



CABRINI UNIVERSITY

**These students' works were
presented at the 2016 Arts, Research
and Scholarship Symposium**



TABLE OF CONTENTS

CONTENTS

03

EDITORIAL STATEMENT

SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

06

MINDSET AND THE
POWER OF YET

07

MINDSET IN
STUDENTS AND
TEACHERS

09

EL CID: UN HOMBRE
JUSTO DE LA EDAD MEDIA

12

PROPERTY CRIME IN RELATION TO
RATIONAL DECISION MAKING

29

LACK OF CAPABLE GUARDIANSHIP AND
ILLICIT DRUG USE THROUGH ROUTINE
ACTIVITY THEORY

SCHOOL OF NATURAL SCIENCES AND ALLIED HEALTH

47

DEVELOPMENT OF A COMBINED BOYDEN-FLOW CYTOMETRY PROTOCOL
TO INVESTIGATE CHEMOTAXIS IN THE INVERTEBRATE EISENIA HORTENSIS

SCHOOL OF BUSINESS, ARTS, AND MEDIA

65

NATIONAL RIGHT
TO LIFE

66

PREVENT CHILD
ABUSE AMERICA

67

SHADOW V

68

GEN MED

69

AMENSTY INTERNATIONAL

EDITORIAL STATEMENT

The Cabrini UNIVERSITY Journal of Undergraduate Research is an annual, reviewed publication dedicated to the discovery, promotion, and publication of outstanding work done annually by Cabrini undergraduates.

The Journal's Editorial Board reviews, selects and cultivates the best work for inclusion. Drawn from the Undergraduate Arts, Research, and Scholarship Symposium—an annual event where students present and showcase their research to the College community—the Board seeks academically rigorous and distinctive efforts that demonstrate Cabrini students' evolution into public intellectuals with a firm grasp of the stakes and conventions of meaningful scholarship.

Articles are selected for publication based on their scholarly and rhetorical quality. They are from all disciplines and exemplify one or more of the following accomplishments:

- An original research project
- Unique contribution to the scholarship of the student's field
- A new interpretation of an intellectually important problem; phenomenon or text
- An interdisciplinary endeavor that suggests an innovative approach to an altogether new subject for scholarly inquiry

The board also considers for publication any work of artistic merit that demonstrates academic seriousness and intellectual ambition.

EDITOR

- John W. Cordes, PhD - Department of Communications

REVIEWERS

- Jennifer Bulcock, PhD - Department of Philosophy
- Raquel Green, PhD – Department of Romance Languages
- Caroline Nielsen, PhD – Department of Science
- Courtney Smith, PhD – Department of History and Political Science
- Vivian Smith, PhD Department of Sociology and Criminology



SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

Mindset and the Power of Yet

Author: Chip Comly

Faculty Advisor: Tamarah Smith, PhD

Here is the power of yet
It's about the knowledge we are suppose to get
But kids aren't learning and their going into debt
Well I'd be willing to bet
The kid's got a fixed mindset

Stuck in the tyranny of now
Like a bad trip, Tim Leary, oh wow
I'm super sensitive severely in a crowd
I can think more clearly out loud,
But In school I'm not allowed

All the teacher's care about is the grade
They want product, so to process they don't aide
The child loses interest and his mind does fade
The child loses interest so he picks up the blade
And the teacher doesn't care cuz they still get paid
"They are just stupid, it's how they were made"

Well that's just insane
Growth needs to be instilled in the brain
We have a whole generation afraid
Cuz they took advice and obeyed
To their knees at night they prayed
To get good grades, to get the next A
And look at how they're repaid,
On their sick crusade

A mission for knowledge
If you wanna good job, you gotta go to college

Well what about having a dream?
Imagining yourself part of a team
And you have to come up with a scheme
To teach the theme, to your regime
And the theme is self-esteem, and building growth in teens
To make them solid at the seams

Teachers and students need to compromise
Teachers gotta know how to praise wise
Both need to be willing to make strong ties
And never say can't cuz that's all lies

You are not dumb and shouldn't be treated like a pet
So what you don't learn at the speed of the jet
That's why we have the **power of yet**
It rewards process, the grind, the sweat
Growth, it's all about the mindset
And for that, we thank Carol Dweck.

Mindset in Students and Teachers

Author: Grace R. Capuzzi

Faculty Advisor: Tamarah Smith, PhD

“A negative thinker sees a difficulty in every opportunity, a positive thinker sees an opportunity in every difficulty.” (Gadal, 2013)

Research conducted by Carol Dweck (2006) revealed a powerful model to enhance insight on motivation and how one can learn to fulfill their own potential. She discusses the “power of belief,” a simple belief about yourself that guides a large part of your life. This power rests on the fact that it is not just our abilities and talents that lead to our success, but whether we approach our goals with a fixed or growth mindset. An individual with a fixed mindset believes that their intelligence or talents are fixed traits; they avoid challenges rather than embracing them. An individual who displays a growth mindset, welcomes failure, and believes that their most basic abilities can be developed through strategies and hard work. Mindsets can help change the meaning of failure for not only students but also for parents, coaches and teachers.

In the film, *Waiting for Superman* (2011), the main idea is how and why the public education system is failing children in today’s society. In the movie, Maria, the mother of a second grade boy, Francisco, discusses her frustrations with her son’s education. Throughout the film, Maria is attempting to get in contact with Francisco’s teachers so that she can track her son’s progress, but does not receive any response. Maria decides to take action and she begins a long difficult journey to find a more suitable school for Francisco to attend in order to improve her son’s education. Dweck’s theoretical model applies here because Maria’s ambitious and fearless attitude towards Francisco’s learning shows she has a growth mindset. Maria’s growth mindset allows her to embrace this challenge.

Maria exemplifies a growth mindset by doing everything in her power to give her son an equal opportunity to learn, regardless of the area they reside in. She has enrolled Francisco in two after school reading programs at a local college and she studies with him nightly. By Maria spending the time to assist Francisco with his education, she is relaying the message that he is capable of learning, despite the teacher’s assessment of his intellectual abilities.

A parent’s mindset can influence how competent their child may believe themselves to be. A parent with a growth mindset recognizes that an individual’s abilities can be developed and they will help them work to their full potential. Dweck states: “Rather than stay gripped in the power of now, embrace the power of not yet” (Dweck, 2006). Maria’s views coincide with Dweck’s research

because Maria believes that through dedication and hard work anything is possible regardless of the circumstance. As Babe Ruth once said: "Never let the fear of striking out keep you from winning the game"

My attitudes toward education are consistent with the views of Maria and Dweck, in that I believe mindsets can change. My reaction is positive to the decisions that Maria is making for Francisco because I think this will raise his confidence and boost his self-esteem. In the documentary it is evident that Francisco is discouraged with his education. His attitude towards school may have been shaped from his teacher's attitude or the messages they are conveying to him. Although Francisco may currently have a fixed attitude towards his education, his mother has helped to change his mindset through her seeking better opportunities, creating concrete strategies and praising his effort rather than his intelligence. Francisco's mother can help create motivation and cultivate a growth mindset in Francisco, which will in turn motivate him to be successful.

Mindsets can change. The impact that teachers' and parents' mindsets have on students is profound. I can speak from experience in saying that my parents' mindsets directly impacted my mindset. As a child, I had a fixed mindset, and I believed that my abilities were innate with regard to education. My parents believed in my abilities and that I was capable of succeeding far beyond my expectations. Throughout my childhood, my parents provided me with useful feedback and valuable tools that helped me view my failures as an opportunity to learn, rather than a reason to stop trying. Over time, my parents helped my fixed mindset shift to a growth mindset. I began to realize my full potential, approach challenges head on and find alternative ways to succeed where I had previously failed. My past experiences led me to connect with Maria and Francisco when I watched *Waiting for Superman*. I was able to draw a connection to not only a similar experience in my past but the theoretical model from Dweck's (2012) groundbreaking research.

References

- Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.
- Gadal, D. (2013, July). A positive thinker sees an opportunity in every difficulty. Retrieved from <http://simpledailychange.com/a-positive-thinker-sees-an-opportunity-in-every-difficulty/>
- Guggenheim, D., Kimball, B., Chilcott, L., Strickland, B., Canada, G., Rhee, M., Weingarten, R., ... Paramount Home Entertainment (Firm). (2011). *Waiting for "Superman"*. Hollywood, Calif: Paramount Home Entertainment.

El Cid: Un hombre justo de la Edad Media

Author: Jessica Paradysz

Faculty Advisor: Cynthia Halpern, PhD

El Cid era un soldado valiente y padre muy cariñoso. Los enemigos del Cid lo acusaron de robar dinero de los tributos del reino español y, debido a esto, el Cid perdió el favor del rey, Alfonso VI. En vez de vivir muy enojado, el Cid aceptó su destino con gracia, pero determinado a restaurar su honor. Durante su exilio, sus hijas fueron víctimas de la brutalidad de los Infantes de Carrión. Sin embargo, como hombre valiente y justo que era, el Cid no se vengó de los Infantes con sus propias manos. El Cid demostró su honor como hombre respetado del pueblo en la manera que trató a los Infantes, y un hombre de familia y modelo para otros durante la Edad Media por la dedicación y el amor que tuvo hacia su familia. Al comienzo del poema épico popular, el Cid estaba muy triste por el exilio que tenía que sufrir, pero a la vez con esperanza de volver a su pueblo. Durante un momento muy importante de su destierro, al salir de su pueblo Vivar y al entrar en Burgos, una chica joven le dijo al Cid, "Campeador que en bendita hora ceñiste la espada el rey lo ha vedado, anoche a Burgos llegó su carta, con severas prevenciones y fuertemente sellada. No nos atrevemos, Cid, a darte asilo por nada, porque si no perderíamos los haberes y las casas, perderíamos también los ojos de nuestras caras." (Mujica 11.) La chica habló con el Cid usando un lenguaje de mucho respeto. Se puede ver el respeto y la fama del Cid con el uso del nombre "Campeador". Estas palabras son muy emocionantes porque la chica del pueblo le dijo que la gente lo quería, pero no podía ayudarlo porque sería traición ante los ojos del rey. Sus palabras demuestran la sensación de terror porque no se podía hacer nada que fuera en contra del deseo del rey. La gente de su pueblo admiraba al Cid, pero no podía ofrecer sus casas como asilo porque no quería vivir con el castigo real. Por estas palabras profundas, se ve claramente la fama y la reputación del Cid entre la gente de Burgos y de los jóvenes en la Edad Media. La voz de una niña de nueve años prueba el valor de el Cid y la importancia de la justicia.

Aunque era importante que la gente reconociera su valentía, el Cid demostró su justicia y su gracia en sus acciones directas. Cuando el Cid estaba con sus seguidores y los Infantes, los Infantes estaban muy avergonzados de su cobardía porque los Infantes se escondieron y se escaparon corriendo de un león. En vez de burlarse de los Infantes, el Cid les dijo a sus hombres que dejaran de hablar mal de los Infantes para calmar la situación. A continuación, el Cid domó al león, y, cuando al fin encontraron a los Infantes, sus rostros estaban sin color por el susto, "Tanta broma y tanta risa nunca en la corte se vio, tuvo que imponer silencio Mio Cid

Campeador.”(Mujica15.) Los Infantes de Carrión tenían mucha fuerza social durante esta época, pero la gran diferencia entre ellos y el Cid es que el Cid utilizó su reputación y poder para demostrar gracia.

Aunque el Cid demostró misericordia hacia ellos, los Infantes igual se sintieron resentidos sobre el evento. Lamentablemente, los Infantes buscaban venganza contra el Cid con la meta de dañar a sus hijas. Los Infantes probaron su maldad y cobardía en sus acciones horribles. Ellos estaban avergonzados y decidieron hacer daño indirectamente al Cid a través de sus hijas. El Cid confió en los Infantes cuando ellos le pidieron las manos de sus hijas. El Cid nunca les habría dado las manos de sus hijas a los Infantes si hubiera sabido lo que querían hacer. Un hombre honesto y justiciero, el Cid nunca receló nada de los Infantes, teniendo confianza en su bondad. Después de casarse con las hijas del Cid y durante un viaje a Carrión con sus esposas, los Infantes “les pegan sin compasión, hiérenlas con las espuelas donde sientan más dolor, y les rasgan las camisas y las carnes a las dos, sobre las telas de seda limpia la sangre asomó” (Mujica 25.) Cuando el Cid supo de las acciones de los Infantes, no utilizó violencia contra ellos, en cambio, el Cid confió en el sistema jurídico de España para castigar a los Infantes y dejó el caso en las manos de las Cortes. Esto probó su mente justa durante un episodio muy terrible. El Cid probablemente quería matarlos por su traición y su plan premeditado de dañar y matar a sus hijas, sin embargo las acciones del héroe son un ejemplo de su dedicación a la justicia y la moderación. Al final, los Infantes fueron acusados del crimen por las Cortes y sufrieron el peso de la justicia.

El Cid Campeador siempre antepuso a su familia a todo lo demás. Cuando él necesitaba salir de Burgos en desgracia completa, su familia se fue con él. El le amaba a su esposa Jimena, y a sus hijas, Doña Elvira y Sol. Aunque parece increíble que él no se vengara de los Infantes por sus injusticias, él fue un hombre valiente que sabía cuando se debía usar la fuerza y cuando se debía usar la moderación. El Cid era un hombre muy bueno que siempre protegía a su familia de una manera honorable. Por ejemplo, el Cid le dijo a su esposa ,Doña Ximena, “Quiera Dios y con El quiera la Santa Virgen María, que con estas manos pueda aún casar a nustras hijas y que me quede ventura y algunos días de vida para podersos servir, mujer honrada y bendita.”(Mujica 13). Ella también quería a su esposo y sabía que era una injusticia considerar al Cid un criminal. Tuviéron que separarse cuando el Cid las dejó en un monasterio por su seguridad, pero se reunieron después. Aunque fueron tiempos duros, él demostró su honor en todas las situaciones y al final Alfonso VI le restauró la gracia perdida.

En conclusión, el Cid fue un guerrero fuerte y honorable. Sin embargo, él tenía mucha paciencia y compasión. Cuando fue acusado de robar dinero de su reinado, fue a su exilio con su

familia sin resistirse. Su meta era demostrar su lealtad al rey. El Cid no utilizó violencia cuando no era necesaria y demostró misericordia a la gente. Creía en el sistema de justicia especialmente cuando los tiempos eran difíciles. Sobre todo, vivió para su familia. El Cid era un hombre muy justo en la Edad Media y fue un personaje que sirvió de inspiración por muchos siglos.

Works Cited

"Texto y vida: Introducción a la literatura española." El Cantar de Mio Cid. Ed. Barbara Mujica: New York: John Wiley & Sons, Inc., 2002, 8-29. Print.

Property Crime in Relation to Rational Decision Making

Author: Katelyn Melahn
Faculty Advisor: Katie Farina, PhD

Abstract

This article will explore the idea of Rational Choice Theory and how it relates to property crimes. Three hypotheses are examined. It is predicted that the higher the level of concern displayed by a student about getting caught committing a property crime, the less likely they will be to offend. It is also predicted that the stronger a student's moral beliefs, defined as principles or habits with respect to right and wrong conduct, the less likely they will be to commit a property crime. Finally, it is predicted that the more people a student knows that have gotten away with committing a property crime, the more likely they will be to offend. Looking at property crime from a rational choice perspective is an important topic to explore in that schools and law enforcement can use the results to determine if there are better methods of prevention that could be implemented. Research was conducted through self-administered surveys given to 135 Cabrini College students. These students were found in random classes throughout campus. With one exception, the results did not find support for the predictions made. Limitations and future research recommendations are noted.

