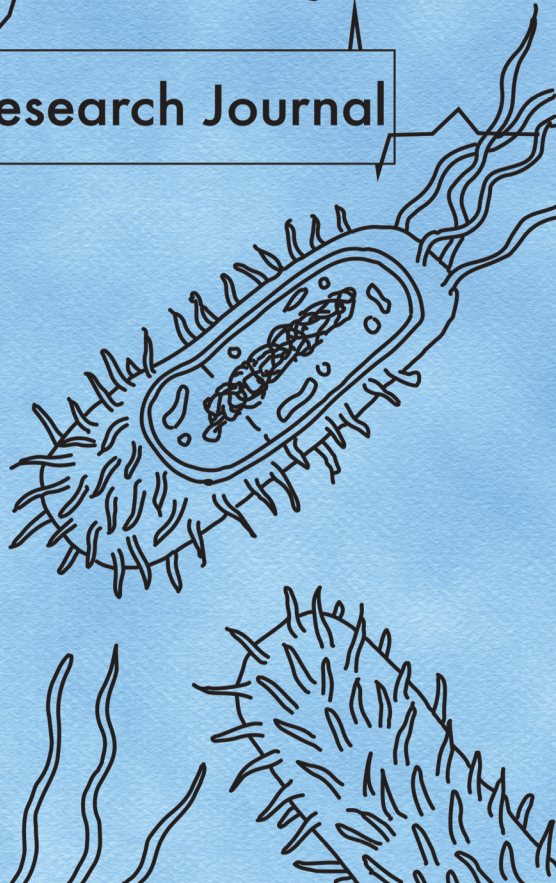
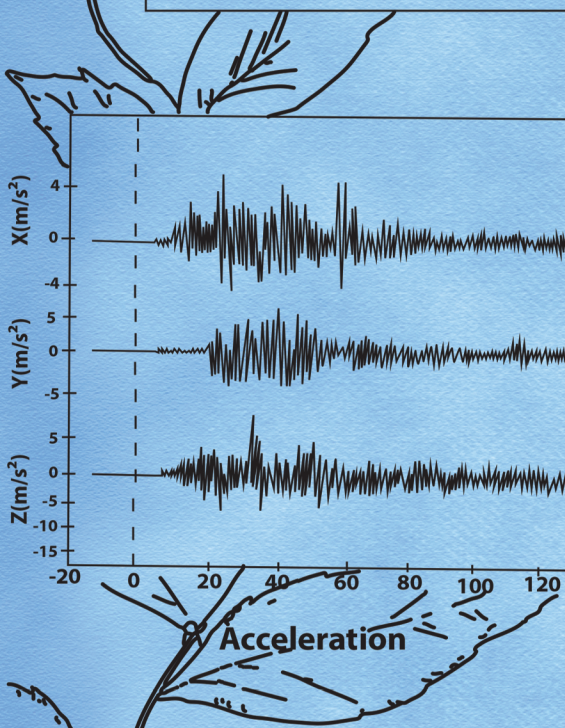


## Undergraduate Research Journal



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## From the Co-Editors-In-Chief:

We are pleased to bring you volume five of the Florida Atlantic Undergraduate Research Journal. As a university, we continue to make great strides in undergraduate research across all academic fields and disciplines. Through the opportunities Florida Atlantic University provides for undergraduate researchers, students are able to create and pursue innovative ideas under the mentorship of faculty members. Opportunities like this distinguish FAU as a prestigious institution and bring to light the great young minds we have that are sculpting the future. We would like to thank all of the students who have submitted their work for the 2015-2016 publication. You all have shown immense dedication to your research and we wish you the best in your future endeavors.

The FAURJ is an interdisciplinary, peer-reviewed journal that is published annually. FAURJ is published online as well as in print and its mission is to showcase high quality undergraduate research in all fields, supply undergraduates with an idea of the standard of research, and promote inquiry-based activities at Florida Atlantic University.

The FAURJ is brought to you by the Council for Scholarship and Inquiry (CSI), a registered student organization at Florida Atlantic University. The purpose of the organization is to promote and foster a culture of research at Florida Atlantic University across as many disciplines as possible. CSI strives to enhance scholarship, creativity, critical thinking and academic excellence of undergraduate students at FAU. Opportunities sponsored by CSI include FAURJ, student workshops, promotion of faculty-student interaction, peer mentoring, and advising.

We hope you enjoy this edition of FAURJ, and encourage you to stay curious!

Makenzie Rynn  
Emilio Matthews

## Artist Statement

### Cynthia Raaijmakers

*Undergraduate Major: Biology*

Scientists are artists. Although they may seem like complete opposites, they are more alike than different. Scientists spend a lot of time honing their craft, answering unanswered questions, and going beyond what is known. This takes a certain level of creativity. The way we perceive the world is through images taken in by our eyes and transferred to the brain. We interpret those images and analyze them in our own unique way. This is how we perceive the world around us. This perception is what drives scientists to answer questions. As a biology major with a love of the environment, I use my artwork to express that passion. The cover design shows a range of diversity among research areas. I was given the opportunity to learn a musical instrument which reminded me of the rhythm of the beating of a heart. Two things that seem vastly different, yet are very much alike. A lot of these research areas may seem different and apart, but they are all intertwined within each other. Art can be used to express science, and science can be used to express art.

## Gender and Agency in Young Adult Fiction

Jodi Weissman and Elizabeth Swanstrom

Department of English

**Abstract:** This research paper investigated a gender shift in the identity search within Young Adult Fantasy novels between the mid-twentieth century and the contemporary period utilizing an emergent Structuralist pattern of four Emotional Discourses. The author argued that an adolescent's search for identity (within the context of the Young Adult Fantasy genre) during the mid-twentieth century focused on personal reflection and self-realization regardless of gender; whereas, the coming-of-age journey for self-discovery in contemporary novels, or series of novels, (of the same genre) hinged on gender. Applying these discourses, readings from *Earthsea* and *Twilight* series texts analyzed the discourses (challenges and identifications) of both male and female characters to determine how each made decisions. Structuralist analysis showed female teens today gain identity through self-sacrificing means while contemporary male adolescents and both teens of both sexes discovered identity through self-realization in the midtwentieth century. With the inception of the young adult genre in the mid-twentieth century, character identity for both male and female adolescents developed through independent choice and internal consideration. Initially, this genre contrasted the ways women in literature were identified, generally by their relationships to others, such as wife or mother. However, a trend in contemporary young adult fantasy seems to shift the motivation behind adolescent female identity search from self-realization to self-sacrifice. Utilizing a structuralist lens and various psychoanalytical theories, a pattern of emotional discourses emerges in the young adult coming-of-age stories. Close readings and explication of representative texts utilizing this overarching blueprint expose this new trend. As a result of this analysis, I argue that an adolescent's search for identity (within young adult fantasy) during the mid-twentieth century focuses on personal reflection and self-realization regardless of gender; whereas, the coming-of-age journey for self-discovery in contemporary novels (of the same genre) hinges on gender. While boys continue to pursue their identity through internal means, girls' identity decisions center on their relationships with others, specifically romantic interests and familial connections.

### Emotional Discourses – From Conception to Utilization

To focus my examination on identity, I studied numerous young adult novels containing searches for identity, tracking the patterns of emotional challenges the characters faced as well as the outcome of these challenges that produced the elements of their personalities, defining their identities upon entering adulthood. These repeated emotional propensities created a structural pattern that can be applied to most literary adolescent searches for identity. This pattern emerged as the emotional discourses that structure my analysis and close readings. These discourses take the form of binary oppositional pairs: Desire-Happiness and Conflict-Peace. These pairs are characterized as "little hierarchies. That is, one term in the pair is always *privileged*, or considered superior to the other" (Tyson 254). These discourses follow a particular pattern that

places the inferior term, or emotional challenge, on the left side and the superior term, or emotional identification, on the right side.

My analysis examines these oppositions – the circumstances by which a character comes upon a challenge and the decisions that character makes to deal with such challenges – not only to bring forth the culminating elements of identification, but also to determine what factors the character prioritizes when making a choice that moves him or her from the "challenge" to the "identification" within the binary pair. Fleshing out the elements of identification provides a framework for whom the character intends to become at the threshold of adulthood; however, determining whether the character deals with challenges through internal resolution or external sacrificial considerations governs the autonomy of the character. The logic behind a character's search

for identity is disclosed through these motivations, independent or codependent, creating a tangible mode of comparison between young adult characters and their identity development.

While definitions provide a foundational understanding, the rationale leading to the development and employment of these discourses to represent the underlying emotions within the text is necessary for a working comprehension of text analysis: "The investigation of the representation of emotions in literary works demands the analysis of [a] multitude [of] aspects, for instance, the author's intention, the reception by the reader guided by his or her perceptions and assumptions, and the literary work's emotional structure" (Kummerling-Meibauer 131). The challenges that the adolescent faces must be overcome, accepted, defeated, achieved or gained. The foundations that the adolescent discovers through facing these challenges become the elements with which the young adult finds happiness and peace. Those elements form his or her identity entering adulthood.

The background for the structural analysis rests within a psychoanalytical lens in literary theory. The idea of identity formation as a series of challenges comes from Erik Erikson's Theory on Psychosocial Stages: "Ego identification is considered as the construction of a synthesis of opposing issues and attitudes... all the 'negative' senses are and remain the dynamic counterpoint of the 'positive' ones throughout life" (Erikson 273). The pairing of challenge and result provides a groundwork to study young adult identity search. "If Erikson's descriptions of identity and intimacy in adolescence are to be understood in the context of life-course development, and not merely as descriptions of isolated crises," then this emotional blueprint offers a method to compare trends in motivations for the determination of how young adult characters deal with challenges as well as from where (internal or ex-

ternal) these decisions come (Meachem 1466).

### Desire-Happiness

During the tumultuous adolescent years, literary characters' desires range from compulsive participation in hobbies to obsessive yearning for the object of one's affection. The desire itself does not factor into the pattern, only that the young adult experiences one or more desires that need rectification in order to transgress this discourse. Jacques Lacan provides the model for desire and the truth behind the inability to fulfill it: "Human desire is carried by signifiers which stand in for a lack that can never be filled in... Processes of signification of the kind that are frozen temporarily in works of literature constitute the human subject and determine the shape of its life" (Rivkin 395). Lacan describes an individual's pursuit of desire as an endless chain of substitutes for what is actually desired because if desire fulfillment occurs, happiness rarely follows. The unconscious determines that wholeness be consistently sought although it can never be achieved, creating the binary opposition between desire, to always be in a state of lacking or loss, and happiness (Lacan 445). Therefore, happiness occurs when desire resolves through other means – the acceptance of nonfulfillment, the perpetual substitution of desires, or the ability to overcome the obsessive desire present; however, within literature, characters can and do obtain their desires which may result in happiness. When a young adult recognizes the facets of life that bring true joy, those elements of identity can be determined.

### Conflict-Peace

Carl Jung examines conflict in his theory on the collective unconscious: "The tension that can develop between our old, socially adapted self and the developing new identities [likens to] 'crucifixion' between opposites. Enduring the conflict leads to a birth of a new, enlarged identity that reconciles in the unconscious" (Jung 382). This concept examines the movement from conflict to peace within the unconscious mind to create identity. Conflict in literature applies to both internal and external struggles a character undergoes; furthermore, as an adolescent enters adulthood, the features of his or her personality that

"[A discourse] is not a slender surface of contact, or confrontation, between a reality and a language (langue)... Of course discourses are composed of signs; but what they do is more than use these signs to designate things. It is this more that renders them irreducible to the language (langue) and to speech. It is this 'more' that we must reveal and describe" (Foucault 96).

Emergent research reveals the possibility of dividing the discourses into more specific binary pairs with the addition of Isolation-Affiliation and Weakness-Strength currently encompassed or implied within the Desire-Happiness and Conflict-Peace discourses, respectively. Further research will provide insight into the benefit of a more in depth examination of young adult identity development in terms of four instead of two discourses.

All terminology used in these discourses are defined according to the latest version of the Oxford English Dictionary.



bring peace to his or her existence will define a portion of his or her identity.

### **The Discourses at Work: Evidentiary Support through Structural Analysis**

In order to explore this shift, I selected representative texts from each time period within the genre. For contemporary texts, I chose The Twilight Series by Stephenie Meyer due to its popularity both in print and film. Comprised of four novels; *Twilight* (2005), *New Moon* (2006), *Eclipse* (2007) and *Breaking Dawn* (2008), this series journeys with Bella Swan as she moves to Forks, WA to live with her father. A clumsy, awkward teen, uncomfortable with herself and others, Bella agrees to live in a place she hates to give her mother a chance to travel with her new husband. Bella falls in love with Edward, a vampire over one hundred years old (frozen at seventeen), and his "family" coven. The story revolves around their love and her unwillingness to accept anything other than a life of vampirism with Edward. A love triangle forms with Bella's best friend Jacob, a werewolf (the vampires' enemy), whose story forms an integral part of the narrative. In the end, Bella and Jacob shape their identities through their individual choices and motivations behind them.

To represent the mid-twentieth century, I elected the first two books in *The Earthsea Cycle* by Ursula K. Le Guin. *A Wizard of Earthsea* (1968) tells the coming-of-age tale of a motherless child, Ged. His aunt recognizes inherent magic within him, and he becomes apprentice to the mage (learned wizard), Ogion. During his early teens, Ged's impetuosity causes him to lose patience with Ogion's teachings, triggering him to uncover a shadow yet lacking understanding of its nature. Ogion sends him to study at a wizard's school where he continues to battle arrogance and impatience with his tremendous gift. He allows these emotions to control his magic and unleashes the dark shadow into this world. As Ged learns, travels, protects others, performs magic and discovers the world, he finds the truth he needs to comprehend the shadow and gain his identity.

(1970) follows the female protagonist, Tenar. At a young age, Tenar is chosen to be the High Priestess of the Nameless Ones, stripped of her

identity, removed from her home and family, taken to the city of Atuan (to live amongst the other priestesses, girls training to be priestesses and eunuch slaves), and renamed Arha (the Eaten One). She learns the traditions and faith of her people. She grows to believe in this faith and accept her fate as Arha. As the highest of the High Priestesses, an isolated Tenar rules over the underground tombs of the city, including a dark labyrinth forbidden to all but her. At age fourteen, Tenar catches Ged in the labyrinth. She must make difficult choices that will define who she chooses to become instead of who she is forced to be. These decisions determine her identity.

Each series provides a strong protagonist experiencing a definitive search for identity, giving ample opportunity for analysis within the emotional discourses as well as additional evidence from critical literary sources.

