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LETTER FROM THE DIRECTOR

Note for Readers

It is with great pleasure that the University of Wisconsin-Superior presents our 22nd edition of The McNair Scholars Journal. These 9 papers are a culmination of research the scholars began in the spring and completed over the summer of 2021. The research papers presented here are representative of the diverse group of students in the program and their current or intended fields of interest in graduate school.

Due to the ongoing pandemic, our scholars and their mentors had to regularly adjust and adapt to accommodate extenuating circumstances out of their control in order to complete their research projects. Pandemic circumstances did not hinder the scholars from completing thorough, exhaustive research studies. The McNair staff is proud of the barriers our scholars have overcome this year to present you with the depth and comprehensiveness you will see in the following research papers.

The TRIO McNair Scholars Program began at the University of Wisconsin-Superior in the fall of 1999. The McNair Scholars Program is a federal TRIO program originally established in 1986 by the U.S. Department of Education, with 187 currently funded programs nationwide with nine programs housed within the UW System. The Ronald E. McNair Postbaccalaureate Achievement Program (TRIO McNair Scholars Program) at the University of Wisconsin-Superior prepares income eligible, first-generation college students and students from groups underrepresented in graduate education for doctoral study by providing transformative research experiences, exceptional mentorship, and intentional professional & personal development.

The University of Wisconsin-Superior TRIO McNair Scholars Program serves students from three different institutions within the region, including Northland College, University of Minnesota-Duluth, and University of Wisconsin-Superior.

We would like to thank the scholars for their hard work and dedication to the program. We are proud of the students' work contained in this journal and support them wholeheartedly in their future educational, career, and life pursuits. We would also like to thank our faculty mentors for providing students with guidance, direction, and support on their respective projects.

Monte Stewart

Director, TRIO McNair Scholars Program
Division of Student Success
University of Wisconsin-Superior
Swenson 2047
801 N 28th Street
Superior, WI 54880
(715) 394-8043
www.uwsuper.edu/mcnair

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QUEER EMBODIMENT: REPRESENTATIONS OF THE VARI-ABLED IN THE FIRST ENGLISH NOVEL AND THE VICTORIAN ERA

McKenzy Cich, University of Wisconsin-Superior
Dr. Hilary Fezzey, PhD, Mentor

Victorian literature is the most popular era of literature studied by scholars, as it is the strongest in which to identify and analyze social changes that correlate with the Industrial Revolution and advancements in technologies. While scholarship is thorough, there is a gap within the intersection of two criticisms: disability studies and gender studies. It is important to understand and learn from issues of the past, especially thinking about the issues we struggle with in modern society. Disability theorists and scholars tend to focus heavily on the physical deformities of characters rather than cognitive or mental illness. Queer and feminist theorists, on the other hand, have looked into the portrayals of the mental illnesses of some characters in Victorian literature as it applies to gender stereotypes and queerness. In order to bridge this gap, I will be employing the theoretical lenses of disability and queer studies or queer-crip. Specifically, how the representations of mental illness and its intersection with gender and class have evolved from the first English novel, Samuel Richardson's *Pamela* (1740), to the Victorian novel and its subgenre of the sensation novel in Charles Dickens's *Great Expectations* (1861) and Mary Elizabeth Braddon's *Lady Audley's Secret* (1862). I will also demonstrate that mental illness is a variably abled or vari-abled embodiment to analyze its correlation with the intersectionality of queerness and gender within the representation of fictional characters. My contribution to this discourse will be to point out the similarities in their generalized fields regarding the representations of marginalized groups of people and combine them into a queer-crip examination of the intersectionality of identity.

Over the course of human history there has always been 'the other,' or the groups of people who do not conform to the rules and laws that society dictates. Within the early ages and creation of the novel genre, there have been many representations of such marginalized and disregarded members of society. *Pamela* was originally written as an instruction novel that was meant to teach readers and writers alike how such stories should be told and interpreted, as it was also the 'birth' of the novel. Within this novel there is a representation of a character that stands outside of society's definition of 'normal' and contributes to a scholarly discourse concerning the representations of embodiment and queerness. One such scholar, Mark

Jeffreys, describes the representation of disability as "not so much a pathological condition as it is a cultural condition, a marginalized group identity that has a history of oppression and exclusion, a stigmatized category created to serve the interests of the dominant ideology and its privileged classes" (32). As Jeffreys argues, disabilities and/or disparities regarding embodiment are a cultural construction rather than a pathological condition. According to Jeffreys and other disability theorists, society decides what is 'normal,' and anyone outside of that structure is considered to express this 'strange' or 'queer' embodiment. When applying this to queer theory and ideas about how such fictional characters are represented, there is a connection between this view of disability and other scholars' perspectives on disability studies, gender studies and queer theory, respectively. I believe Jeffreys' explanation of the cultural construction of embodiment begins to address the intersectionality of disability and queerness. Within *Pamela*, and throughout *Great Expectations* and *Lady Audley's Secret*, there are characters that share similar traits of masculinity in terms of power and strength within society and simultaneously represent physical and/or mental embodiments that fall outside of social norms. The juxtaposition of Mrs. Jewkes (*Pamela*), Lady Audley (*Lady Audley's Secret*), and Miss Havisham (*Great Expectations*) will be of their respective ailments and disruptions of societal bounds regarding gender roles in an effort to reveal their similarities as well as differences to analyze the discourse about mental or physical abilities and gender. Mrs. Jewkes, Lady Audley, and Miss Havisham are all representations of strong females who break societal dictations about gender roles but also present with 'symptoms' of a diverse embodiment.

Pamela is an epistolary novel published in 1740 and is considered one of the first novels. In correlation with this label and the influence of conduct literature on the genre, it exhibits factors that offer a fruitful constructivist analysis of intersectional identity and societal boundaries regarding marriage and gender. Mrs. Jewkes is an antagonist within her story, which prevents her from having a favorable description. However, the indulgence of those same negative qualities shows the reader just how Mrs. Jewkes's behavior is reflected within her descriptive characteristics, reiterating disability as a cultural construction: "The naughty woman





came up to me with an air of confidence and kissed me... and looked in such a manner as I never saw a woman look in my life” (Richardson 144). This is the precursor event that later shapes her visual appearance, and it represents a strict social boundary being disturbed and broken. Mrs. Jewkes is represented as a character that seems to indulge in masculine desires towards Pamela, exhibiting the same forcefulness and forthcoming attitude as Mr. B does in her previous letters. These interactions shape her recount of Jewkes’s appearance a few pages later. This example of masculinity within Jewkes and her queerness are being equated with disfigurement and demonization when she is immediately described as looking nothing like a woman. As Jason Farr establishes, “Mrs. Jewkes assumes a vigorous masculinity that provokes anxiety in Pamela,” that begins to shape her characteristics (74). In this instance, it was not Mrs. Jewkes’s appearance alone that presented this fearsome masculinity but rather her previous actions that influenced the characterization. The significance of this understanding is important to begin recognizing the intersectionality of these systems of queerness and embodiment.

Mrs. Jewkes is not just described as masculine and suffering from a disfigured embodiment; she is portrayed as developing or embracing this visual appearance after disrupting gender norms. As such, her queerness and masculinity can be equated with a disfigured embodiment. In Robert McRuer’s intersectional approach to disability studies and queer theory, he perceptively theorizes, “The system of compulsory able-bodiedness that produces disability is thoroughly interwoven with the system of compulsory heterosexuality that produces queerness; that – in fact – compulsory heterosexuality is contingent on compulsory able-bodiedness and vice versa” (89). Mrs. Jewkes’s queerness and gender bending epitomize this statement, as she is depicted as a physically vari-abled person in order to reflect Pamela’s discomfort. Richardson, through Pamela, depicts Mrs. Jewkes as a character whose sexual preferences and ‘masculine’ strength impacts her outward appearance and ‘able-bodiedness’:

“Now I will give you a picture of the wretch! She is a broad, squat, pousy, fat thing, quite ugly, if any thing human can be so called; about forty years old. She has a huge hand, and an arm as thick – I never saw such a thick arm in my life. Her nose is flat and crooked, and her brows grow down her eyes; a dead, spiteful, grey, goggling eye: and her face is flat and broad; and as to colour, looks as if It had been pickled a month in saltpetre. I dare say she drinks. She has a hoarse man-like voice, and is as

thick as she’s long; and yet looks so deadly strong, that I am afraid she would dash me at her foot in an instant, if I were to vex her. So that with a heart more ugly than her face, she is at times (especially when she is angry) perfectly frightful: and I shall be ruined, to be sure, if heaven protects me not; for she is very, very wicked.” (Richardson 152)

This paragraph describes the features and likeness of Mrs. Jewkes in Pamela’s eyes, but previous to this knowledge of her appearance, we are also shown her abrupt nature and ‘masculine’ attitudes when she kisses Pamela upon her capture. By villainizing her character, Richardson is demonizing queer individuals, as well as using features of vari-abled embodiment to portray a ‘wretched’ creature that exists outside of heteronormative and able-bodied society.

Richardson provides a certain amount of pathos to this character through the physical abnormalities. However, he is presenting a type of pathos that is not sympathetic, but rather creating a fear of this character, equating varied physical and cognitive embodiment with rejection and fear. As *Pamela* was one of the first novels ever written, it carried a lot of weight with subsequent writers attempting to enhance the genre. Within this novel are instructions not only on how it should be written, but how it should be read. In this sense, there is some severe injustice done to those people within society who have differing physical abilities, as this first novel presents such characters as a source of evil and someone of whom to be frightened. In short, this novel and its author set up an ableist discourse regarding vari-abled people that set society up for fear and the marginalization of such individuals. As Farr argues, “in establishing a correlation between foul heart and face, Pamela writes Mrs. Jewkes’s deformity into the narrative as a corporeal repository of that which is uncouth and compromising to young women’s virtue” (74). Within Pamela’s fearful description, she is correlating abnormal bodies to fear and lamentation for her loss of virtue. In other words, Mrs. Jewkes has fallen so far from virtue and honesty that her outward appearance changes and morphs into something physically abnormal, but this creates a discourse regarding physically unique individuals, suggesting that they are out of God’s favor and have fallen from virtue. This representation of Jewkes’s deviance from virtue in terms of her physical and cognitive embodiment and sexual identity combines to demonize and villainize her. This instance emblemizes the value of utilizing queer-crip theory in order to analyze Mrs. Jewkes.

As feminist scholars within rise of the novel stud-

ies have established, in the earliest creations of the novel genre, male writers were seen as adding to the social and political discourses while female writers’ novels were seen as imitations of patriarchal work in literature and were considered illegitimate in terms of those discourses. This oppression and ‘casting off’ of female perspectives reminds me of one such feminist scholar, Sabine Volk-Birke, as she examines how the readers of the Victorian era viewed romances, “Romances provoked particular criticism. Their reading clashed with the training necessary to make a good wife. Romances encouraged extravagant ideas, because they softened the mind by love, and because readers fooled away so many days, even years, which they could use for a better purpose” (Volk-Birke 71). While Richardson’s novel was a type of manual, it was presented under the guise of romance and marriage plots. Charlotte Lennox, a female author from the same period, created work that was a social commentary on the same issues of marriage and gender roles but was most likely critiqued and understood by the patriarchal society as nothing more than an ‘imitation’ of discourse that already existed, because in this patriarchal mindset, a woman should remain in the private sphere and not add to a discussion of politics and society. Despite these differences in Samuel Richardson’s and Charlotte Lennox’s novels and the reception of them as male and female writers, they both provide excellent commentaries on social discourse about queer embodiment in the twenty-first century. While Lennox’s work may not have been as appreciated by the critics and social commentators of her time, she is certainly a voice that holds more power today as shown from works such as Volk-Birke. It is worth noting these differences between Lennox and Richardson in order to lay the groundwork for the gendered experiences of the Victorian novelists. Looking ahead to the Victorian era, these same disparities exist between Charles Dickens and Mary Elizabeth Bradden in their respective novels because of their gendered experiences as writers.

As time progressed, authors became more apt to disregard some of these earlier logistical establishments of what a novel should look like and how it should be read. Due to the influence of specific predecessors, such as Richardson, who provide an instructional manual for literature, it is no surprise that there are plenty of similarities that emerge in later works of fiction, such as that of Dickens and Braddon, as they not only appreciate and utilize some of those early instructions but deviate from them to administer change and growth into the novel genre. Besides initiating these advancements within a structural ideology regarding genre, Victo-

rian era society began to shape the ideologies of what we view as commonplace. These authors faced different struggles that influenced the way in which they viewed certain aspects of life and literature. For instance, there was an emergence of ‘freak show’ culture that received a certain amount of backlash from citizens who decided that people who suffer from physical ailments were not to be exploited for profit or spectacle; rather, they saw such individuals as deserving of sympathy (Mitchell). However, they did not think about the fact that such people could not integrate with ‘normal’ society and therefore were forced to live a life of seclusion and poverty. Jennifer Esmail and Christopher Keep coined the term “laughing at lunacy” and explored the history of how this notion came to be an acceptable pastime for Victorian Society. An exploration of this and how sympathy and pathos regarding vari-abled individuals evolved during this time period with the incorporation of intersecting aspects of identity will shape the remainder of my paper.

During the Victorian era there was a huge shift in ideologies regarding mental and physical vari-abled embodiments. The emerging ideology was one that correlated with freak show culture and the condemnation of it, while society simultaneously encouraged marginalization and mockery of the mentally ill or vari-abled cognitive embodiments. This has been historically analyzed by Simon Cross:

In the eighteenth century, the governors of London’s Bethlem Hospital, popularly known as Bedlam, seized on a market opportunity allowing paying visitors to gawp at lunatics... Such a practice confirms our twenty-first-century sensibility that early modern attitudes to madness were unfeeling. But this raises a hermeneutical problem, which is how we are to interpret humour about madness and mad folk in a different historical period under different historical conditions. (Cross 2)

This example is how we begin to analyze ‘madness’ as disability. According to Cross, ‘lunacy’ became something to gawk at and something that was considered different and unacceptable. In other words, cognitive vari-abled embodiments generated a lack of sympathy while freak show culture was condemned at the same time. Society was gaining sympathy for physical ailments over cognitive ones. This shift in society’s ideologies proves a cultural significance in the ways in which people are marginalized and how disabilities and intersecting identity markers of a person or character can create a new discourse. David Michell and Sharon Snyder are two renowned disability scholars who initiated



discourses around disability theory and created the concept of “narrative prosthesis” as a way of analyzing disabled characters within literature. They have expertly explored through their scholarly work how “The interpretation of representations of disability strikes at the very core of cultural definitions and values” (Mitchell and Snyder 52). Mitchell and Snyder’s definition of disability recognizes the intersectionality of identity that causes these characters to exhibit such vari-abled embodiments. Authors’ representations of literary characters’ gender, sexual, and class identity originate from the values from their generation and culture.