Introduction

It can be hard to imagine a college campus being a place where crime consistently occurs every day. It may be even harder to believe that the majority of these crimes are property crimes (NCVRW Resource Guide, 2013). According to the Federal Bureau of Investigation's Uniform Crime Reporting Program, the category of property crime includes any of the following: burglary, larceny-theft, motor vehicle theft, and arson (FBI, 2010). Under the subcategory of larceny-theft, it seems likely that almost everyone will at some point encounter a property crime, whether as an offender or a victim. How? Taking and keeping a pencil left in an empty classroom, although appearing to not belong to anyone, would still be considered larceny in that the person taking the pencil is technically stealing it from whoever bought it in the first place. There are, however, different levels of property crimes, index-one and index-two. Index-one property crime includes the FBI's categories of the crime: burglary, larceny theft, motor vehicle theft, vandalism, and arson (Anderson, n.d.). Index-two property crimes, however, are the higher level crimes including bribery, counterfeiting, forgery, embezzlement, extortion, and fraud, although they are not typically thought of as such (Anderson, n.d.).

Even though property crimes are not meant to physically harm a person, they are still a large problem in our society today because crimes like vandalism can cost communities tax dollars for

clean-up. Being the victim of a burglary may not be physically harmful, but can be very emotionally taxing in that the victims may no longer feel secure in their own home. Keep America Beautiful Incorporated (2015) states that Pittsburgh, Pennsylvania spends almost 350,000 dollars annually to clean up graffiti alone. According to the UCR, over nine million property crimes were reported in the United States in 2009, and that figure does not include the crimes that were never formally reported (FBI, 2010). This same report had the monetary losses from over nine million property crimes reported at about 15.2 billion dollars (FBI, 2010). Before any reduction strategies are discussed, it is important to think about why these crimes are potentially happening. "Two of the leading sociological explanations for property crime in society today are poverty and inequality and drug use and abuse" (Anderson, n.d.). This particular report will be looking at how Rational Choice Theory and property crimes are related. Therefore, understanding that poverty, inequality, and drugs are the leading explanations of property crime, helps tie Rational Choice Theory to the idea that these impoverished civilians, those who may have a lesser class status, or those who use drugs make a "rational choice" when choosing to commit a property crime. In this study, an experiment will be conducted to test that college students will be more likely to weigh the costs of a crime against, like certainty of punishment, moral condemnation, and punishment avoidance, before committing a property crime.

Theoretical Review

Rational choice theory originates from what Cesare Beccaria constructed as classical criminology (Vold, Bernard, & Snipes, 2002). Beccaria's classicalism then became, and remains still today, as the basis for the United States' criminal justice system. In his model of human choice, Beccaria says that people make decisions based on their calculations of the perceived costs and benefits of said decision (Vold et al., 2002). Eventually, criminologists stopped looking at crime through classicalism and started looking from a positivist point of view, only to revive classicalism in the 1970s (Vold et al., 2002).

Positivist criminology was based on the idea that criminals are born as such and therefore outside factors, not an internal decision, are what lead a person to a life of crime (University of Cincinnati, n.d.). The new and improved classical approach viewed the criminal justice system from its deterrent effect on criminals (Vold et al., 2002). Deterrence theory and rational choice theory were then derived from this neoclassical approach. Within deterrence theory, it is said that people make decisions based on their interests-what will maximize their pleasure and minimize their pain (Cullen and Agnew, 2006). Rational choice theory, or RTC, however, is formally "a perspective that holds that criminality is the result of conscious choice and that predicts that individuals choose to commit crime when the benefits outweigh the costs of disobeying the law" (Schmallegger, 2015). RTC could

potentially be called an opportunity theory because it assumes that anyone will commit a crime, all costs and benefits weighed, when given the opportunity instead of focusing on what motivations one would have to commit such crime (Vold, Bernard, & Snipes, 2002). There are three main components to rational choice theory. The first component, which can be called the cardinal rule, is that one must never “dismiss a criminal act as wanton or senseless or irrational”; instead it is necessary to look at the reasons why, or the purpose, of such an act (Vold et al., 2002). The second component is understanding that the rationality of everyone, offender or not, is limited due to the fact that there is always uncertainty involved when weighing risks. The final component is that different crimes require different thinking processes and ultimately different decision making (Vold et al., 2002).

Since rational choice theory is a thought based theory, it could become difficult to measure what one is actually even weighing when considering their options. Three examples of possible risks weighed against any potential benefit emitting from a crime are discussed in Mason and Monk-Turner’s article about rational choice theory. The authors begin with formal sanctions, breaking the category up into certainty of the offense, or the likelihood of getting caught, and severity of the offense, how serious one considers the offense to be (Mason & Monk-Turner, 2010). The next possible risk is moral condemnation, measuring how one’s principles of what is right and what is wrong either deters or does not deter them from committing a crime. The final risk is punishment avoidance, measuring the amount of times a person knows someone who has gotten away with committing the crime (Mason & Monk-Turner, 2010). Overall, rational choice theory is very situational based and makes the assumption that all crime committed is purposeful.

Literature Review

Property crime is a broad term that covers a wide variety of misconduct that consists of some of the most common crimes experienced. The Uniform Crime Report defines property crime as including the offenses of burglary, larceny-theft, motor vehicle theft, arson, and vandalism (FBI, 2010). As an overview, burglary is defined as “the breaking and entering into the dwelling of another at night with the intent to commit a felony theft therein” (Burglary, 2015). Theft is considered dishonestly appropriating property that belongs to another person with the intent of permanently depriving them of it (Theft Act 1968, n.d.). Lastly, vandalism, a broader term, simply refers to willful destruction, injury, or defacement of any public or private property without the consent of the owner (FBI, 2010). As a researcher, the next step is to determine an explanation as to why or how these crimes occur. Looking into the potential explanations for how property crime occurs, rational choice theory helps to create a clearer picture. As a part of routine activities theory, rational choice has not been highly explored in the field of criminology. RTC, however, can be used to explain an offender’s thought

process before committing a crime, in that the offender would weigh the costs and benefits of the crime before actually doing it. Although RTC has not been used frequently to explain property crime, the theory itself is on a rise as a whole in the social sciences (Matsueda, Kreager, & Huizinga, 2006). These next few articles come from researchers who have explored the theory and found, for the most part, that decision making in property crimes is rational.

To further understand rational choice theory and property crime, it would help to explain more thoroughly how rational choice plays into criminology as a whole. Criminal involvement can be broken up into three parts, initial involvement, continuance, and desistance, and looking individually at each part helps further understand the offender (Seyhan, 2013). Seyhan introduces the reader to the offender by explaining initial involvement as the decision to start committing crime based upon the offender's lifestyle with which they are not satisfied (2013). To remedy their situation, an offender looks to illegal activities in order to gain money or status. Next, in continuance, the offender increases their skill, experience, and confidence with each and every crime committed (Seyhan, 2013). In other words, if the offender does not get caught after committing the first crime they will commit a second, a third, and a fourth crime, ultimately continuing until they get caught. Until they are formally sanctioned, their confidence that they will not get caught heightens due to their repeated experience and, like with all other things, practice makes perfect. Desistance, the third and final part of criminal involvement, is a step that may or may not occur. Desistance is when the offender lessens their criminal involvement either rapidly or slowly and either stops partially or entirely (Seyhan, 2013). If an offender does have a desistance phase, it can be attributed to either external events or personal characteristics such as a decrease in potential targets or if the offender gets married. These three parts can be used to understand that "rationality preoccupies while intending to commit an offense based on a material calculation of gain and loss" (Seyhan, 2013).

Mason and Monk-Turner (2010) follow this same rationale in which they believe that individuals' decisions have the potential to be influenced by perceived certainty or severity of punishment, moral beliefs, or punishment avoidance when considering the costs of offending. However, their findings only showed support for moral beliefs as a deterrent from walking and driving under the influence. Property crime, as opposed to other street crime, creates a better logic for rational calculation since it presents concrete material gain. For example, in a study done by Christopher P. Rosbough, property crime at the Atlanta International Airport was measured both before and after the events of September 11th, 2001. As there was an overtly large increase in the number of security measures within airports after the terrorist attacks, it is very clear to see if criminals are taking the added risk of being caught into consideration before committing a property crime, such as theft. Within the study

specifically, larceny crime rates were looked at from January of 2000 to September of 2010. It was found that there was a significant and permanent decrease in the number of reported larcenies in the Atlanta International Airport immediately after September 11th (Rosbough, 2012). Rosbough states that the added security indeed altered the intent to commit crime and that the motivation once held prior to the security intervention after the attacks was affected by a rational decision making process (2012).

Another study by Ross L. Matsueda, Derek A. Kreager, and David Huizinga (2006), looked at a rational choice model of theft and violence and how it pertains to delinquents. Before getting to the meat of the study, the researchers begin specifying the relevant costs and returns of crime as explained by the Bayesian learning model of perceived risk formation: perceived costs of crime, perceived returns to crime, and criminal opportunities. They begin by talking about the perceived costs of crime, also known as formal sanctions. These formal sanctions include arrests, convictions, jail, or imprisonment. The next is the perceived returns to crime which can be defined as income, as well as psychic returns such as excitement and thrills (Matsueda et al., 2006). These returns can come in the form of actual money, or they can come as respect and honor among peers, feeling good about oneself, and excitement and thrills in the form of an adrenaline rush. The last step to risk formation is criminal opportunities which an offender would have to wait for even if they have already decided that the rewards outweigh the crimes. These opportunities differ from offender to offender because not every person has the same perception of what they can and cannot get away with. After conducting the study, Matsueda et al. (2006) found consistent deterrent effects of having a perceived risk before committing a crime, right in line with the definition of rational choice theory.

With support from *Offender Decision Making Process in Property Crimes and its Policy Implications* (2013) and *Deterring Delinquents: A Rational Choice Model of Theft and Violence* (2006), it is predicted that the higher the level of concern displayed by a student about getting caught committing a property crime, the less likely they will be to offend. Mason and Monk-Turner (2010) found that belief that something is morally wrong is a deterrent, therefore it is predicted that the stronger a student's moral beliefs, defined as principles or habits with respect to right and wrong conduct, the less likely they will be to commit a property crime. The final hypothesis has roots in the Rosbough study; the more people a student knows that have gotten away with committing a property crime, the more likely they will be to offend.

Methods

A nonprobability sampling method was used to collect the data for this study. Self-administered surveys were given out to Cabrini College students found in random classes throughout

the campus, with permission given by the instructor to administer the survey. Data was collected in March of 2016 following IRB approval. Control variables in this study included gender, age, race, and grades. Respondents were given three options for gender (male, female, other) and asked to circle one. The majority of the sample answered female equating to 65.2% of total respondents. Respondents were also asked 'How old are you today?' 'Which of the following best describes you?' and 'What one category best describes your overall grades?' Response options for these questions are displayed in Table 1. The most common response for age was recorded as 19-20, being 50.4% of all respondents. The sample was predominately white/Caucasian (78.5%) and an equal number of respondents reported that their overall grades are best described as mostly A's and mostly B's (48.1%).

Table 1. Demographics (N = 135)

Variable	Percent (N)
<i>Gender</i>	
Male	34.1(46)
Female	65.2(88)
Other	0.0(0)
<i>Age</i>	
17-18	7.4(10)
19-20	50.4(68)
21-22	32.6(44)
23+	9.6(13)
<i>Race</i>	
American Indian/Alaskan Native	0.7(1)
Asian	2.2(3)
Black/African American	12.6(17)
White/Caucasian	78.5(106)
Other	5.2(7)
<i>Grades</i>	
Mostly A's	48.1(65)
Mostly B's	48.1(65)
Mostly C's	3.0(4)
Mostly D's or F's	0.0(0)

Independent Variable

The independent variable in this study was the cost aspects of rational choice theory. This variable was measured in terms of formal sanctions, moral condemnation, and punishment avoidance (Mason & Monk-Turner, 2010). The frequency distributions of the independent variables are dis-

played in Table 2. To measure formal sanctions, respondents were asked questions about their level of concern about getting caught while committing a property crime. In order to avoid confusion, respondents were told that property crime is defined as an act of vandalism, theft, burglary, motor vehicle theft, and arson. Answers to these questions were ranked on a scale of one to five, with one being not at all concerned and five being very concerned. The two most common responses were not concerned about getting caught

Table 2. Independent Variable Frequencies (N = 135)

Variable	Percent(N)
<i>Formal Sanctions</i>	
1 (Not Concerned)	40.7(55)
2	7.4(10)
3	7.4(10)
4	13.3(18)
5 (Extremely Concerned)	31.1(42)
<i>Moral Beliefs</i>	
1 (Never)	12.6(17)
2	3.7(5)
3	6.7(9)
4	20.0(27)
5 (Always)	55.6(75)
<i>Punishment Avoidance</i>	
1 (Never)	52.6(71)
2	17.8(24)
3	20.0(27)
4	5.2(7)
5 (Almost Always)	3.7(5)

Committing a property crime at 40.7% and extremely concerned about getting caught at 31.1%. Measuring moral condemnation included, on a scale of one to five (never to almost always), how often their moral beliefs deter them from committing any sort of property crime. The majority of students (55.6%) reported that their moral beliefs would always deter them from committing a property crime. Using the same scale of never to always, punishment avoidance was measured by asking the participants how often they or someone they know has stolen without being caught by the police (Mason & Monk-Turner, 2010). For this question, 52.6% of respondents reported that they have never known someone who committed a property crime and got away with it.

Dependent Variables

The dependent variable, property crimes, was measured in frequency of vandalism, theft (one or two items worth less than \$50) and theft (one or two items worth more than \$50) (Jang &

Table 3. Dependent Variable Frequencies (N = 135)

Variable	Percent(N)
<i>Number of times – Vandalism</i>	
Never	76.3(103)
1-2 times	19.3(26)
3-4 times	3.0(4)
5+ times	0.7(1)
<i>Number of times – Theft (<\$50)</i>	
Never	74.1(100)
1-2 times	16.3(22)
3-4 times	3.7(5)
5+ times	5.2(7)
<i>Number of times – Theft (>\$50)</i>	
Never	93.3(126)
1-2 times	3.0(4)
3-4 times	3.0(4)
5+ times	0.0(0)
<i>Scale – Destroy Property</i>	
0-5	93.3(126)
6-10	3.7(5)
11-15	1.4(2)
16-20	0.0(0)
21-25	0.0(0)
<i>Trouble With Police</i>	
0 (Never)	43.7(59)
1	14.1(19)
2	16.3(22)
3	11.9(16)
4	10.4(14)
5 (Always)	3.0(4)
<i>Trouble With School Authorities</i>	
0 (Never)	52.6(71)
1	10.4(14)

2	12.6(17)
3	9.6(13)
4	11.9(16)
5 (Always)	2.2(3)

Franzen, 2013). These frequencies were measured according to Jang and Franzen’s scale, with zero being never committed any of those crimes, one being committed the crime one or two times, two being committed the crime three or four times, and three being committed the crime five or more times (2013). The majority of respondents (76.3%) answered that they have never committed an act of vandalism, with the next most frequent response choice being 1-2 times (19.3%). There was a similar trend in the following theft variables with 74.1% reporting they never stole 1-2 items worth less than 50 dollars and 93.3% reporting they never stole 1-2 times worth more than 50 dollars.

A series of five questions pertaining to how often one commits certain property crimes were also asked. The specific questions asked about damaging equipment or property, ruined or damaged other people’s property or possessions on purpose, purposely destroyed family property, purposely set fire or tried to do so, and broke into an empty building. The response choices were measured on a scale of 0 to 5, with 0 being never participated in the act to 5 being always participated in the act and were adapted from *Delinquency Measures* (Belmi, P., Barragan, R., Neale, M., and Cohen, G., 2015). These five questions were then condensed into an additive scale named Destroy Property. Cronbach’s Alpha for this scale was 0.779. Since these five variables were made into an additive scale, answers will range anywhere from zero to 25, the number indicating a respondents total frequency of committing property crimes. A zero indicates that the respondent never committed any of the five property crimes and a 25 indicates that they always commit all five property crimes. After scaling, it appeared that most students (93.3%) fell into the range of zero to five. The remaining 5.1% fell anywhere between six and fifteen; no student’s scale added up to be anywhere between 16 and 25. Two additional questions asking respondents about the number of times they did something that could have gotten them in trouble with the police and the number of times they did something that could have gotten them in trouble with school authorities were added; responses choices were measured the same way as the five questions just mentioned with a scale of 0 to 5, 0 being never participated in the act to 5 being always participated in the act. The frequency distributions for all six variables are displayed in Table 3, however answers to these questions ranged a little more than the others. When asked about how often the respondents did something that could have gotten them in trouble with the police, 43.7% indicated never, 16.3% indicated 2, and 14.1% indicated 1. Overall the majority was less likely to risk trouble with the police, however the answers were more evenly distrib-

uted. The same pattern follows with risking trouble with school authorities: 52.6% indicated never, 12.6% indicated 2, and 11.9% indicated 4.