### **Desire-Happiness**

Ged faces dangerous desires and must learn how to overcome them to achieve his self-identifying happiness. Power and the knowledge to exercise it over others speak within Ged as his driving desire from the onset of adolescence. As the novel describes, "Yet other cravings were in him that would not be stilled, the wish for glory, the will to act" (Le Guin, "Wizard" 33). In order to achieve happiness, Ged discovers, through his triumphs and mistakes at school and then through his early travels as Mage, that acquiring the knowledge to control his extraordinary power is the true key to happiness. Trying to fulfill his adolescent desire unleashes the evil, the shadow, which Ged must overcome to find his happiness and complete his search for identity. In examining the true purpose of the shadow, Elizabeth Cummins recognizes that "The adolescent has a frightening confrontation with the dark side of self" (28). In this respect, desire drives Ged's search for identity, only ceasing when he overcomes the consequence of youthful desire fulfillment: "Their hearts were very light as they entered into the firelight and warmth under the roof..." (Le Guin, "Wizard" 255). Ged resolves desires through self-awareness, a trait shared with Jacob.

Jacob's desires include cars, friends and an unrequited love in Bella. When Jacob faces the reality that he will not be Bella's choice, he chooses to

deal with his disappointment and find happiness in his wolf pack: "I had four legs now, and I was flying. The trees blurred into a sea of black flowing around me... But I wasn't alone" (Meyer, "Eclipse" 628). Eventually, Jacob reconciles his desire for Bella through animal imprinting (instinctual lifelong pairing) with her daughter, Renesmee, creating a new happiness for Jacob free of want for Bella. Internal reflection and patience provide Jacob, like Ged, with the solution to his desires, reinforcing the consistency of male identity resolution regardless of the text's publication date. Females, however, do not share this consistency. Only Tenar deals with desire fulfillment internally.

Serving her Masters becomes Tenar's desire once she is named Arha and continues throughout her early teens: "Arha liked this game in the dark, she wanted a greater puzzle to be set her" (Le Guin, "Tombs" 45). Tenar wants and enjoys the fear and reverence of the other priestesses because of her position among them. Although her identity as Arha had been forced on her as a child, by fourteen Tenar assumes the traditions, rituals and beliefs of her faith. Her adolescent desire to serve initiates her search for identity when Ged (her captive within the labyrinth) forces her to face the truth: "But they are not your Masters. They never were. You are free, Tenar. You were taught to be a slave, but you have broken free" (Le Guin, "Tombs" 154). Just like Ged, Tenar's desire becomes the framework of her identity search as she sheds her forced identity as Arha and reclaims her individuality as Tenar. She must make her choices based on what she believes to be true of her faith, Masters and herself. Only by rejecting her adolescent desires and reclaiming her name can Tenar begin to make decisions toward happiness: "I am Tenar," she said, not aloud, and she shook with cold, and terror, and exultation, there under the open, sun-washed sky. 'I have my name back. I am Tenar!'" (Le Guin, "Tomb" 140). She moves toward finding her self-realized individuality; however, Bella's desires move her away from an independent identity.

Bella expresses desire through a lack of concern for her own safety, resulting in many instances where she faces mortal danger. However, unlike the moments of fatal reality she encounters by being involved with vampires, her desires

push her to self-exhibitions that put her in danger. Her reckless attitude stems from her desire for Edward and his family. During her self-imposed isolation (when Edward leaves her at the beginning of *New Moon*), Bella's desire for Edward manifests in her imagination as his voice and image, specifically when she is in danger, reminiscent of his overly-protective nature: "I knew this was the stupidest, most reckless thing I had done yet. The thought made me smile. The pain already easing, as if my body knew that Edward's voice was just seconds away" (Meyer, "New Moon" 358). In the months apart, Bella falls into a pattern of engaging in reckless activities to invoke Edward's disapproval in her mind. At the epitome of desire to be with him, if only in her mind, Bella intends to cliff dive: "My toes felt ahead blindly, caressing the edge of the rock when they encountered it. I drew in a deep breath and held it ...waiting. 'Bella?' I smiled and exhaled" (Meyer, "New Moon" 358). As with all her emotional crossroads, Bella faces her desire with actions for another. She does not choose to act on her desires through self-reflection as to whether her delusions of Edward are healthy for her growth or her identity; she acts solely on the desire to be with him, regardless of the consequences to her body, her mental state. In contrast, Tenar chooses to break free of her youthful desire to serve her masters and escape her labyrinth because she sees the truth of her options. Leaving the Tombs with Ged provides the better option for her health and well-being regardless of the consequences those she leaves behind might face. Tenar's happiness blooms from free choice unlike the reckless happiness Bella experiences through connecting herself to an aberration of love and family. This change in desire resolution highlights the differences between contemporary and mid-twentieth century adolescent female identity development; whereas, male characters incorporate the resultant elements of happiness into their identities by analogous means in both time periods.

### Conflict-Peace

Ged's fear begins and remains with the shadow he releases. His internal battle with his fear of this shadow commences when he speaks an unknown incantation without Ogion's consent: "Looking over his shoulder, he saw that something was crouching beside the closed door, a shapeless clot of shadow darker than the dark-

ness" (Le Guin, "Wizard" 30). Once the shadow knows Ged, he feels its presence even before he allows it to crossover into the realm of light when it becomes a tangible evil, an external conflict for Ged. His fear of this shadow and his eventual need to face it present focal conflicts Ged must resolve to find his identity. Ged's gradual understanding that he must face the shadow, not run from it, allows him to resolve and conquer his fear: "I must go where I am bound to go... I was in too much haste, and now I have no time left. I traded all the sunlight and the cities and the distant lands for a handful of power, for a shadow, for the dark" (Le Guin, "Wizard" 235). This realization does not eliminate his fear, but it allows him to embrace the anxiety inherent in this confrontation and gain the strength to complete this battle and his search for identity. Ged decides to seek out the shadow; furthermore, Ged owns his fear and takes responsibility for his actions due to his fear. Ged resolves his fears through individual choice and agency, allowing him to progress in a similar manner as Jacob many decades later.

Jacob faces several conflicts: his ongoing fight for Bella's love, his struggle to make Bella see that she loves him, and his internal collision between man and werewolf. During the final battle of *Eclipse*, the werewolves and vampires of Edward's clan band together to combat a larger threat. Out of fear for his life, Bella asks Edward to stay out of the fight and remain at her side (which he does). Jacob teases Bella about this, but he makes it clear that he would not do the same. Jacob sees this battle as something in which he must take part. Only by being true to the werewolf inside can he forge that part of his identity. Facing the battle instead of fleeing, just as Ged faces his shadow to merge the parts of himself, resolves Jacob's inner conflict. Both Ged and Jacob face conflict and find peace through self-defining choices and actions, discoveries also made by Tenar but not Bella.

Tenar's fear (of her Masters, the older priestesses, her powers and Ged) rules her actions. Although external conflict sprinkles the road on which she travels, at the heart of all these conflicts, fear flourishes. Even after Ged explains the truth of Tenar's faith, she cannot resolve her fear: "Nothing will [show us the way]. It is lost. We are lost.' The dead silence closed in upon her whisper, ate

it" (Le Guin, "Tombs" 171). Until Tenar releases Arha and all that being "the Eaten One" entails, she cannot find peace; however, once she sheds Arha, Tenar acknowledges her beliefs to be false and discovers peace in the absence of fear: "There was no answer. There had never been an answer" (Le Guin, "Tombs" 175). The unearthing of peace allows Tenar to seek out her strengths just as Ged had before her. Although Ged provides Tenar with information, she must make her decision to release her fear and continue on her path, without considering Ged, the other priestesses or the eunuchs that serve them. "She, for the first time, exerts her *power to* – her freedom of choice," she rids herself of Arha and claims Tenar of her own will and not for or because of anyone else (Le Guin, "Tombs" 219). Unlike Tenar, regardless of the magnitude or type of each conflict she faces, Bella's reactions are universally dependent on how her decision will affect the relationships in her life.

Bella never focuses on the consequences of conflict as an individual or the resultant residue on her identity. Anna Silver notes this as she explores this anti-feminist heroine, noting "the series' persistent theme that identity comes from affliction rather than individual accomplishment" (Silver 126). This reinforces the argument that Bella's identity forms based on decisions made within her relationships; affliction, an all-consuming term for the challenge side of the emotional discourses presented in this argument, allows Bella to hide behind Edward and his family instead of forming an individual identity, separate and autonomously created from her choices like Jacob, her male counterpart, does within the same saga.

Bella's choice of which love her heart should follow remains the undisputed main conflict she faces throughout the series. At seventeen, the impact of the decision between two competing suitors should be small in the scope of life and literature yet a contributing factor to the ultimate identity of the character. However, in Bella's case, becoming a vampire cannot be undone. She decides for life; therefore, shaping her identity involves decisions that will last throughout her adulthood: "...Her transformation into vampirism represents a step into an idealized fantasy adulthood rather than her growth into a mature and confident adult" (Hawes 171). Thus,

Bella makes a decision based on which relationship brings peace to the most people in her life while minimizing the hurt she causes. Yes, she chooses Edward because she loves him, but she loves Jacob as well: "I loved him [Jacob], much more than I should, and yet, still nowhere near enough. I was in love with him. But it was not enough to change anything; it was only enough to hurt us both more" (Meyer, "Eclipse" 528). Ultimately, she stays with Edward to become a vampire because he cannot live without her (which he proves by trying to end his existence in *New Moon* when he believes Bella has committed suicide cliff-diving). Furthermore, the way in which they get married is not for her but for others, specifically, for the sanctity of Edward's soul:

I will not leave Charlie and Renee without the best resolution I can give them. I won't deny Alice her fun, if I'm having a wedding anyway. And I will tie myself to you in every human way, before I ask you to make me immortal. I'm following all the rules, Edward. Your soul is far, far too important to me to take chances with it. (Meyer, "Eclipse" 619)

Unlike Tenar, who decides to escape the life of Arha and find her own peace, Bella bases her peace on what makes others experience peace. By identifying herself as wife, she entangles herself to many others, complicating her life at an age when most teenage girls are developing aspects of identity that provide themselves peace. For this reason, Bella's search for identity reinforces the new trope for adolescent female actualization – identity with and for others, self-sacrificing in nature.

### Conclusion

As young adult fantasy grows in popularity, more female characters in search of identity disclose self-sacrificing natures, creating young adult characters defined by others instead of their own agency. "Bella's identity crisis is one to which many teenage girls can relate. The restoration of her identity at the end of the novel as vampire wife and mother provides an image of security and safety that evidently appeals to numerous readers today" (Silver 128). Literary critics, such as Silver, share the thoughts of others concerned

with the possible influence the happily-ever-after ending of Bella Swan Cullen may have on young girls today. These self-sacrificing heroines present a possible future that attracts girls to plausible domestic issues. The correlation between these types of female characters' searches for identities and possible dangerous trends in society may have an effect on society as a whole. Increases in domestic violence in teen relationships and an upswing in teen marriages may be correlated to these new images of female identity.

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# Laser Tweezers and Orbital Angular Momentum Photons

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**Abstract:** A photon can be considered both a particle and a wave in quantum mechanics. Quantum optics deals with such quantum mechanical properties of a photon. One such property that has been of particular interest recently is that of light's momentum, specifically its linear momentum and orbital angular momentum (OAM). Light carrying both types of momentum are of particular utility to the life sciences. Linear momentum (LM) photons have the ability to directly manipulate particles. For example, photons with these properties can be used to separate one specific particle from a group. One can then more closely observe its properties. OAM photons have the potential to unravel DNA strands using the torque of the photons to further observe certain specific physical properties. Light carrying OAM has also shown promise in the field of information technology as a new means of sending large amounts of data over long distances securely and extremely quickly. Because photons behave quantum mechanically, the encryptions are much more difficult to decode, and since the information is being sent as light it clearly travels at the speed of light. This paper will provide background on the quantum optics of particle manipulation and the results from experimental studies performed on this topic. The results show evidence of light with both types of momentum being created and used to manipulate particles. We generated light with both types of momentum, trapped particles with optical tweezers, and measured the force on the particles with a high speed video camera, optical tweezers, and computer programs that we used to track the particles.

## Introduction

Light is a fairly complex notion to discuss as it has properties that are odd and unfamiliar in everyday applications. Energy from light is quantized, meaning that it comes in discrete allowable amounts (there are certain amounts of energy that are "not allowed") as realized by Maxwell Planck in 1901. Then in 1905, Albert Einstein realized that light must be made up of particles called photons that carry momentum [1]. Photons can be thought of as particles and waves, hence wave-particle duality as discovered by Arthur Compton upon shining a beam of light through a carbon sample and noticing that upon exiting, the light had a longer wavelength. The scattered photons transfer momentum to the carbon resulting in lower energy and longer wavelengths [2].

Light has three different types of momentum: spin angular momentum, orbital angular momentum, and linear momentum. This paper will be focusing on orbital angular momentum (OAM) and linear momentum (LM). Quantized OAM of photons was discovered in 1983 by Miller and Wheeler [3], and readdressed relatively recently in 1992 by L. Allen, et al. It was discovered that if a beam of light was phase shift-

ed causing it to have a certain phase dependence, it would carry OAM. The OAM photon beam has a helical wavefront as opposed to the plain wavefront of the LM photon beam. The LM of photons is responsible for propagating the photons through space. Since photons follow the rules of relativity, the momentum is  $p = h/\lambda$  where  $h$  is Planck's constant and  $\lambda$  is the wavelength of the light [4].

Light's momentum can be used to manipulate miniscule objects. In 1970, Arthur Ashkin et al. used light to trap dielectric particles leading to the invention of the optical tweezer [5]. A different experiment used OAM photons to straighten out the individual strands for further observation using the characteristic torque of the photons [6]. Another experiment, performed by Liu and Zhang, used LM photons to manipulate biological cells and stretch or organize them [7]. Due to the importance of LM and OAM of light, the goal of the experiment was to create separate beams carrying both types of momentum and then use those beams to manipulate particles.