Novelists are cultural agents that both represent and influence the gender, sexual, and class identities of their time and place. As a male author during the Victorian era, Dickens created the character of Miss Havisham that exhibits some aspects of a vari-abled mental embodiment. Not only is this character a woman but is a part of the upper-class. Miss Havisham is an “immensely rich and grim lady who lived in a large and dismal house barricaded against robbers, and who lived a life of seclusion” (Dickens 87). Elaine Showalter, a renowned expert in feminist studies, explores the ways in which female mental illnesses are explored by critics and artists alike within the eighteenth century. She coined the term “female malady,” which relates to the cognitive and mental embodiments that seem to accompany women throughout historical literature and art. She explains “madness as one of the wrongs of woman; madness as the essential feminine nature unveiling itself before scientific male rationality” (Showalter 3). This feminist viewpoint of how writers represent mental illness in women correlates to another definition of disability within literature imagined by Tabitha Sparks: “Disability has too often been problematically read as a straightforward metaphor for lack, the result of which has been a tendency to efface the material specifically of what it meant to live in society largely governed by ableist assumptions about which bodies matter and which do not” (Sparks). Within this explanation, there is a reiteration of fact that what it means to be ‘disabled’ is subjective and determined by the ruling classes of society. It is not a condition, but rather a social and cultural creation that is ‘governed’ by bourgeois ideology, which is patriarchal, ableist, and heteronormative. In terms of Miss Havisham, it is not what she lacks that evinces this definition, but what she holds over other individuals, such as her masculine traits, social standing, and wealth, along with her stereotypically feminine physique and disposition. Miss Havisham exhibits signs of mental illness and stress, and through this in correlation with her high social standing and clout within society, which

represents a position that is usually masculine, Dickens is equating her social class with mental illness or a vari-abled cognitive embodiment, because Miss Havisham is a woman that holds such a position in high society:

“I saw that everything within my view which ought to be white, had been white long ago, and had lost its lustre, and was faded and yellow. I saw that the bride within the bridal dress had no brightness left but the brightness of her sunken eyes. I saw that the dress had been put upon the rounded figure of a young woman, and that the figure upon which it now hung loose, had shrunk to skin and bone. Once, I had been taken to see some ghastly wax-work at the Fair, representing I know not what impossible personage lying in state. Once, I had been taken to one of our old marsh churches to see a skeleton in the ashes of a rich dress, that had been dug out of a vault under the church pavement. Now, wax-work and skeleton seemed to have dark eyes that moved and looked at me. I should have cried out, if I could.” (Dickens 93)

Within this passage from the *Great Expectations*, Dickens alludes to the freak show culture mentioned earlier through his descriptive passages about Miss Havisham, as she exhibits the same qualities of “ghastly wax-work” as witnessed at a fair or carnival, which is where such shows would have been. Aside from the point Dickens seems to be exhibiting regarding freak show culture and Miss Havisham’s relation to it, he is also using misogynistic language to describe her state of being, with age and marital status as markers of worth. She is described as old and unmarriageable, which leads to the description of her skeleton and horrid waxwork like body, something unsightly in the eyes of a young man.

The role of love and romance within this novel, along with most novels of the era, is complex and depicted in an antifeminist manner. There was also an emergence of linking sexual desire in women with insanity and lunacy, as stated by historian Roy Porter: “Love madness became integral to the province of mad-doctors and the emergent psychiatric profession,” (216). Porter’s analysis shows that historically, insanity was a women’s issue, which created a gendered discourse around vari-abled mental embodiments. This correlation and sexist undertone of love and madness shows through in the characterization of Miss Havisham when she expresses her delusional thoughts on love: “I’ll tell you... what real love is. It is blind devotion, unquestioning self-humiliation, utter submission, trust

and belief against yourself and against the whole world, giving up your whole heart and soul to the smiter—as I did!” (Dickens 269). This speech is not only a definition of love in Miss Havisham’s eyes, but a confession of her jilted heart. She was driven insane by the lack of love she received and the way in which she lost her agency within society with age and marriageability, which were all women were valued for at this time. This kind of torture she brings upon herself is a result of earthly love becoming a perversion of godly love. Again, as Porter explains, expressions of “religious melancholy” were a mode of “love melancholy,” forming a casebook of the crazy self-inflicted torments mankind brought upon itself by its perversions of the love of God” (Porter 216). There was a sexist demonization of gender in this depiction of women’s love. Dickens embraces this idea through Havisham’s character as she screams “love her! Love her! Love her!” to Pip in an attempt to turn the young and beautiful Estella into a weapon that she can wield to break young men’s hearts as hers was once broken (Dickens 269). This creates an image of women so driven to madness by love and its religious perversions, portraying a whole gender as wicked.

Within Victorian literature there is a subgenre of the novel known as the sensation novel. In this genre, authors combine romance and realism with influences of melodrama and Gothicism to explore provocative themes and controversial societal issues. Sensation novels were usually written by women for women, the equivalent of a Lifetime movie in today’s popular culture. Dickens was a more traditional novelist, whereas Mary Elizabeth Braddon is considered the queen of the sensation novel, and she introduces some of the most idealistic and interesting characters in terms of femininity and class mobility. By initiating some discourse regarding femininity and class structure through her character of Lady Audley, Braddon is depicting some of the same traits that Porter examines within the perversion of godly love to earthly, and more specifically womanly love: “Woman, the emblem of love, became revealed as Lamia, the siren, femme fatale, temptress, tyrant, vampire, to love whom was a madness ending only in torment and destruction” (Porter 215). Lady Audley is illustrated as this dangerous womanly character that wielded the womanly weapons of love and destruction throughout her story, representing the epitome of Porter’s analysis. Even before the crimes she committed are brought to light, she is described in such a foreshadowing way that one can assume her wickedness:

Surely a pretty woman never looks prettier than when making tea. The most feminine and most domestic imparts a magic

harmony to her movement, a witchery to her every glance... Better the pretty influence of the teacups and saucers gracefully wielded in a woman’s hand, than all the inappropriate power snatched at the point of the pen from the unwilling sterner sex. (Braddon 242-243)

Braddon utilizes such imaginative figurative language in her descriptions of Lady Audley with terms such as “witchery” to describe her glances during her domestic duties of making tea. Something so trivial, domestic, and feminine is portrayed as something dark and magical as she “wields” the teacups as a type of magical weapon. These images are representative and a metaphor for the inappropriate power she holds over her husband, the baronet, and demonizes her gender in such a way that leads to her subjection to what Showalter has termed the “female malady.” We can utilize Lynn Voskuil’s analysis to understand the reasons why a feminist writer, such as Braddon, would shroud her message in such a cause-and-effect relationship:

“Braddon’s novel was threatening because, in the controversial figure of Lady Audley, the Victorian logics of authenticity were pushed to their conceptual and ideological extremes—thereby exposing the cruel paradoxes that authorized middle-class constructions of its own superiority... Alarmed reviewers spoke their minds in almost all the major and minor Victorian journals, focusing in many cases on Lady Audley as a character who had spuriously misplayed the natural roles of women.” (Voskuil 613-614)

The Victorian age was also one that produced an emergence of critics and reviewers for the novel, as readership, authorship, and production became more prevalent due to technological advancements, including the printing press. Due to these historical milestones with printing technology and an increase in readership due to factors such as education, public opinion influenced the plot of novels. Public unrest forced Braddon to adapt Lady Audley’s character to admit madness to appease the public who scrutinized her as a female novelist. Lady Audley’s crimes do not reflect insanity originating from love but rather an insanity emerging from a want of position and class status, which was very unusual and made her a character that endangered the minds of women, and this unfeminine desire was portrayed as madness.

Lady Audley’s Secret was written in the first person from the perspective of a male, Robert Audley, the nephew to Lady Audley’s husband, Sir Michael Audley. Robert plays the detective protag-

onist who is torn by the concern of justice for the loss of his friend, George Talboys, and the happiness of his uncle. When Robert gains the courage to confront his aunt, Lady Audley, regarding the crimes he uncovered, he expresses his concerns:

“I do not say that Robert Audley was a coward, but I will admit that shiver of horror, something akin to fear, chilled him to the heart, as he remembered the horrible things that have been done by women, since the day upon which Eve was created to be Adam’s companion and help-meet in the garden of Eden. What if this woman’s hellish power of dissimulation should be stronger than the truth, and crush him?... and remembering a hundred stories of womanly perfidy, shuddered as he thought how unequal the struggle might be between himself and his uncle’s wife.” (289-290)

Robert’s thoughts reveal the degree to which he is intimidated by Lady Audley’s fiendish, female nature. Her power lies in her deceptively fragile feminine appearance. He remains worried for his own protection and safety from her powers. Braddon is empowering women while also demonizing them. She is utilizing the male fear of “hellish” women and their original sin to express the feminist ideology of womanly strength under the guise of evil to placate critics. She is wielding a double-edged argument to project her feminist ideas while saving face with the patriarchal reviewers and society in general.

Within *Pamela*, and throughout *Great Expectations* and *Lady Audley’s Secret*, I have placed a spotlight on characters that share similar traits of masculinity in terms of power and strength within society and simultaneously represent physical and/or mental embodiments that fall outside of social norms. This juxtaposition of Mrs. Jewkes, Miss Havisham, and Lady Audley has been of their respective ailments and disruptions of societal bounds regarding gender roles and while revealing their similarities and differences also provides a source in which to analyze the discourses surrounding mental or physical abilities and gender throughout the rise of the novel. Mrs. Jewkes, Lady Audley, and Miss Havisham are all representations of strong females who break societal dictations about gender roles but also present with ‘symptoms’ of a diverse embodiment. Reading their characters with a backdrop of intricately examined cause/effect relationships regarding queer and gender identity with variable physical and cognitive embodiments shows how these aspects of identity intersect and correlate with each other and the societal and class

structure of the Victorian era. I have located and discussed the gap I found within scholarly literature on the topics of disability, gender, and queer studies and utilized definitions and examples from them to explain that gap and attempt to bridge it using these female characters while also historicizing cultural events. Throughout my research I have utilized the female characters within this era of literature to explain the use of gender and queerness as demonizing and ‘othering’ because of their mental and physical vari-abled embodiments. However, to further the research and discourse on this topic it would be beneficial to look at the male characters of these same novels, as they too exhibit some characteristics of queer identity. For the future, researchers might also choose to look at Oscar Wilde’s novel *The Picture of Dorian Grey* as a primary source as not only the characters within that novel exhibit similar characteristics, but the author himself identified as LGBTQ+. Understanding disability in correlation with queer and gender identity is significant when analyzing the rise of the novel in particular; the demonization of gendered and queer individuals was epitomized, solidified, and even liberated within these novels. With Richardson’s initial discourse surrounding Mrs. Jewkes, Dickens’ creation of the ‘love insanity’ from which Miss Havisham suffered, and veiled double-edged feminine argument made by Braddon regarding Lady Audley’s ‘fiendish’ femininity.

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EXAM ANXIETY AND ITS EFFECTS ON COLLEGE STUDENTS' PERCEIVED AND PHYSIOLOGICAL STRESS

Lexy M. Doolittle, University of Wisconsin-Superior
Dr. Shanna Nifoussi, PhD, Mentor

Students at the University of Wisconsin-Superior participated in this study on exam anxiety and stress. The goal of this research was to look at how exams affect students' perceived and physiological stress and whether college students can recognize their level of stress by correlating it to their physiological stress. Participants at UW-Superior were asked to complete surveys to quantify their perceived stress levels and an electrocardiogram to determine their physiological stress 3 days pre-exam, the day of an exam, and 3 days post-exam. The data was then analyzed and subdivided by gender to look for trends among participants. Results indicated that participants have higher levels of physiological and perceived stress on the day of the exam compared to either pre-exam or post-exam stress levels. While participants identified many factors that influenced their stress levels on all three days, course exams clearly contributed to the perceived and physiological stress that they were feeling as indicated by the significant changes seen between exam and post-exam testing days.

Introduction

College is known to be a stressful time in students' lives. Academic stressors, including exam anxiety, can lead to chronic stress beyond their time in college. This study investigated University of Wisconsin-Superior students' physiological and perceived stress, to see if college exams have an impact on students' stress levels. Continued research on this topic is so important due to the increased incidence of people facing anxiety, depression, cardiovascular issues, and suicide rates. This study investigated potential stressors to make students more aware of what is causing their stress as a means of helping them work on stress reduction strategies moving forward. It will also spread awareness on how essential combating stress is, to peoples' overall health.

Literature Review

College students struggle daily with stress, e.g., classwork, tests, quizzes, and even external factors such as work, relationships, and extracurricular activities. The stress from these various aspects of life can be detrimental to a person's overall health. Baghurst & Kelley's (2014) study showed that college students are at high risk of declining mental health, due to issues of chronic stress. One thing that

is known to bring about a massive amount of stress is exam anxiety; students often have heightened anxiety during exam times because of the pressure to perform well (Melillo et al., 2011). Stress can lead to many different psychological and physiological effects on students, including mental health disorders, cardiovascular issues, heart attack, strokes, and even suicide. However, there are ways to reduce these harmful effects, such as less time on the internet, exercise, enough sleep, and even time management (Garett et al., 2017). This research is specifically examining students' perceived stress versus physiological stress. Along with looking at how exams affect students' perceived stress and physiological stress, the differences of perceived stress between genders were also considered. Raising more awareness towards this issue can help diminish the amount of stress students are facing every day.

Stressors

Stress is an unavoidable emotional tension that comes with being a college student. When students enter college, they are beginning a very important, developmental period of their lives (Baghurst & Kelley, 2014). Along with this collegiate transition there are many changes and big decisions to be made, and overwhelming challenges that students are faced with. One major stressor for students that comes from school is stress from college exams (Melillo et al., 2011). Results from a study done by Adnan et al. (2012) found that students had more stress at the end of the semester compared to the beginning of the semester, probably due to the amount of university exams that students have at the end of the semester. These exams are usually worth a large portion of the course grade and therefore can either help the grade or hinder it. Having all this pressure on one hour worth of being tested on a specific material is very stressful. Another stressor, going along with exams, is the pressure for perfection. Students that are pursuing high performance majors, such as in the STEM fields have a lot of pressure put on them (Rice et al., 2015). This pressure to achieve good grades and be the best versions of themselves leads to a lot of stress and mental exhaustion. However, the students who strive for perfection often do better than students who do not, but the cost is often students' mental health (Rice et al., 2015).

Perceived Stress

Perceived stress is something that is easily measurable and is defined as the feelings or thoughts that a person has about the amount of stress that they are currently under (Baghurst & Kelley, 2014). This perceived stress is used to analyze how difficult or uncontrollable people find their lives, and therefore how stressed out they are because of this (Ahuja & Banga, 2014). Naceanceno et al. (2021) found that there was a significant difference in anxiety levels and stress perception among females and males. According to a study, "Female students reported experiencing more stress and reactions to stressors than did male students" (Misra, 2000, pg. 12). This difference of females having higher perceptions of stress is because females rate their experiences as more stressful, which therefore leads to a higher score. The research by Misra et al. (2000) found that "Higher scores on self-imposed stress among females than males indicated that females liked to compete, be noticed, loved, and worry for others, sometimes seeking perfect solutions that lead to higher anxiety and stress" (Discussion section, para. 3). Additionally, females might aspire to achieve more and do several activities at once, including taking care of family, achieving academic excellence, working, and maintaining a social life (Misra et al., 2000). This high achieving desire of females might be what increases their perceived stress levels and causes them to have more stressors and react more to stress.

Stress Effecting Overall Health

Stress can have both psychological and physiological detrimental effects on a student and impact their overall mental health. Khosrowabadi et al. (2011), found that, "chronic mental stress can influence the brain activity in various mental states" (p. 5). Through the use of a Brain-Computer Interface, they found that the connectivity between brain regions can be used as a biomarker for signs of chronic mental stress. One psychological effect that stress has on a person is mental health disorders. Two of the most commonly diagnosed mental health disorders are depression and anxiety; according to the American College Health Association (2019), 66% of students reported having high, overbearing anxiety in the 2019 spring school semester. There is an "unbelievably high" number of cases of students committing suicide between 15 to 29 years of age (Ahuja & Banga, 2014). Sano et al. (2018) found that one tenth of the college students, out of the approximately 47,000 student sample they were examining, had a plan for suicide with the most common reason behind suicides being a psychological issue, such as depression or anxiety. These

psychological issues can stem from stress and cause a person's mental health to decline. Cardiovascular disease is a major physiological effect that can be caused by stress (Melillo et al., 2011). Heart disease is the number one leading cause of deaths in the United States, which makes this a very serious issue. Stress can also increase the chance of a heart attack and a stroke (Ahuja & Banga, 2014), and it lowers human performance, even on simple tasks such as a person driving a car or cooking a meal (Melillo et al., 2011). Stress, therefore, affects a person's overall health and can have major detrimental impacts.

Stress Reducing Strategies

Stress can be alleviated through different stress reduction strategies, including changing daily tasks and study habits. One example is by changing internet habits; spending less time on the internet has been shown to lower stress (Ahuja & Banga, 2014). The internet is known to be a very time-consuming place for people, and this can interfere with time that could be spent on academics, therefore, leading to increased stress for students (Garett et al., 2017). Another way academic stress can be controlled and managed is through using effective study techniques and having time management (Misra et al., 2000). Students are known to have increased stress around exams, often due to a lack of time management. Participants who were perceived to be in control of their own time had more satisfaction and therefore less stress compared to participants that were not in control of their own time (Misra et al., 2000). Exercise has also been proven to aid in relieving stress (Garett et al., 2017). Adding movement to one's daily routine can help improve brain function, mood, and physical health. Sleep is another activity that can help ease stress. Getting enough hours of sleep is very important to memory consolidation, which can inadvertently lower stress levels.