A Spearman correlation will be run on the data to test if there is significance between the independent and dependent variables. This particular test will be used since the variables were measured at the ordinal level.

Table 4. Variable Descriptives (N = 135)

Variable	N	Mean	Median	Mode	Range	SD
Age	135	-	-	19-20	-	-
Gender	134	-	-	Female	-	-
Race	134	-	-	White/Caucasian	-	-
Grades	134	-	-	Mostly A's and Mostly B's	-	-
Formal Sanctions	135	2.867	3.00	1.00	4.00	1.757
Moral Condemnation	133	4.038	5.00	5.00	4.00	1.395
Punishment Avoidance	134	1.889	1.00	1.00	4.00	1.128
Number of times – Vandalism	134	0.276	0.00	0.00	3.00	0.554
Number of times – Theft worth <\$50	134	0.396	0.00	0.00	3.00	0.795
Number of times – Theft worth >\$50	134	0.089	0.00	0.00	2.00	0.377
Risked trouble with police	134	1.396	1.00	0.00	5.00	1.537
Risked trouble with school authorities	134	1.239	0.00	0.00	5.00	1.562
DestroyProp	133	1.165	0.00	0.00	15.00	2.419

Results

In the Spearman correlation table there are only six points of significance which can be found in Table 5. Under formal sanctions, there is only a positive, significant relationship with the number of times a student stole 1 to 2 items worth less than 50 dollars. This indicates that as the level of concern a student has about getting caught increases, the likelihood that they will steal 1 to 2 items worth less than 50 dollars also increases. The correlation between punishment avoidance and three dependent variables—the number of times a student vandalized, the number of times they stole 1 or 2 items worth less than 50 dollars, and how often they risk getting in trouble with the police—was significant at the .01 level. More simply, the correlation shows that the more people a student knows who commit property crimes and get away with them, the more likely it is that the student will vandalize, the more likely it is that the student will steal 1 or 2 items worth less than 50 dollars, and the more likely it is the student will do something that could get them in trouble with the police. At the .05 level, the correlation between punishment avoidance and number of times a student steals 1 or 2 items worth more than 50 dollars and between punishment avoidance and how often they risk getting in trouble with school authorities

Table 5. Spearman Correlation (N = 135)

Measures		Formal Sanctions	Moral Condemnation	Punishment Avoidance	Number of times – Vandalism	Number of times – Theft worth <\$50	Number of times – Theft worth >\$50	Risked trouble with police	Risked trouble with school authorities	DestroyProp
Formal Sanctions	r	1								
	Sig.									
	N	135								
Moral Condemnation	r	.179*	1							
	Sig.	.039								
	N	133	133							
Punishment Avoidance	r	.098	-.085	1						
	Sig.	.260	.333							
	N	134	132	134						
Number of times – Vandalism	r	.003	-.092	.231**	1					
	Sig.	.970	.293	.007						
	N	134	132	133	134					
Number of times – Theft worth <\$50	r	.233**	-.089	.344**	.314**	1				
	Sig.	.007	.312	.000	.000					
	N	134	132	133	134	134				
Number of times – Theft worth >\$50	r	.005	-.078	.183*	.349**	.408**	1			
	Sig.	.955	.372	.035	.000	.000				
	N	134	132	133	134	134	134			
Risked trouble with police	r	.054	.071	.283**	.551**	.320**	.146	1		
	Sig.	.537	.418	.001	.000	.000	.092			
	N	134	132	133	134	134	134	134		
Risked trouble with school authorities	r	.085	-.018	.213*	.488**	.335**	.193*	.715**	1	
	Sig.	.332	.837	.014	.000	.000	.025	.000		
	N	134	132	133	134	134	134	134	134	
DestroyProp	r	.057	-.128	.159	.479**	.272**	.290**	.474**	.476**	1
	Sig.	.514	.146	.068	.000	.002	.001	.000	.000	
	N	133	131	132	133	133	133	133	133	133

is significant. Again, this means that more people a student knows who commit property crimes and get away with them, the more likely it is that they will steal 1 or 2 items worth more than 50 dollars and the more likely they are to risk getting in trouble with school authorities. The correlation between punishment avoidance and the additive scale variable, destroy property, is approaching significance at $p = .068$. In Table 5, it can be seen that there is significance between many of the dependent variables, but this can be explained by the simple fact that if a student is likely to commit one type of property crime, they are more likely to commit other types as well.

Conclusion

When testing to see if rational choice theory has any effect on a college student's decision to commit a property crime, three costs of crime were evaluated. Overall, two of the three hypotheses regarding these costs were not supported. The first was formal sanctions. It was predicted that the higher the level of concern displayed by a student about getting caught committing a property crime, the less likely they would be to offend. It appears that no matter how concerned students are about getting caught, they will commit a property crime more often than not. In the case of the positive, significant relationship between formal sanctions and theft of 1 or 2 items worth less than 50 dollars, the correlation signifies that as a student's concern about getting caught increases, the number of times they steal 1 to 2 items worth less than 50 dollars increases as well. Studies like the one by Daniel Nagin and Raymond Paternoster (1993) found that undergraduate students at the University of Maryland take their perceptions of the risks and satisfactions of offending into consideration before drunk driving, stealing, and committing sexual assault. Another study by Thomas Loughran, Raymond Paternoster, Aaron Chalfin, and Theodore Wilson (2016) found that individuals are more likely to make rational responses to their environment based on their perceived costs and benefits of the situation. Since there is so much literature to support rational choice theory in relation to theft, it can be assumed that limitations of the study had an effect on the results. Another explanation for the findings could be that since the positive correlation was found between formal sanctions and theft of 1 or 2 items worth less than 50 dollars, even if students worried about getting caught they might not care so much since the punishment for inexpensive items would not be very severe.

The second prediction that the stronger a student's moral beliefs, the less likely they will be to commit a property crime was associated with no significance across any categories. This means that the moral beliefs of students do not deter them from committing any property crimes. A study conducted by Andrea Schoepfer and Alex Piquero (2006) examined if the moral beliefs of undergraduate students at a large western university in 1997 affected their likelihood of either stealing or acting out violently when combined with low self-control. As expected they found that low moral beliefs when

combined with low self-control lead to an increase in both theft and acting out violently. However, in line with the findings of this study, Schoepfer and Piquero found that when low self-control remained constant, even those with high moral beliefs still engaged in these delinquent behaviors (2006). The current study did not find that moral beliefs increased or decreased the likelihood of committing a property crime, only that they had no effect on a student's decision making process. The students in the Scheopfer and Piquero study also did not take their moral beliefs into consideration before offending. This could possibly be attributed to the age range of most undergraduate students. They are still approaching adulthood and might not yet have their values and morals fully developed and polished. Unless devotedly religious, some individuals may never have a fully established set of morals and therefore, when making a decision, may not rely very heavily on them.

Finally, the study found support for the third hypothesis that the more people a student knows that have gotten away with committing a property crime, the more likely they will be to offend. More specifically, the more people a student knows who vandalized, stole 1 or 2 items worth more or less than 50 dollars, or risked trouble with police or school authorities and got away with it, the more likely it is that they will also engage in these behaviors. Jonathan Brauer and Stacy De Coster (2007) found that when understanding adolescent delinquency, it is important to understand the influences they are under from peers. Though this study did not focus on adolescents, typically age twelve to eighteen, and did not focus on delinquency in general, only specifically on adult offending, it could be helpful to take their study into consideration. When deciding to commit a property crime, students took into account the number of people they knew that have ever gotten away with committing one. This means that their decisions are being influenced by outside sources. Though these sources could be anywhere from family members to complete strangers, the study examined college students and it is most likely that their largest influences are their peers. Rational choice theory also prevails in this finding in that the cost of committing a property crime decreased as the number of people a student knows that got away with offending increased. Following the cost aspect of the theory, as the costs of committing a crime decrease, the likelihood of offending increases. Through this finding, the theory of the study partially supports the research question searching to determine if students weigh the costs of committing a property crime before they decide to commit one.

Limitations and Future Research

There were several limitations for this study. The first is the lack of resources. This only allowed for a limited number of surveys to be printed and distributed, a limited amount of time to conduct research, as well as a limited sample to be selected. Within the sample chosen, the male to female ratio at Cabrini College impacted the responses received, with females completely outnumbering males.

bering the males. This could not be prevented because only students in classes in which the professor allowed the survey to be administered took the survey and therefore getting an even number of male and female students could not be controlled for. Research was also limited solely to the Cabrini College campus. If the sample size was larger and more schools were involved in the study, the results would be more generalizable. For future research, it would help to also test for the benefits of committing property crimes, not just the costs. This would allow for a better understanding of the decision making process of those who choose to offend. Gaining this insight might be beneficial to policy makers because if it is found that students steal often due to a lack of money for food or other positive recreational activities, they might be interested in finding more funding for activities on college campuses to be free. If they found significant reasoning behind why students choose to vandalize, policy makers might be interested in letting colleges and universities know that they need to invest in more events for students so they are busier and less likely to get into trouble. It might also benefit to study similar populations at different age levels to see if the decision making processes change as individuals get older and become more mature.

References

- Anderson, T. L. (n.d.). Property Crime. Retrieved from <http://www.udel.edu/soc/tammya/pdfs/Property%20Crime.pdf>
- Brauer, J. R., & De Coster, S. (2012). Social relationships and delinquency: Revisiting parent and peer influence during adolescence. *Youth & Society, 47*(3), 374-394. doi:10.1177/0044118x12467655
- Burglary. (2015). Retrieved from http://nationalparalegal.edu/public_documents/courseware.asp_files/criminalLaw/againstHome/Burglary.asp
- Cullen, F. T., & Agnew, R. (2006). Reviving classical theory: Deterrence and rational choice theories. In *Criminological theory: Past to present : essential readings* (pp. 404-426). Los Angeles, CA: Roxbury Pub. Co.
- FBI — Property Crime. (2010). Retrieved from <https://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/property-crime>
- FindLaw. (2015). Vandalism. Retrieved from http://findlaw.co.uk/law/government/anti_social_behaviour/7984.html
- Jang, S. J., & Franzen, A. B. (2013). Is being “spiritual” enough without being religious? A study of violent and property crimes among emerging adults. *Criminology, 51*(3), 595-627. doi:10.1111/1745-9125.12013
- Keep America Beautiful, Inc. (2015). Graffiti Hurts. Retrieved from <http://www.graffitihurts.org/getfacts/cost.jsp>
- Loughran, T. A., Paternoster, R., Chalfin, A., & Wilson, T. (2016). Can rational choice be considered a general theory of crime? Evidence from individual-level panel data. *Criminology, 54*(1), 86-112. doi:10.1111/1745-9125.12097
- Mason, A., & Monk-Turner, E. (2010). Factors shaping the decision of college students to walk or drive under the influence of alcohol: A test of rational choice theory. *Drugs: education, prevention, and policy, 17*(5), 560-572. doi:10.3109/09687630802629530
- Matsueda, R. L., Kreager, D. A., & Huizinga, D. (2006). Detering delinquents: A rational choice model of theft and violence. *American Sociological Review, 71*(1), 95-122. doi:10.1177/000312240607100105

- Nagin, D. S., & Paternoster, R. (1993). Enduring individual differences and rational choice theories of crime. *Law & Society Review, 27*(3), 467. doi:10.2307/3054102
- NCVRS Resource Guide. (2013). *School and campus crime*. Retrieved from http://www.victimsofcrime.org/docs/ncvrs2013/2013ncvrs_stats_school.pdf
- Schmalleger, F. (2015). Classical and neoclassical thought. In *Criminology today: An integrative introduction* (7th ed., pp. 51-78). Upper Saddle River, N.J.: Prentice Hall.
- Schoepfer, A., & Piquero, A. R. (2006). Self-control, moral beliefs, and criminal activity. *Deviant Behavior, 27*(1), 51-71. doi:10.1080/016396290968326
- Seyhan, O. (2013). Offender decision making process in property crimes and its policy implications. *Turkish Journal of Police Studies, 15*(2), 155-170.
- Theft Act 1968. (n.d.). Retrieved from <http://www.legislation.gov.uk/ukpga/1968/60/crossheading/definition-of-theft>
- University of Cincinnati. (n.d.). Criminology Schools of Thought. Retrieved from <http://cjonline.uc.edu/resources/news/criminology-schools-of-thought/>
- Vold, G. B., Bernard, T. J., & Snipes, J. B. (2002). Contemporary classicism: Deterrence, routine activities, and rational choice. In *Theoretical criminology* (5th ed., pp. 196-208). New York: Oxford University Press.

Lack of Capable Guardianship and Illicit Drug Use
Through Routine Activity Theory

Author: Liam Crowley

Faculty Advisor: Katie Farina, PhD

Abstract

Through Routine Activity Theory (RAT), this research will analyze if there is a correlation between capable guardianship and illicit drug use in adolescence. Routine Activity Theory was developed by Marcus Felson and Lawrence E. Cohen in which three components must be present in order for crime to occur. The three components are a motivated offender, suitable target, and lack of capable guardian. In the past Routine Activity Theory has been used to explain property crime and less geared towards adolescents and illicit drugs. One aspect of RAT that has little to no previous research is the lack of capable guardianship. Capable guardianship can take many different forms such as a security camera, a fence, and even a parent. The focus of this study was to use the parental aspect of capable guardianship and whether parental involvement played a role in adolescence and illicit drug use. Since adolescence is a crucial time period in one's life, it begs the question if more or less parental guardianship will turn adolescents to use illicit drugs. The study at hand hypothesizes that lack of capable guardianship will turn adolescents to illicit drug use. The hypothesis was in fact supported by the findings. It was concluded that lack of parental guardianship will increase an adolescence drug use.

Introduction

In 2013, in the United States, the number of drug related deaths was 43,982. The total deaths for prescription analgesics was 16,235. Heroin overdose was third on the list with 8,257 deaths. These numbers are found in the 2013 Data Detailing Drug Induced Deaths, breaking out specific data for prescription analgesics and heroin as reported by the Center for Disease Control (CDC, 2014).. According to the Food and Drug Administration (2015), a drug is a substance that is used as a medicine, whereas an illegal drug is a harmful substance (such as cocaine, LSD, or marijuana) that people take for pleasure. Both illegal and legal drugs can cause death, this is known as a drug overdose. Overdose is defined as a large intake of a drug or medicine that is too much for the body to handle and usually is dangerous. Drug use affects every part of a person's life, from their mental and physical health to their relationships and future ambitions. According to Dr. Howard J. Schaffer (2013), a noted Harvard Professor

Recent use of illicit substances is most common among people in their mid-teens to mid-20s. Given the age distribution of substance use, it's not surprising that the rates of substance abuse and dependence were highest among people ages 18 to 25. Roughly 23% of people in that age group had problems with abuse and dependence, compared with just under 9% of the general population. During 2010, about one in five people ages 18 to 20 admitted using illicit drugs during the past month. This rate declines as people grow older.

Dr. Schaffer is implying that adolescents are the most populous group to experiment and abuse drugs. An adolescent is a young person who is going through puberty. Adolescents use drugs for several reasons, such as: to fit in, to feel good, to feel better, to do better, and to experiment.