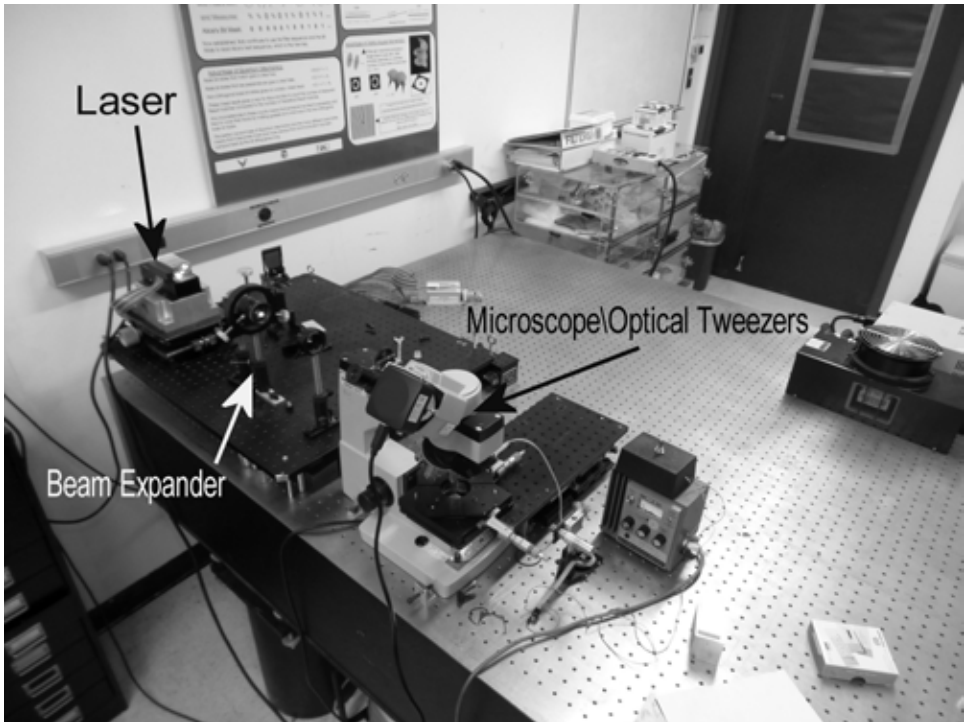
## Equipment and Experimental Setup

The first important piece of equipment we utilized was a spatial light modulator (SLM). This

piece of equipment is a tiny LCD screen that was used to project a binary  $\ell = 1$  (quantum number) forked diffraction grating in order to phase shift the photons and create OAM photons. The SLM was connected to a computer through a VGA cable acting as a second monitor of the computer. For the gratings used in this experiment, multiple existing MatLab codes were referenced and pieced together to get the forked diffraction gratings [8][9].

The second important piece of equipment we used is optical tweezers which essentially is a modified microscope to allow the laser light to enter the microscope and be reflected by internal semi-transparent mirrors to the sample stage. The laser light is then used to manipulate the particles. Since the particles are larger than the wavelength of the laser, ray optics can be used to describe the particle trapping mechanics [10]. For example, consider a particle is within the

radius of the beam but is displaced a certain distance  $x$  left of the center of the LM photon beam (having the strongest intensity). At this position the rays of light that are interacting with the particle are more intense to the right than they are to the left. As these light rays enter the particle, they are refracted out in a direction towards the center of the particle in the  $x$  direction. This means that if a ray enters on the left side of the particle, it will be bent slightly to the right upon exiting and vice versa for a particle entering on the right side. Since light is a particle, the change in direction is a change in momentum which is a force that is exerted on the particle pulling it into the “trap” or center of the beam and then keeping it in that position following Newton’s first law of motion. For laser tweezers using OAM photons uses the same mechanics but since the wavefront is helical, the center of the beam changes position going around in a circle of constant radius making the particles rotate.



**Figure 1:** The setup used for the linear momentum particle trapping phase of the experiment.

The first part of the experiment was achieving trapping of particles with LM photons. The green 532 nm wavelength laser beam was directed through a 10x beam expander then through the microscope towards 2 micrometers, 1 micrometer, and 0.5 micrometers (in diameter) polystyrene particles. These particles were prepared on a sample slide with deionized water and placed on the stage of the microscope. The motion of the particles near the center of the laser beam was recorded with a high quality 1024x770 resolution, 50 fps video camera. The recordings started when the particles were too far away from the beam to feel a force, but the random Brownian motion of the particles (random moving due to the vibrating water particles) moved the particles into the range of the laser beam. The computer program that converted the video in .wmv format to individual jpeg files of each frame was the VeryDoc Video to GIF Converter. Then the images were loaded into the Able Particle Tracker program that tracks the movement of the particles based on the pixels. Then, this information was put into an Excel file and interpreted. We used a conversion of 13 micrometers per pixel and found the radius ( $\sqrt{x^2 + y^2}$ ) and velocity ( $v = \Delta r / \Delta t$ ). The acceleration of the particle going into the trap was also found ( $a = \Delta v / \Delta t$ ) and the Brownian motion forces that were acting on the particle were found using the Langevin equation:

$$m\ddot{r} = -\gamma\dot{r} + F(r) + \sigma\xi(t)$$

where  $m$  is the mass, determined from the density equation with the density of polystyrene being 1.05g/cm<sup>3</sup>, and  $a$  are the acceleration and velocity of the particle, respectively,  $\gamma$  is the scalar friction constant,  $F(r)$  is the total force on the particle,  $\sigma$  is the amplitude of the fluctuating force, and  $\xi(t)$  is the equation governing the fluctuations of the random force [10]. The  $\gamma$  term can be found using the equation  $\gamma = 6\pi\eta a$ , where  $\eta$  is the viscosity of the liquid, in this case water, and  $a$  is the radius of the particle. The  $\sigma(t)$  is found using experimental data.

For this particular experiment, the data indicated that  $|\gamma| \gg |m|$  allowing equation 1 to be rewritten as:

$$\dot{r} = F(r) + \sigma\xi(t)$$

From this, the force can be solved by subtracting the experimental dependent value,  $\sigma(t)$ , from the right and left sides of the equation. The  $\langle t \rangle$  can be found by recording the motion of the particle without the influence of the laser beam and calculating the average force.

Following our investigations of photons with LM we next considered photons with quantized amounts of OAM. Initially we verified that proper OAM beams were producible (the projection of the beam resembled a donut) [4]. The setup remained the same as before, except for an SLM placed between the laser and the beam expander and the addition of an aperture to ensure only one maximum of the beam entered the microscope. The data analysis process was the same as for the LM beam. The only difference was an additional calculation for torque since the particles were rotating [11].

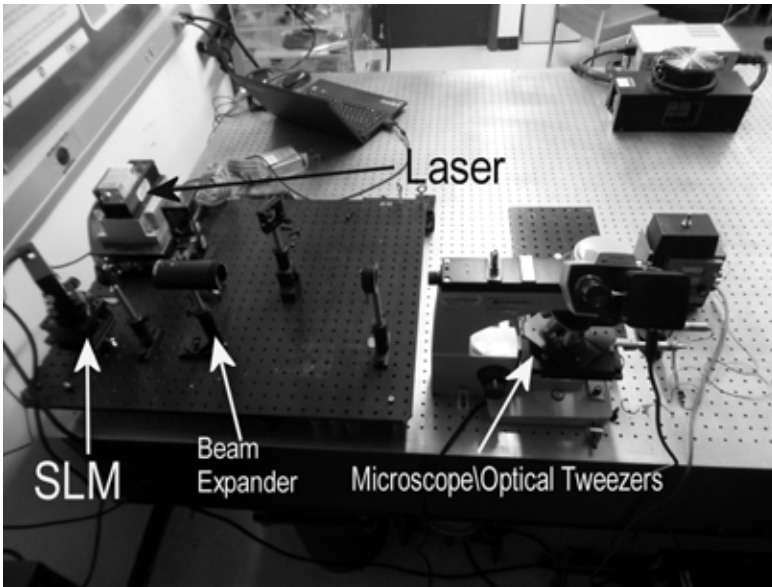
## Results

The for the LM photon beam, the 2 micrometers and 1 micrometer polystyrene particles were sufficient to get data for and for the OAM photon beam, the only valid data was for 1 micrometer as the 2 micrometers particles were too large to be trapped. For both LM and OAM beams, the 0.5 micrometer particles were too small for the camera to track properly since it did not have enough resolution. The average force that was exerted on the particles was then calculated as described above. For the LM beam and the 1 micrometer particles, the average trapping force was  $2.30 \times 10^{-13}$  N and for the 2 micrometer particles it was  $1.86 \times 10^{-13}$  N. After subtracting the force due to Brownian motion which was  $3.27 \times 10^{-14}$  N for 1 micrometer particles and  $7.02 \times 10^{-14}$  N for 2 micrometer particles, the forces due to the photons alone was  $1.97 \times 10^{-13}$  N and  $1.15 \times 10^{-13}$  N respectively.

For the OAM beam, overall it was difficult to obtain valid data. The particles tended to escape the trap easily and ended up only rotating somewhat without having a clear center that was circumnavigated. Fortunately, a few of the runs did produce useful data. The average trapping force was  $1.25 \times 10^{-14}$  N and the torque imparted on the particles was  $6.18 \times 10^{-21}$  Nm.

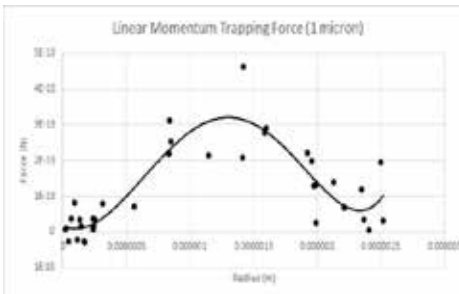
The LM graphs below illustrate the data on plots



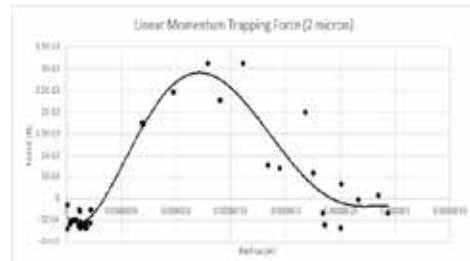


**Figure 2:** The setup used for the orbital angular momentum particle trapping phase of the experiment

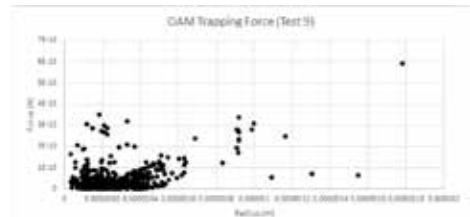
in Excel that have been fit with the polynomial line of best fit. The LM plots demonstrate that particles within a certain radius of the beam from the laser are affected by the force. The OAM plots demonstrate that the particles are confined within a certain radius.



**Figure 3:** One Micrometer Particle Linear Momentum Trapping Force



**Figure 4:** Two Micrometer Particle Orbital Angular Momentum Trapping Force



**Figure 5:** One Micrometer Particle Orbital Angular Momentum Trapping Force

## Conclusions

Overall, this experiment was successful. It was clearly evident that photons with LM exert a force and although it is a small force. For particles on the order of 10-6 m or smaller, this force is fairly significant on the order of 10-13 N. Also, beams of photons with OAM were successfully created using a simple SLM and forked diffraction grating code. The only issue that we encountered was with the OAM photon setup. After further research, it was determined that there was difficulty trapping particles using photons with OAM for two reasons: we had access to lasers that were too weak (not high enough intensity), and our particles were too large. The video camera did not have high enough resolution to track particles smaller than 1 micrometer; therefore, we determined that a video camera with higher resolution would also be necessary to improve this experiment.

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## Relative Abundance and Biomass of Exotic Fish in Roadway Corridors

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**Abstract:** The introduction of exotic fish has been detrimental to wetland ecosystems, thus making it important to understand their distributions in respect to roadway corridors in the South Florida region. We sampled fish with modified minnow traps at 18 study sites within three different landscape (urban, herbaceous marsh, forested marsh) and habitat type features (storm water ponds and canals) in order to determine the relative abundance of exotic fish. Our results suggest that exotic fish do have a higher relative abundance and proportion of biomass in the urban landscape, the canal habitat feature type, and the urban canal feature. Understanding patterns of exotic fish biomass and relative abundance in roadway corridor features could be useful for future management of these species in the South Florida region.

### Introduction

Invasive species are the second greatest threat to native biodiversity next to habitat destruction (Rahel, Bierwagen, & Taniguchi, 2008). Invasive species are exotic species that are likely to cause environmental or economic harm (Beck et al., 2008). In wetlands of South Florida, exotic fish species have the potential to become invasive depending on their behavior, diet, and other interactions within the ecosystem (Florida Fish and Wildlife Conservation Commission, 2015). Understanding the impacts that exotic fish have on the overall biodiversity in South Florida is limited by the lack of science-based information. There have been a minimum of 34 established exotic fish populations recorded in Florida (Schofield, Slone, Gregoire, & Loftus, 2014), though measures of biomass and relative abundance in various landscape and vegetation types are poorly known. Such information would be useful for developing management plans that could prevent the spread of exotic fish into other areas of Florida, and aid in understanding the impacts that these species may have on the surrounding ecosystem (Havens & Aumen, 2000). The spread of exotic fish into marshes of South Florida is facilitated through the canal system that was created to drain the vast Everglades wetland. Dispersal of fishes through this canal system has been demonstrated effectively for members of the family Cichlidae (Kline et al., 2014; O'Connor & Rothermel, 2013). Though Florida is not home to indigenous species of Cichlidae, they make up the majority of exotic fish in South Florida with as many as 13 cichlid species re-

corded in the region (O'Connor & Rothermel, 2013). The African jewelfish *Hemichromis letourneuxi* is one of the most common cichlid species found within the region, thought to have been released in the 1960s from the aquarium trade. Today it has successfully established itself from Miami-Dade County throughout the freshwater wetlands and tidal habitats of the Florida Everglades system and into selected areas of Central Florida. Originally from Africa, *H. letourneuxi* is considered an opportunistic carnivore that preys on a wide range of fish and crustaceans and will tolerate water salinities up to 50 ppt (Schofield et al., 2014). This cichlid species, similar to others of its kind, has a reputation of being aggressive. Therefore, scientists believe that the *H. letourneuxi* may out compete native fish species for spawning sites.

The Mayan cichlid *Cichlasoma urophthalmus* of Central America has also become a prominent member of the fish community in South Florida. The species was first recorded in Everglades National Park in 1983 (Loftus & Kushlan, 1987), approximately two decades after the introduction of the *H. letourneuxi*. Since then, it has spread north over 300 kilometers on both coasts and can now be found throughout South Florida in canals, marshes, and mangrove swamps (Faunce, Patterson, & Lorenz, 2002). *C. urophthalmus* can tolerate water salinities up to 38 ppt and breeds in both fresh and saltwater (Adams & Wolfe, 2007). Though *C. urophthalmus* mostly feeds on fish, it is considered a generalist because it consumes a wide range of vegetation, crustaceans, and gastropods. Its ability to breed and eat

indiscriminately makes it a species of concern for fresh and brackish water ecosystems (Porter-Whitaker, Rehage, Liston, & Loftus, 2012). Our goal was to determine whether the proportion of exotic and native fish species and their biomass differed among landscape types (urban, forested marsh, and herbaceous marsh) and between smaller-scale habitats (canals and ponds) in South Florida. We hypothesized that exotic fish species would have a higher relative abundance and proportion of biomass in the urban landscape compared to the forested and herbaceous marsh landscapes due to the closer proximity of urban study sites to the highly populated east coast of South Florida. Further, we expected a higher relative abundance and proportion of biomass of exotic fish species in canals versus stormwater ponds because the canal network has few barriers to dispersal (Schofield et al., 2014).