In summary, stress can negatively impact a person's health if the right precautions are not taken, and it becomes too much to handle. Several things can lead to increased stress levels, one of them being college exams (Melillo et al., 2011). However, there are many ways to improve stress levels such as coping strategies and getting a better quality of sleep (Garett et al., 2017). The goal of this current study is to analyze the differences between perceived and physiological stress of students, to look at the correlation of exams and stress, and to spread awareness to how grave of an issue chronic stress can be.

Research Questions

For this study, I asked three questions:
1. Do college exams have an impact on students'

- perceived stress?
2. Do college exams have an impact on students' physiological stress?
 3. Can college students perceive their level of stress by correlating it to their physiological stress?

This study also explored the differences of stress perception and physiological stress between genders.

Hypotheses

For this research I have developed the following hypotheses: Participants will have a higher perceived stress result on the exam day survey versus the non-exam day surveys. Participants' physiological stress will be higher on the exam day ECG compared to the post-exam day ECG. However, the pre-exam day ECG physiological stress might also be higher due to the stress of doing an ECG for the first time/first time being involved in a research study. Participants perceived stress scores will go up on the exam day in correlation with what their physiological stress shows. Finally, due to trends in past research, females will have overall higher perceived stress than males.

Methods

Participants

The sample included ten students' total: five students from the BIOL 405: Neurobiology class, four students from the CHEM 321: Organic Chemistry II class, and one student from the SO W 325: Crisis Intervention class. Initially there were two different majors chosen: Biology representing the natural science major and Human Behavior, Justice, and Diversity (HBJD) representing the social science major. However, due to a lack of participants, students were recruited from the CHEM 321: Organic Chemistry II class as well. These three classes were used to get a decent sample size and to get enough data on students from both genders. Due to the gender differences of stress perception described above, both females and males were used in the study to analyze if there was variation.

For this study, there was specific inclusion and exclusion study criteria. The inclusion criterion is what the participants must be, while the exclusion criterion is what the participants must not be (Creswell & Creswell, 2018). Inclusion criterion for the sample was that the participant must be an on-campus student at University of Wisconsin-Superior (UW-Superior), due to the physiological measurements that were taken as described below and must be from one of the upper-level classes that were chosen. Upper-level classes are defined as

being 300- or 400-level, according to UW-Superior and are usually junior or senior level classes. The class difficulty was kept at the same level between the three classes, so there wouldn't be a factor influencing the amount of stress for the exams. The criteria for participants to be UW-Superior on-campus students and the need to keep the class difficulty the same ensure the results are as accurate as possible with the least number of variables due to the small sample size.

Surveys

Qualtrics based surveys were used in this study to collect the quantitative data, as well as some qualitative data related to participant perceived stress. The surveys were modified from the Perceived Stress Scale (PSS), included in Appendix A, because "it is the most widely used psychological instrument for measuring the perception of stress" (Cohen, 1988). The PSS is a very well-known survey on perceived stress that has been used by many authors who have tested its accuracy. An article by Baghurst & Kelley (2014) stated that, "good reliability for the PSS (0.85) has been found in previous research and validity was established" (Measures section, para. 3). The PSS is a survey with ten questions; however, a shorter version can be made from four specific questions. The study utilized four out of the ten questions from the PSS scale, and one unique question, for a total of five questions, which can be viewed in Appendix B. The unique question is open ended, rather than a rating, and asks, "In the last week, what are the top two things that are contributing to your stress?" This question allowed for more specific information to evaluate if there are external factors affecting their other PSS survey answers.

The surveys were administered through Qualtrics, an online survey product, and were sent out via email to the participants. This online survey technique is the preferred method, because of the convenience and efficiency of it, but also to decrease personal interaction due to the current pandemic. The surveys were submitted virtually, and the data was collected on a spreadsheet through Microsoft Excel. The surveys were brief (five questions in length) and sent out to the participants via email. They were then completed online and submitted virtually. Participants completed the survey several times over the course of two weeks. They took the surveys three different days right before the start of their class, and on the same day as the ECG tests. They did the first survey three days before the exam day, one on the day of the exam, and then the last survey three days following the exam. Once all the surveys were completed and submitted, the answers were inputted into a spreadsheet where they were

converted into numerical values.

The survey uses a five-point Likert 0-4 scale which can be evaluated using the numerical score (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, and 4 = very often). The numerical scores are then added together to get an overall result of the level of perceived stress. Questions #2 and #3 from the survey are reversed, so the number added is inversed (ex: if the participant put 1 as their answer for question #2, it would be inversed to be 3). The composite score is then found by adding up the values from each question. The ratings from this survey are computed to a composite score, where the higher the score, the greater the perceived stress the individual is indicating (Cohen, 1988). Perceived Stress Results for this study ranged from 2-13 for the participants. As for the short answer question, the answers from the participants were coded to fit into one of the three following groups; stress about the exam (if they stated: "organic chemistry exam" or "the exam"), other academic stress (if they said: "finals week" or "assignments for other classes"), and non-academic stress (if they stated: "work" or "the future" or anything else that wasn't academic related). The students' perceived stress and top stressors were collected through the brief surveys and then the results were calculated as described above. Then the data was analyzed and averaged using Microsoft Excel, and some significance was found from the performed t-tests.

Electrocardiograms

Electrocardiograms (ECGs) are another tool that was used in this study to collect quantitative data. ECGs are tests that record the electrical signals of the heart and were used to look at heart rate variability based on changes in interval frequency (Figure 1a and 1b) and wave amplitude (Figure 1c). The pulse was automatically given from the online software, Kura cloud, when a specific heartbeat was selected. The T-P interval was quantified by using two markers to distinguish the desired area, and then the software calculated the value (as seen in Figure 1b). The R wave amplitude was quantified by estimating the height of the wave by using the scale (not shown) to the left of the ECG reading (Figure 1c).

The ECG readings were taken in the biology lab of Barstow Hall on the UW-Superior campus. The participants came in on three different days to do the ECG readings. The first ECG was a baseline ECG completed three days before the scheduled exam to get the participants ECG data when they are not stressed about their exam (pre-exam). The second ECG was taken on the day of the exam (exam). And the third ECG was completed three days after the exam (post-exam). A 3-lead electrocardiogram test

was completed on each student, and all three readings were completed in under 10 minutes. Then, three separate heart beats of each person's individual ECG were analyzed, and the data was collected, averaged out and numerical values were calculated.

Once the ECG data was collected, the recordings were deleted, and the data was analyzed anonymously. This was done by removing participants' names from the data which was then associated with random numbers rather than identifiable student information, and everything was evaluated blindly with no association of the individual data to a particular participant. The numerical values collected from the ECG data was compared to the survey question answers and everything was evaluated together on Microsoft Excel. All the data was also averaged, and significance was found using t-tests.

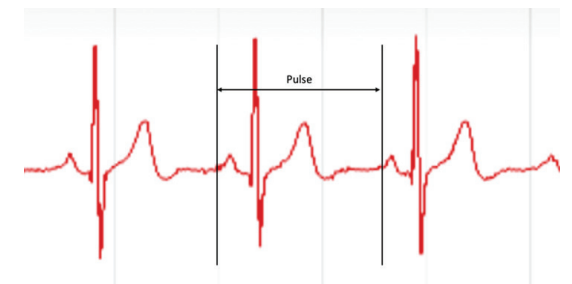


Figure 1a
ECG Reading showing calculation for Pulse

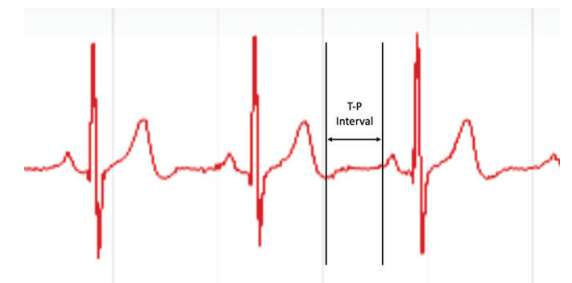


Figure 1b
ECG Reading showing calculation for T-P Interval

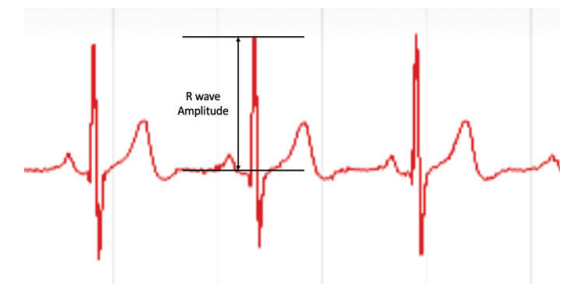


Figure 1c
ECG Reading showing calculation for R wave Amplitude

Results

Perceived Stress

Perceived stress was calculated using the surveys, which identifies a person's perception of their stress, as described above. The results show that participants' average perceived stress levels did go up on the day of the exam, compared to the pre-exam and post-exam days (Figure 2, dark blue bars). When examining the differences in perceived stress between genders, female participants had lower average Perceived Stress Results (PSR) compared to male participants on the pre-exam and post-exam days, and a similar perceived stress average on the exam day (Figure 2, comparing turquoise and light blue bars).

Stressors

The stressors were found through the surveys, the open-ended question #5, "In the last week, what are the top two things that are contributing to your stress?" The results from Figure 3 show that overall, participants did have the most stress about the exam on the day of the exam, along with academic and non-academic stress. When examining the differences of top stressors between genders, male participants reported the exam being a top stressor on exam day more than female participants did (Figure 3, comparing the grey bars for males and females under the exam stressor).

Pulse

The pulse was calculated through the Kura cloud software, by highlighting the specific heartbeat that is being evaluated, and the software automatically calculates it. As seen in Figure 4, the results show that participants' average pulse did go up on the day of the exam, compared to both the pre-exam and post-exam days (dark green bars). Looking specifically at differences in the pulse between genders, there was a trend that female participants had lower average pulse compared to males on the exam and post-exam days, and a similar pulse on the pre-exam day (Figure 4, medium green and light green bars).

T-P Interval

The T-P interval was calculated using the Kura cloud software, by measuring the distance between heart beats on the ECG reading, as seen in Figure 5. The graph shows that the participants' average T-P interval did get smaller, indicating a faster heart rate, on the day of the exam, compared to the pre-exam and post-exam days (Figure 5, brown bars). When looking at the differences in T-P intervals between genders, males had longer average T-P intervals compared to females on the pre-exam day (Figure

5, bright yellow and pale-yellow bars). However, females had longer average T-P intervals compared to males on the exam and post-exam days (Figure 5, pale yellow and bright yellow bars). Significance was found for total participants between pre-exam day and exam day, along with between exam day and post-exam day.

R wave

The R wave was calculated with the Kura cloud software, based off the amplitude of the R wave peak. The R wave amplitude signifies the heart's strength of contraction. The results from Figure 6, show that the participants' average R wave amplitude was higher on the pre-exam day ECG, compared to the exam and post-exam day ECGs (dark red bars). When looking at the differences in R wave amplitude between genders, male participants had a higher average R wave amplitude on pre-exam, exam, and post-exam days than female participants (Figure 6, bright red and pale pink bars).

Correlations of Perceived Stress Levels versus Physiological Stress

To explore if there are correlations between perceived stress and physiological stress, we used Excel to create a scatterplot to visualize any comparisons. Figure 7 below, shows the correlations between perceived stress and the physiological value pulse. The other figures comparing the correlations between perceived stress and T-P interval and R wave amplitude are not shown.

For perceived stress versus pulse, Figure 7 shows that there is, in fact, a correlation between them. The female participants' data points showing the correlation between the perceived stress result and pulse, more closely followed the trend line, compared to the male participants' data points. However, the trend line for female participants does show a downward trend, which indicates that the higher the perceived stress result, the lower the pulse was. This counters the original hypothesis that predicted the higher the perceived stress result, the higher the pulse.

For perceived stress versus T-P interval, there isn't a correlation between this data, along with perceived stress versus R wave amplitude (Data not shown).

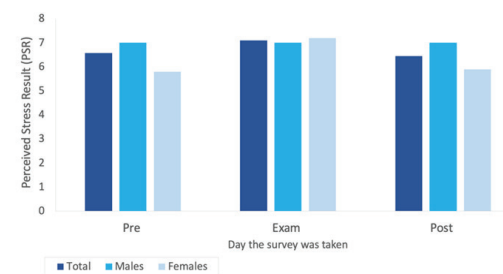


Figure 2
Perceived Stress Levels for Undergraduate Students around Exam Day

Note. Undergraduate students were asked to complete surveys evaluating their stress level 3 days prior to a scheduled course exam (pre-exam), on the day of the scheduled exam (exam) and 3 days following the scheduled exam (post-exam). The Perceived Stress Result (PSR) was calculated based on the survey answers and an average score on each survey day was calculated (total). Participants were also subdivided by gender to determine if there were differences in PSR between males and females. The data was analyzed and averaged using Microsoft Excel, and no significance was found from the paired t-tests.

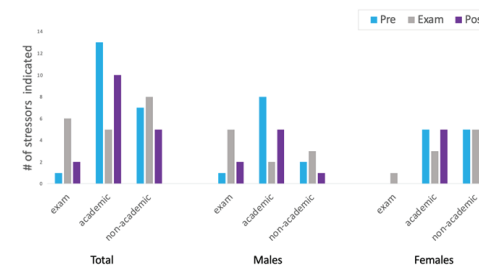


Figure 3
Stressors Contributing to the Stress of Undergraduate Students

Note. Undergraduate students were asked to complete surveys evaluating their stress level 3 days prior to a scheduled course exam (pre-exam), on the day of the scheduled exam (exam) and 3 days following the scheduled exam (post-exam). The stressors indicated by the participants were an open-ended answer to question #5 on the survey. Participants were also subdivided by gender to determine if there were differences in exam versus academic versus non-academic stressors between males and females. The data was analyzed, and a figure was created using Microsoft Excel.

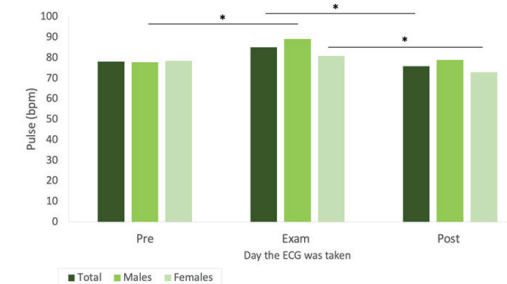


Figure 4
Pulse for Undergraduate Students around Exam Day

Note. Electrocardiograms (ECGs) were conducted on undergraduate students to evaluate their physiological stress. The pulse was calculated using the Kura cloud ECG software and an average pulse on each ECG Day was calculated (total). Participants were also subdivided into groups by gender to determine if there were differences in pulse between males and females. The data was analyzed and averaged using Microsoft Excel, and significance was found between the exam and post-exam day for total participants, between the pre-exam and exam day for males, and between the exam and post exam day for females. The significance was found using the paired t-tests, and all had significance below 0.05.

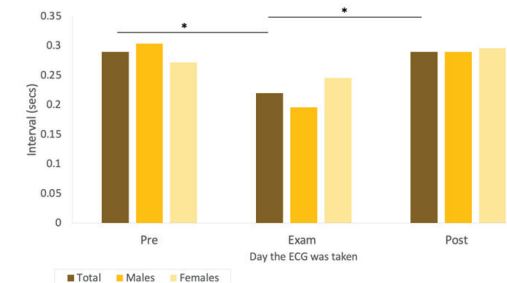


Figure 5
T-P Intervals for Undergraduate Students around Exam Day

Note. Electrocardiograms (ECGs) were conducted on undergraduate students to evaluate their physiological stress. The T-P intervals were calculated using the Kura cloud ECG software and an average T-P interval on each ECG Day was calculated (total). Participants were also subdivided by gender to determine if there were differences in T-P interval between males and females. The data was analyzed and averaged using Microsoft Excel, and significance was found between pre-exam and exam days, and between exam and post-exam days for total participants. This significance was found by using paired t-tests.