Literature Review

Routine Activity Theory was originally developed by Cohen and Felson (1979) in order to provide a simple and powerful insight into the causes of crime. In order for a criminal opportunity to develop, a motivated offender, a suitable target, and a lack of capable guardianship must converge in time and space. A motivated offender is a person who has the inclination to offend. A suitable target can be an object or a person that the offender desires to have or control. The lack of capable guardianship can be a number of various different objects or people that could potentially thwart off crime. Crimes are often random, but certain daily routines may increase a person's chance of being a victim (Cohen and Felson, 1979). Lifestyle choices, which are the way a person chooses to behave or live, can affect the volume and type of crime variations in crime result of variations in targets and lack of guardian. The supply of target and guardians is part of daily lives. an individual who lives a precarious lifestyle is more likely to be victimized (Cohen and Felson, 1979). Those factors influence a range of choices available. In order to fully understand Routine Activity Theory, one must fully comprehend the three main concepts of what motivates the offender, the suitable target, and the lack of capable guardianship that entail.

Placement or location of capable guardianship is critical in order to prevent crime from happening. As stated above, a capable guardian is a person that can prevent one from committing a crime, this includes parents, neighbors, security guards, a police officer, etc. Another type of guardian would be a security camera. People are less likely to commit a crime when near a security camera, for fear of being caught.

Although Routine Activity Theory does not explain what motivates a person to commit an offense, it does assume that motivated offenders are a constant presence. Certain people in society turn towards delinquency and will pursue these motives if given the chance.

Depending on the crime, a suitable target can be a number of things; this can range from

a valuable item to another human being. Brantingham and Brantingham (1981) focused on the relation of target suitability and the characteristics of the target. "Target suitability is related to the characteristics of the target as well as the characteristics of the target's environment. Within individuals' routine activities, there are certain characteristics, individual and situational, that expose them to increased risk of victimization" (Drawve, et. al., 2013, p. 455). For example, a woman walking down the street wearing a big engagement ring catches the attention of a mugger. Another example could be a person lurking around outside an empty house and notices that it is vacant. The person uses this opportunity to burglarize the vacant house. Cohen and Felson (1979) suggest "large scale societal changes influence the quantity of suitable targets nationally" (p. 596). Depending on the offender, he or she will determine what is and is not a suitable target.

The final element of Routine Activity Theory is the lack of capable guardianship. This has the potential to prevent the crime from occurring even with a motivated offender who has selected their suitable target. Capable guardianship can range from being an object, such as a fence, to another human being, such as a police officer. Police officers and other law enforcement agents are a well-known form of protection from crime and victimization. Routine Activity Theory suggests that presence of these objects or law enforcement agents have the potential to stop a crime from being committed (Cohen and Felson, 1979). Motivated offenders would think twice about committing a crime or engaging in deviant behavior when there are police officers nearby. According to Cohen and Felson (1979), "common citizens provide more guardianship in society than the police because there are comparably fewer police officers patrolling neighborhoods than there are citizens" (p.590). However, Cohen and Cantor (1981) suggested "while effective guardians are those who would come to the aid of a victim, it is difficult to judge the effectiveness of a guardian who may be capable of deterring crime" (p.453). However, this research does not suggest a capable guardians' willingness to intervene.

In 2014, Danielle Reynald conducted a study to shed light on the capable guardian and how it is just as important as the other elements. The author showed how the capable guardian is the critical actor within the crime event model with the power to deter crime. During this study, Reynald (2014) interviewed residential guardians to see what can stop them from disrupting opportunities for crime. Results showed three crucial elements of capable guardianship at "hot spots:" 1) the willingness to supervise, 2) the ability to detect potential offenders, and 3) the willingness to intervene when necessary. No research was conducted prior to this study on the informal guardians' ability to distinguish potential offenders from community dwellers.

Only research on formal guardians, such as police officers, was conducted in the past. In South Holland, Netherlands, thirteen neighborhoods were chosen for this study. Out of the thirteen, two of the towns were selected. These two towns were selected due to their diversity of wealth. The average number of respondents across the residential areas was twenty, with 48% male participants and 52% female. One flaw to this interviewing process was that not everyone in the town participated (Reynald, 2014).

Overall, the role of capable guardian was set apart by his or her willingness to take action to prevent or discourage the occurrence of crime (Reynald, 2014). The more a guardian watches over his/her neighborhood, the more likely they are to intervene when illegal activities arise. Thus, capable guardianship can play a critical role in the neighborhoods, however, intervening during this suspicious or illegal behavior depends on how intertwined the guardian is with his or her neighborhood. This study plays a pivotal role in the current research since lack of capable guardianship will result in illegal activities.

Illicit Drug Use

In 2013, an estimated 24.6 million Americans aged 12 or older—9.4 percent of the population—had used an illicit drug in the past month (NIDA, 2015). This number is up from 8.3 percent in 2002. The increase mostly reflects a recent rise in use of marijuana, the most commonly used illicit drug (NIDA, 2015). Illicit drug use includes the abuse of prescription medication or household substances (NIDA, 2015). Illegal drugs which have limitations on their ownership or use by a government and are illegal in certain situations (meaning a person is not allowed to have them.) According to the National Institute on Drug Abuse (NIDA) (2015) prescription drugs have psychoactive (mind-altering) properties and, because of that, are sometimes abused—that is, taken for reasons or in ways or amounts not intended by a doctor, or taken by someone other than the person for whom they are prescribed (NIDA,2015). The most common misuse of prescription medication are opioids such as Fentanyl, Hydrocodone, Oxycodone, Oxymorphone, Hydromorphone, Meperidine, Diphenoxylate, and Propoxyphene (NIDA, 2015). Prescription medication is misused by taking a doctor prescribed drug in a higher quantity or in another manner than it was originally prescribed for. Most prescription drugs are dispensed orally in tablets, but abusers sometimes crush the tablets and snort or inject the powder. This is a quicker way for the drug to get into the bloodstream and the brain and intensifies the effects (cite). The misuse of household items is frequently due to the fact they are easily acceptable and cheaper in cost. The most common way is through inhaling such items as toxic glues to even huffing spray paint. A household can be a very dangerous place if not

watching how certain toxic items are being used.

Consequences of Illicit Drug Use

Use of illicit drugs has many consequences that can result in incarceration or even death. Most drugs are a gateway to another harmful more potent drug. Over time certain drugs can cause multiple health hazards. Such hazards can include cardiovascular disease, stroke, cancer; HIV/AIDS, hepatitis, and lung disease can all be affected by drug abuse (NIDA, 2015). Some of these effects occur when drugs are used at higher doses or after prolonged use; however, it may occur after just one use of the drug. Drugs also affect the brain and will slow one's response in daily tasks. Over time and chronic use, the brain will be use to this "slow process" and begin to regulate as such. Some abusers have a tough time holding a conversation and will begin to nod off during the conversation. This will affect the abusers daily and will cause several setbacks. Abusers living with these effects will have a tough time trying to hold down a job and will often associate with other frequent drug users. Once a job is lost their currency will begin to dwindle and paying for such drugs will begin to be difficult. Drug users will find any way in order to get their next "fix" in a fast manner. Certain abusers will turn to ways in which money will be acquired in a manner that is fast and easy. These easy money schemes will most likely be illegal and dangerous for the user and the innocent bystanders who may cross their paths. The most common way drug addicted users acquire these funds is by stealing various items and selling them to local pawn shops that will pay bottom dollar in return for these stolen items. For example, a drug addict can steal copper or steel from an abandon house and sell it to a metal shop and once paid the user will usually head right to the drug supplier for their next fix. Another way is a male/female drug addict will have sexual relations with random men or women in exchange for money in order to pay for the drugs. This way carries many dangerous health hazards such as getting Sexually transmitted diseases including HIV/AIDS. The most common way for a teenager to get money for drug use is to steal from his/her parents as well as friends and their parents. Most of the ways in which these users pay for their drugs is illegal and can lead to Incarceration.

Incarceration is when police officers and other law enforcement officers are authorized by federal, state, and local lawmakers to arrest and confine persons suspected of crimes. The judicial system is also authorized to confine an individual convicted of crimes. This confinement, whether before or after a criminal conviction, is called incarceration. Juveniles and adults alike are subject to incarceration. Adolescents who begin using drugs can put them and their loved ones on a dangerous path.

Illicit Drug Use and Adolescents

Adolescence can range from the ages 12 to 17 years old and is the most susceptible stage of one's life. This is the period in which a child goes through the process of becoming an adult. Illicit drug use has long term effects on an adolescent's developing brain. Using drugs can interfere with family and peer relationships as well as school performance. Most adults who report having a substance abuse problem, have stated that they started using during their adolescence (Teen Drug Abuse, 2015). Thus it is important to identify the problem and intervene early. By the time, they are seniors in high school, more than 20 percent will have used a prescription drug for a nonmedical purpose (Teen Drug Abuse, 2015). Adolescents turn to drugs for many different reasons. Some have a desire for new experiences; others use illicit drugs as an attempt to deal with their problems or to perform better in school. Some also use drugs because they were peer pressured into doing so. Not taking the illicit drugs when peer pressured can result in exclusion from their peers. Adolescents are always trying to seek out new experiences and take risks, as well as to shape their own identity. There are various factors that influence an adolescent to experiment with drugs, these factors include: the availability of drugs in the community, school, or neighborhood, as well as, whether or not the adolescent's friends or peers are doing drugs. A person's family atmosphere can also play a critical role in adolescent drug use. Whether it is violence, physical or emotional abuse, mental illness, or even drug use in the household can increase the probability of an adolescent to experiment with illicit drugs. Finally, an adolescent's inherited genetic vulnerability; personality traits like poor impulse control or a high need for excitement; mental health conditions such as depression, anxiety, or ADHD; and beliefs such as that drugs are "cool" or harmless make it more likely that an adolescent will use drugs. Many factors and strategies can help adolescents stay drug free: Strong positive connections with parents, other family members, school, and religion; having parent's present clear limits and consistent enforcement of discipline; and reduced access in the home to illegal substances. (US Department of Health, 2013)

Illicit Drug Use and Routine Activity Theory

In 2006, Barnes and colleagues conducted a study using a mixture of social control theory and the routine activity perspective to identify problem behaviors by examining how adolescents spent their time. Barnes and her colleagues analyzed a wide variety of time use categories, including homework, extracurricular activities, sports time, alone time, after school jobs, housework, television watching, as well as indices of family time and peer time, for their effects on heavy alcohol consumption, cigarette smoking, illicit drug use, delinquency and sexual

activity. A total of 606 subjects/participants were examined. Barnes et al. (2006) also took into account social demographic factors – gender, age, race (Black and White), and social economic status. The majority of behavioral problems were caused with peers, while family time showed quite the contrary. Hence, family time serves as a protective factor against all five problem behaviors while peer time is a highly significant risk factor for all five problem behaviors (Barnes, Hoffman, Welte, Dintcheff, 2006).

Joel Miller (2012) conducted a study using Routine Activity Theory to see if different activities are associated with different types of crimes among adolescents. Such crimes include fare evasion, shoplifting, vandalism, assault, and drug use. Miller (2012) used data from the longitudinal Edinburgh Study of Youth Transitions and Crime, with a sample size of over 4,000 adolescents around the age of fifteen years old. This study was conducted in Scotland’s capital city, which also provided a diverse range of socioeconomic backgrounds. Activities were identified as; hanging around with peers locally, consumer and culture activities, and night life. Results showed that engaging in night life was associated with assault and drug use. Sports were positively associated with assault and fare evasion, and hanging out with peers locally was connected to assault shoplifting and vandalism (Miller, 2012). However, Miller’s study did not identify why these adolescents turned to these behaviors in the first place.

In 2007, Christopher Bratt wanted to explain the limitations of Routine Activity Theory and how it cannot explain the origin of motivation. Routine Activity Theory does not explain how some individuals come to be motivated to behave in a criminal or delinquent matter. In 1994, Coggan and Mckeller said, “adolescents who frequently participate in out of home activities withdrawn from parents control actually get involved in use of illegal drugs” (p.18). Bratts (2007) study investigated drug use among adolescents in a Norwegian town. The ages of the participants were between thirteen and fifteen years old. Social workers were placed to watch over local teen hangouts in order to see what would happen. By the end of the study the town had a huge reduction in adolescent’s drug use. Bratt (2007) concluded by saying:

We may state that a strict situational approach for prevention of drug use among adolescents is likely to lead us astray. Other factors than situational variables are crucial, though being together with peers and without guardian’s present is an important factor for how adolescents come to experiment with drugs (p.402).

The Current Study

Using Routine Activity Theory this research will analyze if there is a correlation between capable guardianship and illicit drugs through one’s adolescence phase. Even though Routine

Activity Theory was used more towards property crime and less geared towards adolescence and illicit drugs. One aspect of RAT that has little to no previous research is the lack of capable guardian. Since lack of capable guardian can take many different forms. The focus of this study will use the parental aspect of capable guardian and whether parental involvement has a role in adolescences and illicit drug use. Since adolescence is a crucial time period in one's life it begs the question if more or less parental guardianship will turn adolescences to use or not use illicit drugs. The study at hand will show that lack of capable guardianship will turn adolescences to illicit drug use.

With this in mind, this study aims to answer the following research question:

- 1) Will having no capable guardian present turn adolescents towards illicit drug use?
 - a. What specific illicit drugs are adolescents using while the capable guardian is not present?

Hypothesis

Adolescents that lack capable guardianship are more likely to turn to illicit drug use.

Methodology

Study Setting

Cabrini University is located in Radnor, Pennsylvania. Cabrini University is a Catholic, liberal-arts college dedicated to academic excellence, leadership development, and a commitment to social justice. As of 2016, Cabrini University has a total enrollment of 2,150 in which 1,300 are undergraduates and 850 are graduate students. Cabrini's student body is comprised of 37% male and 67% female with a diversity of 33% (Cabrini, 2016).

Materials

A ten-page survey consisting of 66 questions was created in order for this research to be conducted. Questions involving illicit drugs were adapted from the 2015 Delaware Secondary School Student Assent. The questions involving parental supervision was designed and created by the researcher and Dr. Katie Farina of the Criminology Department at Cabrini College. The results of the survey were entered on IBM SPSS software to analyze the relationship between parental supervision and illicit drug use among adolescents.

Sample

Cabrini College students were selected based on availability/convenient sampling method. The researcher went from classroom to classroom with the consent of the classroom professor and to solicited participation of students in the study. Upon consent of the professor,

the researcher then gave a lecture consisting of 5 minutes describing the study at hand and insuring that those who participate were are at no foreseeable risk. The researcher also explained that the survey would take about 10-15 minutes in order to complete. The target was to acquire 150 completed student surveys. A student sample size over 100 should reduce Type II errors and help with generalizability. The classes sampled were mainly criminology based classes. The researcher also surveyed college required elective class and a college required mathematics class. This provided variability among the sample size. Since it was such large sample size the threats to validity were minimized. The sample included students ranging from freshman to seniors in terms of class rank.

Demographics

Out of 150 surveys distributed only 145 of them were completed. From there a frequency was conducted to see the race, class, gender, and age of the respondents The ages of the students ranged from 18-25 years of age, with the average being 20 (Table 1). The gender distribution was made up males being 39.3% and females being 60.7% (Table 2). Ethnicity comprised of: Caucasians 58.3%, African Americans 26.2%, Hispanics 10.9%, Asian and Native Americans 2.1% and Other 2.8% (Table 3). Majority of the students that participated were Sophomores 40.6% and Juniors 26.6% (Table 4). The statistical findings from the frequency table shown in figures 1-4 made the generalizability increasingly possible.