## Method

Fish were sampled in two habitat types (canals and stormwater ponds) at three replicate sites within three landscape cover types (urban, forested marsh, herbaceous marsh) for a total of 18 sample sites (Figure 1). Each of the 18 sampling sites within canals and stormwater ponds were divided into three subsites. The first subsite location within each canal and stormwater pond was randomly selected by estimating the minimum and maximum bearing and distance that encompassed the site with a compass and rangefinder. A random bearing and distance within the predetermined ranges were chosen using a random number table. The second and third subsite locations were determined by selecting a random direction and a random distance ( $\geq 10$  m) from the first and second subsites, respectively.

*Fish Sampling* Within each subsite, an array of minnow traps was set at various distances and

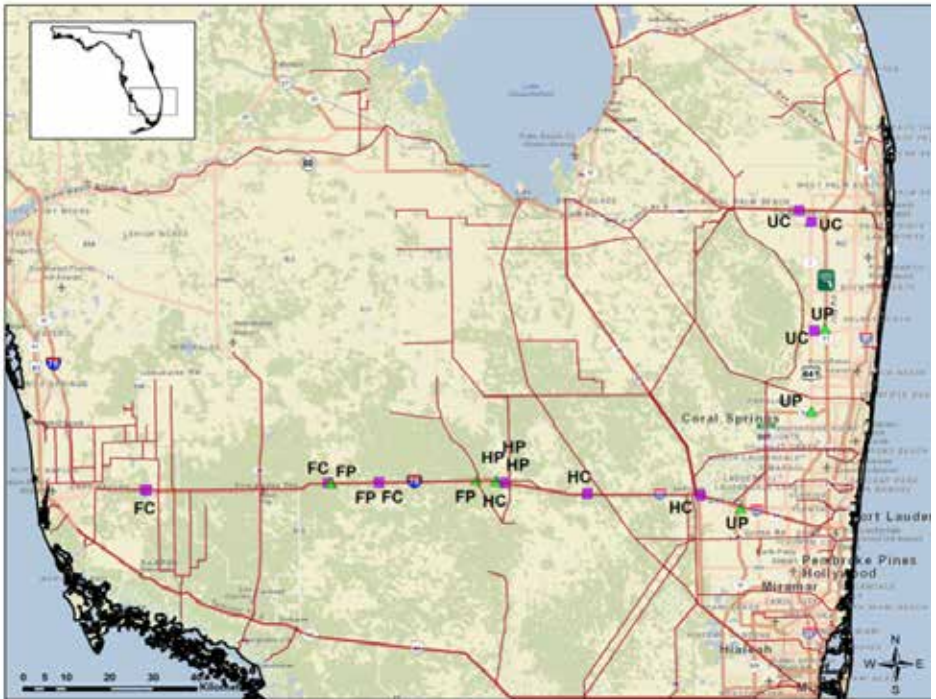


Figure 1. Locations of fish sampling sites at canals (□) and stormwater ponds (Δ) within herbaceous marsh, forested marsh, and urban landscapes along roadway corridors in South Florida. UC = Urban Canal, UP = Urban Pond, HC = Herbaceous Canal, HP = Herbaceous Pond, FC = Forested Canal, FP = Forest Pond.

depths (Figure 2) to sample the full range of the water column. From one edge of the shoreline to the other, minnow traps were placed horizontally and equally spaced across the subsite with some additional traps suspended below on a line. The number of minnow traps suspended on a line varied based on the depth of the site. Suspension lines in deep (>1.5 m) canals or stormwater ponds consisted of three traps: one just below the water surface, one mid-water column, and one resting on the substrate. For sites at intermediate depths (1.0-1.5 m), suspension lines held two traps: one just below the water surface and one resting on the substrate. For shallow site depths (<1.0 m), each suspension line contained only one trap resting on the substrate. Minnow traps consisted of two inverted funnel openings on both ends of a mesh-covered cylinder.

The funnel openings were modified from a 2.54 cm diameter opening to a 10 cm oval with a maximum width of 3 cm to allow the capture of larger-bodied prey (Evans, Klassen, & Gawlik, 2015). Minnow traps were set periodically throughout the day and retrieved the following day after being deployed for a minimum of 18 hours. Fish retrieved from traps were immediately euthanized with a Tricainemethane Sulfonate (MS-222®) solution (350 mg/L). In the lab, fish specimens were fixed with Prefer® and identified to species using keys, field guides, and online databases. Also, each fish was weighed to the nearest 0.01 g and measured (standard length). Within seven days, specimens were transferred to a 70% ethanol solution for storage. Fish were handled in accord with Florida Atlantic University's Institutional Animal Care and Use Committee Protocol A14-11.

## Statistical Analyses

Chi-square tests were used to test for differences in the proportion and biomass of exotic fish among landscape types (urban, forested marsh, herbaceous marsh), habitat features (canal and pond), and landscape types (canals only). All chi-square tests were performed using Microsoft Excel.

## Results

A total of 5,057 individual fish were collected from 9 July to 14 December, 2014, of which, 608 were exotic species and 4,449 were native species (Table 1). *C. urophthalmus* (111 individuals) and

*H. letourneuxi* (387 individuals) were the most abundant exotic fish species captured. Another member of the Cichlidae family, the spotted tilapia *Pelmatolapia mariea* (86 individuals), was also observed in relatively high numbers but only in forested landscapes. Other exotic fish such as the blue tilapia *Oreochromis aureus*, brown hoplo *Hoplosternum littorale*, peacock bass *Cichla ocellaris*, and other exotics were captured as well, but not in high numbers (Tables 1-3).

**Table 1. Number of exotic species identified from minnow traps in landscape cover types and habitat types. UC = Urban Canal, UP = Urban Pond, HC = Herbaceous Canal, HP = Herbaceous Pond, FC = Forested Canal, FP = Forest Pond.**

Common name	Scientific name	UC	UP	HC	HP	FC	FP
African Jewelfish	<i>Hemichromis letourneuxi</i>	62	325	0	0	0	0
Black Acara	<i>Cichlasoma bimaculatum</i>	11	0	0	0	0	0
Blue Tilapia	<i>Oreochromis aureus</i>	2	0	0	0	0	0
Brown Hoplo	<i>Hoplosternum littorale</i>	2	0	0	0	0	0
Jaguar Cichlid	<i>Parachanna managuensis</i>	3	0	0	0	0	0
Mayan Cichlid	<i>Cichlasoma urophthalmus</i>	64	0	40	7	0	0
Peacock Bass	<i>Cichla ocellaris</i>	0	0	1	0	0	0
Spotted Tilapia	<i>Pelmatolapia mariea</i>	0	0	3	0	39	44
Unknown Cichlid	<i>Osteichthys</i> sp.	0	0	0	0	2	0
Walking Catfish	<i>Clarias batrachus</i>	0	0	0	0	3	0
Total Exotic Fish		144	325	44	7	44	44

**Table 2. Number of exotic fish identified from minnow traps by landscape cover types and corridor features.**

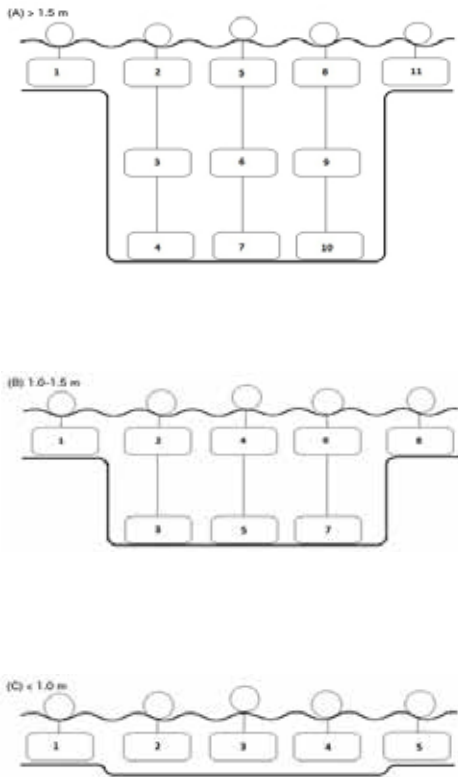
Landscape	Exotic Fish	Native Fish
Urban	232	648
Herbaceous	276	380
Forested	88	3364
Habitat	Exotic Fish	Native Fish
Canal	232	648
Stormwater Pond	276	380

**Table 3. Biomass of exotic fish identified from minnow traps by landscape cover types and corridor features.**

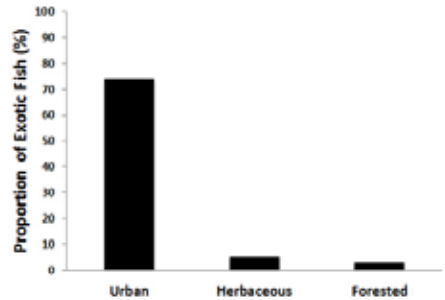
Landscape	Exotic Fish (g)	Native Fish (g)
Urban	918.80	134.83
Herbaceous	91.36	286.81
Forested	107.15	667.00
Habitat	Exotic Fish (g)	Native Fish (g)
Canal	347.43	240.15
Stormwater Pond	769.26	782.16

### Exotic fish among landscape types

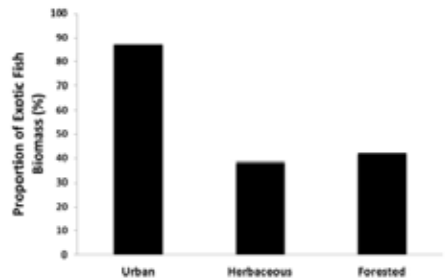
There was a significant difference ( $\chi^2 = 2648.48$ ,  $df = 2$ ,  $p < 0.001$ ) in the relative abundance of exotic fish among the landscape types. The proportion of exotic fish sampled in the urban landscape (74%) was more than ten-fold that of the herbaceous (5%) and forested (3%) landscapes (Figure 3). There was also a significant difference ( $\chi^2 = 1088.44$ ,  $df = 2$ ,  $p < 0.001$ ) in the proportion of exotic fish biomass among urban (87%), forested (14%), and herbaceous marsh (24%) landscapes (Figure 4).



**Figure 2.** Figure from Evans et al. (2014). Model of minnow trap distribution at fish sampling sites with depths (A) >1.5 m, (B) 1.0-1.5 m, and (C) <1.0 m. Circles depict floats that are connected via line to the minnow traps, which are depicted with rectangles.



**Figure 3.** The proportion of exotic fish in urban, herbaceous and forested landscape types.



**Figure 4.** The proportion of biomass of exotic fish in urban, herbaceous and forested landscape types.



### Exotic fish between habitat types

The relative abundance of exotic fish in the canal habitat (26%) was significantly higher ( $\chi^2 = 207.14$ ,  $df = 1$ ,  $p < 0.001$ ) than in the stormwater pond habitat (10%; Figure 5). Similarly, there was a significantly higher ( $\chi^2 = 15.56$ ,  $df = 1$ ,  $p < 0.001$ ) proportion of biomass of exotic fish in the canal habitat (59%) than in the stormwater pond habitat (50%; Figure 6).

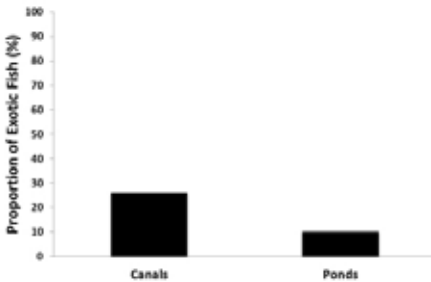


Figure 5. The relative abundance exotic fish in stormwater pond and canal habitat types.

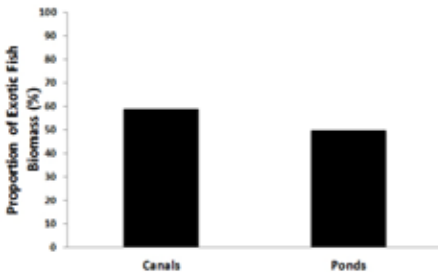


Figure 6. The proportion of biomass for exotic fish species in stormwater pond and canal habitat types.

### Exotic fish in canals among landscape types

There was a significant difference ( $\chi^2 = 275.92$ ,  $df = 2$ ,  $p < 0.001$ ) in the relative abundance of exotic fish among urban (69%), forested (24%), and herbaceous marsh canals (9%) (Figure 7). There was also a significant difference ( $\chi^2 = 132.27$ ,  $df = 2$ ,  $p < 0.001$ ) in the proportion of exotic fish biomass among urban (87%), forested (38%), and herbaceous marsh canals (42%) (Figure 8).

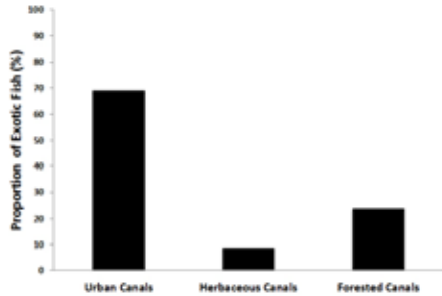


Figure 7. The relative abundance of exotic fish in urban, herbaceous, and forested canals.

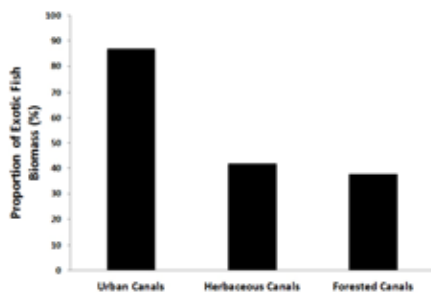


Figure 8. The proportion of biomass of exotic fish in urban, herbaceous, and forested canals.

## Discussion

Results from this study suggest that exotic fish are predominantly found in the urban landscape and in canals. These patterns are consistent with the notion that aquarium fish releases are the origin of most introduced exotic fish (Florida Fish and Wildlife Conservation Commission, 2015). The connectivity of other landscapes to the urban landscape, via canal systems, allows for their dispersal, as has been documented with the sailfin catfish *Pterygoplichthys multiradiatus* and Asian swamp eel *Monopterus albus* (Lof-tus & Kushlan, 1987; Shafland, 1996; Shaflan, 2008). The connectivity of the urban landscape to more natural landscapes in South Florida deserves special attention because Everglades restoration projects (e.g., The Comprehensive Everglades Restoration Plan (CERP), 1999) will increase water delivery from canals to natural areas. Such management activities could potentially enhance the invasion and range expansion of exotic fish (Kline et al., 2014). Furthermore, as hypothesized, the same features (i.e. the urban landscape and canals) that supported a higher proportion of exotic fish also supported a higher biomass of exotic fish species relative to native species. It is not clear whether landscapes and canals are higher quality habitat for exotic fish or whether they have not had enough time to disperse to other habitats.