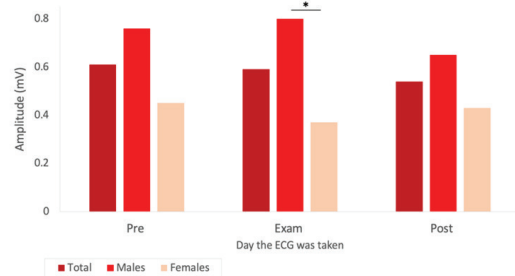


Figure 6
R wave Amplitude for Undergraduate Students around Exam Day

Note. Electrocardiograms (ECGs) were conducted on undergraduate students to evaluate their physiological stress. The R wave amplitude was calculated using the Kura cloud ECG software and an average R wave amplitude on each ECG day was calculated (total). Participants were also subdivided by gender to determine if there were differences in R wave amplitude between males and females. The data was analyzed and averaged using Microsoft Excel, and significance was found between males and females on exam day from the t-tests.

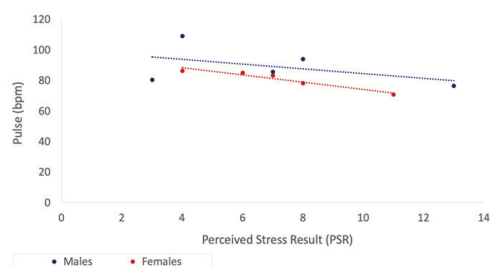


Figure 7
Correlation of Perceived Stress Levels and Pulse for Undergraduate Students around Exam Day

Note. Undergraduate students were asked to complete surveys evaluating their stress level on the day of an exam. The Perceived Stress Result (PSR) was calculated based on the survey answers and an average score on the exam day survey was calculated for male and female groups. On the same day, an ECG was conducted to find the physiological stress of the participants. The data was then analyzed to explore if there was any correlation between perceived stress and pulse of the participants. The R squared value for males is $R^2 = 0.222$ and females is $R^2 = 0.9291$.

Discussion

When examining the perceived stress levels of students, results that were found, verify the original hypothesis of exams effecting students' stress levels. As seen in Figure 2, the conclusion can be

drawn that, exams do heighten students' stress levels based on their Perceived Stress Result (PSR). Figure 2 shows that the total participants' average PSR was higher on exam day compared to the pre-exam and post-exam day. The participants are most likely feeling stress related to their exams as their values are higher on exam day than non-exam days. Therefore, their stress levels are being influenced by the exams. Furthermore, we can conclude that females might have lower perceived stress than males on non-exam days, based off the results shown in Figure 2. However, the results of this study contradict past research done on this topic of stress and exam anxiety, which all state findings that females have a higher perception of stress than males. This could be due to the small sample size and an inaccurate representation of genders, or males in classes such as neurobiology and organic chemistry are more confident with speaking about their stress levels. When focusing specifically on the top stressors contributing to the stress of the students, there were some interesting trends between genders. Males say academic stressors are more pressing and were by far more stressed by exams while females largely had non-academic stressors and every female indicated non-academic stressors for pre-exam and exam day surveys, and four out of 5 females on the post-exam day survey. Therefore, it appears that the females were more worried about stressors outside of school, while males were focused more on academic stressors. This could be because females worry about many different things such as relationships or work, rather than focusing on one stressor.

When examining the physiological measures of stress, results showed that exams do affect the stress levels of students. These physiological data was the pulse, T-P interval, and R wave amplitude (Figures 1a, 1b, and 1c). When a participant's pulse increases, the heart is beating faster which is a sign of increased stress. This is the same for when the participants T-P interval decreases, the heart is beating faster because the length of time between heartbeats is shorter. When a participant's R wave amplitude increases, this means that the participant's heart is contracting stronger, which is also a sign of increased stress. We can draw the conclusion that exams do increase students' physiological stress, specifically by increasing pulse, based on the ECGs conducted. Figure 4 shows that the total participants' average pulse was higher on exam day compared to the pre-exam and post-exam days, indicating that participants experienced higher physiological stress on the day of the exam. We can also conclude that exams do increase students' physiological stress, specifically by decreasing the T-P interval, based on

the ECGs conducted. The decrease in T-P interval, is the shortening of the length of time between heart beats. When looking at Figure 5, the total participants' average T-P interval was shorter on exam day compared to the pre-exam and post-exam day, suggesting that students had more physiological stress on the day of the exam. As seen in Figure 6 showing R wave amplitude, no specific conclusions can be drawn. The results of the total participants' average R wave amplitude being higher on pre-exam compared to the exam day, trends differently than expected. This could be because it might have been stressful for a participant to have an ECG conducted on them for the first time, or their first interaction with me, or their first time being involved in a research study.

Based off Figures 7, showing the correlation between perceived and physiological stress, no specific conclusions can be drawn. The graph has data points outside of the trend line, and there are no trends in the data. This contradicts the original hypotheses that the physiological data would correlate with the perceived stress data on exam day. They were all inconclusive, which could be due to the small sample size.

Conclusion

The purpose of this research project was to gather information and data on how exams effect students' perceived and physiological stress levels. Exams appear to increase the perceived stress levels (Figure 2) along with the physiological stress (Figures 4, 5, and 6) when survey and physiological data is compared to non-exam days. Furthermore, female participants showed less perceived stress than male participants on non-exam days, contrary to past research, which found that females typically have more perceived stress than males. This could be due to a small sample size and outliers skewing the data. Also, Figure 3 shows that males had more stress about exams than females did, on exam day. Males also stressed more about academics, overall, compared to females. This shows that males indicated more stress on academics than females did, which could've led to more perceived stress. Along with the gender trends, we also explored different age groups (Group 1: ages 18-20 and Group 2: ages 21-23) to see if we could find any correlations between the data. We originally hypothesized that Group 2 with the older students would have higher stress because they are closer to graduation and could have more stress about the future. However, no conclusive results were found, and the data was insignificant.

Limitations

There were multiple limitations with this research project. One major limitation was the relatively small sample size. This study consisted of 10 participants total, making it very difficult to get significant data. More participants would provide greater data to analyze and the possibility of significant results.

Another limitation was the timing of the data collection for this project. The data was collected over this past spring semester of 2021, during the COVID-19 pandemic, and classes were held mostly online. This led to a very difficult process of recruiting students to partake in this study.

Future Directions

Some modifications that could be made to the methods are having students take the surveys at the exact same time as the electrocardiogram. For the current study, the students had to take the survey on the same day, but they could be taken hours apart. Having the participants take them both at the same time would help to have more accurate data for the correlations between perceived stress and physiological stress. Another thing that could be done differently next time, is having the student wait 10 minutes in the room without talking or moving before conducting the ECG, to get more accurate readings. This is important because students could have been showing physiological stress due to outside factors, which would influence the ECG reading. Some students were in a rush because they were running late, and their heart rates were high due to increased physical activity to get to the lab where the test was conducted. If this could have been avoided, the results might have been different and more accurate.

As for future research, it would be interesting to follow up on perceived and physiological stress differences in genders. There were trends in both perceived and physiological stress in my study, between males and females. But my sample size wasn't big enough to have many significant results showing these differences. Additionally, future research could be done on exploring perceived stress in students in different majors. I had originally wanted to look into this but couldn't because of the small sample size. However, it would be interesting to see if students in different majors have differing amounts of stress. I believe that students in life science majors might have more perceived stress compared to students in social science majors, because social sciences can be up to interpretation while life sciences are more concrete. But it would be compelling to see if this hypothesis is true or if other majors also show different levels of stress

perception.

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BARRIERS TO WELLNESS IN A POPULATION OF DEAF INDIVIDUALS

Jacqueline S. Fontaine, University of Wisconsin-Superior
Dr. Eleni Pinnow, PhD, Mentor

In order to better understand the needs of Deaf people whose primary communication is American Sign Language; a nationwide sample of Deaf adults were surveyed. Previous research involving the Deaf community has been based on the opinions and experiences of professionals and providers, such as those of doctors, counselors, and American Sign Language interpreters. There is very little research based on the experiences of members of the Deaf population. Upon a review of existing literature, one of the prevalent themes is that the Deaf population, which makes up for 10% of society, is three times as likely to experience mental illness, addiction, and domestic violence (Bones, 2016). This study narrowed the scope of ways in which health-care access and communication can be addressed directly, and not solely through the employment of professional interpreters (Phillips, 1996).

When providing healthcare services to the Deaf population, a thorough understanding of the unique values of Deaf culture and the Deaf community is of major importance and needs to be taken into careful consideration. Unfortunately, there is an astonishing lack of research documenting the personal experiences of Deaf people within healthcare settings (DeVinney, 2002; Pollard, 1994). Documented information has been limited to that which has been provided by professionals who work with Deaf patients, such as American Sign Language (ASL) interpreters and healthcare providers. To best provide for the needs of the Deaf community, understanding Deaf culture, values, and barriers is also critical to preventing mistakes and in providing the best possible care to this underserved and marginalized population. The current study seeks to explore how Deaf people are accessing healthcare and what barriers they are experiencing.

Literature Review

This literature review explores the difficulties experienced by members of the Deaf community concerning accessibility to healthcare and mental health services. Due to the differences noted in some of the author's works on which this review is based, it is important to include an explanation of the terms "Deaf," "deaf," and "Hard of Hearing," that are used in the scope of cultural background and social identity (Phillips, 1996). The term "Deaf" is used in a cultural context and describes an individual who identifies with a Deaf cultural community or the

cultural community itself. The term "deaf" is used in the context of the physiological condition of having severe to profound hearing loss and does not necessarily associate an individual with a cultural community. The term Hard of Hearing (HoH) can represent both an individual identity within the Deaf community and the physiological condition of having a degree of decibel hearing loss.

Cultural Values

Misdiagnosis and misunderstandings are not uncommon due to medical professional's lack of knowledge of Deaf cultural norms and professional trainings. Trainings in disability competency represent only a small percentage of the overall training that professionals receive (Leigh et al., 1996). Many Deaf cultural values, such as storytelling, attention to detail, and differences in physical boundaries can be misinterpreted by non-deaf individuals as characteristics of neurodivergence or deviation of social norms. These types of misvaluations are, in part, a reason for Deaf individuals making a choice not to seek mental healthcare support altogether or choosing to not participate in continuing treatment after an initial diagnosis is made. This is often influenced by a culturally widespread mistrust of non-Deaf individuals, fear of misdiagnosis, or unnecessary treatment of their condition. (Boness, 2016). Though the use of interpreters and assistive devices may help to minimize errors in communication, they do not make up for a lack of cultural competency that can lead to under- or overdiagnosis of clients (Leigh et al., 1996).

Commonly Faced Issues

There are several common experiences discussed throughout the available published research of the Deaf and HoH community. These experiences, though varying in impact and effect, all stem from difficulties with aspects of communication and culture that are not faced by people in the hearing population. It is estimated that between two-hundred-fifty thousand to one-million Deaf signers live in the United States (Mitchell as cited in Panzer et al., 2020). However, in respect to ASL preferences, the use of interpreters can only help to alleviate some of the difficulties in information exchange. Furthermore, the inclusion of an ASL interpreter is often not ideal in all situations, particularly those where mental health counseling is involved (Brunson, 2002; Kuenburg, 2016). For example, in the

therapeutic counseling setting, the relationship between patient and provider is one that is most effective when that relationship exhibits the qualities of trust and respect. "The trust/respect scale was significantly associated with patient willingness to share" (Crits-Christoph et al., 2019, p. 6). In a triadic, or three-person setting for therapy or intervention, the dynamic of having an interpreter present has the potential to change the patient's willingness to share. There is also increased opportunity for error in translation when using an interpreter, as not all interpreters are trained to work within the complex field of medical interpreting. The English language, often being a second language to a patient's primary ASL, can create a potential for lack of clarity and lead to misunderstanding and miscommunication between counselor and client (Meador et al., 2005). The effect of miscommunication may lower the beneficial results of counseling, or further the likelihood of the misdiagnosis of symptomatic behavior. Additionally, the presence of an ASL interpreter may unintentionally influence the mood of the session through nuance of body language, regardless of the interpreter's training and ability to perform as an impartial language conduit (Brunson, 2002).

Well-Being, Longevity, and Health Literacy

While Deafness itself has not been shown to be an inherent cause for early mortality rates among the Deaf population, it is a factor for concern (Contrera et al, 2015). The average Deaf population tends to be at an increased risk of mortality than that of the non-deaf population. Of course, there are factors that increase this risk such as smoking and cardiovascular disease. This is often due to the resistance of seeking healthcare, lower health status, and lack of health literacy. As was concluded in a survey of the National Health index data between the years of 1990 and 1995, "adults with post lingual onset of deafness appear to have higher mortality than non-deaf adults, which may be attributable to their lower self-reported health status" (Barnett & Franks, 1999, p. 330). One limitation of the Barnett study that should be noted is that it was difficult to draw a conclusion in the differences between mortality in prelingual and post-lingual deafness.

People of the Deaf population may also experience what is described as limited access to information and inadequate health literacy due to lack of incidental exposure to what is otherwise considered to be general knowledge (Leigh et al., 1996). Another thing to be taken into consideration are accommodations for Deaf-friendly literature and health brochures. Care should be taken in the design and development of health-related literature to provide ease of readability for persons who may

have lower comprehension of the structure of the written English language (Meador & Zazove, 2005).

Poor health literacy among the Deaf population is further compounded because they are not exposed to information that many people who are not deaf are exposed to "in passing." For example, they are unable to hear information in radio announcements made regarding health concerns, also it is typical that pharmaceutical and healthcare commercials are not available in closed caption. Due to this lack of health literacy, it is common culture that Deaf people are often more likely to turn to friends or family members for help or advice in times of need or crisis. To help to encourage health literacy and help-seeking, the inclusion of community outreach has been discussed to try and negate the lack of visibility for Deaf services (Anderson, 2017).

Current Alternative Strategies

The Teach-Back Method. The Teach-Back method, also known in healthcare as the "show me" method, is a method that asks the patient to teach back to the provider what instructions they have been given to ensure clear understanding of the instructions and allow the provider to assess patient understanding of the information. Though this method seems that it would be a logical way of ensuring understanding between patient and provider, eighty-one percent of ASL interpreters who were surveyed at the 2015 National Symposium on Healthcare Interpreting reported the Teach-Back method is a seldom used strategy (Hommes et al., 2018).

Technology. While there have been great strides in the creation and implementation of communication technology, it is not considered by Deaf people to be a reliable solution. Many users of these kinds of software programs and equipment experience problems with connectivity and individual access. (Hommes et al., 2018). The use of videophones, text messaging, and email also raise concerns about patient privacy and HIPPA policies (Panzer et al., 2020; Lesch, 2019).

Professional Ethics, Diversity, and Cultural Awareness

When surveyed about their education and experience, most professionals report having little training that is specific to working with people who have disabilities (Meador, 2005). This lack of experience can prove detrimental when the cultural values of a population are misunderstood or unknown. In the past, the Deaf population has been subject to manipulation and there still exists a distrust of hearing people, professionals, and researchers. This fear

extends as far as to cause hesitation towards signing medical documents such as insurance release forms and healthcare plans. Another concern is the still existing "deaf=dumb" phenomenon, which can adversely affect patient care should a person choose to not inquire further about something they do not understand for fear of appearing intellectually inferior. The competence of Deaf patients whose first language is ASL may not be reflected in written English and may cause misplaced concern and misguided efforts during provider-patient interaction. This is not to say that all Deaf, deaf, or Hard of Hearing people have the same communication needs, but to better serve the variety of subgroups within the Deaf community, providers have an obligation to educate themselves about the history and the culture of this population (Meador, 2005).

With fifteen percent of the overall U.S. population being deaf or HoH, the questions this study seeks to answer are as follows: Are communication and cultural barriers preventing or discouraging Deaf people from seeking the care they need? Also, how can services be improved upon to provide better information and access to wellness for this population?

Methodology

Participants

A total of eighty-one Deaf, deaf, or Hard of Hearing individuals participated in this study. Thirty-nine individuals who identify as culturally Deaf completed the survey. Of those thirty-nine respondents, nineteen (57.58%) report American Sign Language as being their preferred method of communication. Of the thirty-nine respondents, 38.46% overall, were between the ages of 35-44 at the time of completion of the survey. Seventy-six-point ninety-two percent received a diagnosis of hearing loss by the age of 5.