Table 1: Age of Respondents

		Percent
18	11	7.6
19	25	17.2
20	49	33.8
21	36	24.8
22	19	13.1
23	3	2.1
25	1	.7
Total	145	100.0

Table 2: Gender of Respondents

		Percent
Male	57	39.3
Female	88	60.7
Total	145	100.0

Table 3: Race of Respondents

		Percent
Caucasian	84	58.3
African American	38	26.4
Hispanic	15	10.4
Asian	2	1.4
Native American	1	.7
Other	4	2.8
Total	144	100.0

Table 4: Class Level of Respondents

		Percent
Freshman	20	14.0
	58	40.6
Junior	38	26.6
Senior	27	18.9
Total	143	100.0

Survey Questions

The Independent measures in this study include: "How often did a parent, guardian or adult supervise after school finished for the day?" "How often were you left alone or with others who were under the age of 16?" "How often did you spend time with friends without adult supervision?" The answer choices to select were Always, Often, Sometimes, Rarely, and Never. A binary question was asked to see if parental supervision was not present to due to career or job obligations. The question asked was: "If you were raised in a single parent household, was your parent/guardian working a full time job?" "If you were raised in a dual parent household, were both your parents working a full time job?" Answer choices were restricted to a yes or no option. The dependent variables questions asked in this study included the following: "How often did you use marijuana?" "How often did you use over the counter medication (cough or cold medicines) to get high?" "How often did you use downers (tranquilizers, Xanax, barbs) to get high?" "How often did you use inhalants (aerosol spray cans, gasoline, wippets, glue)?" "How often did you use Ritalin, Adderall, Strattera, Ctlert, Concerta without a prescription?" "How old were you when the first time you tried marijuana?" and "How often do you use drugs?" These

answer choices varied from binary to likert style depending on what question was asked.

Data Analysis Procedure

Upon the completion of 145 surveys, the researcher then used the software SPSS to key in the respondent's answers. When imputing the surveys into SPSS the researcher had to change the students answers into numerical form due the fact that the software could not do a proper analysis with such a variety of answer choices. For example, a "yes" or "no" answer was imputed as "0" being "yes" and "1" being "no". Another example is when the answer choices were: never, a few times a year, once or twice a month, once or twice a week or almost every day. This ranged from "never" being "0" to "almost every day" being coded "4". Once all the surveys were all successfully imputed a Cronbach's Alpha test was conducted to see if the independent questions (parental supervision) could be scaled together. Cronbach Alpha measures how well a set of variables or items measures a single, one-dimensional latent aspect of individuals. In order for this test to be used the Cronbach Alpha needs to have a reliability score of .70 or higher. In the case of combining the parental supervision questions, the Cronbach Alpha test revealed a reliability score of .26. This was not sufficient enough for that test to be used. The next step was to then run the questions as individuals and to do so a Spearman Rank Correlation test was conducted. A spearman Rank Correlation measures the strengths of two variable and does not require continuous data due to the fact it uses ranks instead of assumptions about the two variables and allows them to be ordinal as well. Since my dependent and independent variable questions were ordinal and binary the Spearman Correlation was a proper test to run.

Results

The results of the Spearman Correlation analysis predicting that the lack of capable guardianship will result in illicit drug use among adolescents are presented in Table 5. As expected adolescents who spent time with friends without supervision had an increase use of; taking pain killers that they were not prescribed to ($r_s = .204, p < .05$) and the use of drugs in general ($r_s = .276, p < .01$). As parental supervision increased, adolescents were not likely to engage in the following: marijuana use ($r_s = -.222, p < .01$), the use of downers to get high ($r_s = -.232, p < .01$), the use of uppers to get high ($r_s = -.254, p < .01$), the use of inhalants to get high ($r_s = -.211, p < .05$), and using drugs without a prescription ($r_s = -.213, p < .05$). When parental supervision increased while spending time with friends, the use of marijuana decreased creating an inverse relationship. Inverse relationships are due to how answers are inputted when coding in SPSS. This coding also created inverse relationships for the questions pertaining to: downers, uppers, and using drugs without a prescription. In regards to the question regarding parent/s working

full time jobs, the use of inhalants was significant ($r_s = .229, p < .01$). As respondents answered no to parent/s working full time jobs, the use of inhalants increased when both parents were not working rather than when they were. When left home alone with others under the age of 16, the use of drugs, over the counter medication, downers, and uppers were significant. Adolescents were more likely to use drugs when left home alone or with others who are under the age of 16 ($r_s = .196, p < .05$). Respondents answered that they were more likely to use drugs when often left home alone. The next significant relationship while being left alone was with over the counter medication to get high ($r_s = -.191, p < .05$). This created an inverse relationship due to the fact the median of respondents answered *never* to using over the counter medication to get high while rarely left home alone. The following significant relationship while being left home alone was the use of uppers ($r_s = -.214, p < .05$) and downers ($r_s = -.242, p < .01$). This also was an inverse relationship in which respondents answered a median of *never* while rarely being home alone. The final independent variable was the likelihood of supervision after school which led to two significant relationships: taking pain killers that were not prescribed to the respondent ($r_s = -.187, p < .05$) and drug use in general ($r_s = -.186, p < .05$). Respondents on average were rarely supervised after school but they did not take any pain killers within the previous year, however, they every so often did drugs in general. See Table 5.

Working parents	-.106	-.076	-.076	.043	.015	-.002	.165	.077	.107	.229**	.093
Left home alone	.040	.062	.196*	-.121	.068	-.109	-.191*	-.242**	-.214*	-.093	-.164

Table 5: Spearman Correlation of Independent and Dependent Variables

Spearman Correlation

****.** Correlation is significant at the 0.01 level (2-tailed).

*****. Correlation is significant at the 0.05 level (2-tailed)

Spearman Correlation

*****.*** *Correlation is significant at the 0.01 level (2-tailed).*

******* *Correlation is significant at the 0.05 level (2-tailed)*

Discussion

As a result of this study, capable guardianship decreased the use of drugs in adolescents. This study was geared towards answering the following research question:

- 1) Will having no capable guardian present turn adolescents towards illicit drug use?
 - a) What specific illicit drugs are adolescents using while the capable guardian is not present?

Before conducting this study, the researcher's hypothesis was that a lack of capable guardianship will result in illicit drug use. This hypothesis was in fact supported by the data collected from the student surveys. Results showed that when a student was left home alone, they were more likely to engage in the use of drugs. Also, when students spent time with friends without supervision, they were more likely to take pain killers that were not prescribed to them and were more likely to use drugs in general. One surprisingly positive correlation was when both parents were home, the chances of using inhalants increased. This could be due to the fact that in households there are cleaning products that can be used as an inhalant. For example, a person could tell their parents they are going to clean their room and grab the inhalants and use them for recreational purpose instead of their intended use. One limitation for this question was that it did not specify when the parents were actually working. For example, some parents may work overnight shifts, while the other works day shifts. The parent working overnight would be home before the other parent went to work during the day, so the adolescent would rarely be left home alone. Results also revealed that when parental supervision was present, the use of painkillers, over the counter medication, downers, uppers, inhalants, and drugs without a prescription decreased. Overall, the results implied that as parental supervision decreased, illicit drug use increased.

Results from this work reinforce the results found in the study at hand? In *Adolescent Time Use*, majority of the behavioral problems, such as, heavy alcohol consumption, cigarette smoking, and illicit drug use, were caused when with peers while family time showed quite the contrary. Overall, in this study family time served as a deterring factor against these deviant behaviors. The results of this study confirmed that when spending time with friends without parental supervision, the use of illicit drugs will increase.

Limitations of Routine Activity Theory

Routine Activity Theory was geared more towards property crime and less towards illicit drug use. This theory is outdated and should be updated to conform to today's society.

Little to no research has been conducted analyzing the capable guardianship aspect of Routine Activity Theory. That being said, RAT was developed post World War II when women were often homemakers and were home majority of the time. The theory was created by men and given to only male participants. Therefore, it was only geared towards male subjects. Overall, RAT was a good theory for its time, however, as society evolves RAT will need to evolve as well in order to keep up with society's advancements.

Limitations of This Study

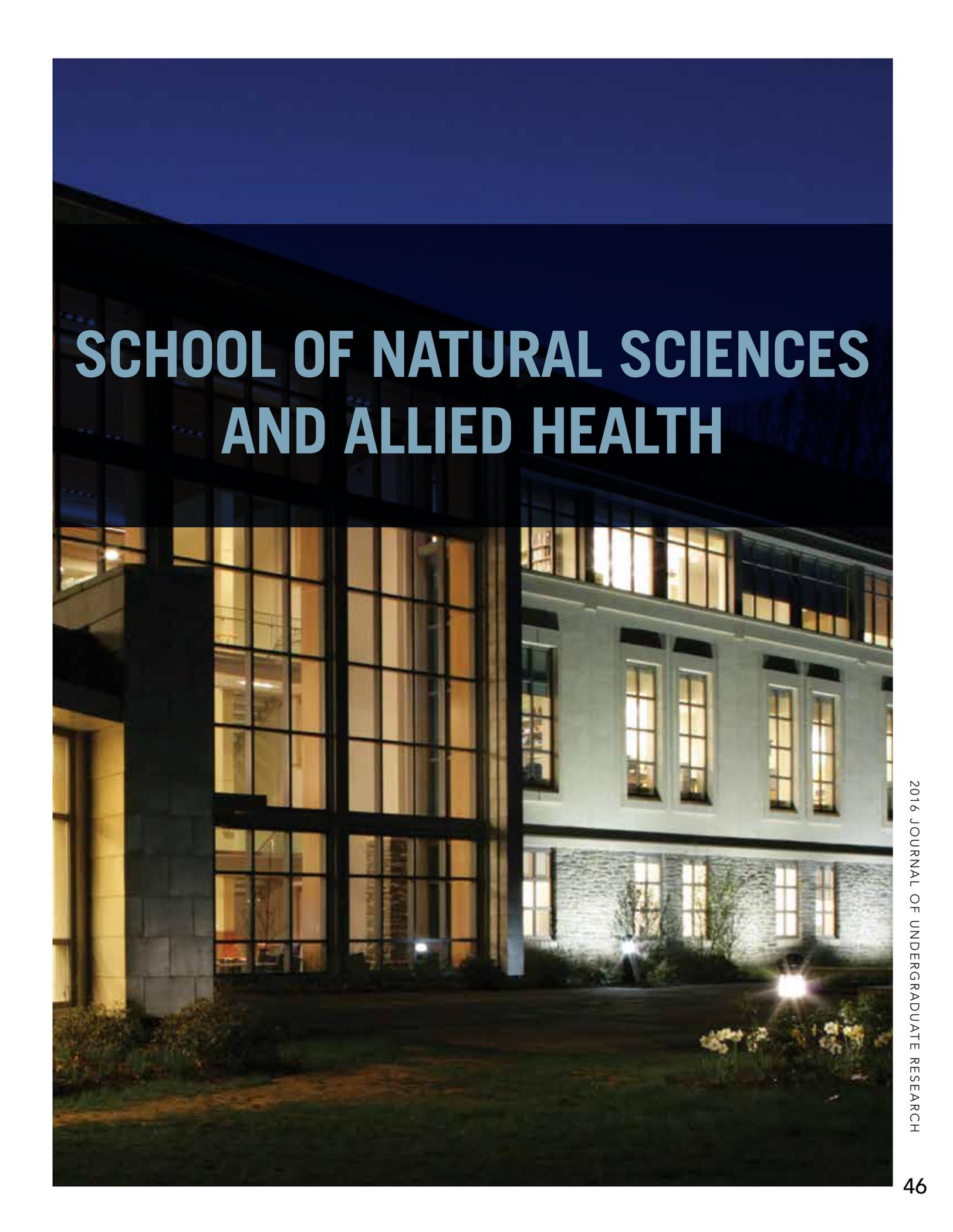
Again, since there was little to no previous research on capable guardianship when analyzing the parental supervision aspect, this made it difficult to find previous studies on this topic. Another limitation was that the survey was ten pages long, so students may have rushed their answers in order to complete it. Also, some students may not know what some drugs are and may have just circled never. The final limitation was that students may have not answered truthfully due to the fact they may feel embarrassed or uncomfortable answering some of the questions regarding drug use.

Implications of This Study

This study ultimately suggested that a lack of capable guardianship will result in illicit drug use in adolescents. This study also implied that when a capable guardian was present, drug use decreased. Future research needs to be conducted on a broader scale instead of just being limited to Cabrini College. Even though this research was generalizable to Cabrini College, it does not necessarily mean it could be applied elsewhere. Overall, monitoring adolescents during this impressionable time will cause them to stray away from illicit drug use. Thus, capable guardianship ultimately serves as a protective barrier between adolescents and drug use.

References

- Annual Causes of Death in the United States. (n.d.). Retrieved October 13, 2015, from http://www.drugwarfacts.org/cms/Causes_of_Death#sthash.J2C6SnOf.UUYOVROp.dpbs
- Barnes, G., Hoffman, J., Welte, J., Farrell, M., & Dintcheff, B. (2006). Adolescents' time use: Effects on substance use, delinquency and sexual activity. *Journal of Youth and Adolescence*, 36(5), 697-710. doi:10.1007/s10964-006-9075-0
- Brantingham, Patricia L. and Paul J. Brantingham (1981). "Notes on the Geometry of Crime." In *Environmental Criminology*, edited by Paul J. Brantingham and Patricia L. Brantingham. Beverly Hills: Sage.
- Bratt, C. (2007). Guardians to Counter Adolescent Drug Use? Limitations of a Routine Activities Approach. *Youth & Society*, 385-405.
- Cohen, Lawrence E. and Marcus Felson (1979). "Social Change and Crime Rate Trends: A Routine Activity Approach." *American Sociological Review*. 44:588-605.
- Delaware School Surveys (DSS). (n.d.). Retrieved February 09, 2016, from [https://www.cdhs.udel.edu/seow/school-surveys/delaware-school-survey-\(dss\)](https://www.cdhs.udel.edu/seow/school-surveys/delaware-school-survey-(dss))
- Drawve, G., Thomas, S., & Walker, J. (2013). The Likelihood of Arrest: A Routine Activity Theory Approach. *American Journal of Criminal Justice*, 39, 450-470. doi:10.1007/s12103-9226-2
- Dube, S., Felitti, V., Dong, M., Chapman, D., Giles, W., & Anda, R. (2003). Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: The Adverse Childhood Experiences Study. *American Academy of Pediatrics*, 111, 564-572. doi:10.1542/peds.111.3.564
- Incarceration. (n.d.). Retrieved December 12, 2015, from <http://legal.dictionaty.thefreedictionary.com/incarceration><http://legal-dictionary.thefreedictionary.com/incarceration>
- Kittle, Jesse T. Mr., "A Study of Surveillance and Privacy Rights" (2013). Electronic Theses and Dissertations. Paper 1170. <http://dc.etsu.edu/etd/1170>
- Miller, J. (2012). Individual Offending, Routine Activities, and Activity Settings: Revisiting the Routine Activity Theory of General Deviance. *Journal of Research in Crime and Delinquency*, 390-416.
- Reynald, D. Guardians on Guardianship: Factors affecting the Willingness to Supervise, the Ability to Detect Potential Offenders & the Willingness to Intervene. Retrieved October 13, 2015, from http://www98.griffith.edu.au/dspace/bitstream/handle/10072/37373/68997_1.pdf?sequence=1
- Schaffer, H. (n.d.). What age group is most likely to use illegal drugs? - Illegal Drug Use.