Apart from the connectivity that canals create, it is also possible that sampling bias played a role in the observed patterns of exotic fish. For instance, large cichlids >155mm and >70g were consistently captured in one large urban pond, while individuals from other sampling sites ranged from 16-87mm and 0.08-13.73g. Although sites were selected randomly within habitat and landscape types, it is possible that the inclusion of particular sites with unusual characteristics could have biased the subsequent samples. Nevertheless, the chances of selecting an unusual site were equal among the landscape and habitat types.

Out of all the exotic fish captured in the 18 study sites, *H. letourneuxi* and *C. urophthalmus* were the most abundant and comprised the largest proportion of exotic fish biomass. These results were generally expected based on prior knowledge of *H. letourneuxi* and *C. urophthalmus*

being two of the most abundant exotic species found throughout South Florida (Kline et al., 2014). Other exotic fish such as spotted tilapia *Pelmatolapia mariea*, blue tilapia *Oreochromis aureus*, brown hoplo *Hoplosternum littorale*, peacock bass *Cichla ocellaris*, and others were not observed in relatively high numbers, suggesting that perhaps landscape, habitat and/or other existing factors are limiting these species from achieving the high relative abundances demonstrated by *H. letourneuxi* and *C. urophthalmus*.

One limitation of our study was that it was temporally restricted to a six-month sampling period during the summer and winter in South Florida. During the winter months, low water temperatures can be lethal to exotic fish and have the potential to lower their abundance drastically (Adams & Wolfe, 2007). The average minimum temperature recorded from Miami on July 4, 2014 to December 14, 2014 was 23°C. However, in 2010 temperatures dropped to 0°C and caused widespread mortality of both native and exotic fish. This highlights the importance of rare, but severe temperature events on fish populations; however, it was beyond the scope of this study to determine how exotic fish populations change as a function of extreme weather events. Access to longer term data may allow scientists to better understand how density and biomass fluctuate seasonally and possibly identify specific locations where exotic fish seek thermal refuge from cold water. Year-round sampling would also provide a clearer picture of seasonal variation in fish density and biomass patterns.

Another limitation of this study is spatial restriction to roadway habitats in three South Florida counties. Data from other Florida counties, particularly more northern counties, would provide a fuller picture of exotic fish patterns in the state. For example, a comparison of urban exotic fish between South and Central Florida would be particularly informative because it would quantify the role of temperature, a likely limiting factor for many exotic fish species.

The information gathered from this project identified new patterns of exotic fish abundance and biomass in South Florida roadway corridors. To that end, we propose that our research could be

useful for management actions aimed at eliminating thermal refuges (e.g. filling unnaturally deep habitats to allow water cooling; Schofield et al., 2009), as well as for hydrological, electrical, and biological methods designed to control the spread of exotic species. Our study suggests that early detection for exotic fish should focus on urban areas, particularly on canals. These areas allow for harsher eradication methods because of low impacts to native fish, which are proportionately more abundant in marshes. Focusing management of exotic fishes in canals is likely to be more effective and less harmful to native species than attempting to manage exotic fishes after they are established in natural marshes.

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## Space, Art, and Activism: The Innovative Poetics of Anne Waldman & Rachel Blau DuPlessis

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**Abstract:** This article explores commonalities between the poetry of Anne Waldman and that of Rachel Blau DuPlessis. Superficially, the poetics of Waldman and DuPlessis appear quite disparate from each other with the exception that they are both female American poets working during the same historical period. While Waldman is associated with the second generation of the New York School, the Beatniks, and the Outrider experimental poetry movement, DuPlessis is more prominently lauded for her work as a feminist critic and essayist. Though the pairing of Waldman and DuPlessis seems incongruous, close readings of both poets reveal several common threads, most prominently their innovative utilization of space, the connection of their poetics to other art forms, and the rooting of their work in activist causes.

In the preface of their landmark collection *The Norton Anthology of Literature by Women*, feminist critics Sandra M. Gilbert and Susan Gubar define their anthological work as an attempt to gather “literary works in which women writers have expressed their sometimes problematic, sometimes triumphant relationship to culture and society...[in order to]...recover a long and neglected literary history” (xxvii). Due to a historically patriarchal emphasis upon male literary figures and models throughout standard literary canons, Gilbert and Gubar’s anthology addresses the problem not only of the fringe-like existence of female authors but also of the resulting lack of critical recognition for the literary legacy passed between different generations of women as well as their own temporal counterparts. When placed within the context of Gilbert and Gubar’s argument, the stakes of connecting the poetics of Anne Waldman and Rachel Blau DuPlessis are nothing less than the status of the female literary tradition as neither poet’s work fits neatly into the standard categorization schema of the male-dominated literary canon. Initially, Waldman and DuPlessis appear quite disparate from one another with the exception that Waldman and DuPlessis are both female American poets working during the same historical period. While Waldman is associated with several literary schools, including the second generation of the New York School, the Beatniks, and the Outrider experimental poetry movement (Poetry-Foundation 1), DuPlessis remains unassociated with any specific literary movement and is more

prominently lauded for her work as a feminist critic and essayist, with the exception of her life poem project. Although the pairing of Waldman and DuPlessis seems incongruous, close readings of both poets reveal several common threads, most prominently their innovative utilization of space, the connection of their poetics to other art forms, and the root of much of their work in activist causes. When viewed through the lens of feminist literary criticism, the initial seeming disparity but ultimate connection between Waldman and DuPlessis suggests not simply an exemption to the standard classification scheme of male literary canon but further evidences Gilbert and Gubar’s belief that “though conventional literary periodization does not suit women’s literary history, women’s history does have significant phases of its own” (Gilbert and Gubar xxvii). Within this context of female literary legacies, the poetic commonalities between Waldman and DuPlessis become indicative of a shared historical movement potentially corresponding to second-wave feminism in which both poets express their newfound power as women in late twentieth century American society. By creating a uniquely female poetic space, collaborating with other art forms rather than assuming a solitary, fringe-like literary existence, and ultimately grounding their work in feminist activism, Waldman and DuPlessis both create a poetics that innovatively reflects a historically novel framework of female independence and power.

One of Waldman's most deliberate and self-referential manipulations of space is unsurprisingly demonstrated within her poem "Makeup on Empty Space." Her formal utilization of space begins with the literal application of various makeups (e.g. rouge blushing, pasting eyelashes, piling creams) upon the repeated titular phrase "on empty space" for the first seven lines. The eighth line, "painting the phenomenal world" (Waldman 1), then provides the first shift within the poem in which Waldman implies the solipsistic concept of unavoidable subjective perception by repeatedly creating a literal world outside the self and then erasing any sense of verisimilitude by introducing figurative imagery, leaving the narrator as the sole constant within the ever-shifting poem. In the first eight lines, Waldman thus delivers a superficial imaginary and empty space by describing literal makeup practices and then thematically subverts her own imagery with a rupturing of the perceivable world by introducing the figurative notion of painting the phenomenal. For the next three lines, Waldman again superficially decorates and interacts with this empty space using literal objects until another shift occurs: "I pour words over empty space, enthrall the empty space" (12). By pouring words over the empty space, the narrator again disrupts the literal with the figurative as well as connotes a meta self-awareness in the narrator by pointing towards Waldman's deliberate manipulation of the poem's space through specific shifts in diction. The next shift from literal to figurative is even more rapid when the act of spinning necklaces in line 14 is followed directly by "Fancy this, imagine this: painting the phenomenal world" (15). Functioning as imperatives, the phrases "Fancy this" and "imagine this" imply a second-person subject since commands require a subject that is being commanded with the speaker assuming the role of the commander. Waldman thus further explores her capacity to manipulate space by formally drawing the reader into the situation through the use of imperatives and then thematically delivering a moment in which to consider the irony of makeup's unnaturalness by not allowing any literal applications of makeup to persist for more than a few lines without being interrupted by the figurative. Such self-referential commentary about its manipulation of space continues sporadically throughout the poem, such as when the narrator directly states, "I want

to take this old wall apart I am rich in my mind thinking / of this, I am thinking of putting makeup on empty space" (59-60). Within these two lines, the narrator begins with a literal wall and then figuratively retreats into her mind so that line 60 can liken putting on makeup to the act of interweaving the literal and the figurative so that they cancel one another out. This pattern of repeating phrases and subsequent shifts continues for the entire duration of the poem until the final moment of "singing & moaning in empty space" (146), thus inverting and encapsulating the poem in a perceived shroud of empty space by ending with a figurative shift so that the last of the literal details are disrupted and erased so that all that is left at the end of the poem is the empty space, i.e. the woman.

In a segment of her life poem project entitled "Draft 5: Gap," DuPlessis innovatively manipulates space in a manner that is thematically reminiscent of Waldman's while remaining formally distinct. As predicted by the title, DuPlessis' poem contains several instances in which blocks of texts are blacked out, beginning with the supposed first word of the poem. This mimicry of redacted information simultaneously creates its own hidden space and formally invites the reader to attempt to invade said space in a manner similar to the use of imperatives towards the beginning of Waldman's "Makeup on Empty Space." Rather than the empty solipsism demonstrated through figurative erasure in Waldman's poetry, DuPlessis instead delivers an extra-linguistic device that blocks the capacity of the reader to observe the language; she does so instead of simply stripping the language of its validity by interweaving the literal and the figurative as Waldman does. DuPlessis additionally parallels Waldman through her occasional instances of direct references to the manipulation of space within the poem. For example, the use of the color white in the line "eyes whitened behind glass" ("Anne" 13) comments upon the phrase's position within the poem as it directly follows several lines of blacked out text while the mention of eyes references the visual trickery of the poem; in addition, the preposition "behind" points towards the hidden language in the poem just before the "indelible black squares" in line 15 directly references DuPlessis' formal disruption of space through redaction. By using continuous

indentation and line spaces to draw the reader's attention to the formal aspects of the poem and then sporadically blacking certain portions of text all while referencing its own spacial manipulation, DuPlessis essentially creates a shifting poetic pattern that thematically withholds information from the reader, just like Waldman's poem, while innovatively disrupting the space of her poem in a much more active manner.

Although their rupturing and manipulation of space functions as an exclusive gesture by not allowing a privileged male perspective to enter their female poetic space, the second commonality Waldman and DuPlessis share is inclusive: their incorporation of other art forms or types of media to accentuate and shape their own poetics. For Waldman, the preferred accentuating art form is the performance of the poetry itself. Armed with her own powerful and resilient voice and often background bands of varying instruments, Waldman's performances go beyond pure poetry readings in that the performance adds additional layers to the poem that were not and could not be present in print. An excellent example of such a moment is Waldman's performance of her poem "To the Censorious Ones" at Naropa University in 1990. In her performance, Waldman began by emphasizing the "I" in the line "I'm coming up out of the tomb, Men of War" (1). By elongating the word "I" and voicing it in a manner that gradually transitions from a very low, gravelly pitch to a medium pitch, Waldman utilized her voice to mimic the rising from the tomb that the narrator of the poem forewarns. This use of onomatopoeia continued in the line "Can you feel the ground rumble under your feet?" (4) as Waldman shifted her voice so the sound of the "rum" portion of the word "rumble" rumbled as if it were made of the earth the poem's narrator discusses. Waldman continued the repetition of rising pitch and intensity until the final moment in which the narrator exclaims, "I'm opening the box / Bool!" (23-24). By suddenly dropping all loudness and intensity from her voice for an elongated pause between the words "box" and her exclamatory "Bool," Waldman ended her performance of the poem with an audible moment of peace; by allowing a moment of silent composure before her scare attempt, Waldman negated the potentiality of being viewed as an exponentially angry woman

and instead demonstrated acute control of her passion and allowed her listeners to wait as she silently demonstrated her authority over that space. Through her performance, Waldman thus added a third dimension to her uniquely powerful and gendered space.

While Waldman's incorporation of other art forms into her poetics is primarily auditory, DuPlessis' work relates mainly through visual art, especially the way in which her formally fragmented and varying poems mimic collage. In an interview piece for Jacket Magazine entitled "Desiring visual texts: A collage and embroidery dialogue," DuPlessis explicitly states that her past "is pertinent to my poetry, but it is also important to collage. Collage now might be a way of reconnecting with that past and reclaiming it" (Damon and DuPlessis). The thematic reconnecting and reclaiming alluded to in DuPlessis' comments become formally represented in the collage-like structures present within much of her poetic work, such as in the first section of her poem "O" from Draft X: Letters:

*Overwhelming.*

Stuck  
two owls hooting  
thru and thru  
the domèd cupola of night.

They try to tell you  
The feel of dying.

*I lose my breath.*

The poem appears to be constructed in a manner similar to a collage, for the italicized and non-italicized words and phrases act as differently shaped pieces due to their slant or lack thereof and they are then set upon or near one another in the form of somewhat neat and purposeful layers with space in between just as pieces of a collage would lie. This reading of DuPlessis' poetry is further supported by her statement that "collage became a vital and central poetics for my current poetry, but more on the level of structure than in the realm of individual image juxtapositions" (Damon and DuPlessis). According to her own elaboration upon collage's influence on her poetics, DuPlessis' work may be interpreted as collage-like not in its creation of one specific image but of the semantic conjunctions made possible by placing different blocks of texts together in varying spacial and formal arrangements. In the first collage by DuPlessis included in the arti-



cle, "Wishes on the Wish Tree," several small and different pieces of cloth appear to be haphazardly attached with varying degrees of space between one another to a large piece of cloth. Likewise, DuPlessis' poems are more visually accessible if imagined as fragmented thoughts and bits of the narrator's identity and past that the poet specifically organizes in a way that forces the reader to find some connection within the space between all of the pieces in order to reclaim some sense of a cohesive whole. The seemingly great superficial disparity and spacing between the fragments of cloth in DuPlessis' collage forces the viewer to visually construct a space in which these physical pieces fit cohesively just as the fragments of sentences and phrases within DuPlessis' poems force the reader to mentally construct connections within the gaps the poet leaves. The potential correlations between DuPlessis' work and the structure of collages are relevant not only to further interpretations of her poetry but also to the manner in which DuPlessis and Waldman utilize different art forms to structurally support and expand their poetics and the space in which their poems persist. Within the context of feminist criticism, Waldman and DuPlessis' poetic incorporation of other art forms also reflects a rejection of the solitary female artist described by Gilbert and Gubar; rather than remaining on the fringe of artistic society while male writers dominate the art scene, Waldman and DuPlessis actively engage in art communities and thus create their own shared literary tradition.