Materials

The Barriers to Wellness in a Population of Deaf Individuals survey was adapted from an existing Barriers survey designed to study accessibility barriers to healthcare for people diagnosed with Parkinson's disease (Dobkin et al., 2013). The adapted survey contained 31 items for which the options to response included yes/no, multiple-choice questions, Likert scale rating, and text fill box. The text fill box ensured that participants were given the opportunity to respond to the question of what they think can be done to help resolve the barriers they have experienced to healthcare, in their own words. The revised survey can be found in Appendix A.

Procedure

An invitation link to the digital survey was shared via direct email and social media to Deaf Associations across the nation with additional Deaf clubs invited from cities with higher population density of Deaf people. The organizations were invited to share the link with others in their community. Seventy-two Deaf Associations were contacted in all. The survey was available to participants from May 31 to July 8, 2021.

Results

Of the 57.58% of participants who use ASL, only 36.36% of them prefer to use interpreters for mental healthcare appointments and 39.39% prefer to use an interpreter for healthcare appointments. These numbers indicate that of the participants who use ASL as their primary language, a little over half of them prefer to use an interpreter (see Table 1). In response to question 21 regarding interpreter availability by request for healthcare appointments, 15.63% responded there are interpreters always available, 37.50% responded interpreters are sometimes available, and 31.25% responded that interpreters are never available (see Table 2 in Appendix B). Upon a qualitative analysis of questions 28 and 29, which ask about specific barriers, it was found that people have experienced barriers such as lack of interpreter services, insensitivity to cultural issues, time constraints, and difficulty scheduling appointments just under fifty percent of the time for both mental and physical healthcare settings.

Eighty-three-point seventy-eight percent of participants report having a primary healthcare provider and 68.42% also receive annual physical check-ups. However, 56.76% of people answered "yes" to feeling they have needed help managing mental health concerns such as depression, anxiety, and stress in the past. Currently, 13.51% attend weekly or monthly counseling appointments with a therapist or psychologist and 52.63% of individuals express awareness of resources in their community. Of thirty-six respondents, twenty-eight (77.78%) have private or commercial health insurance coverage. When asked if they have a primary care provider, 83.78% responded "yes." Responses to question 30, "How familiar are you with the Teach-Back Method," indicate that 75% of participants are not familiar at all with the method. Reporting for education for having earned a bachelor's degree and above was a cumulative 76.32%, with only 2.63% having not completed high school, 7.89% having earned a high school diploma, and 13.16% having completed some college. For full text responses, see Appendix C.

Discussion

Among those whose primary language is ASL and who identify as culturally Deaf, previous studies and the current study both demonstrate a strong consensus in favor of access to healthcare providers who can communicate directly in ASL and are knowledgeable in Deaf culture (Leigh et al., 1996). Despite availability of interpreter services, it is not widely preferred or used. Data reveals this is more so due to apprehensions about confidentiality and clear communication than it is interpreter availability (Crits-Christoph et al., 2019). There are also concerns about the close-knit nature of Deaf communities along with the value of sharing information (Boness, 2016). In general, the sample seems well informed and reported having high levels of access but concerns of interpreter service availability might be an artifact of the sample and not of the population (DeVinney, 2002).

The barriers reported by the participants are similar to those of prior research, apart from the difficulties in technology (Hommes et al., 2018; Lesch, 2019; Panzer et al., 2020). The results in this study imply that the difficulties are not necessarily due to access or internet connectivity, but rather a lack of the conversational aspects that one would similarly expect during an in-person appointment. Healthcare web portals are either not an effective platform for direct communication, or they are non-existent, and there are expressed concerns about patient confidentiality and HIPAA law. This technology barrier extends into the insurance aspects of healthcare as well when it is the responsibility of the client to negotiate interactions between their insurance companies and their providers.

Overall, the sample population receives annual physical check-ups, but has not often sought out professional services for mental health issues due to apprehension relating to a lack of confidence and mistrust of using interpreter services in small Deaf communities (Leigh et al., 1996). Lack of knowledge or employment of the Teach-Back method is consistent with previous studies and likely ties into the time allotted for each care appointment (Hommes et al., 2018). The major deficits in healthcare services as reported by the participants in this study reflect more concerns regarding legal confidentiality and linguistic differences than they do concerns of cultural understanding that has been explored in past studies (Meador, 2005). Past studies show that healthcare providers generally have minimal experience in providing adequate service to Deaf individuals (Meador, 2005). In this study, communication preferences and lack of access to professionals who are knowledgeable in Deaf culture and values seem to have more of an impact

on psychological treatment than physiological treatment. Though there are strong feelings of needing Deaf or ASL fluent providers for both mental and physical health care, participant responses reflect that the barriers are not as deterring in seeking physiological treatment.

Whether observed as cultural or non-cultural identities such as Deaf, deaf, or HoH, this study puts into perspective the importance of understanding people's individual needs and past experiences (Phillips, 1996). Furthermore, it highlights the need to utilize their input in the development of systems specifically designed to provide better care and to navigate, if not remove, communication barriers.

Limitations

One of the major limitations to the study was that the sample may not have been representative of the population. The small sample size was likely a contributing factor to the absence of demographic diversity within the sample. Also, most of the respondents are well-educated and have a seemingly high literacy rate. According to a 2017 national survey conducted by the National Deaf Center on Postsecondary Outcomes, deaf people generally attain lower levels of education than those who are hearing, showing a fifteen percent gap in completion of a bachelor's degree. The education gap increases steadily from high school to graduate degree levels of education (Garberoglio et al., 2017).

Another limiting factor is there were no questions included in the survey to differentiate between individuals who are Deaf, deaf, or HoH which could have a substantial impact on the way that healthcare is delivered and received. Someone who is Deaf and uses ASL as a first language might prefer direct communication in ASL. Whereas someone who became deaf later in life, may prefer written communication.

There are questions remaining as to if the small sample size was due to the lack of trust of researchers as mentioned in the literature review (Boness, 2016). It is difficult to resolve the discrepancy in reporting for questions 21 and 22, as the type of appointment was not specified as regarding either mental health or physical health. More information is needed to determine if this discrepancy is due to healthcare institutions having full-time interpreters on staff, or otherwise.

Additional limitations to the study might include unexplored variables such as access to transportation, healthcare service availability, or interpreter availability in rural communities.

Future Research

To increase the sample size and circumvent

concerns regarding literacy, future study would recommend that surveys be made available in delivery modes that would include American Sign Language in person or over prerecorded video. One particularly relevant question to include in future research may be to inquire if lack of trust in professionals continues to be a culturally widespread belief, as it might help to explain why there is minimal published research that involves members of the Deaf community. An interview-based qualitative design could prove useful in gaining a more granular understanding of participants thoughts and feelings and be a useful guide in addressing the specific needs of this highly diverse group (Sutton & Austin, 2015). It would allow for exploration into individually worded responses to expand on the importance of increasing the number of Deaf providers and people who are fluent in both medicine and ASL.

Appointment Type	Mental Health	Physical Health
Yes	36.36	39.39
Sometimes	21.21	30.30
No	42.42	30.30

Table 1
Interpreter Preference by Percent

Appointment Type	Mental Health	Physical Health
All of the Time	18.75	15.63
Most of the Time	43.75	3.13
Half of the Time	15.63	12.50
Less Than Half of the Time	3.13	37.50
Services Not Available	18.75	31.25

Table 2
Interpreter Availability by Percent

Type of Service	Mental Health	Physical Health
Lack of Interpreter Services	35.00	38.44
I Was Not Comfortable/ Had History With the Interpreter	46.56	43.31
Professionals Not Sensitive Enough to Cultural Issues	48.14	43.89
I Don't Trust Professionals	37.63	24.25
I Have Been Treated Unfairly/ Disrespected In the Past	25.88	40.31
I Was Not Actively Involved in How to Best Handle My Care	30.21	23.77
I Thought the Treatment Was Not Necessary	13.00	22.33
No Quality Options Were Available to Me	26.77	20.42
I Did Not Have Enough Time With My Provider/I Felt Rushed	41.44	55.43
Information Was Not Thoroughly Explained to Me	35.13	38.87
Difficulty Scheduling Appointments	38.08	38.50
Technological Barriers/ Lack of Access	45.13	28.06

Table 3
Barriers by Percent of Time

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Appendix A

Survey of Deaf Individuals Regarding Accessibility in Seeking Healthcare

- Q1 Survey of Deaf Individuals Regarding Accessibility in Seeking Healthcare
 Yes, I agree to participate
 No, I do not agree to participate

- Q2 Has your hearing loss been confirmed by an audiologist using a hearing test/audiology evaluation?"
 Yes
 No
- Q3 Do you culturally identify as Deaf or Hard of Hearing?
 Yes
 No
- Q4 What was your age when it was determined you had hearing loss?
 Birth - 1 year
 2 - 5 years
 6 - 11 years
 12 - 17 years
 18 - 24 years
 25 - 30 years
 31 - 36 years
 37 - 45 years
 46 - 51 years
 52 - 60 years
 Over 61, Please specify age
- Q5 Your Current Age:
 18 - 24 years
 25 - 34 years
 35 - 44 years
 45 - 54 years
 55 - 64 years
 65 - 74 years
 75 years or older
- Q6 Which state do you live in?
 ▼ Alabama ... I do not reside in the United States
- Q7 Highest level of education:
 8th grade and below
 Some high school
 High school graduate
 Some college
 College graduate
 Some graduate school
 Graduate degree
- Q8 Work status (select all that apply):
 Full time
 Part time
 Not employed
 On disability
 Retired
 I work more than 1 job
 I am a student
- Q9 Health insurance
 Medicare only
 Medicare plus secondary insurance
 Medicaid
 Private or commercial insurance
 None
- Q10 Do you have a primary care provider?
 Yes

- No
- Q11 Do you go to annual physical check-ups with a primary care provider?
 Yes
 No
- Q12 Do you go to weekly or monthly counseling with a therapist or a psychologist?
 Yes
 No
- Q13 In the past, have you felt that you have needed help managing depression, anxiety, or stress?
 Yes
 Sometimes
 No
- Q14 Are you aware of community resources for mental health and healthcare in your area?
 Yes
 Somewhat
 No
- Q15 Have you ever personally experienced addiction?
 Definitely yes
 Probably yes
 Unsure
 Probably not
 Definitely not
- Q16 If you answered yes to question 15, did you seek help?
 Yes
 No
- Q17 If you answered yes to question 16, where did you seek help?
 Friend or family
 Self-help literature
 Professional counseling/ treatment center
 Work/ School resources
 Community resources
 Other
- Q18 What is your preferred method of communication?
 American Sign Language
 Auditory/ Verbal
 Written
 Lip reading
 Assistive electronic devices
 Other (please specify)
- Q19 Do you prefer to use interpreter services when you attend mental health appointments?
 Yes
 Sometimes
 No
- Q20 Do you prefer to use interpreter services when you attend healthcare appointments?
 Yes
 Sometimes
 No

- Q21 When at a healthcare appointment, how often have you requested the use of an interpreter, but none was available?
 Always
 Most of the time
 About half the time
 Sometimes
 Never
- Q22 In the past, how often has there been an interpreter available for you at appointments?
 All of the time
 Most of the time
 Half of the time
 Less than half of the time
 Interpreter services not available
- Q23 Are mental healthcare appointments available to you when you need them?
 Always
 Most of the time
 About half the time
 Sometimes
 Never
- Q24 Are healthcare appointments available to you whenever you need them?
 Always
 Most of the time
 About half the time
 Sometimes
 Never
- Q25 Do you feel you are given clear instructions about procedures, medications, or follow-up appointments from medical professionals?
 Definitely yes
 Probably yes
 Sometimes
 Probably no
 Definitely no
- Q26 Do you feel like your provider understands your questions and concerns about your care?
 Definitely yes
 Probably yes
 Sometimes
 Probably no
 Definitely no
- Q27 How often do you feel you have experienced barriers to mental health care or healthcare services?
 Always
 Most of the time
 About half the time
 Sometimes
 Never
- Q28 Using the slide scales below, please rate how much each barrier has interfered with your access to mental health services. (Scale represents 0% to 100% of the time)
 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100



Lack of interpreter services,
I was not comfortable with the interpreter/ I had prior history with them,
Mental health professionals are not sensitive enough to cultural issues,
I don't trust mental health professionals,
I have been treated unfairly or disrespected by mental health professionals in the past,
I was not actively involved in the decision as to how to best handle my care,
I thought the treatment was not necessary,
No quality options were available to me,
I did not have enough time with my provider/ I felt rushed,
Information was not thoroughly explained to me,
Difficulty scheduling appointments,
Technological barriers/ lack of access,
Other (please explain),

Q29 Using the slide scales below, please rate how much each barrier has interfered with your access to healthcare services. (Scale represents 0% to 100% of the time)

0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Lack of interpreter services,
I was not comfortable with the interpreter/ I had prior history with them,
Healthcare professionals are not sensitive enough to cultural issues,
I don't trust healthcare professionals,
I have been treated unfairly or disrespected by healthcare professionals in the past,
I was not actively involved in the decision as to how to best handle my care,
I thought the treatment was not necessary,
No quality options were available to me,
I did not have enough time with my provider/ I felt rushed,
Information was not thoroughly explained to me,
Difficulty scheduling appointments,
Technological barriers/ lack of access,
Other (please explain)

Q30 How familiar are you with the "Teach-Back" method?

Extremely familiar
Very familiar
Moderately familiar
Slightly familiar
Not familiar at all

Q31 What changes do you think would be helpful in improving mental health and healthcare accessibility for Deaf people?

Please enter text response here
I decline to respond to this question

Appendix B

Barriers: Text Responses by Theme

Confidentiality

"I don't want to use interpreters as [I] use them for work so don't want my information known."
"Confidentiality."
"I have never used an interpreter during my doctor appointments. I am a private person and most of the interpreters in my area are not well-versed in HIPPA. Many came from continuing education programs."
"The challenge I experience is that I know almost all of the interpreters in my area due to my job. Having one of them in an appointment with me is quite uncomfortable as I don't want my personal business shared. I am aware of the code of ethics and confidentiality, but it is still awkward."

Frequency of Service Seeking
"I only have annual physical check-up at my primary care physician's office."
"New doctor and office. More accents and had [to] call supervisor, as they would not look at me when talking."

Communication Barriers

"I refuse to use interpreters for mental health as I have seen too many communication misunderstandings. As for doctor offices, it is fine as I am able to help clear things up if I catch it. There are no direct mental health folks using ASL or knowledge of deaf culture in my state."
"During Covid, I had to visit the emergency room, but there was a door phone to screen for symptoms. I felt absolutely awful and was in pain when I basically had to guess what they were saying before I was let in."

Lack of providers/interpreters

"For dental appointments, the dental office wants me to provide my own interpreter. They won't do it."

Provider inadequacy

"Not having enough service providers who are familiar with hearing loss and the challenges, barriers, etc. it provides daily... how to function in a hearing world as a person who isn't hearing."
"Some doctors are good, others [that are] not used to deaf people are harder to work with. Some doctors do not listen well, despite my requests for some things when a process isn't helping at all, so it depends on the type [of

appointment] and who the doctor is, as it is a mixed bag."

Technology

"Zoom."

Appendix C

Suggestions for Improvement by Theme: Text Response

Culture

"Accessibility through OUR language and OUR culture. I refuse to go to someone who is hearing because they just don't get it. They don't understand us and it's challenging."
"More awareness of the issue from the practitioners."

Communication

"For physical health – more time. I need doctors/nurses to repeat themselves often, as I lipread, and half the time their back is to me while they're on the computer. This takes time and I feel rushed, and I never get all of my questions answered."
"Healthcare is more flexible in terms of communication, but more awareness would be helpful as many do not realize how dependent we are with our eyes, hands, etc. Especially when it hurts to use it. For example, a pinched nerve is enough to impact functionality. Same can be said for sleep doctors as that was one of the more challenging things to deal with due to no interpreters repeatedly and bad care."
"Better access hearing assistance as well as interpreters."
"People should be more aware of Deaf people's needs and also be more flexible."