SCHOOL OF NATURAL SCIENCES AND ALLIED HEALTH

Development of a Combined Boyden-Flow Cytometry Protocol to Investigate Chemotaxis in the Invertebrate *Eisenia hortensis*

Authors: Juliann M. Jakeman, Jennifer H. Daly

Faculty Advisor: Sheryl L Fuller-Espie, Ph.D., DIC

Abstract

At different stages of development vertebrate leukocytes are influenced by the presence of chemoattractants as they migrate to different anatomical locations. Vertebrate leukocytes perform a variety of physiological activities that contribute to innate and adaptive immune responses. Cell migration (chemotaxis) is essential for cellular processes such as wound healing, inflammation, immune response, angiogenesis, and embryonic development. In vertebrates, there is much known about the effects of chemotaxis on important cellular processes, but in invertebrates this knowledge is far more limited. Furthering the knowledge about chemotaxis in invertebrates was the driving force behind this research because it has the potential of providing a greater understanding of the evolutionary relationships between vertebrates and invertebrates. This is of great interest to scientists who study evolutionary convergence of biological function. In this *in vitro* study the earthworm *Eisenia hortensis* served as the model organism providing coelomocytes which are easily extruded in large quantities for experimental treatments. We believe this is the first time that earthworms have been used to study chemotaxis. A combination of two methodologies including the Boyden migration chamber and flow cytometry was used to analyze earthworm coelomocyte migration in response to five chemoattractants: connective tissue growth factor (CTGF), vascular endothelial growth factor (VEGF), formyl-methionyl-leucyl-phenylalanine (fMLP), interleukin 8 (CXCL8), and transforming growth factor-beta (TGF- β). Based on this study, CTGF, VEGF, CXCL-8, and fMLP induced significant migratory responses in the positive control cell line, COS-7L, but not in the earthworm coelomocytes. The COS-7L cell line and the earthworm coelomocytes both exhibited statistically significant migration in response to TGF- β . However, this response was not reproducible in all assays. Given the encouraging results observed with TGF- β , it would be of interest to use TGF- β at a wide range of concentrations to optimize conditions for chemotaxis using this growth factor.

Introduction

Vertebrate leukocytes possess the ability to migrate under the influence of chemoattractants. A range of physiological activities contributing to the innate and adaptive immune responses are carried out by vertebrate leukocytes (reviewed in van der Valk & Herman, 1987). During different stages of leukocyte development these cells can travel to various locations throughout the body due to the influence of chemoattractants. Cellular processes such as wound healing, inflammation, immune response, angiogenesis, and embryonic development are affected by the migratory capability of immune cells. In humans, the receptor:ligand interactions that are involved in cell migration are well studied and described. These interactions have a crucial role in better understanding immune defenses, disease progression, and metastasis of cancer cells (reviewed in Bravo-Cordero, 2012; Bloes, Kretschmer & Peschel, 2015; Zabel, Rott & Butcher, 2015). Chemotaxis (the migration of cells in response to a stimulant) has been well categorized in vertebrates and there is also much known about the process in bacteria. However, little is known about chemotaxis in relation to invertebrates (Cabrera et al., 2002).

This study selected five growth factors and/or cytokines based on a review by Tettamanti et al. (2006) which compared the effects of these particular growth factors and chemokines between invertebrates and vertebrates. The effects that the mammalian cytokines had on coelomate invertebrates were also discussed in that paper. Cell shape changes, induction of chemotactic effects, as well as an increase in phagocytic activity of the immunocytes in response to cytokines were noted in these invertebrates. Additional studies involving invertebrates have shown that in the leech, *Hirudo medicinalis*, interleukin-1 and interleukin-6 stimulated the phosphorylation of substrates in nervous ganglia (Bottai, Garaci-Gil, Zaccardi, Fineschi & Brunelli, 1994). Cabrera et al. (2002) also showed that *T. petricola* (a coelomated sipunculan marine worm) exhibited migration towards fMLP-, lipopolysaccharide-, and zymosan-treated plasma. Below is a description of the five chemoattractants that were used in this study in order to provide background on these molecules, namely interleukin 8 (CXCL8), formyl-methionyl-leucyl-phenylalanine (fMLP), , transforming growth factor-beta (TGF- β), connective tissue growth factor (CTGF), and vascular endothelial growth factor (VEGF),

The most potent chemoattractant is the small cytokine, CXCL8 (de Oliveira et al., 2013). CXCL-8 is a member of the CXC chemokine family and is involved in mediating inflammatory responses (Di Cioccio, 2004). Several different types of cells are responsible for secreting the chemokine CXCL-8. CXCL-8 is a powerful angiogenic factor and acts as a chemoattractant. In humans, CXCL-8 is produced by a series of early inflammatory events that stimulate the activation of tissue and endothelial cells (Li et al., 2006). The migration of neutrophils to an affected site is induced by the chemokine CXCL-8. Once the neutrophils reach the site, they work to disable pathogens by means of phagocytosis (Li et al., 2006). Studies involving bacteria, such as *Fusobacterium nucleatum*, *Porphyromonas gingivalis*, *Aggregatibacter actinomycetemcomitans*, *Eikenella corrodens*, *Prevotella intermedia*, or bacterial compounds such as fimbriae and peptidoglycan have shown that epithelial cells produce CXCL-8 in order to cause neutrophils to travel through the junctional epithelium into the gingival sulcus (Kim et al., 2012). CXCL-8 functions in early immune responses in humans referred to as innate immunity. Earthworms possess innate immune function, however, they do not utilize the more sophisticated adaptive immune mechanisms observed in vertebrate species. For this reason, we were interested in determining whether CXCL-8 may be able to function in a similar manner to functional homologs that operate in earthworms as they initiate innate immune responses to pathogenic challenges.

The powerful chemoattractant molecule fMLP, is thought to have originated from degraded mitochondrial or bacterial proteins. fMLP has an N-formyl peptide receptor that is G-protein coupled (Wittmann, Fröhlich, & Daniels, 2002). The receptor for fMLP, formyl peptide receptor (FPR), was identified in the surface of phagocytes first and in later studies was found to be expressed in astrocytes, dendritic cells, microglia cells, hepatocytes, the tunica media of coronary arteries, and non-leukocytic cells (Kim et al., 2007). When the N-formyl peptide receptor is stimulated with fMLP it causes tissues to produce reactive toxin derivatives such as hydrogen peroxide (Wittmann, Fröhlich, & Daniels 2002). In mammals, fMLP is known to enhance phagocytosis and chemotaxis. This information motivated the study directed by Cabrera et al., (2002), which involved investigating the chemotactic capabilities of coelomocytes in response to fMLP in *Them-*

iste petricola, a marine worm that lacks segmentation. Their study found that *T. petricola* exhibited chemotactic responses to bacterial-derived fMLP. We were interested to determine if earthworms demonstrate a similar response to fMLP.

TGF- β is a pleiotropic growth factor that regulates processes such as homing, cellular adhesion, and chemotaxis. T-cell activation, differentiation, and apoptosis are also regulated by TGF- β . According to Lúðvíksson & Gunnlaugsdóttir (2003), recent studies suggest that the stage of T-cell activation/differentiation, the chemotactic adhesion molecule expression pattern, and the condition at the immunological synapse determining their sensitivity are affected by TGF- β regulation. In mammals, the TGF- β family is made up of several different isoforms characterized as TGF- β 1, - β 2, and - β 3. These isoforms have 70-76% sequence homology, but they possess different expression profiles and functionalities. The use of knockout mice has identified the differences in these isoforms. Various studies have found that in mammals TGF- β 2 and TGF- β 3 are crucial regulators or cellular differentiators and also affect the development and embryogenesis. TGF- β 1, in contrast, has a predominantly immunologic effect (Lúðvíksson & Gunnlaugsdóttir, 2003). In addition to platelet-derived growth factor (PDGF), TGF- β was shown to induce chemotaxis in the mollusk in addition to enhanced phagocytosis (Ottaviani, Franchini, Kletasas, Bernardi, & Genedani, 1997). To our knowledge, there have been no studies conducted on earthworms to ascertain the ability of TGF- β to stimulate chemotactic responses.

CTGF functions as an inflammatory mediator. Elevated levels of CTGF are seen in areas of severe injury in the body and in inflammatory diseases (Liu et al., 2012). Part of the C-terminal cysteine-rich proteins (CCN) family, a type of secreted multifunctional protein with high levels of cysteine, is known to have several functions such as fibrosis, tumorigenesis, and angiogenesis (Perbal, 2004; Takigawa, 2003). CTGF can regulate growth, proliferation, and apoptosis and is a chemotactic factor for monocytes. Endothelial cells, smooth muscle cells, and fibroblasts produce CTGF (Cicha et al., 2004). In vertebrates, CTGF is essential in the development and differentiation of tissues, particularly of hard tissues such as teeth and bones (Tettamanti et al., 2006). The protein twisted gastrulation (TSG) in *Drosophila* has been shown to exhibit marginal sequence homology to

the CTGF family in humans. The report of Mason, Konrad, Webb and Marsh (1994) indicates that TSG and CTGF have functional similarity in relation to cytoskeletal rearrangements. This study was aimed at determining whether CTGF, which functions as a cysteine-rich mitogen and powerful chemoattractant in human cells, can stimulate chemotactic behavior in the coelomocytes of the earthworm.

First described as an essential growth factor for vascular endothelial cells, VEGF is also a potent angiogenic factor. In tumors, VEGF is up-regulated and contributes to tumor angiogenesis. It is produced in a variety of cell types such as, tumor cells, macrophages, platelets, keratinocytes, and renal mesangial cells. The functions of VEGF are not limited to the vascular system; it plays a role in normal physiological functions including, bone formation, hematopoiesis, wound healing and development (Duffy et al., 2000). It is the most relevant growth factor for the synthesis and maintenance of vessels (Tettamanti et al., 2006). VEGF signals cells and is known to be involved in a variety of tumor cell developments and the signaling of many cells. Certain cellular functions that prevent apoptosis are inhibited by VEGF, which contributes to the metastasis of cancer (Tettamanti, et al., 2006). Other studies have shown that homologs of VEGF are expressed in the descendants of various germ layers in Radiata and Bilateria invertebrates (Kipryushina, Yakovlev, & Odintsova, 2015). They are believed to contribute to the formation of the vasculature in these organisms. Our study investigated whether VEGF is capable of stimulating chemotactic responses in a different invertebrate species, namely *E. hortensis*.

Researchers that study chemotaxis typically use a gradient-driven cell migration assay, such as the transmembrane/Boyden chamber. A transmembrane/Boyden chamber functions by placing cells in an upper chamber that is separated by a porous membrane from chemoattractant located in the lower chamber. The cells that cross the membrane during an allotted culture incubation time are counted in order to measure cell migration. In a study by Gomez-Lopez et al. (2011), the Boyden chamber was used to perform chemotaxis assays. Using the Boyden chamber method alone provides only an estimation of cells that have migrated toward the chemoattractant. This study in particular utilized the flow cytometer together with the Boyden chamber to quantify the total number of mi-

grated cells. The combined Boyden-flow cytometry method allowed for accurate quantification as well as phenotypification of different migrating cells in one assay (Gomez-Lopez et al., 2011).

In summary, the objective of this study was to investigate the capacity of earthworm coelomocytes to exhibit chemotactic responses when cultured with the chemoattractants CTGF, VEGF, fMLP, CXCL8, and TGF- β using a combined Boyden-flow cytometric method. Our laboratory used the coelomocytes of the invertebrate *Eisenia hortensis*, an earthworm which is also referred to as the European nightcrawler. When the earthworm is agitated, coelomocytes (leukocytes) are extruded through the dorsal pores. Coelomocytes include, eleocytes (also referred to as chloragocytes), hyaline amoebocytes, and granular amoebocytes (Englemann, et al., 2004) which are part of the earthworm's innate immune system. Coelomocytes are released when the earthworm is under stress due to environmental or experimental factors. Phagocytosis, natural killer-like activity, encapsulation, and lytic activities are all functions of coelomocytes (Salzet, Tasiemski & Cooper, 2006). Before this study, an earthworm model had never been used to study chemotaxis in invertebrates.

Materials and Methods

Animal handling

Eisenia hortensis is a species of earthworm that is very easy to maintain and is able to extrude a large quantity of coelomocytes (leukocytes) upon agitation through its dorsal pores. The earthworms used in this study were supplied by Vermitechnology Unlimited, Inc. (Tel: 352-591-1111, www.vermitechnology.com). The earthworms were maintained in plastic boxes containing autoclaved wood chips and moistened shredded paper in a dark air-conditioned room, and were fed twice weekly with Gerber's baby food powder and Quaker Oats.

Harvesting of coelomocytes

One day prior to extrusion of coelomocytes from *E. hortensis*, a predetermined quantity of healthy active earthworms were removed from their habitats and placed into Petri dishes in groups of 6-8 containing sterilized paper towels with 2.5 μ g/mL Fungizone (Fisher Scientific). This allowed for defecation and removal of fungi on the surface of the

earthworm to help reduce contamination by microbes during the extrusion process. The day following the overnight treatment, individual earthworms were placed into sterile troughs containing 3mL of ice cold BD FACSTFlow sheath fluid (BD Biosciences) using sterile forceps. The BD FACSTFlow sheath fluid served as the extrusion buffer that agitated the earthworms and caused them to release their coelomocytes from their coelomic cavity through the dorsal pores. The coelomic suspension was transferred into 0.5mL of Accumax™ (Innovative Cell Technologies, Inc.), which was used to disrupt cellular aggregates in order to obtain single cell suspensions. After 2-3 min incubation at room temperature, the cells were diluted with 5mL of phosphate-buffered saline (PBS) on ice. The samples were then centrifuged immediately at 800RPM (150xg) for 5 min at 4°C. After decanting the supernatant, 1mL of serum-free Dulbecco's Modified Eagles Medium (GIBCO) supplemented with penicillin, streptomycin, amphotericin B, ampicillin, kanamycin, tetracycline, chloramphenicol, glutamine, non-essential amino acids, and HEPES buffer according to Fuller-Espie, Harris, Daly, & Jakeman (2015). This medium is referred to as SF-DMEM in this report. Nystatin (50µg/mL) was also included as an additional antifungal agent (Fisher Scientific). A small portion of the cell sample was added to the hemocytometer and the cell concentration was determined using a phase contrast microscope. The cells were adjusted to a desired concentration of 2.0×10^6 cells/mL. After coelomocytes were harvested, earthworms were euthanized by freezing at -20°C.

Assay progression

Because this study was the first one conducted utilizing earthworms to study chemotaxis, challenges were encountered including the development and optimization of a standard procedure and identification of the appropriate controls. Consequently, in the early stages of the course of this study the protocol underwent significant modifications in order to improve the experimental procedure and optimize results. As a team, we faced many challenges ranging from fungal contamination issues to the identification of the appropriate cell line as the positive control. The pore size of the Boyden chamber permitting optimal migration was also a factor. Additionally, the method used to release the migrated cells from the membrane was altered; initially Accumax™ was used, but later this was changed to a more rigorous method using trypsin/EDTA. Cell numbers and

temperature were additional factors to consider when optimizing the results. The use of fluorescence microscopy for quantitation of migrated cells was eventually eliminated from the protocol due to the inability to deliver consistent results and the high degree of subjectivity depending on the observer. Initially, the positive control cell line K562 (an erythroleukemic cell line derived from a patient with chronic myelogenous leukemia) was used, but this cell line did not exhibit the predicted migration results leading to the change to COS-7L cell line (derived from African Green Monkey kidney cells). The progression of our assay set-up over the course of 9 assays is illustrated in **Table 1**, with modifications indicated in red. The methods described below are based on assays 4-9 which were conducted using the same standard procedure deemed to be optimal for our experimental model.

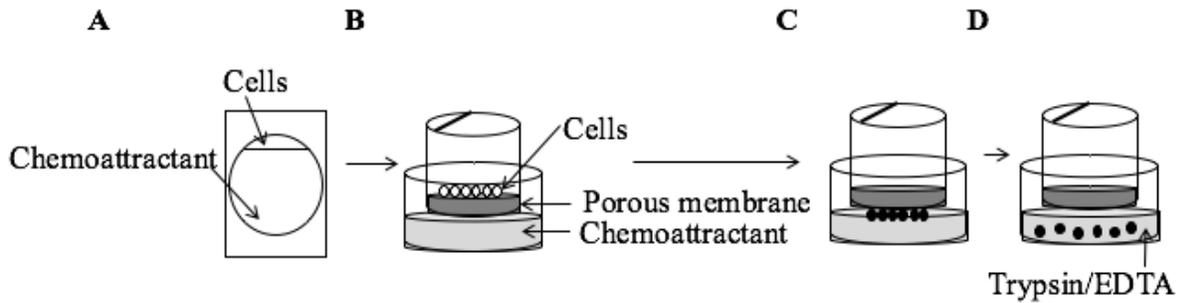
Conditions	Assay 1	Assay 2	Assay 3	Assay 4-5	Assay 6-7	Assay 8-9
Pore size	3 μ m	8 μ m				
Cell number	2.0x10 ⁵	4.0x10 ⁵				
Control Cell Line	K562			COS-7L		
Temp (°C)/Time (h)	25/~20	29				
Antibiotics/ Antimycotics	Penicillin, Streptomycin, Amphotericin B			Add Nystatin, Ampicillin, Kanamycin, Chloramphenicol, Tetracycline		
Chemoattractants	fMLP CXCL8			fMLP CXCL8 TGF β VEGF CTGF		
Cell Release Enzyme	Accumax™		Trypsin EDTA			
Quantitative analysis	Fluorescence Microscopy		Flow Cytometry			

Table 1: Assay progression throughout the course of the study. The specific condition is located in the leftmost column, the assay number of choice is located on the top of the table, and the changes in the protocol are indicated in red.