As part of a female literary tradition tied to the novel self-empowerment of women in late twentieth century feminism, the final prominent correlation between Waldman and DuPlessis is their mutual affinity towards utilizing their poetics to serve an activist purpose. In her 2005 essay "Anne Waldman: Standing Corporeally in One's Time," DuPlessis argues that "Anne Waldman's work in poetry exists at the intersection of activist passion, gender critique and wariness, and long poem ambitions". The activist passion to which DuPlessis refers is visible within a wide variety of poems, such as "To the Censorious Ones," beginning with the speaker's demarcation of "Men of War" (1) as her enemy. Waldman's moment of feminist power then becomes even further cemented as she utilizes her linguistic power to transformatively broaden her targets

from "Men of War, Censorious Ones" (7) to "big boys" (8) in the following line so that her poem transitions from a piece specifically regarding Helms to a more generalized oppressive male political presence. As the alternative title implies, Waldman's poem can then function primarily as an "Open Address to Senator Jesse Helms," angrily protesting his promotion of censorship and his extremely conservative views in general by pitting a female speaker against her patriarchal oppressors. DuPlessis additionally argues for the feminist activism of Waldman when she quotes Waldman's poem "Iovis" in *Kill or Cure*: "He rules through possession, rape, and through the skillful means of the shape-shifter as well. From the psychological point of view (as a 'daughter'), I need to call him out, reveal him, challenge him, steal his secret". By quoting Waldman's description of and aggressive engagement with Jove and Zeus as procreative male deities, DuPlessis suggests that Waldman's poetics function generally as a form of activism by arguing for social change within the current political sphere as well as particularly functioning in a feminist sense by enabling a distinctly female speaker to grab control from a primarily male power source. The gendered aspect of Waldman's work here, i.e. the manner in which Waldman's poetics engage with gender politics, is grounded in the causes of feminist activism by continually attempting to, as DuPlessis argues, create a distinctly female power and energy within her poetry. By allowing the poem to serve as a space in which a female speaker can escape societal limitations and exclude any potential domination by a distinctly male point of view, Waldman's poetics mimic the newfound female power currently being realized in late twentieth century feminism. By creating a female position of power within her poetics, Waldman's art demonstrates its inherently political nature by advocating for the necessity of social reform regarding the patriarchal oppressors present within the current political hierarchy. Known primarily as a critic and essayist entrenched in feminist theory (Poetry Foundation 2), DuPlessis' poetics is also heavily rooted within feminist activism. In her 1990 essay "OTHER-HOW," DuPlessis argues that the main aspect of poetry that must be completely ruptured is the centrality of the lyric voice as wholly privileged and originating from a male source:

As a woman writing, my language space, my cultural space is active with a concatenation of constructs — prior poems, prior poetics — a lot of which implicates women. But not often as speaker. As ideal. As sought. As a mediator towards others' speech. As object. As means. As a thing partially cannibalized. Neutralized. (581)

Through her series of equations, DuPlessis problematizes the masculine lyric voice, i.e. the way lyric poetry traditionally privileges a strictly male point of view, by referencing the prevalence within poetic tradition of using women primarily as referential objects rather than as speakers with agency. The poetic rupturing that DuPlessis states is necessary to achieve such female freedom can be observed in an *ars poetica* segment of the long poem "Writing":

*Making her and watching her*

.All like little novels?  
Novels are nothing like this. *make herself*

*The synchronicity of seeing that when this –*

By destabilizing the very form of the poem through a confusing, non-traditional spacial arrangement of phrases with varying gaps in between, DuPlessis destabilizes the narrator's sense of self by introducing the concept of "making her" and creating a lens through which to observe "her" in the first line and then immediately introducing a non-italicized portion of text with a subject seemingly unrelated to the first line. By restating the notion of creating a general female presence in the phrase "make herself" and then interrupting the italicized section again, DuPlessis avoids the possibility of gendering the lyric voice of the poem by formally disrupting any sense of a cohesive point of view, especially one that privileges a male perspective, while simultaneously utilizing the line "Novels are nothing like this" to self-referentially remind the reader of the poem's own deliberate attempt to break with literary tradition. Taking into account Du-

Plessis' concern for women existing in poetry simply as referential objects viewed through a male poetic lens, the shift from "making her and watching her" (1) to the statement "make herself" (3) turns the third-person "her" of the first line into an inwardly pointing, self-referential "herself" so that the woman being described is no longer an inactive presence being observed and created by a secondary source but is instead a female with the agency to construct her own identity; if there is any gendering within DuPlessis' poetry, it is one that rejects the tradition of a privileged male lyric voice and instead leaves room for either a female speaker with agency to exist or for no cohesive perspective at all.

As previously stated, the commonalities between the poetics of Anne Waldman and those of Rachel Blau DuPlessis remain significant most prominently in relation to their implications for the study of movements or trends in women's poetry. Within the section of her essay "OTHERHOW" entitled "Rupturing the History of Poetry," DuPlessis questions the validity of using the standard of a male-centric literary canon, especially concerning poetry, by asserting that "the very idea of a history of poetry is a fictional sequence formed by choices, exclusions, interests, silences, — a whole and contingent politics of discourse" (586-587). In her call to rupture the history of poetry, DuPlessis mirrors Gilbert and Gubar's concern that a female literary tradition not only exists but that it has also been silenced and marginalized to the point that any of the significant common movements or trends within it remain inscrutable when using schemata that privilege male authors and their own literary heritage. Though their poetics remain irrevocably disparate and unique, Waldman and DuPlessis find their connective core in the manner through which they fashion themselves, as female poets must, by rupturing the male-dominated schemes of past poetics. When viewed through the lens of feminist literary criticism, Waldman and DuPlessis both innovatively manipulate space within their poetry, collaborate with other art forms, and ground their work within activist causes in a manner that corresponds to the novel space and agency for women specifically fought for and afforded by late-twentieth century feminism.

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## The Code-Switching and Confluence of Languages in Esmeralda Santiago's *When I was Puerto Rican* (1993)

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**Abstract:** "The Code-Switching and Confluence of Languages in Esmeralda Santiago's *When I was Puerto Rican* (1993)" is an essay/article written to produce and analyze thought on the style of code-switching of Spanish-English bilinguals. Santiago's memoir details her young life in Puerto Rico in a rural home and society and then how she had to transition when she and her family moved to New York. Code-switching is when, in reference to Spanish and English, a person who speaks English will substitute an English word or phrase for a Spanish word or phrase. This occurs primarily with bilinguals. In *When I was Puerto Rican*, Santiago includes some Spanish words in her English context (because her primary language is English), practicing code-switching. This essay demonstrates the fundamentals of code-switching, how it is detailed in *When I was Puerto Rican*, and how events in history aided to its modern formation.

"Code-switching" and the confluence of languages has been a linguistic manifestation of the encounters between people of different cultures. Specifically concerning Spanish and English between the Caribbean and the United States, the convergence of these two languages has greatly heightened with the ever-continuing influx of immigrants from Spanish-speaking countries. This is primarily due to migration movements as well as U.S. influence in Puerto Rico, which became a commonwealth of the United States in 1898. This essay is going to analyze the linguistic impact of the U.S. influence in Puerto Rican society that has caused linguistic interferences in language and at the mechanics of code-switching in Esmeralda Santiago's memoir, *When I was Puerto Rican*. This is to demonstrate how the acculturation of Spanish-speaking societies has facilitated the phenomenon of code-switching and what effect this confluence has had on the people as they incorporated themselves in the U.S. To first understand the linguistic impact of code-switching, one must first understand its technicality. Roberto R. Heredia and Jeffrey M. Brown explore the logistics of this linguistic process in their article "Code-Switching" as they describe how bilinguals tend to blend their languages when they communicate and how the amalgamated sentences follow a specific structure. Heredia and Brown describe it as the "phenomenon [that] occurs when bilinguals substitute a word or phrase from one language with a phrase or word from another language."

The investigators discuss code-switching by referencing Spanish-English bilinguals and Chinese-English bilinguals. In addition, they give an example of the mechanics associated with code-switching by considering a specific sentence and studying how multilingual individuals incorporate more than one language:

(1) *I want a motorcycle VERDE.* In this sentence, the English word "green" is replaced with its Spanish equivalent. A noteworthy aspect of sentence (1) above is that the Spanish adjective "verde" follows a grammatical rule that is observed by most bilingual speakers that code-switch. Thus, according to the specific grammatical rule-governing sentence (1) above, sentence (2) *I want a VERDE motorcycle* would be incorrect because language switching can occur between an adjective and a noun, only if the adjective is placed according to the rules of the language of the adjective. In this case, the adjective is in Spanish; therefore, the adjective must follow the Spanish grammatical rule that states that the noun must precede the adjective (1) (Heredia & Brown).

John M. Lipski (2005) poses an interesting and legitimate topic in his article "Code-switching or Borrowing? No sé so no puedo decir, *you know*." He discusses how multilinguals will code-switch by speaking Spanish and adding an English word every now and then. Some of these words in

particular are *so*, *but*, *anyways*, *I mean*, and *you know*; however, it is noted that this switch with words, according to Lipski, only happens among true bilinguals:

It would appear that the placement of English *so* and similar items [(*but*, *anyways*, *I mean*, and *you know*)] into Spanish discourse in the United States began as insertion among immigrants and among vestigial or transitional bilinguals, and evolved lexicalization. (7)

It evolved into lexicalization because people get used to saying a particular phrase and thus incorporate it into their vocabulary. An example of *so* used and an example of *you know* used from Lipski's article are "...y yo soy el mayor de la familia, *so* yo tuve que ir a trabajar..." and "...una película que tenga un tema, *you know*, Ud. sabe, un tema especial..." (5). Likewise, *so* crosses many boundaries in language and as specified by Lipski, "*so*-insertion is one of the few bilingual switching phenomena to occur in both bilingual and second-language speech" (3). "The incorporation of *so* potentially represents a window of opportunity, highlighting the means by which functional elements from one language gradually insert themselves into another language during bilingual encounters" (3). This could be happening due to the question of time, due to that while the speaker is saying "*so*" he is providing time to think of the next sentence in Spanish. Code-switching occurs in a variety of ways, one of which is, where Lipski (2005) states, "calques of idiomatic expressions in English [calques being another word for *loan translation*] are frequent when speaking Spanish, with fewer cases of Spanish calques in English discourse, and numerous loans from English are present." And, relating to the previous paragraph, Lipski details that "unassimilated English words may be freely inserted whenever the Spanish word is unknown," which is what is normally seen when code-switching is witnessed. An example he provides is "*Anyway, yo creo que las personas who support todos estos grupos como los Friends of the Earth son personas que are very close to nature.*"

Lipski (2005) references Spanish-English bilinguals, French-English bilinguals, Italian-English bilinguals, as well as languages from distinctly different families such as Korean, Japanese, Ta-

galog, Arabic, Hebrew, Cantonese, Berber, Nahuatl, and Polish, but I am specifically discussing the linguistic tendency of bilingualism in Puerto Rican diaspora. This tendency occurs gradually and not deliberately with the contact of English language because they are completing the action of incorporating something new into their vocabulary. When a Hispanic person comes to a new area he/she initially is still extremely attached to their language, culture, and ideals. Leisurely, they begin to accept more and more of U.S. culture and begin to slightly change. This is when code-switching is especially prominent—when the speaker uses his/her own language and borrows a term (or "functional item" according to Lipski [3]) from another language that he/she knows very well.

The introduction of Puerto Rican people to U.S. society and vice versa occurred due to some specific historical events. Starting with some basic history, Puerto Rico achieved its independence from Spain in 1898 and then became a colony of the United States following the Treaty of Paris. The Jones Act in 1917 then granted Puerto Ricans U.S. citizenship. In 1947 the Puerto Ricans elected their own governor and in 1948 their first elected governor was Luis Muñoz Marín. Finally, in 1952, Puerto Rico became a commonwealth of the United States. Additionally, Operation Bootstrap (in Spanish known as *Operación manos a la obra*) was established in 1947. It transformed Puerto Rico from an agricultural economy into an industrial economy that was incredibly developed. Operation Bootstrap created strong economic growth, but the rapid modernization was disadvantageous in that there were negative social effects, like the accompaniment of "an absolute decrease in employment" due to the introduction "of industries of higher productivity," (Economy: Operation Bootstrap). The time period of Operation Bootstrap was also a time when Puerto Rican migration to the United States (especially "Nueva York") increased considerably.

The effects of U.S. intervention in Puerto Rico through the Operation Bootstrap and other acts created to control the commonwealth's economy is shown in Esmeralda Santiago's memoir, "*When I was Puerto Rican.*" Santiago's memoir details her life as a child living in Puerto Rico.

She begins her life living in the rural Mancun, Puerto Rico with her mother, father, and two sisters. She grows up with the hardships of living in a rural area but is content. Her father is not around very much and her mother has three other children in her young life. When her mother gets a real job because they need money, Esmeralda (Negi) has to do more work as the oldest child. They have to move to places such as Santurce, and stay with family/friends dealing with a variety of living conditions. Due to one of her younger brothers getting terribly injured Esmeralda's mother starts going to New York occasionally until finally the entire family (minus her father) move to New York. Initially Esmeralda hates living in New York and the language barrier is a struggle for her. She struggles some at school but tries incredibly hard because she wants to do better, especially when she tries to get into a performing arts school. The memoir ends with Esmeralda finally getting into the performing arts school (not because the interviewers were impressed by her performance, but because they were impressed by her courage—which is demonstrated throughout the memoir) and eventually attending a year at Harvard, just showing how far she came.