Direct Providers

"More Deaf, deaf, Hoh, DB [(deafblind)] in the field."
"Have more mental health professionals that know sign language. Also, healthcare professionals that know how to interact with patients through interpreters."
"[Censored expletive] interpreters. We need direct services, deaf doctors, deaf nurses, ASL fluent doctors, ASL fluent nurses, etc. Not limited to on-site, but also available via telehealth."

Ethical considerations

"Revise code of ethics to reflect linguistic minorities."

"Confidence in interpreter confidentiality."
"Workshop on understanding HIPPA law."

Incentives

"Increase number of deaf/ASL speaking mental health professionals via scholarships and grants."
"More incentives for more direct language services, primarily [for] mental health."

Technology

"Expand remote based therapy."
"Online access and more insurance options for nationwide deaf resources/mental health/therapy/counseling."
"More text-based or low-cost accessible options, education about interpreting access and confidentiality."
"There has to be some way to contact healthcare that involves a chat-like conversation. Since phone is not an option to me, I need to use our web portal to ask questions or book appointments. In most cases, I have been given poor or incorrect information or support just because there is no way to reply to messages. If the healthcare provider misunderstands something or needs more information, they cannot ask for it in the web portal, and instead provide generic answers that don't fit my specific condition or request."
"More online/virtual options for scheduling and contacting insurance/providers, having insurance/providers communicate with each other rather than me being a middleman and having to find a way to communicate with both."

COVID-19 AND THE UPPER MIDWEST COMPANY STOCKS

Grant Garding, University of Wisconsin-Superior
Dr. Rubana Mahjabeen, PhD, Mentor

In 2020 COVID-19 emerged as the global pandemic and impacted human lives and economies. With COVID-19 ravaging humans, as reflected by the number of cases and deaths, the federal and state governments of the United States responded by locking down economies and movement of people and implementing three stimulus packages to cushion the slowdown of economic activities and loss of jobs. With vaccinations against the virus, economies have started reopening and reestablishing jobs. It is extremely important to study how economies reacted to events related to the pandemic. This paper provides analysis on how the financial indicators, stock and commodity returns, reacted in real time to different stages of COVID-19. This study collected data on COVID-19 related major event dates and returns of ten stocks and commodities on those dates to study responses of the U.S. and three upper Midwest states. Through empirical analysis we find that returns on financial/industrial stocks reacted more than the returns on agricultural commodities. Overall, the stocks associated to Michigan had more negative responses while stocks related to Minnesota had positive responses. We find that the WHO declaration of the pandemic caused downturn in almost all stock returns while stimulus packages and vaccination improved reactions of the financial indicators. The results show that initially market over-reacted with COVID-19 cases and deaths, and as more information became available, people started adjusting their expectations to pandemic related events and market started correcting itself.

Introduction

The United States (U.S.) recorded the first COVID-19 case on January 21, 2020. Since then the U.S. has accumulated over 33 million cases of COVID-19, over 600 thousand deaths, and administered over 300 million vaccinations. During this devastating time for the entire world the economy of the U.S. took a massive hit. To lower the spread of the virus, the U.S. federal and state governments decided to lockdown the economy. The U.S. GDP decreased by 2.3% or about \$500 billion. The growth rate of real GDP declined nearly -3.51% from 2019 to 2020. The unemployment rate in the U.S. rose from 3.7% in 2019 to 8.1% in 2020. The U.S. seemingly risked the economy for the overall health of the U.S. population.

During the devastating COVID-19 pandemic there is no rulebook, no policy prescriptions, and no models that governments can reference. Much of the learning during the containment of the pandemic was self-taught, self-learned and learnt from other states and countries. This is precisely what the experience of COVID-19 has taught us and is still teaching us. We have now seen how COVID-19 has unfolded and at which point the devastation has slowed and recovery has begun. This pandemic stressed governments at state and federal levels and people living across the U.S. The development and distribution of a vaccine is not the only thing that science needed to figure out but also the need to understand the evolutions and future mutations of the COVID-19 virus. Social and economic stability rests on the accuracy to answer those questions. It is necessary to learn the medical side of COVID-19 as well as its economics and the unpredictability that people faced with not knowing what to expect in days, weeks, and months ahead.

This paper focuses on the following question. How has COVID-19 affected the financial and commodity markets of the U.S. upper Midwest region? We aim to answer this question to better understand the true impact of COVID-19 on a regional level within the U.S. This paper attempts to expand on the global impact of COVID-19 that Phan and Narayan (2020) studied. Following their research we investigate the fact that COVID-19 represents fear of the unknown in the economic realm. All the stocks and commodities we investigate have investors affected by COVID-19 and every stakeholder is expected to make a loss due to the pandemic. The local and federal governments are the lead investors as they want to minimize losses for all. We research at the state level in the U.S. and local companies and commodities represented in the upper Midwest states to examine how each state reacted to the pandemic. We relate the policy responses to reactions of the stock returns of companies and commodities heavily represented in the three Midwest states. The goals are to identify trends in the stock returns and potential implications of how those indices can use this information for future pandemics. We conduct an empirical research on three Midwest states of the U.S. and the ramifications the pandemic may have at the regional level.

In this paper, we study federal and local government responses to COVID-19 for the U.S., Michigan, Minnesota, and Wisconsin and the returns of

stocks and commodities that are heavily represented in those upper Midwest states. The data signal possible overreactions and market corrections as COVID-19 evolved. We observe stocks and commodity returns and how they reacted to cases, deaths, and vaccinations associated with COVID-19. We find that during the early stages of the pandemic many of the stocks and commodities reacted negatively trending downward. However, gradually when the indices began to reach the higher milestones in each event category, stocks began to recover and started trending positively.

We organize the paper into five sections. The first is the introduction, which includes the research background. The next section is literature review. We then explain our data and methodology in the third section. In the fourth section, we explain our findings and discuss results of the U.S., Michigan, Minnesota, and Wisconsin. The last section provides the conclusion of the study.

Literature Review

In 2020 the COVID-19 pandemic tremendously affected the health, social, economic, and financial lives of people around the world. We study how COVID-19 affected the financial market. Specifically, how the Midwest company stock prices are impacted during the major events associated with the pandemic. We search the major event dates of the pandemic based on declaration by the World Health Organization (WHO), the U.S., and the Midwest states. This topic is important because it is a useful guide for the local economy as we will study local companies in the states of Michigan, Minnesota, and Wisconsin. Reaction of the regional economy is a significant indicator and can gauge how locals feel in that area around a major event.

Stock Market Literature

In this section we researched articles related to the stock market during the COVID-19 pandemic. Albuquerque, Koskinen, Yang, and Zhang (2020) investigated theories of environmental and social policies that the COVID-19 pandemic and subsequent lockdowns brought on the economies. This paper highlighted the importance and likelihood of investors staying loyal to their originally invested specific stocks. The article on 2020 annual review of private markets written by McKinsey & Company (2020) analyzed the long-running research on private markets and industry leading data sources. The authors gathered worldwide data on gross profits and limited partnerships to draw comparisons of private markets. In another study, Robertson (2021) looked at how private equity performed and reacted to the COVID-19 pandemic. The article stated that

deal-making was changed a lot by COVID-19 and market found a better way to make deals. Williams and Young (2020) analyzed a study done by FINRA Foundation and NORC that showcased the volatility of the housing market during the pandemic.

US Stock Market during COVID-19

In this section we take a deeper look into the US stock market to get a sense of where people are in terms of the pandemic and if there is optimism or pessimism. Two articles written by Fontes, Ganem, Lush and Mottola (2020a, 2020b) investigated market volatility during COVID-19 and its effects on minority groups in the U.S. The first paper (2020a) found that both the African American and Hispanic/Latino households were less optimistic on the recovery timeline of the market and the stock market was shrouded with uncertainty. In their second article (2020b) they found that while some of the investors reported major negative impacts on their investments, many of those investing still had high optimism about investment and believed the stock market was resilient and would remain high. The paper by Tompor (2021) detailed how volatile the market became during the COVID-19 pandemic. The author pointed out the fact that many of the new investors are young people who are more diverse and willing to buy seemingly random stocks like GameStop. In a similar study Robertson (2021) researched the rise of new investors in the stock market. The author stated that the rise in younger investors has led to an influx of “meme stocks” being purchased like GameStop and Dogecoin. The Conference Board (2021) discussed a survey conducted on American consumers. The survey investigated consumers’ concerns, spending priorities, and financial health. It utilized charts that are useful about stock investments and household improvements by category for our research.

Global Stock Market

There are multiple articles written on various global financial market reactions to the COVID-19 pandemic. The article by Gherghina, Armeanu, and Joldes (2020) examined stock market returns in the U.S., Romania, China, Germany, Spain, Italy, France, and the UK. The paper by Liu, Manzoor, Wang, Zhang, and Manzoor (2020) investigated the top 21 stock market indices around the world. Their analysis included the U.S., Germany, Japan, Korea, Italy, Singapore, and the UK. The authors found that countries in Asia had more negative returns when they were compared to countries of Europe and North America. The article by Phan, and Naryan (2020) showcased how 25 countries have responded to COVID-19 as reflected through

their stock markets reactions. This study analyzed the real time reaction of stock prices as many of the different lockdowns and events happened. The article explained what each of those previous events meant for the stock market and the effect the events had on stocks. Authors found stock market overreacted with unexpected news of the pandemic and as more information became available market corrected itself. An article by the World Bank Group (2021) investigated the current global outlook after the COVID-19 pandemic. This article investigated some regional prospects, the global economy, and the potential that this decade might be filled with disappointment and how the asset purchases by central banks had stabilized financial markets in emerging markets and developing economies during the pandemic.

Research Question

Literature review helped to shape our research topic. There is a growing number of research on how COVID-19 affected the stock market. However, there is a lack of study on the impact of the pandemic on company stocks of specific region or states of the U.S. Our research question is how COVID-19 affected Midwest company stock and commodity prices during the major events associated with the pandemic. We focus on the major events dates related to the pandemic. The WHO declaration of the pandemic, lockdowns, U.S. declaration of stimulus package 1, 2, and 3, and travel bans placed in the states of Minnesota, Michigan, and Wisconsin. We study when these states reached their first, 100, 500 and 1,000 cases of coronavirus and effects of these events on certain stock prices. Further, we investigate the effect of COVID-19 deaths on the returns of stocks and commodities using the same milestones as the virus cases. Through this investigation our goal is to study percentage change in the stock price index returns on the above-mentioned pandemic related macro event dates in the U.S. and the Midwest states. This paper contributes to the existing literature by conducting study on impacts of COVID-19 related events on the financial market. This study focuses on stock returns as well as returns on commodities during the COVID-19 related events. Further, the paper fills gap of research on regional economy by studying upper Midwest states of the U.S.

Data & Methodology

Data

The data used in this study begins with the macro-economic events of COVID-19, this includes WHO declaration of the pandemic, lockdown, three stim-

ulus packages provided by the U.S. federal government, travel ban, and peacetime emergency. We then look at the number of cumulative infected cases, cumulative deaths, and cumulative vaccinations in the U.S. and the three upper Midwest states, namely, Michigan, Minnesota, and Wisconsin. Information on these events are collected from publicly available websites using Google News (2020) statistics. From Trading Economics (2021) and Macrotrends (2021) we collected the stock/commodity prices for the specified dates to analyze the trends and measure the volatility of indexes. The data ranges from January 2020 to April 2021. This range shows the start of the COVID-19 pandemic to the milestones of 3 million vaccines distributed in the U.S. and the three upper Midwest states.

Methodology

This research is an exploratory analysis using quantitative and qualitative data from secondary sources to study how COVID-19 related events impacted stock/commodity indexes. First, we conducted a literature review on the chosen topic. Based on the literature, we collected various dates (e.g., date of declaration of the pandemic, date of lockdowns, date of first 100 cases, date of first 100 deaths, date of first 100 vaccinations, etc.) to record COVID-19 related major macroeconomic events. These event dates are recorded for the U.S. and three upper Midwest states. Next, we chose major companies that are prevalent to the above-mentioned locations. To learn about the financial market, we studied how those companies reacted on the pandemic related major event dates in terms of returns on the stocks and commodities. We analyzed and displayed the data using trend lines and tables. Finally, we compared the findings of the U.S. and the three upper Midwest states in detail in this paper.

Results

COVID-19 Related Events

Table 1 records COVID-19 related event dates. It shows data provided by multiple sources to find out the major events associated with the COVID-19 in the U.S., Michigan, Minnesota, and Wisconsin. Panel A shows the macro event dates associated with the COVID-19 pandemic. As seen in this panel, the U.S., and the three corresponding states have the same dates for many of the events. The only variation we see in event dates in Panel A is the statewide lockdowns, and peacetime emergency declarations. According to the Lockdown column, the U.S. declared lockdown first and Minnesota was the last to enforce their lockdown. Peacetime Emergency was first declared in Michigan while Minne-

sota and the U.S. were tied for last to do so.

Panel B of Table 1 represents the cumulative infected cases milestones, from first case to 100,000 cases. Cumulative infected cases are chosen as these were some of the first massive events seen during COVID-19. When looking at this panel we see that the U.S. is the fastest to reach all the milestones. Wisconsin had the earliest date for their first case of COVID-19 being on February 5, 2020. Minnesota ended up being the slowest to reach the last milestone of 100,000 COVID-19 cases on October 1, 2020. Michigan had the highest rate of infected cases of the three states reaching 100,000 cases in about five months.

Panel C of Table 1 shows how quickly the U.S., Michigan, Minnesota, and Wisconsin reached the milestones of their first death to 5,000 deaths. Obviously, the U.S. was the fastest in terms of reaching each of the death milestone numbers. The U.S. had their first death on March 1, 2020 and reached 5,000 deaths on April 2, 2020. Michigan experienced their first death the earliest, on March 18,

2020. Wisconsin was the slowest overall in reaching the final milestone of 5,000 deaths on December 24, 2020. Michigan experienced the fastest rate of death reaching 5,000 deaths in almost two months.

Lastly, Panel D of Table 1 vaccine distribution shows how quickly each state and the U.S. rolled out vaccinations to the public. The U.S. was the fastest in terms of reaching all the milestones distribution, the first vaccine on December 20, 2020, and 3 million vaccines on January 1, 2021. As for the states, Minnesota was the fastest to get out their first vaccine on January 1, 2021. Michigan overall was the fastest state reaching 3 million vaccines on March 13, 2021. To provide 3 million vaccines it took Michigan two months, Wisconsin two and a half months and Minnesota three months.