Chemotaxis assay

A membrane migration plate (BD Falcon FluoroBlok 24 well 8 μ m pore) was set up in the biosafety cabinet using aseptic technique (**Figure 1**). The earthworm coelomocytes (4.0x10⁵ in 0.2mL SF-DMEM) were added to the upper chamber of the plate. The desired

chemoattractant was added to the lower chamber in either quadruplicate or triplicate at concentrations indicated in the results. The plates were incubated at 29°C, 5%CO₂, for 20



h.

Figure 1. Flow chart of the methodology for cell migration of harvested coelomocytes. **A:** Representation of a single well of a 6x4 Boyden chamber plate is depicted. The chemoattractant was injected on one side of the well leading to the lower chamber and the coelomocytes were injected into other side of the well leading to the upper chamber. **B:** Cross-sectional view of chamber is shown. Coelomocytes were placed on top of the porous membrane and the chemoattractant was placed below. **C:** Post-migration of the coelomocytes. The migrated coelomocytes adhered to the underside of the membrane. **D:** Release of migrated cells. The coelomocytes that adhered to the underside of the membrane were released by treatment with trypsin/EDTA to release them into cellular suspension.

Post-migration

Once the incubation time had elapsed, the insert was removed from the lower plate. The upper chambers were emptied by carefully and forcibly flicking out the contents. The insert was then placed into a new 24-well plate that contained 250µl of 1x trypsin/EDTA (Invitrogen, Cat. 25200-056) to dissociate the migrated cells from the surface of the membrane. After 10 min incubation at 25°C with gentle shaking, 250µl of 5% bovine serum albumin (fraction V, Fisher Scientific, in PBS) was added to quench the enzyme activity of the trypsin. The released cells were harvested from the lower chamber by pipetting them into a flow cytometry tube and then analyzing them immediately by flow cytometry for the purpose of enumerating the number of migrated coelomocytes of *E. hortensis*.

Flow cytometric data acquisition

The samples were subjected to a forward and side light scatter on the flow cytometer. In order to gain quantitative measurements, all of the samples were run on the flow cytometer for 1 min per file and this was repeated for a total of two collections per

sample. The number of events (cells) for each sample was averaged to give an estimate of the number of migrated cells. This was repeated for the samples in each triplicate or quadruplicate treatment group, and finally an overall average was determined. This data was analyzed further to generate graphical representations and determine statistical significance using the student t-test, paired two sample for means. **Figure 2** provides a diagrammatic flow chart of the data acquisition via flow cytometry.

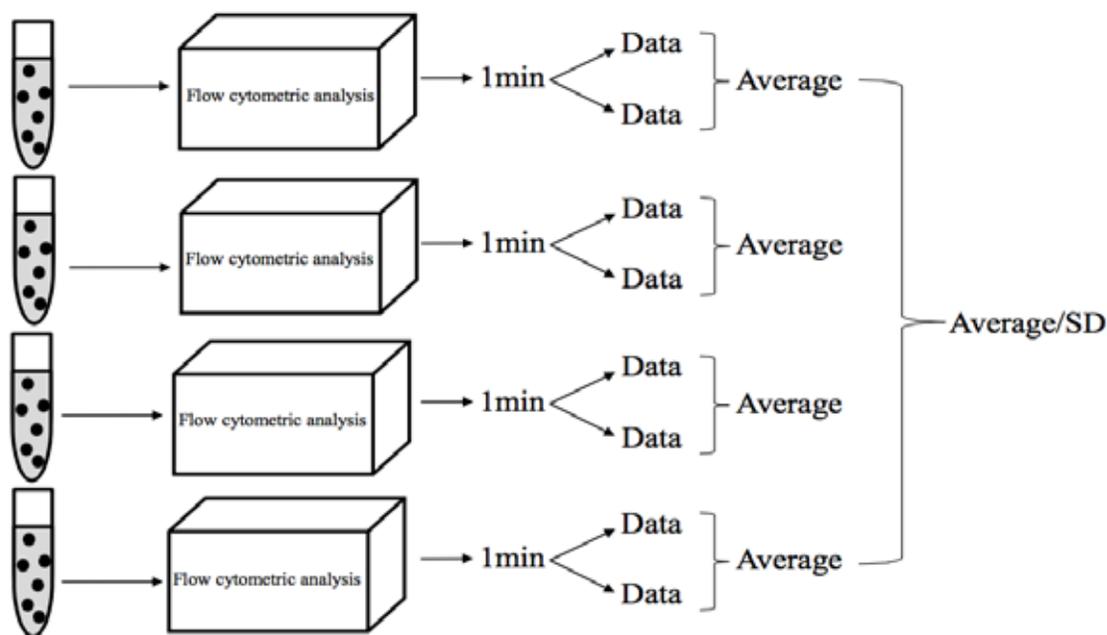


Figure 2. Flow chart of data acquisition by flow cytometry. Coelomocytes in suspension were run on the flow cytometer 2 times for each sample, 1min each. The data was collected in either triplicate or quadruplicate and averaged. The average of the averages was taken and the standard deviation was determined.

Results

The results discussed in this paper represent assays 4-9 where the final conditions of the protocol had been optimized and remained unchanged. **Figures 3-6** show the results for earthworm coelomocytes versus the positive control cell line COS-7L. The number of earthworm coelomocytes that migrated in response to the chemokine CXCL-8 (600ng/mL) for earthworm coelomocytes (left panel, **Figure 3**) exhibited a higher average number of cells compared to media, however, this was not a statistically significant increase. This result could be attributed to the high degree of standard deviation observed in the control. The COS-7L cells, in contrast, did respond as predicted to CXCL-8, and a significant increase was observed compared to the media control (right panel,

Figure 3).

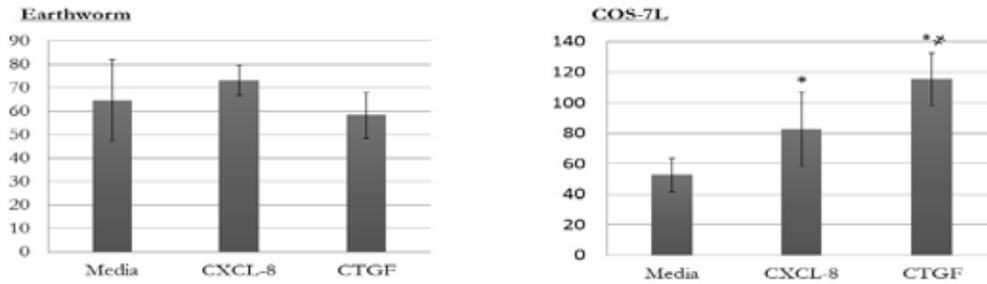


Figure 3. Graphs of CXCL-8 at 600ng/mL and CTGF at 200ng/mL assay 4. (Left) earthworm coelomocytes (right) COS-7L cells. Significance is denoted by an asterisk for a p value of <0.05 and the \square mark is for a p value less than 0.00005.

Three separate assays to determine if CTGF (200ng/mL) could induce chemotaxis in earthworm coelomocytes were attempted (**Figures 3 and 4**). In no instance did CTGF exhibit a high level of cell migration compared to the media control when using earthworm coelomocytes (left panels of **Figures 3 and 4**). The positive control cell line, COS-7L, showed significant migration in only two of the three attempts (right panels of **Figures 3 and 4**). When testing the growth factor VEGF (100ng/mL) in two separate assays, (**Figure 4**), no migration above baseline was observed for either earthworm coelomocytes (left panels) or COS-7L cells (right panels).

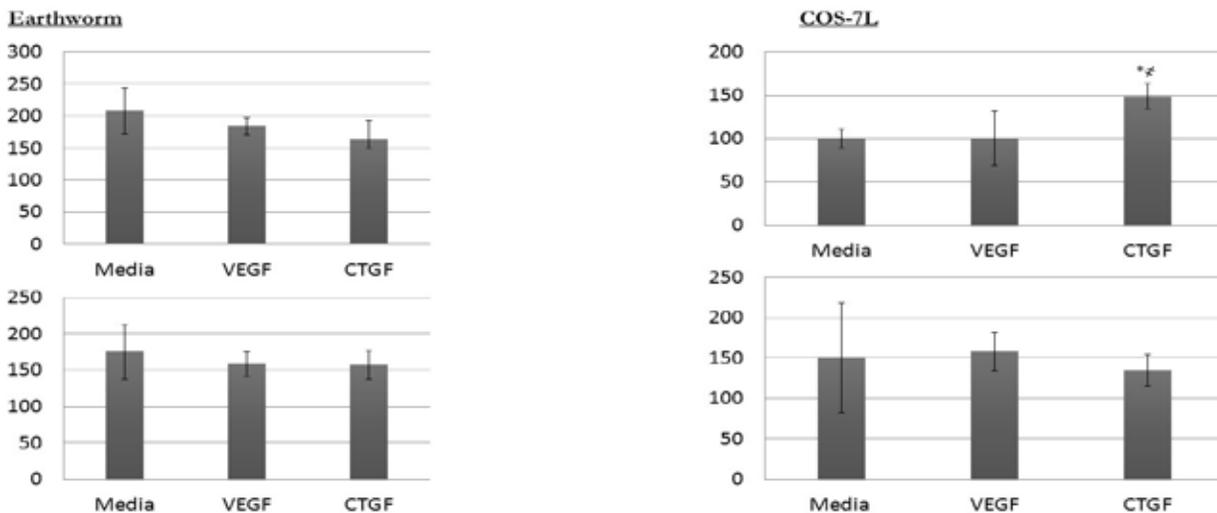


Figure 4. Graphs of VEGF at 100ng/mL and CTGF at 200ng/mL (top) assay 5 (bottom)

assay 6. (Left) earthworm coelomocytes (right) COS-7L cells. Significance is denoted by an asterisk for a p value of <0.05 .

Figures 5 and 6 show the results of chemotaxis when using fMLP ($5\mu\text{M}$) with earthworm coelomocytes (left panels) and COS-7L cells (right panels). Because fMLP was dissolved in dimethylsulfoxide (DMSO), the vehicle control for baseline measurement contained the same concentration of DMSO as the treatment group. In none of the assays did earthworm coelomocytes show increased migration compared to the vehicle control. COS-7L cells did not show a consistent response to fMLP, with only one out of the three assays showing a significant increase above vehicle control. The first two attempts at using TGF- β ($20\mu\text{g}/\text{mL}$) (**Figure 5**) showed significant migration for COS-7L cells (right panels) but not for earthworm coelomocytes (left panels). The graphs show that there was an increase in migration of earthworm coelomocytes compared to the media control, however, owing to the large standard deviation of quadruplicate samples, the results were not significant. Interestingly, the third time that TGF- β was used in a chemotaxis assay (**Figure 6**), both earthworm coelomocytes and COS-7L cells exhibited significant migration compared to media controls.

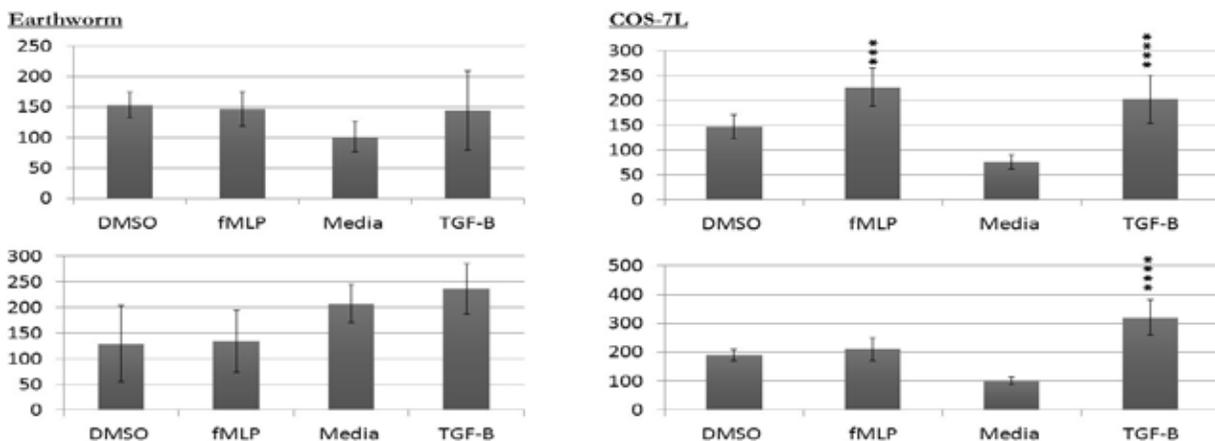


Figure 5. Graphs of fMLP at $5\mu\text{M}$ and TGF- β at $20\mu\text{g}/\text{mL}$ (top) assay 7 (bottom) assay 8. (Left) earthworm coelomocytes (right) COS-7L cells. Significance is denoted by an asterisk for a p value of <0.05 .

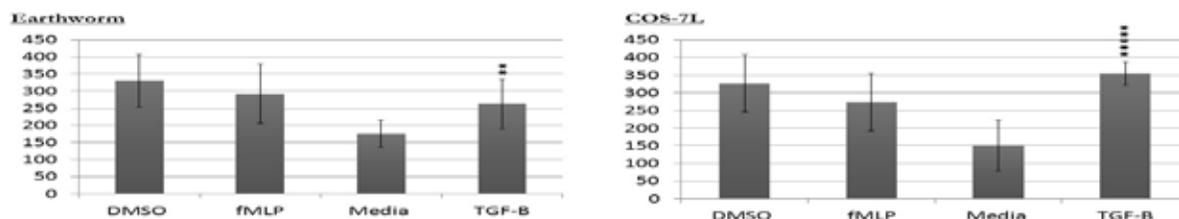


Figure 6. Graphs of fMLP at 5 μ M and TGF- β at 20 μ g/mL for assay 9. (Left) earthworm coelomocytes (right) COS-7L. Significance is denoted by an asterisk for a p value of <0.05 .

Discussion

To our knowledge, this study represents the first time earthworm coelomocytes have been used to study chemotaxis in this invertebrate model. The experimental design developed for this investigation was modified extensively due to the novelty of the experimental invertebrate species utilized. The first assay included a 3 μ m pore membrane and yielded the lowest cell counts due to the cells being too large to fit through the pores. Assay 1 used the lowest number of cells, 2.0×10^5 . The subsequent assays used the 8 μ m pore membrane and a higher number of cells, 4.0×10^5 . This resulted in higher migration events for all remaining assays. Quantifying the cells with the fluorescence microscope was not an accurate way to count the cells because only three areas in the well were quantified and averaged. It was not a clear representation of the actual number of cells that had migrated across the membrane and there was considerable subjectivity involved in this counting procedure between independent observers. The flow cytometer was able to quantify the cells more accurately because it counts each individual cell that is introduced to the instrument. Contamination issues were problematic when performing these experiments and the antibiotics and antimycotics were increased in the media following the third assay. The COS-7L cells proved to be a more effective positive indicator than the K562 cell line.