Esmeralda experienced many things at a young age, especially during a few scenes where imperialism is discussed and detailed through her experiences. Some of these encounters with imperialism include when her father briefly discussed it with her, when she was introduced to it through another student, and primarily through the *centro communal*; the *centro communal* was a community center provided by the government where the children would go receive free breakfast and informational tips and parents received education on diet and hygiene for their children (it was educational programming from the U.S.). This initial step of educational programming from American culture permeating into Puerto Rican society is where the confluence of Puerto Rican Spanish and English occurs. Code-switching begins here on a larger scale with the permeation of American culture and this is shown in Nilita Vientós Gastón's article *The Supreme Court of Puerto Rico and the Language Problem* where she discusses how since the United States took over Puerto Rico there has been confusion as the United States has im-

plemented its primary language of English, especially into the teaching of it into Puerto Rico's schools. Throughout Santiago's memoir she utilizes code-switching. Concerning Santiago's specific case, she grew up in Puerto Rico and then moved to New York when she was a teenager. She struggled at first but soon assimilated into U.S. culture, which she reflects in her epilogue of the book. Now, English is her primary language and that can be seen as she writes her memoir in English. The code-switching occurs as she incorporates Spanish words occasionally that better describe something from her childhood more accurately than an English word could. Examples of this are words like *asopao* because an English word cannot describe a "meat or fish soup thickened with rice and potatoes," (271)—a soup basically made out of leftovers—or a *bodega* which is a "neighborhood grocery store" (272) (*When I was Puerto Rican*). Another fantastic example of this is when Negi (Esmeralda) finds a tapeworm in her underwear and calls it a *solitaria* and then her mother gives them all (she and her siblings) a broth of her own concoction called *purgante* (69). *Purgante* describes this concoction better than an English word like "medicinal soup" would because *purgante* is more specific because in Spanish it has more meaning to it or more details associated with the word. This is how code-switching works; a word from one's original language might describe a thing or situation better in their mind than the new language. This shows that there are multiple causes of code-switching—this previous example and also if a person who speaks English as a first language were trying to speak Spanish and did not know the Spanish word for a specific situation; so, that person forms his/her Spanish sentences and inserts the English word where it is needed. Dana Cole creates a correlation between language and identity in her article "A Linguistic journey to the border." She describes how "language is an integral aspect of identity, both on a personal level, and on a broader social level" and even goes on to quote Chicana writer Gloria Anzaldúa who has stated "ethnic identity is twin skin to linguistic identity—I am my language." She discusses the evils of robbing a people of its language, because this is what happens when colonization occurs, which is almost what happened to Puerto Rico when it became a colony of the United States (now it is technical-



ly a bilingual society, even though many Puerto Ricans who live in the island are not fluent in English). Language is a powerful thing and code-switching makes it even more powerful. Cole discusses why it can be so powerful when she quotes Anzaldúa again saying, “because language can be manipulated, it can also be used as a means to express, reinterpret, redefine and revolt against a static unitary notion of identity and the social world.” Extracting the correlation out even further, code-switching and the manipulation of language causes creative flexibility and innovation, thus drawing out even greater possibilities for a culture. Cole goes on to discuss the relationship between language and identity further by saying how “language is a key component of ethnicity” and nationalism and positively helps people differentiate themselves. This relates to what most Hispanics and Puerto Ricans have been dealing with for years and are also dealing with right now—how their identity is associated with their language. Santiago relates the difficulties felt through her memoir and also through what she personally says on her website by talking about how her identity changed based on her language. She explains this with:

“When I returned to Puerto Rico after living in New York for seven years, I was told I was no longer Puerto Rican because my Spanish was rusty, my gaze too direct, my personality too assertive for a Puerto Rican woman, and I refused to eat some of the traditional foods like morcilla and tripe stew. I felt as Puerto Rican as when I left the island, but to those who had never left, I was contaminated by Americanisms, and therefore, had become less than Puerto Rican. Yet, in the United States, my darkness, my accented speech, my frequent lapses into the confused silence between English and Spanish identified me as foreign, non-American. “(278)

The title of her memoir, *When I was Puerto Rican*, demonstrates a transitional period because she was raised in a Spanish-speaking household but with the contact with U.S. culture in the mainland, she gradually favored the English language towards her mother tongue to communicate—when in the United States, she was Puerto Rican; when in Puerto Rico, she was American. She has lost her nationality due to language as she talks about in her memoir. It is a curious thing to witness the different facets of how language is beneficial towards a person in their diversity but can then be harmful to them. It becomes harmful when they begin losing touch with where they came from and their roots, but it is beneficial in that it helps them gain some leverage in becoming a part of a new society. Different degrees of “transculturalization” occur with Spanish-speaking peoples and this is where the difference between language identities occurs. When a person is bilingual, it makes them more diverse and possibly more powerful. When a Spanish-speaking person comes to the United States and English then becomes their primary language, as in Santiago’s case, it can be detrimental to how their nationality is viewed by their own people. The confluence of Puerto Rican culture and American culture has a push-pull relationship. Go too far and you will not be accepted in your original culture, do not go far enough and you will not be accepted into your newly acquired culture.

A linguistic impact has occurred due to U.S. influence in Puerto Rican society. Puerto Ricans living in the U.S. have changed due to assimilation, but that is truly only natural given the circumstances. People in general make the mistake of looking at it as a negative thing and it can be looked at two different ways as this junction is either causing a dulling of the Puerto Rican nationality or making it more diverse. In reference to code-switching Paul Anisman mentions that “the error here is to assume that simply because the original tongue of an immigrant group is largely replaced by English, that this means that there is no longer a linguistic identity.” He discusses what happened when New York born Italians, Jews, and Irish no longer utilized their national tongues but that “it is certainly conceivable that the English they speak may exhibit substantial differences which can in fact iden-

tify speakers as members of a particular ethnic group.” Another point he makes regarding culture and stereotypes is that:

When we find survivals of culturally specific behaviors in second or even third generations, it is anthropologically naïve to assume that these behaviors are motivated by some mysterious desire to accommodate stereotyped expectations. Rather, it is anthropologically sound to conclude that cohesiveness is nourished by common behaviors, attitudes and values, and that try as we may to ignore these facts of life, we, as humans, perpetuate those behaviors having the most positive (favorable) social consequences within our most intimate groups. (Anisman)

He says this to show that people are not trying to be stereotyped, it just happens because they are finding commonalities between themselves and others around them in similar circumstances. In relation to Puerto Rican identity and diaspora, the identity is not lost. The confluence of cultures and the act of code-switching do not make a nationality lose itself—they just further come together to create two diverse, well-cultured types of people.

The confluence of Puerto Rican culture and American culture is a truly fascinating subject. The assimilation of both cultures is causing such beautiful integration, not just the integration of people and language, but of art, music, ideas, thoughts, and new ways of thinking. The confluence of Spanish and English opens up the borders to creativity, especially linguistic creativity. Like Dana Cole mentions, it has caused the “breaking free of reified linguistic structures and constraints, [providing] the means to open up new ways of knowing and thinking and [enabling] a new set of dialogues to emerge.” That is what code-switching does—it breaks down the barriers, the constraints that keep two languages and cultures apart.

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# The Illusory Nature of the So-Called Objective World

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**Abstract:** This paper investigates the human perception of the world around us and the way we perceive and experience it. Driven by curiosity about the “real world,” and if it truly exists, our senses as a way of interpreting the real world are explored. I also analyze theories about this topic presented by Rene Descartes and British empiricists: John Locke, David Hume and Bishop Berkeley, while ultimately disproving certain aspects of them. In this quest of exploring reality, ideas like the mind, primary and secondary qualities and subjective sense experiences are addressed. I ultimately argue that there is no way of knowing if the real world exists, because we can only know what we experience. Furthermore, if the real world did exist, it would by definition not be as it appears to us, because our senses can only interpret the real world-not perceive it as it truly is.

In the practice of being skeptical of all widely held beliefs, philosophers began to question the concept of reality. They became interested in the relationship between the mind, what we experience and the physical world. This type of skepticism led philosophers to question if what we experience through our senses is what the physical world is really like, or are we victims of our subjective illusions while assuming that our perception is coherent with the real world. The main philosophers who were concerned with these ideas were British empiricists John Locke, George Berkeley and David Hume. Exploring their theories will lead us to conclude that we cannot prove that there is a real world, but if we could, it would by definition be different than it appears to be.

One of the first philosophers whose theories touched on the subject of the real world and our experience of it was Rene Descartes. Descartes was a 17th century philosopher who was interested in experience, existence and knowledge. Searching for absolutely certain knowledge, he wanted to know if the physical world really exists or if it is just an illusion. He concluded that the only undoubted fact that always had to be true was that one truly exists. In order to think about existence, one must exist: “I think therefore I am.” Moreover, Descartes realized that the only way we can know if the physical world is an illusion or not is by our senses. However, our senses cannot be trusted since they can be deceiving; we can never know what the real world is like. An

example he gave was looking at a wooden stick in water. To a naked eye it appears bent, but if we feel it with our hands it feels straight, meaning our senses can be unreliable and contradicting. We cannot trust them since there is no way we could know when they are deceiving us and when they are not. In other words, we can never know if what we are experiencing is true. Another concept that Descartes had about the physical world was the real versus the apparent world. In his theory, the real world was what he referred to as the mind, while the apparent was what he referred to as the world (Husserl 21). In my opinion, the problem with this theory is that he referred to the mind as a material thing. Thus, an object that is experienced must be either in the mind or in the world. If it was in the world, we would not be aware of it. Also, it is in the view of phenomenologists that since the mind cannot be experienced sensorially, it cannot be referred to as a material object or place; we can only experience consciousness or awareness which is immaterial (Glynn, “European Philosophy and the Human and Social Sciences” 110). If we take a chair as an example, we do not experience the chair, but its constantly changing appearances. Meaning, since all we can know is what we experience, we do not know what the real world is like.

When it comes to ideas such as knowledge and experience of the physical world, British empiricists were the leading philosophers in this field. John Locke, a 17th century English philosopher,

was a pioneer of empiricism, a theory in philosophy that argues that all knowledge is acquired through sense experience. Locke believed that all of our knowledge comes from the process of reflecting on our senses, which he called experience (Locke). He suggested that we cannot have any knowledge independent from our sense experiences. Building on this theory, Locke also concluded that we experience properties of our environment. He defined substance as that which has properties. He also believed that we do not see the actual substance, but we experience its properties, which are not independent from our experience. The problem with Locke's theory is his conviction that properties come from the real world. In reality, we can never know where these properties come from because we are not able to perceive objects outside of our own experience. Trying to distinguish the real world and our experience of it, Locke developed a theory that included concepts of primary and secondary qualities. The primary qualities included actual properties of an object, or the objective reality, which in essence represented matter. Thus, primary qualities consist of mass, number, extension and shape (Locke). Since we can measure these quantitative properties, Locke suggested these qualities are the only properties we can be certain of. However, since all properties are relative to observation they appear to be secondary. This concludes that Locke's theory is wrong. When taking an elevator, we feel lighter while going down and heavier while going up. This example proves that primary qualities are also entirely subjective, and not objective as Locke theorized. Meaning, all properties are secondary. On the other hand, secondary qualities represent the power of the object to produce ideas in us, or subjective appearances. The properties included in these qualities are color, smell, sound and taste (Locke 30). Locke believed that secondary qualities are subjective. He also believed that colors do not exist in reality. Instead, he thought they are interpretations of light that are reflected by an object. Since light consists of wavelengths it has no colors, meaning that our eyes create them. This idea essentially makes colors a subjective by-product of interaction between light, objects and perceptual organs. It is the same with sound. Sound waves travel through a medium, which are interpreted by our ears and then manifested as sound in our minds. As a result, if there

are no ears to interpret the sound waves, there is no sound. The real world reflects the sound of silence, which means that sound, just like color, is a subjective illusion. Furthermore, smell and taste are also our interpretations of the physical world through our senses. For example, if we blindfolded someone, put a slice of an apple under their nose and then fed them a slice of a pear, he/she would experience the taste of an apple. In conclusion, everything that we experience through our senses can be labeled as a subjective illusion.

George Berkeley represents the second wave of empiricism and is most known for challenging John Locke's theories. He did not agree with Locke that there are primary and secondary qualities, but he thought that all properties are subjective, and in other words, secondary (Berkeley). In other words, he thought that even primary qualities are experienced subjectively, and that they only exist in our experiences- not the "real world." For Berkeley, all sensations are included in ideas, which are mind dependent (Berkeley). Since we all have separate subjective experiences, in the absence of God who experiences everything, we do not know if these experiences of the world exist independently of our experience. Berkeley backs up his theory by claiming that we either experience something or we don't; we are not aware of something that we do not experience. An example that he used to justify his theory is putting a cold and a warm hand into water at room temperature. The water will feel cold to one hand and warm to the other. Without God, he claims that heat and cold are only sensations that exist in our minds (Berkeley). Even though he hypothesized that all these experiences happen in our mind, he did not believe that the mind is in our head. Essentially, he believed in awareness but did not know how to describe it properly.

Building on his empirical theories Berkeley concluded that what we experience is a series of ideas instead of independently existing objects. He concluded that objects need to be perceived in order to exist: to be is to be perceived (Berkeley). This brings up a conflict that questions what happens to objects that are not being perceived by anybody. When one leaves their car at the parking garage, there is hope that the vehicle will be there upon their return. In the meantime, we

assume that it still exists while we are not perceiving it. However, we can never be certain that our car is really there, because we are not experiencing it while we are away from it. This type of thinking resulted in Berkeley's conclusion that there must be somebody who perceives that object while everyone else is away. Objects cannot just disappear and appear again when we return, so for Berkeley, that somebody is God (Berkeley). Since God is the only one who can perceive the whole physical world at the same time, he is making sure that objects do not disappear while we are away from them. The problem with this part of his theory is that Berkeley uses the less probable, the existence of God, to prove the more probable existence of the real world. Individuals can perceive the world and make assumptions about if what we are experiencing is real or not, making its existence very probable. However, since we cannot perceive God, we cannot experience him. This conclusion puts God's existence into question, making him the less probable to exist compared to the existence of objects in the world, which are more probable to exist.

The last of the British empiricism legacy of philosophers was David Hume. His theory built on both Locke's and Berkeley's conclusions making it the closest one to the truth according to modern empiricists. Hume believed that we do not experience reality, but appearances instead. He thought that even motion and extensions are appearances, and that appearances are ultimately subjective (Hume). In order to prove his theory he used an example of three different people watching the same train in motion. One person is watching the train as it is becoming smaller while it is going away from him/her. For the person that is actually on the train, it stays the same in size. Since the train is approaching the last person, to him/her it appears that the train is getting bigger. This example proves that we only experience appearances, which are created in our mind by interpretations of the real world through our senses. The train is actually in the real world, but we are only experiencing its appearance, which is created in our mind.

In terms of the real world, Hume divided reality into subjective and objective reality. According to him, subjective reality is always interrupted, changing and different from different angles. On

the other hand, the objective reality is always uninterrupted, relatively unchanging and the same. The objective reality serves as the definition for the real world. The midline between subjective and objective reality is experience, which represents similarity, continuity and unity (Glynn). Hume hypothesized that the reason we believe that the real world exists is that there must be something that is causing our experiences. However, the problem with his theory is that he uses causality to back it up (Hume). Causality implies that the relation between two events is linked by the cause, and a physical consequence of the first event called the effect. This theory has been disproved by the example of throwing a rock at a window. If somebody throws a rock at a window and the window breaks, it makes sense to us that the rock is the cause of the broken window. However, correlation does not imply causation. Correlation is something that is made up in our mind, because there could also be a case when the window does not break when we throw a rock at it. Internal conflicts like these disprove the theory of causality. As a result, we cannot know if the real world is truly causing our experiences or not. Therefore, we cannot know if there is a real world at all.