Timeline of COVID-19 Related Events

For Table 2 'Timeline of COVID-19 Related Events' the data provided in Table 1 is expanded to see the responses of the U.S. government and individual state governments. Table 2A records how

Panel A: Macro Events							
	Travel Ban	WHO Declaration	Peacetime Emergency	Lockdown	Stimulus Package1	Stimulus Package2	Stimulus Package3
U.S.	31-Jan-20	11-Mar-20	13-Mar-20	19-Mar-20	11-Apr-20	29-Dec-20	12-Mar-21
Michigan	31-Jan-20	11-Mar-20	10-Mar-20	23-Mar-20	11-Apr-20	29-Dec-20	12-Mar-21
Minnesota	31-Jan-20	11-Mar-20	13-Mar-20	27-Mar-20	11-Apr-20	29-Dec-20	12-Mar-21
Wisconsin	31-Jan-20	11-Mar-20	12-Mar-20	25-Mar-20	11-Apr-20	29-Dec-20	12-Mar-21
Panel B: Cumulative Infected Cases							
	First Case	100 Cases	500 Cases	1,000 Cases	5,000 Cases	10,000 Cases	100,000 Cases
U.S.	21-Jan-20	3-Mar-20	8-Mar-20	11-Mar-20	17-Mar-20	20-Mar-20	28-Mar-20
Michigan	11-Mar-20	19-Mar-20	20-Mar-20	22-Mar-20	29-Mar-20	2-Apr-20	14-Aug-20
Minnesota	6-Mar-20	20-Mar-20	29-Mar-20	7-Apr-20	30-Apr-20	8-May-20	1-Oct-20
Wisconsin	5-Feb-20	18-Mar-20	25-Mar-20	28-Mar-20	23-Apr-20	9-May-20	17-Sep-20
Panel C: Cumulative Death							
	First Death	100 Death	500 Death	1,000 Death	5,000 Death		
U.S.	1-Mar-20	18-Mar-20	23-Mar-20	26-Mar-20	2-Apr-20		
Michigan	18-Mar-20	28-Mar-20	4-Apr-20	9-Apr-20	19-May-20		
Minnesota	21-Mar-20	17-Apr-20	7-May-20	29-May-20	23-Dec-20		
Wisconsin	19-Mar-20	8-Apr-20	23-May-20	7-Aug-20	24-Dec-20		
Panel D: Vaccine Distribution							
	First Vaccine	200,000 Vaccines	500,000 Vaccines	1 Million Vaccines	3 Million Vaccines		
U.S.	20-Dec-20	20-Dec-20	20-Dec-20	23-Dec-20	1-Jan-21		
Michigan	13-Jan-21	13-Jan-21	21-Jan-21	1-Feb-21	13-Mar-21		
Minnesota	1-Jan-21	19-Jan-21	31-Jan-21	19-Feb-21	4-Apr-21		
Wisconsin	13-Jan-21	19-Jan-21	1-Feb-21	17-Feb-21	2-Apr-21		

Table 1
List of COVID-19 Related Event Dates

Panel A: Number of Days from WHO Pandemic Declaration to Events							
	First Death	100 Deaths	500 Deaths	1,000 Deaths	5,000 Deaths	10,000 Cases	100,000 Cases
U.S.	-10	7	12	15	22	3	17
Michigan	7	17	24	29	69	22	156
Minnesota	10	37	57	79	287	58	204
Wisconsin	8	28	73	149	288	59	130

Panel B: Number of Days from Lockdown to Events							
	First Death	100 Deaths	500 Deaths	1,000 Deaths	5,000 Deaths	10,000 Cases	100,000 Cases
U.S.	-18	-1	4	7	14	1	9
Michigan	-1	9	16	21	61	14	148
Minnesota	2	29	49	71	279	128	196
Wisconsin	0	20	65	141	280	127	182

Panel C: Number of Days from Travel Ban to Events							
	First Death	100 Deaths	500 Deaths	1,000 Deaths	5,000 Deaths	10,000 Cases	100,000 Cases
U.S.	28	46	51	54	61	48	56
Michigan	46	56	63	69	108	61	196
Minnesota	49	76	96	118	336	97	243
Wisconsin	47	67	112	189	337	98	229

Panel D: Number of Days from Peacetime Emergency to Events							
	First Death	100 Deaths	500 Deaths	1,000 Deaths	5,000 Deaths	10,000 Cases	100,000 Cases
U.S.	-12	5	10	13	20	7	15
Michigan	8	18	25	30	70	23	157
Minnesota	8	35	55	77	285	56	202
Wisconsin	7	27	72	148	287	58	189

Table 2A
Timeline of COVID-19 Related Events - Closings

many days passed between the different numbers of pandemic related deaths and cases since WHO declared the pandemic, the U.S. ordered travel ban, and three states declared lockdowns and peacetime emergency. Table 2B records how many days passed between the different numbers of pandemic related deaths and cases since the U.S. government provided the three Stimulus Packages.

According to the Panel A of Table 2A, we find that only in the U.S. the first death took place 10 days before the Who Declaration. Minnesota experienced their first death 10 days after the declaration and was the slowest to reach their first death. Minnesota also experienced 100,000 cases the last of the three Midwest states while the U.S. was the first to reach that milestone in 17 days. Wisconsin was the slowest to reach 5,000 deaths, 288 days after the Who Declaration.

Panel B of Table 2A looks at the number of days from the lockdowns to the death and case events. Minnesota and Wisconsin were the only two to not experience a macro event before declaring their individual lockdowns. The U.S. had their first death 18 days before they declared lockdown and their 100 death happened 1 day before lockdown. Michigan had their first death 1 day before declaring their state lockdown. Minnesota was the last to experience their 100,000 cases, 196 days after declaring lockdown. Wisconsin reached their 5,000 deaths

280 days after their lockdown, making them the slowest state to reach that milestone.

Panel C of Table 2A shows the number of days from the travel ban enacted by the U.S. to the death and case events. All three states and the U.S. experienced their first death after the travel ban was declared, Minnesota was the last to experience their first death, 49 days after the travel ban happened. Wisconsin was the last to experience 5,000 deaths, 337 days after the travel ban was enacted. Minnesota was the last to reach 100,000 cases, 243 days after the travel ban was enacted by the U.S.

Panel D of Table 2A showcases the number of days from the peacetime emergency declarations to the death and case events. The U.S. was the only one to experience their first death 12 days before the peacetime emergency declaration. Minnesota had the greatest number of days, 202 days, to reach 100,000 virus cases after the declaration. Wisconsin was the slowest to reach 5,000 deaths milestone, 287 days after the peacetime emergency declaration.

Table 2B showcases the number of days from three of the U.S. stimulus packages to the death and case events. The U.S., Michigan, Minnesota, and Wisconsin, all experienced their first death before the first stimulus package was disbursed. Every state as well as the U.S. experienced their 5000 deaths and 100,000 COVID-19 cases before Stimulus Packages 2 and 3 were distributed.

Panel A: Number of Days from Stimulus Package 1 to Events							
	First Death	100 Deaths	500 Deaths	1,000 Deaths	5,000 Deaths	10,000 Cases	100,000 Cases
U.S.	-41	-24	-19	-16	-9	-22	-14
Michigan	-24	-14	-7	-2	38	-9	125
Minnesota	-21	6	26	48	256	27	173
Wisconsin	-23	-3	42	118	257	28	159

Panel B: Number of Days from Stimulus Package 2 to Events							
	First Death	100 Deaths	500 Deaths	1,000 Deaths	5,000 Deaths	10,000 Cases	100,000 Cases
U.S.	-303	-286	-281	-278	-271	-284	-280
Michigan	-286	-276	-269	-264	-224	-271	-227
Minnesota	-283	-256	-236	-214	-6	-235	-157
Wisconsin	-285	-265	-220	-144	-5	-234	-158

Panel C: Number of Days from Stimulus Package 3 to Events							
	First Death	100 Deaths	500 Deaths	1,000 Deaths	5,000 Deaths	10,000 Cases	100,000 Cases
U.S.	-376	-359	-354	-351	-344	-357	-353
Michigan	-359	-349	-342	-337	-297	-344	-299
Minnesota	-356	-329	-309	-287	-79	-308	-248
Wisconsin	-358	-338	-293	-217	-78	-307	-231

Table 2B:
Timeline of COVID-19 Related Events – Government Support

List of States and Stock/Commodity Index

In Table 3 we designate certain stocks/commodities to a specific state. The S&P 500 Index and crude oil are chosen for the U.S. The S&P 500 is chosen as it is the most accurate depiction of the U.S. economy as it represents the 500 largest U.S. companies. Crude oil is designated to the U.S. due to the vast diversity of where oil is found in the U.S.

Table 3: List of States and Indexes

States	Stock/Commodity Index
United States	S&P 500
United States	Crude Oil
Michigan	United States Steel
Michigan	Morgan Stanley
Minnesota	Corn
Minnesota	Soybeans
Minnesota	UnitedHealth Group
Wisconsin	Cheese
Wisconsin	Dairy
Wisconsin	Enbridge Inc.

Table 3
List of States and Indexes

For Michigan, United States Steel and Morgan Stanley are designated because of their importance in that state. United States Steel has multiple operations in Michigan and represents how other steel companies might be performing. Morgan Stanley is designated to Michigan due to the high volume of banks operating in Michigan and is appropriate to study as it represents the financial sector. For

Minnesota, corn, soybean, and UnitedHealth Group are chosen. Corn is designated to Minnesota as this state is the fourth largest corn producer in the U.S. and the highest producer among the chosen three states. Soybean is designated to Minnesota as the state is the third highest producer of soybean in the U.S. and the highest producer among the three states chosen in this study. UnitedHealth Group is designated to Minnesota as it is headquartered at Minnetonka, Minnesota and operates locally in the northeast Minnesota area. Wisconsin is designated with cheese, dairy, and Enbridge Inc. Wisconsin is the number one producer of cheese in the U.S. and the second highest producer of dairy in the U.S. Enbridge Inc. is tied to Wisconsin as multiple gas pipelines of the company are running through the state and has operations in the regional area.

Discussion

Returns on Stocks and Commodities

Figures in Panel A show the returns of the stocks/commodities (listed in Table 3) on the dates of pandemic related events specific to the U.S. and the three Midwest states. The most volatile stock is United States Steel seen in Figure 1B. United States Steel in Michigan has the lowest return at -51.52% on Stimulus Package 1 date and the highest return at 73.05% during the disbursement of Stimulus Package 3. The least volatile stock is Milk in Wisconsin seen in Figure 1E. Milk experienced its lowest return of -0.19% on Stimulus Package 1 date and its highest return of 0.38% during the disbursement of Stimulus Package 2. The events that proved to cause the most negative returns for all stocks are WHO

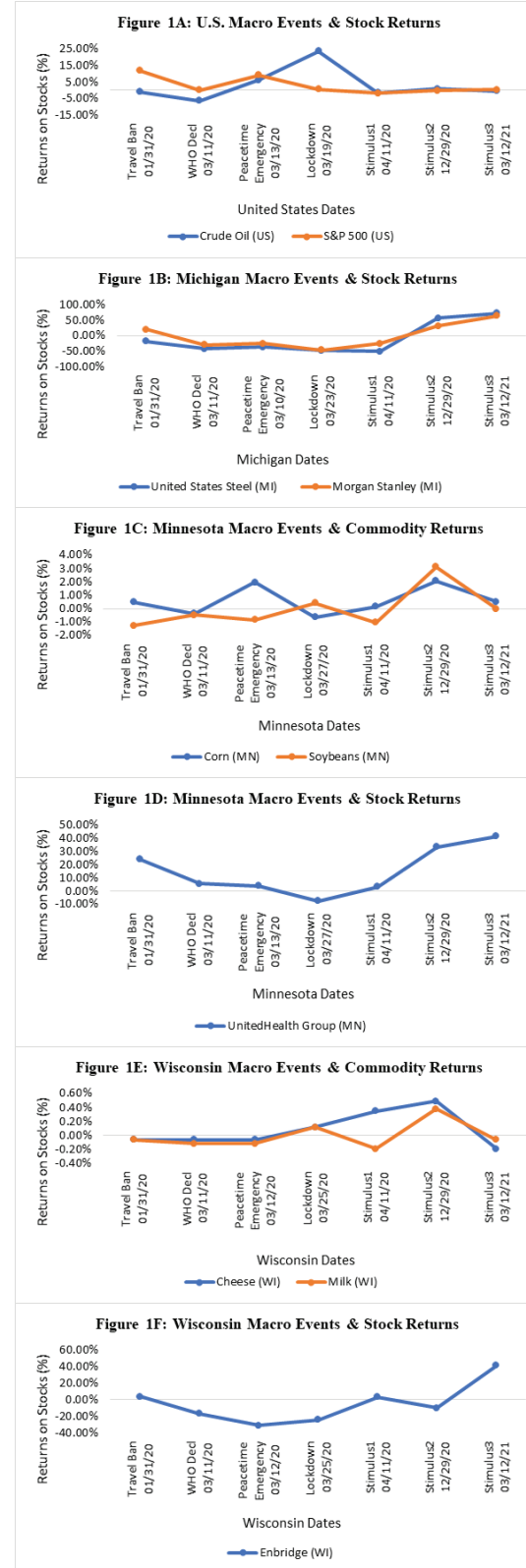
declaration, Lockdown, and Peacetime Emergency.

Panel B shows the returns of the stocks/commodities associated with the cumulative number of COVID-19 cases. The most volatile stock is Morgan Stanley seen in Figure 2B. Morgan Stanley experienced its lowest return at -46.95% when Michigan reached 1,000 cases and its highest return at 1.35% when Michigan hit 100,000 COVID-19 cases. The least volatile stock is represented by Cheese seen in Figure 2E. Cheese experienced its lowest return of -0.41% when Wisconsin reached 500 cases and its highest return of 1.35% when Michigan hit 100,000 COVID-19 cases. The least volatile stock is represented by Cheese seen in Figure 2E. Cheese experienced its lowest return of -0.41% when Wisconsin reached 500 cases and its highest return of 0.81% when Wisconsin reached 10,000 cases. Overall, stocks and commodities saw a sharp decline in returns during the first three milestones of cases but slowly recovered as cases increased.

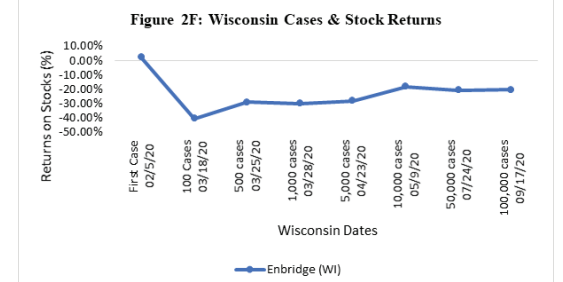
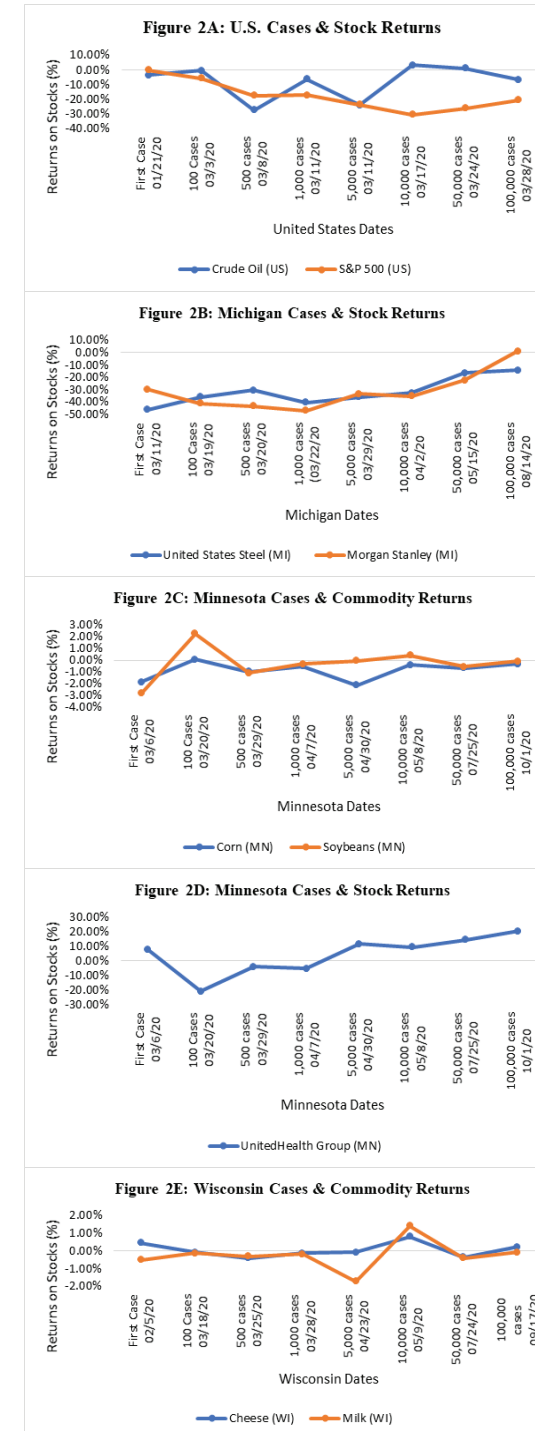
Panel C shows the returns of the stocks/commodities associated with the cumulative number of COVID-19 deaths. The most volatile stock is UnitedHealth Group seen in Figure 3D. UnitedHealth's lowest return at -25.61% reached when Minnesota reached 5,000 deaths. The least volatile stock is represented by Cheese seen in Figure 3E. Cheese experienced its lowest return of -1.96% when Wisconsin reached 100 deaths and its highest return of 0.31% when Wisconsin reached 5,000 deaths. Overall, most stock returns were initially negative but returns started to trend upwards as deaths increased.