Based on this study using the earthworm *E. hortensis*, CTGF, VEGF, CXCL-8, fMLP, and TGF- β induced significant migratory responses for the positive control cell line, COS-7L. Notably, TGF- β showed the most frequently occurring and greatest statistically significant

results with p -values reaching 0.000001 in the positive control cell line. TGF- β did induce higher levels of migration in earthworm coelomocytes in two out of the three assays performed, but a high degree of standard deviation interfered with statistical significance. This cytokine stimulated more migration than its media control. The third time the assay was performed, earthworm coelomocytes did exhibit statistically significant migration in response to TGF- β with a p -value of <0.005 .

We conclude that a multitude of factors negatively affected the results of this study aimed at determining whether migration in response to these mammalian-derived chemoattractants could take place reliably and reproducibly. Follow-up research could address several of these factors including temperature, trypsinization conditions, time of incubation, pore-size of the transmigrating membrane, and a dose-response approach to chemoattractant response. When the earthworm coelomocytes and positive control cell lines (K562 and COS-7L) were incubated at 29°C, neither was incubated at their optimal temperatures of 25°C and 37°C, respectively (Fuller-Espie et al., 2015; Gibco, 2003). They were incubated at this suboptimal temperature because each assay was performed in a single 24 well plate, necessitating the use of one incubator set at a predetermined temperature. The use of trypsin/EDTA for 10 min could have been another contributing factor to the low cell counts because the ideal time for exposure of cells to trypsin/EDTA is 2-3min since it is highly potent. The time of incubation (20 h) could have also been a contributing factor in the low results obtained. The long incubation time might have been associated with the establishment of an equilibrium between the two chambers. Using a 5 μ m instead of a 3 μ m pore membrane could serve to optimize the results obtained when studying chemotaxis in earthworms. Given the encouraging results observed with TGF- β , it would be of interest to use TGF- β at a wide range of concentrations to determine if chemotaxis can be reproducibly induced using this growth factor. It is possible that 20 μ g/mL is not optimal. It is noteworthy that subsequent to these experiments, our lab used pathogen-associated molecular patterns, including lipopolysaccharide, lipoteichoic acid, flagellin, and laminarin, for the purpose of stimulating chemotaxis in earthworm coelomocytes, and observed significant, reproducible migratory responses from the earthworm coelomocytes (submitted for publication).

Acknowledgments

The authors thank the Pennsylvania Academy of Science, the Romano/Borneman Undergraduate Research Fund of Cabrini University, and the Science Department of Cabrini University for providing the funding to conduct this research.

Bibliography

- Bloes, D.A., Kretschmer, D., & Preschel, A. (2015). Enemy attraction: bacterial agonists for leukocyte chemotactic receptors. *Nature Reviews Microbiology*, 13(2), 95-104.
- Bottai, D., Garcia-Gil, M., Zaccardi, M.L., Fineschi, L., & Brunelli, M. (1994) Interleukine-1 and interleukin-6 modify protein phosphorylation in the central nervous system of *Hirudo medicinalis*. *Bran Research*, 641(1), 155-159.
- Bravo-Cordero, J.J., Hodgson, L. Y., & Condeelis, J. (2012). Directed cell invasion and migration during metastasis. *Current Opinion in Cell Biology*, 24(2), 277-283.
- Cabrera, P.V., Blanco, G., Ernst, G., Alvarex, E., Cooper, E.L., & Hajos, S. (2002). Coelomocyte locomotion in the sipunculan *Themiste petricola* induced by exogenous and endogenous chemoattractants: role of a Cd44-like antigen-HA interaction. *Journal of Invertebrate Pathology*, 79(2), 111-119
- Cicha, I., Yilmaz, A., Klein, M., Raithel, D., Brigstock, D.R., Daniel, W.G., Goppelt-Struebe, M., & Garlich, C.D. (2005). Connective tissue growth factor is overexpressed in complicated atherosclerotic plaques and induces mononuclear cell chemotaxis in vitro. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 25(5), 1008-1013.
- de Oliveria, S., Reyes-Aldasoro, C.C., Candel, S., Renshaw, S.A., Mulero, V., & Calado, A. (2013). Cxcl8 (Interleukin-8) mediates neutrophil recruitment and behavior in the zebrafish inflammatory response. *Journal of Immunology*, 190(8), 4349-4359.
- Di Cioccio, V., Strippoli, R., Bizzarri, C., Troiani, G., Cervellera, M. N., Gloaguen, I., & ... Bertini, R. (2004). Key role of proline-rich tyrosine kinase 2 in interleukin-8 (CXCL8/IL-8)-mediated human neutrophil chemotaxis. *Immunology*, 111(4), 407-415.
- Duffy, M.A., Bouchier-Hayes, J.D., & Harme, H.J. (2000). Vascular endothelial growth factor (VEGF) and its role in non-endothelial cells: autocrine signaling by VEGF. *Madame Curie Bioscience Database*, (64)82, 1-14.
- Fuller-Espie, S.L., Harris, D.R., Daly, J.H., & Jakeman, J.M. (2015) Optimization of cell cul-

ture conditions for the earthworm *Eisenia Hortensis*: a study investigating the effects of media, carbon dioxide, temperature, serum, and anti-fungal agents. *Journal of the Pennsylvania Academy of Science*, 89(2), 57-68.

Gomez-Lopez, N., Vadillo-Ortega, F., & Estrada-Gutierrez, G. (2011) Combined Boyden-flow cytometry assay improves quantification and provides phenotypification of leukocyte chemotaxis. *PlosOne*, 6(12), 1-7.

Kim, M.K., Min, S., Park, Y.J., Kim, J.H., Ryu, S.H., & Bae, Y.S. (2007). Expression and functional role of formyl peptide receptor in human bone-marrow derived mesenchymal stem cells. *FEBBS Letters*, 581(9), 1917-1922.

Kim, Y., Jo, A., Jang, D. H., Cho, Y., Chun, J., Min, B., & Choi, Y. (2012). Toll-like receptor 9 mediates oral bacteria-induced IL-8 expression in gingival epithelial cells. *Immunology & Cell Biology*, 90(6), 655-663.

Kipryushina, Y.O., Yakovlev, K.V., & Odintsova, N.A. (2015) Vascular endothelial growth factors: A comparison between invertebrates and vertebrates. *Cytokine & Growth Factor Reviews*, 26(6), 687-695.

Li, S., Smith, J. M., Zheng, S., Hussey, S. B., Wira, C. R., & Fanger, M. W. (2006). Differential regulation of neutrophil chemotaxis to IL-8 and fMLP by GM-CSF: lack of direct effect of oestradiol. *Immunology*, 117(2), 205-212.

Liu, S.C., Hsu, Y.C., Chuang, S.M., & Tang, C.H. (2012) CTGF induces monocyte chemoattractant protein-1 expression enhance monocyte migration in human synovial fibroblasts. *Biochimica et Biophysica Acta (BBA)-Molecular Cell Research*, 1833(5), 1114-1124.

Lúðvíksson, B. R., & Gunnlaugsdóttir, B. (2003). Transforming Growth Factor- β as a Regulator of Site-Specific T-Cell Inflammatory Response. *Scandinavian Journal of Immunology*, 58(2), 129-138.

Mason, E. D., Konrad, K. D., Webb, C. D., & Marsh, L. (1994) Dorsal midline fate in *Drosophila* embryos requires twisted gastrulation, a gene encoding a secreted protein related to human connective tissue growth factor. *Genes & Development*, 8, 1489-1501.

Ottaviani, E., Franchini, A., Kletsas, D., Bernardi, M., & Genedani, S. (1997). Involvement of

PDGF and TGF- β in cell migration and phagocytosis in invertebrate and human immunocytes.

Animal Biology, 6, 91–95.

Perbal, B. (2004). CCN proteins: multifunctional signaling regulators. *The Lancet*, 363(9402), 62-64.

Salzet, M., Tasiemski, A., & Cooper, E. (2006). Innate immunity in Lophotrochozoans: the annelids. *Current Pharmaceutical Design*, 12(24), 3043-3050.

Takigawa, M., Nakanishi, T., Kubota, S., & Nishida, T. (2003). CTGF/Hcs24/ecogenin in skeletal growth control. *Journal of Cellular Physiology*, 194(3), 256-266.

Tettamanti, G., Malagoli, D., Benelli, R., Albini, A., Grimaldi, A., Perletti, G., Noonan, D.M., de Eguileor, M., & Ottavani, E. (2006). Growth Factors and chemokines: a comparative functional approach between invertebrates and vertebrates. *Current Medical Chemistry*, 13(23), 2737-2750.

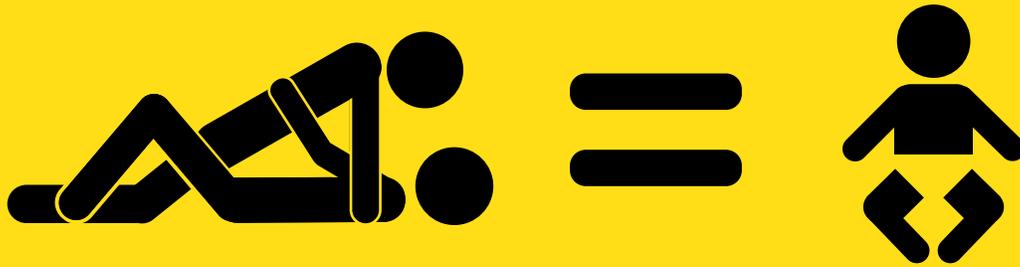
van der Valk, P., & Herman, C.J. (1987). Leukocyte functions. *Laboratory Investigation*, 56(2), 127-137.

Wittmann, S., Fröhlich, D., & Daniels, S. (2002). Characterization of the human fMLP receptor in neutrophils and in *Xenopus* oocytes. *British Journal of Pharmacology*, 135(6), 1375–1382.

Zabel, B.A., Rott, A., & Butcher, E.C. (2015). Leukocyte chemoattractant receptors in human disease pathogenesis. *Annual Review of Pathology: Mechanisms of Disease*, 10(1), 51-81.

SCHOOL OF BUSINESS, ARTS, AND MEDIA





STOP UNNECESSARY ABORTIONS

Take Responsibility

Article 3: Everyone has the right to life, liberty and security of person.
Call 202-626-8813 to donate • Call (800) 848-LOVE toll-free for help





It wouldn't be funny in REAL LIFE.

No one shall be subjected to torture or to cruel,
inhuman or degrading treatment or punishment.

Article 5 — Universal Declaration of Human Rights



Prevent Child Abuse
America

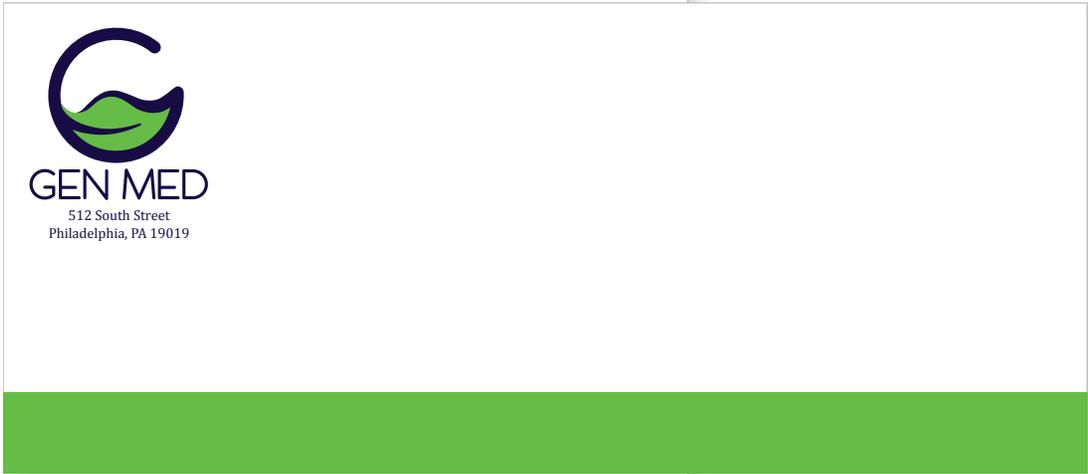
1-800-244-5373

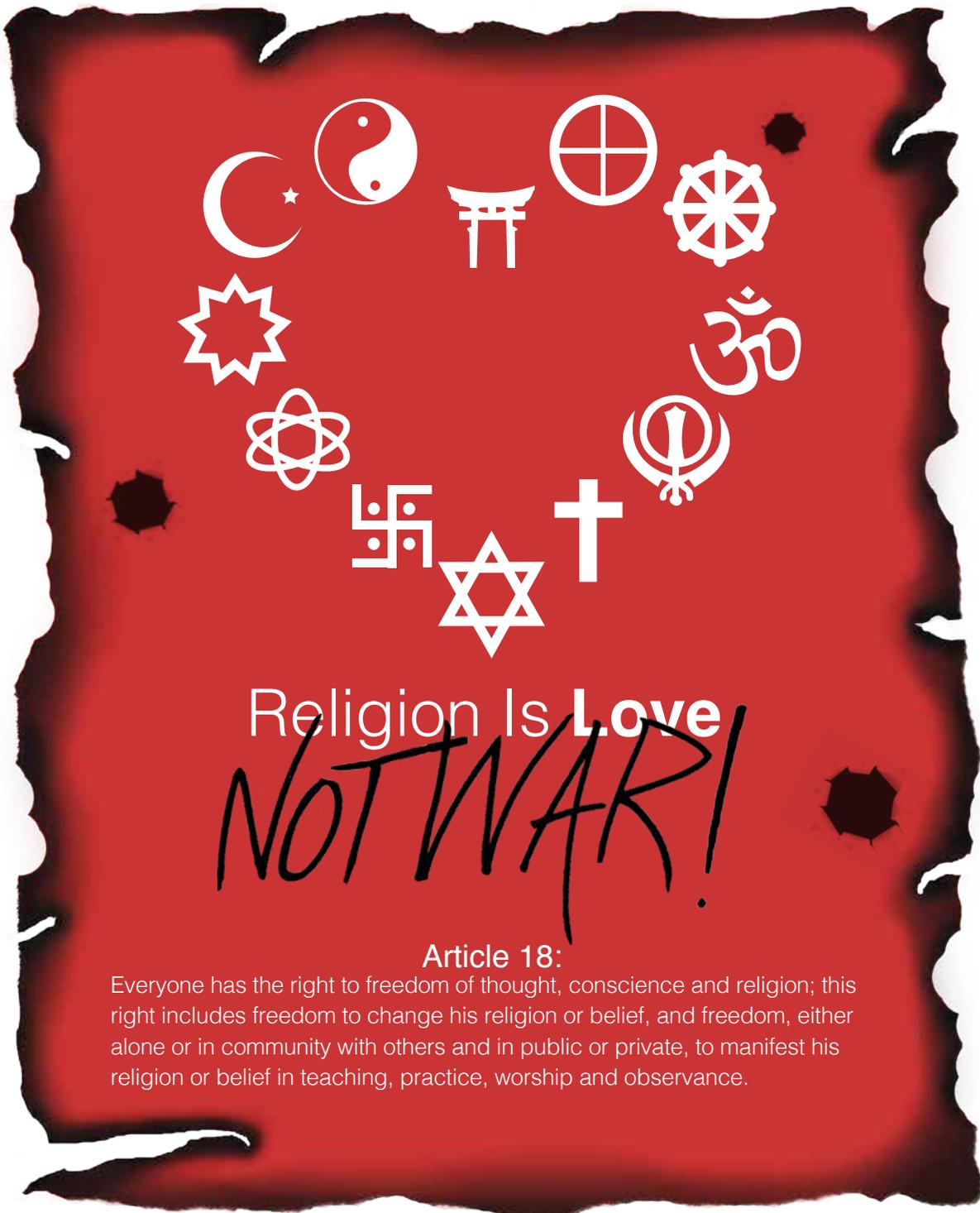


SHADOW



Branding Style Guide





Religion Is Love

NOT WAR!

Article 18:

Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance.



Support our fight for human rights

<http://www.amnestyusa.org/>



CABRINI UNIVERSITY

610 KING OF PRUSSIA ROAD
RADNOR, PA

CABRINI.EDU