In conclusion, the examples above have established that we cannot know if there is a real world; we can only know what we are experiencing. What we are experiencing are appearances of the objects that are in the real world. However, the appearances that we are constantly experiencing are subjective, and do not tell us anything objective about the world as such. Moreover, the real world is by definition constant and uninterrupted, while appearances are continuously changing, different and interrupted. Even if there is a real world, it cannot by definition be as it appears to us.

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# Understanding Multiple Sclerosis By Examination of Theories in Medical Literature

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**Abstract:** Multiple sclerosis (MS) is a neurodegenerative disease which causes inflammation and demyelination in the central nervous system. The demyelination is caused from mediated cell death, apoptosis and/or necrosis, of oligodendrocytes. Although MS can be diagnosed, very little is understood about its pathogenesis. Many researchers have focused on the immune system itself in attempt to understand the pathogenesis of MS. The idea that demyelination primarily resulting from a T cell-mediated immune response to various myelin antigens is widely accepted; however, there are other factors to consider. In order to understand the primary cause(s) of MS which are not fully understood in science research currently, it is important to examine the effects of glutamate excitotoxicity and the environmental factors which could cause it. This opinion paper seeks to outline theories regarding the pathogenesis of MS in attempt to understand this complicated neurodegenerative disease.

## Introduction

Multiple sclerosis (MS) is a disease in which multiple causes are being investigated. MS affects approximately 2.5 million people worldwide and about two hundred cases are diagnosed each week in the United States alone (Pietrangelo & Higuera, 2015). The disease also affects women twice as much as men, and it is more prevalent in individuals of northern European descent. The ethnic groups at the lowest risk of developing MS are Native Americans, Africans, and Asians. "Interestingly, a child who relocates from an area of low risk to an area of high risk (or the other way around) takes on the risk level of the new location. However, if the child relocates after reaching puberty, he or she retains the risk level of the original location" (Pietrangelo & Higuera, 2015). This observation could suggest important environmental factors in MS. It is interesting to note that patients are often diagnosed with MS between the ages of twenty and forty. With MS being the most widespread debilitating neurological disease of younger adults, it is important to understand its pathogenesis in efforts to find a cure.

Most patients diagnosed with MS experience symptoms such as distorted vision, lack of coordination and/or balance, unusual sensations, muscle weakness, bladder problems, etc. There are four known classifications of MS: relapsing-remitting MS (RRMS), secondary-progressive MS (SPMS), primary-progressive MS

(PPMS), and progressive-relapsing MS (PRMS). The most common form of MS is the relapsing-remitting, and it is recognized by exacerbations of worsening neurological function followed by remission periods. Approximately 85% of patients show this type of MS ("Types of MS", 2015). Most patients who are diagnosed with RRMS eventually develop SPMS, a more steady form of the disease which involves fewer periods of remission. Approximately ten percent of patients with MS exhibit the primary-progressive (PPMS) form of the disease. This type of MS is characterized by conditions worsening in a linear progression with no distinct remission periods. The least common form of MS is progressive-relapsing (PRMS), and it involves a steady disease progression with exacerbations.

Multiple sclerosis is classified as a neurodegenerative autoimmune inflammatory disease. There have been debates over whether MS should be classified as an autoimmune disorder or simply a neurological disorder; however, most of the medical research indicates that the disease manifests the qualities of an autoimmune disorder. Oligodendrocytes are neuroglia that exist in the central nervous system to provide support to axons. These cells produce the myelin sheath that serves as insulation to the axon to enable saltatory action potentials. Oligodendrocyte cell death is seen in MS, and it is one of the main topics of interest in studying the disease's pathogenesis.

Several theories have been developed to explain why oligodendrocytes are being destroyed in patients with MS.

### Theories of MS Pathophysiology

Many research groups have focused on the immune system itself in attempts to understand the pathogenesis of MS. The generally accepted view of oligodendrocyte cell death involves inflammation as a result of immune system activation. Acute MS lesions can be characterized as “active demyelination and inflammatory cell infiltrates, including T cells, B cells, macrophages, and activated microglia” (Cudrici, Niculescu, Niculescu, Shin, & Rus, 2006). A study published in 2001 by the Journal of Neuroscience Research showed the presence of myelin-reactive T cells in the blood and cerebrospinal fluid (CSF) of MS patients (Hellings, 2001). It has also been reported that “demyelination primarily results from a T cell-mediated immune response to various myelin antigens” (Cudrici et al., 2006). The theory adopted by Cudrici and others is that MS is associated with the up-regulation of TNF- $\alpha$ , TNF- $\beta$ , IFN- $\gamma$ , and IL-12 pro-inflammatory cytokines. The production of these cytokines leads to the “up-regulation of endo-thelial cell adhesion molecules, to which T cells bind in a receptor-specific manner” (Cudrici et al., 2006).

This theory then suggests that the T cells enter into the perivascular space by way of the blood brain barrier. The T cells are able to enter into the blood brain barrier due to matrix proteases which degrade the extra-cellular matrix. It has also been noted that astrocytes and microglia can regulate inflammation by way of releasing cytokines, chemokine, and reactive oxygen species such as nitric oxide (Cudrici et al., 2006). Although there are many secondary processes involved in the theory of pathogenesis encompassing the upregulation of pro inflammatory cytokines, it is also important to consider the involvement of the tumor necrosis factor (TNF). Tumor Necrosis Factor (TNF)- $\alpha$ , a monocyte derived cytotoxin, can promote both apoptotic and necrotic death of oligodendrocytes. The theory which involves the upregulation of pro inflammatory cytokines and the induction of oligodendrocyte cell death through TNFs seems to be a part of secondary processes rather than primary causes.

In order to understand some of the primary causes of MS which are not fully understood in science research currently, it is important to examine the effects of glutamate excitotoxicity and the environmental factors which could cause it. Glutamate excitotoxicity occurs when the AMPA/kainate type of glutamate receptors are over activated and cause damage to neurons and oligodendrocytes. Excitotoxicity is a pathological process which causes nerve cells to be damaged by excessive stimulation from neurotransmitters such as glutamate. Excitotoxins such as N-methyl-D-aspartate (NMDA) and kainic acid bind to the NMDA receptor and excitotoxicity can occur through excessive glutamate stimulation through high levels of calcium entering into the cell. When the glutamate concentration around the synaptic cleft cannot be decreased, continued glutamate excitotoxicity will lead to apoptosis. The data suggest that this is what is causing the apoptosis in oligodendrocytes in MS patients.

A spinal injury study published by Xu and colleagues in 2004 found that after spinal cord injury (SCI), damaged neural cells within the lesion site allow glutamate to enter into the extra-cellular space where glutamate can stimulate presynaptic glutamate receptors to drive the release of additional glutamate. This research study “demonstrate[d] in vivo that following SCI glutamate reaches concentrations toxic to white matter”. When this occurs, glutamate toxicity to oligodendrocytes occurs via the AMPA/kainate receptors (Xu, Hughes, Ye, Hulsebosch, & McA-doo, 2004).

N-methyl-D-aspartate (NMDA) receptors are calcium favoring glutamate gated ion channels that are expressed in most neurons of the central nervous system. These receptors are important to consider because they are both ligand-gated and voltage-gated receptors. In order for activation to occur, the two different ligands, glutamate and either D-serine or glycine, must bind to the two activation sites. Continuous activation of large numbers of NMDA receptors (especially the NR1/NR2B-subtype) leads to increases in intracellular calcium loads and catabolic enzyme activities, which can trigger a cascade of events eventually leading to apoptosis or necrosis.

These downstream effects include mitochondrial membrane depolarization, caspase activation, production of toxic oxygen and nitrogen free radicals, and cellular toxicity. (Xiao-xia, Wang, & Zheng-hong, 2009). Examination of these receptors is vital to a better understanding of the process of cell death, specifically in neurodegenerative diseases such as multiple sclerosis. In addition, mitochondria play an important role in mediating the state of the cell. "There is evidence that mitochondrial dysfunction and impairment of respiratory complexes play a role in the neuronal loss experienced in neurodegenerative diseases. Recently, the mitochondrion has come to be considered a pivotal organelle in determining cell fate, because it may act as an 'on-off' switch modulating autophagy and apoptosis" (Xiao-xia et al., 2009).

### Conclusion

Although there are different theories for the pathogenesis of MS, oligodendrocyte mediated cell death is one of the main problems with this neurodegenerative disease. Through extensive research in current medical literature, one can understand the different theories of the development and diagnosis of MS. With MS being the most widespread disabling neurological disease of young adults in the world today, it is important to continue to strive to find the primary cause of this neurodegenerative disease. There are many theories about the pathogenesis and progression of MS, including the result of a T cell-mediated immune response to myelin antigens, glutamate excitotoxicity, mitochondrial dysfunction, and the result of environmental factors. The aspects of glutamate excitotoxicity and mitochondrial dysfunction are particular areas of interest that need to be considered more. Since there are many unknown factors currently regarding multiple sclerosis, there is a chance to discover the process and cure of a neurodegenerative disease that has affected many lives.

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## Contributing Author Biographies

### Sean Cruikshank:

Born October 27, 1992 in New York, Sean Cruikshank moved to Florida when he was one year old. There, he attended St Lawrence Catholic School, followed by Tampa Catholic High School where he discovered his passion for science and specifically physics. He then went on to study at the Harriet L. Wilkes Honors College of Florida Atlantic University where he planned to expand his knowledge through a rigorous liberal arts and sciences course load. Now a graduate of FAU, holding a bachelor of arts in liberal arts and sciences with a concentration in physics, Sean plans to take a year off from schoolwork to study and prepare for the physics GRE. With a good score on this test, he then plans on applying to graduate programs in astronomy with the hope of eventually obtaining his Ph.D.

### Nick Brandimarte and Andrew Tabaque:

Nick Brandimarte and Andrew Tabaque are undergraduate researchers perusing B.S. degrees in Biology and the Environmental Science Certificate at Florida Atlantic University. Their major interests lie in the domains of aquatic health issues of bivalves, restoration ecology, wetland ecology, and aquaculture. Nick and Andrew began volunteering and conducting research with the avian ecology laboratory of Dr. Dale E. Gawlik in 2013. They have been collaborating with research staff and other students to collect data on wading birds, fish and aquatic invertebrates in the everglades ecosystem. As undergraduates, Nick and Andrew's research has been focused on studies of wood stork nesting behavior, a pilot study of crayfish burrows as aquatic refuges, and elucidating exotic fish abundance in roadway corridors. While working on this project they received two awards from FAU – a monetary award for supplies on their project and an award for their oral presentation.

### Brandon Gilliland:

Brandon Gilliland is a student at the Harriet L. Wilkes Honors College at Florida Atlantic University. He will receive his B.A with a concentration in Biological Sciences in December 2015. In addition to his studies, Brandon works as an undergraduate research intern in the neuroscience department at The Scripps Research Institute Florida campus in Dr. Seth Tomchik's lab. The primary focus of the Tomchik lab is to study how dopaminergic neurons are involved in memory acquisition, as well as other innate behaviors. Brandon is currently finishing his thesis on how Nf1 mutations impair memory related plasticity in *Drosophila melanogaster* mushroom bodies. It is Brandon's desire to further his academic pursuits by attending medical school to become a pediatric surgeon.

### Zachary Humphrey:

Zachary Humphrey is a recent graduate of the Harriet L. Wilkes Honors College of Florida Atlantic University with a concentration in English Literature. Humphrey is currently focusing on expanding the breadth of his literary knowledge by exploring regions of the canon not fully treated during his undergraduate academic career and working as an independent scholar while taking two gap years before pursuing graduate school. While his studies highly vary in terms of subject, his literary research and criticism centers most heavily upon contemporary poetics, Irish literature, comparative literature, criticism of non-canonical works of literature, and multidisciplinary approaches to literature.

**Aleksandar Vuk Nikolic:**

Aleksandar Nikolic was born in Serbia where he attended elementary and middle school, and then transferred to a sports' academy, IMG Academies in Florida. Due to great performance in school and the basketball court, Aleksandar was recruited by Ivy League schools. Unfortunately, at 17, an injury ended his basketball career. After graduating high school, Aleksandar attended George Mason University where he was a part of the basketball staff while studying Psychology. One year later he was offered an internship in a Sports Technology company in South Florida. Aleksandar accepted it and transferred to Florida Atlantic University where he is a senior now, pursuing a degree in Neuroscience. On February 21st 2015, he held a lecture "The Mind-Body Solution" on human consciousness at the Undergraduate Philosophy Symposium at the University of Central Oklahoma. His lecture "Reality: A Subjective Empirical Illusion" won 1st place at the Undergraduate Research Symposium held at FAU.

**Elizabeth Rubino:**

Born October 24, 1995 in Boca Raton, Florida Elizabeth attended FAU High School and dual-enrolled for the last 3 years of her high school career allowing her to graduate with a bachelor of science from FAU with a major in physics and a minor in mathematics at the age of 19. Elizabeth has participated in several research experiences in nuclear physics as well as this research in quantum optics. She has recently began a graduate program in physics with the end goal of obtaining her Ph.D. in nuclear physics. She wishes to eventually work in a national laboratory conducting research in physics.

**Sarah Stamos:**

My name is Sarah Stamos and I am a sophomore at the Harriet L. Wilkes Honors College of FAU. I am currently pursuing a concentration in Biological Chemistry with a possible minor in Spanish. I am a Henry M. Flagler Scholarship recipient and have attended the Florida Collegiate Honors Council and National Collegiate Honors Council Conferences with research on native medicinal plants in South Florida and the economic barriers and issues surrounding using the Soursop plant as a potential cancer treatment. I plan to either become a physician's assistant or go to medical school and hopefully continue in my growth of the Spanish language to study natural medicine in South American countries.

**Jodi Weissman:**

My name is Jodi Weissman Antman. I returned to school to pursue my passion for writing, specifically fiction, and found a love for literary research as well. I am a senior and will graduate this Spring. As a wife and mother of two wonderful boys, I am a teacher, taxi driver, cheerleader, cleaning lady, answering service, chef and social secretary. In the world beyond our home, I have been a teacher for GRE, GMAT and MCAT test prep, an operations and compliance manager for several brokerage firms and even ventured into real estate investment, but always, the writer inside fought to burst out.

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