Panel D shows the returns of the stocks/commodities associated with the cumulative number of vaccinations. The most volatile stock is Morgan Stanley seen in Figure 4B. Morgan Stanley saw its lowest return at -0.29% when Michigan reached 1 million vaccinations and its highest return at 23.56% when Michigan reached 3 million vaccinations. The least volatile stock is represented by Milk (dairy) seen in Figure 4D. Milk experienced its lowest return of -1.35% when Wisconsin reached 3 million vaccines and its highest return of 0.12% when Wisconsin reached 200,000 vaccines. Overall, returns of half of the stocks/commodities experienced declines when the first vaccination was administered. However, most of the stocks saw the greatest number of positive trends during increasing vaccination period while commodities experienced the opposite.

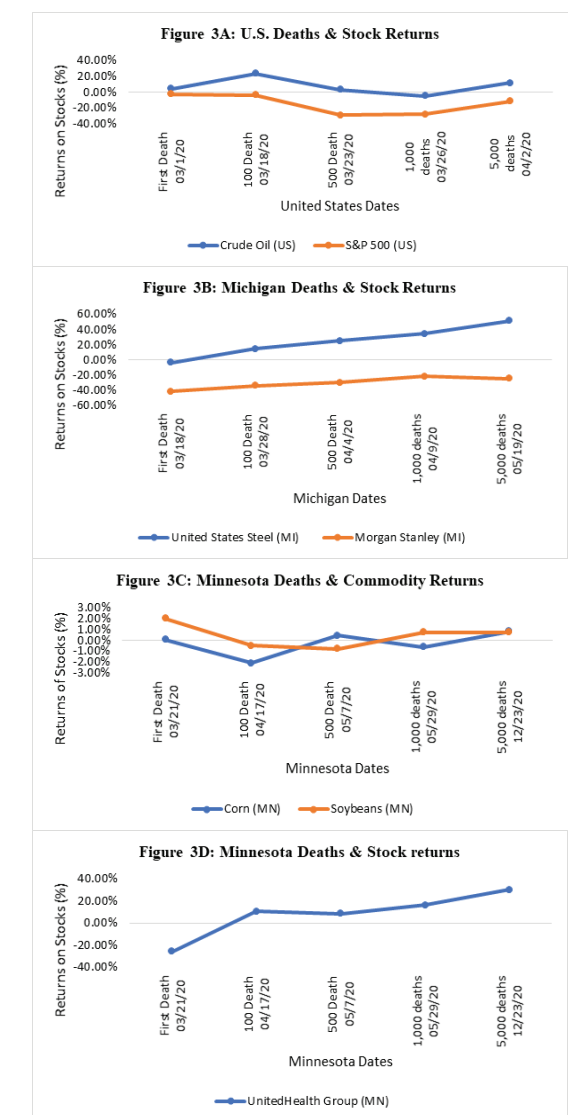
Panel A: Macro Events & Stock Returns

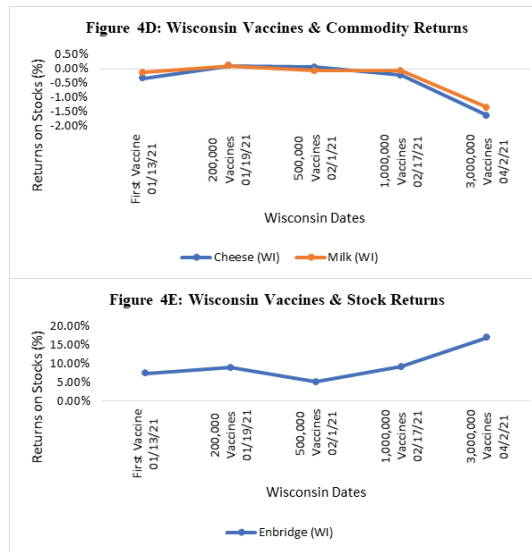
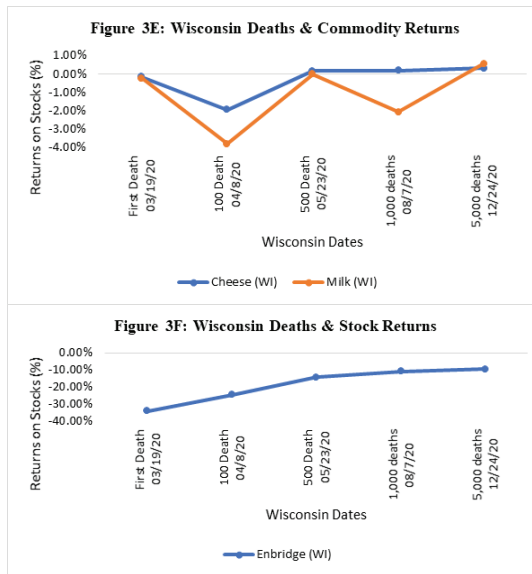


Panel B: Cumulative Infected Cases & Stock Returns

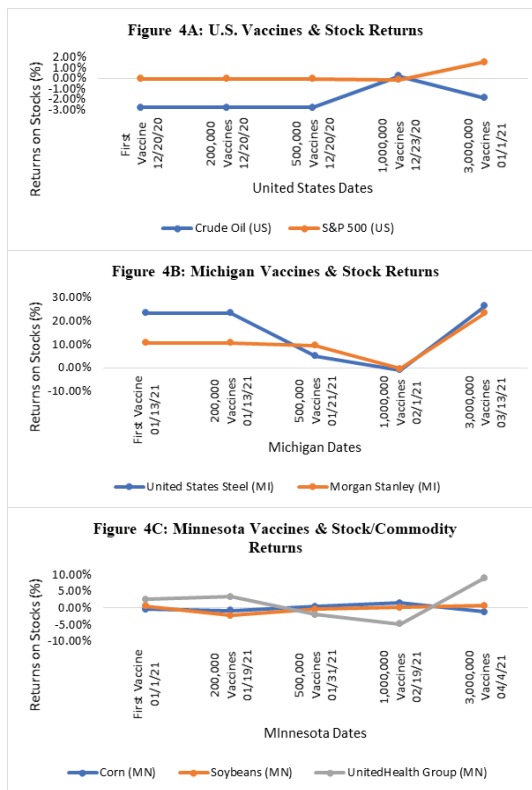


Panel C: Cumulative Deaths & Stock Returns





Panel D: Cumulative Vaccinations & Stock Returns



Comparison among Financial Stocks and Commodities

In Panel A figures, regarding major macro events related to the pandemic, the commodities were not as volatile as the financial/industrial stocks. Initially all stock and commodities experienced negative returns. However, the disbursement of Stimulus Package 1 started a positive trend in all returns. In Panel B figures which show number of COVID-19 cases, the commodities again were not as volatile as the financial/industrial stocks, but all the commodity returns were trending upward while the financial/industrial stocks had negative returns. In Panel C figures the commodities were not as volatile as the financial/industrial stocks, but they all had an upward trend during the death milestones. In Panel D figures regarding number of vaccines administered, again the commodities were not as volatile as the financial/industrial stocks. All the stock returns had a downward trend until the last milestone (3 million vaccines), when those experienced upward spike. Financial/industrial stocks were more volatile due to the differences in supply and demand tactics. Findings by Tompor (2021) support the volatility of the stock market during the pandemic. Commodities have less change in returns due to their constant high demand. Further, supply of agricultural commodities takes time to change due to their production cycle.

Comparison among Locations

In Panel A figures during major macro events Figure 1B displays that Michigan stocks oversaw the most volatile stocks. In Panel B figures of COVID-19 cases, we see a mix of upward and downward trends. In Figure 2B Michigan stocks oversaw the most negative returns and in Figure 2D Minnesota

stocks had the most positive trend. In Panel C figures of number of COVID-19 related deaths, we find an overall upward trend for the indices. Figure 3B shows that stocks related to Michigan had the most overall negative returns and in Figure 3D we see that stock related to Minnesota had the most overall positive returns. In Panel D figures related to number of vaccines administered, we see an overall downward trend until a last milestone upward spike. Figure 4B shows two Michigan stocks had mostly positive returns while Wisconsin stock did not experience any negative returns in Figure 4D. Figure 4A shows that the U.S. stock and commodity mostly had negative returns. The U.S. saw negative returns due to crude oil price going down during the pandemic and Minnesota saw positive returns due to UnitedHealth Group having an increased involvement throughout the pandemic. Michigan flipped from a downward to an upward trend due to the high optimism with rising vaccination, and people began to feel better about spending money.

Comparison among COVID-19 Related Policies

The indices moved at different speeds to embrace and implement policies with respect to the declaration of pandemic status of COVID-19. Most of the indices correspond to the same dates for events but through learning from each other they have different response times in a few indicators. There was a lot of uniformity as most of the bans and regulations were placed on a national level set by the U.S. government but different implementations of policies by states. Judging by the reaction of the stock returns it seems a combination of travel bans, lockdowns, and stimulus packages did work in reducing volatility of stocks. From our data the WHO declaration was the single most devastating event for the stocks and commodities. This makes sense as it was the very first worldwide event regarding the pandemic. The data also points out a possible overreaction and a market correction. When we analyze how each of the stocks and commodities reacted to cases of COVID-19 infections, deaths, and vaccines, we see that during the early stages of cases and deaths, the stock and commodity returns had a negative reaction but as time went on the reaction began to slowly become more positive and had an upward trend. This implies that gradually stock and commodities learned to adjust to the pandemic related events. These results are similar to the findings of Fontes et al. (2020b) and Phan and Narayan (2020).

Conclusion

This paper studies how COVID-19 has affected the financial and commodity markets in the U.S. Midwest region. Since January 21, 2020, the U.S.

has experienced over 33 million cases of COVID-19, over 600 thousand deaths, and rolled out over 300 million vaccines. The U.S. GDP has decreased by 2.3% since then and the growth rate of real GDP decline by 3.51%. Through analyzing the U.S., Michigan, Minnesota, and Wisconsin states, we are able to study the impact that COVID-19 had on the U.S. upper Midwest region. We chose United States Steel, Morgan Stanley, UnitedHealth Group, and Enbridge Inc. to represent the Midwest region company stocks. Since the Midwest region is synonymous to agriculture, we analyzed the returns of commodities such as Corn, Soybean, Cheese, and Dairy (milk). Results show that during the pandemic, overall the agricultural commodities were not as volatile as the financial/industrial stocks. The stocks associated to Michigan had more negative responses while stocks related to Minnesota had positive responses. The data did signal overreactions and market corrections as COVID-19 evolved and governments began to better respond to it. Many of the stocks and commodities reacted initially negatively to most of the events, such as, WHO declaration, lockdown, peacetime emergency as well as rising number of infection cases and deaths. However, with more vaccination and second and third stimulus packages we find positive returns to most stocks and commodities. This is the period when bans and restrictions began to be lifted and the public began to feel a sense of optimism. Our study is limited to three Midwest states and ten relevant stocks and commodities. Future research can include more Midwest states of the U.S. and more companies to get a better representation of the consumers and the investors and thereby, an accurate impact of COVID-19 on a regional scale.

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BARRIERS FACED BY FIRST-GENERATION COLLEGE STUDENTS

Aja Gregg, Northland College
Dr. Kevin Shanning, PhD & Dr. Danielle Sneyd, PhD, Mentors

A first-generation college student is defined as a student whose parents did not complete a four-year college degree (Forbus, Newbold, & Mehta 2011). The goal of the current study was to document the opinions and experiences of first-generation college students on how social, racial, and financial barriers affect them and their transition into college. All interviews were audio recorded and transcribed. Transcripts were analyzed by using thematic content analysis using excel spreadsheets to document and compare each interviewee's answer to every interview question. The participants of this study were asked to discuss their lives at home, transition into college, financial support systems, social support systems and connections at college, and their lives on campus. Major findings in the study show first-generation students who are athletes have an easier time transitioning to college; minority first-generation students were nervous about attending a predominantly white institution away from home, and: building connections with faculty does help the social, and financial barrier first-generation college students face.

Introduction

The topic being studied is the “Barriers First-Generation College Students Face.” Fifty-six percent of undergrad college students were first-generation students as of 2016 response to intervention (RTI) International. (2019). The goal of the current study is to understand why first-generation students have a difficult time staying in school. Nationally, 89 percent of low-income first-generation students leave college within six years without a degree (Fitzgerald & Delaney, 2002). The current study investigated factors that lead to lower graduation rates among first-generation students.

Financial Barriers

First-generation college students are defined as having parents who do not possess a college degree (Longwell-Grice & Longwell-Grice 2008). Without a college degree many of these parents will be part of the working class; suggesting that first-generation students have parents who are employed in occupations that require lower-level skills, lower pay, and do not need a college degree (Longwell-Grice & Longwell-Grice, 2008; Stuber, 2011). When parents have a lower economic status, first-generation students may feel a tension between wanting

to pursue higher education and helping to financially support their families. The recognition that one's parents may not have an abundance of financial resources causes low-income students to attend colleges they can afford, not colleges they are actually interested in, which negatively affects their college success. Often, first-generation students apply only to a single college and do that without help from high school councilors or parents. They cannot afford multiple application fees and they are unsure of how to determine a good fit between their interests and a college or university, as their parents have taken them to few, if any college tours (Banks-Santilli, 2019).

First-generation college students are particularly vulnerable to financial stress and the inability to manage scarce resources which can impede persistence and degree completion (Lyons, 2004). Filling out the free application for federal student aid (FASA) is imperative before every academic year because it allows students to apply for work study, federal grants, and federal student loans. The stress of filling out the FAFSA affects most college students in the United States, but it can be even more stressful when parents also do not know how to fill out these forms. Not understanding the FAFSA is detrimental for anyone who wants to attend college. Financial aid is a major source of support for first-generation college students, as they are less likely to receive financial support from parents for college-related expenses (Nomi, 2005). These financial concerns lead to a majority of first-generation college students selecting to attend a community college before transferring to a four-year institution (Perez-Antonio, 2016).

Since Black and Latinx students are more likely to come to college from lower socioeconomic backgrounds (compared to White and Asian American students), it is also more likely that they will personally endure much of the financial responsibility of college outside of what is covered by financial aid. (Baker & Robnett, 2012). This may mean spending more time than other students working at a part-time or full-time job in order to support themselves in college, which can impede from fulfilling college requirements. Additionally, Black and Latinx students often face different responsibilities like working and other family-oriented responsibilities. These responsibilities may distract from college responsibilities and have a negative impact on college success (Baker & Robnett, 2012).

Familial Support

A study conducted by Gibbons and Woodside (2014) found that fathers, specifically, had a large impact on the students' lives. Participants fathers also typically had working class jobs and participants felt they either had to join the workforce or go straight to school. Many participants chose to attend college because they have seen the repercussions of their fathers working minimum wage jobs for a living. The participants expectations about college were also heavily influenced by what their parents have told them about college increasing their chances of having a good career. The common ground between each participant was that to them and their families, finishing college is associated with success, not just for a career but also financial success along the way as well.

Research by Greene, Jewell, Fuentes and Smith (2019) also indicated the importance of family relationships in first-generation students' decisions to attend and matriculate in college. Many students turn to the support of important people in their lives, such as peers or parents, to help them navigate the transition to college (Dawson & Pooley, 2013). However, once students decide to attend college, there can be friction between the student and their family members. The friction is due to the family believing the student thinks they are better than them because they are receiving an education. Shifting family dynamics often causes the student to feel guilty for wanting to pursue higher education. One way which these supportive others may help first-generation students handle the transition to college is through a sense of security and intimacy, both of which can be obtained by supporting students' basic needs (Greene et al., 2019).

The lack of family support that results from the perception that the student is "better than" the parents is a barrier faced by many first-generation students. Greene et al. (2019) wanted to see if the need for college students to have satisfaction in the relationship with their parents is negatively related to their stress about college. The researchers investigated if higher levels of need satisfaction in the parental relationship will predict lower levels of worry about college and lower levels of family achievement guilt. They also wanted to investigate if parental involvement will moderate these above associations. The results of the study were that higher levels of autonomy-supportive parenting will strengthen these relationships, whereas higher levels of helicopter parenting will weaken them. Helicopter parenting does in fact hinder student success because it essentially adds more stress onto the student.

Racial Barriers

Huynh (2019) described the difficult transition to college life as a minority, specifically an Asian American. Huynh attended a predominantly white institution (PWI), and he talks about his own experiences and how institutions can help not only first-generation Asian Americans but all first-generation college students. Students who hold both Asian American and first-generation identities must reckon with the expectations of success and overcome the challenges they face in higher education, all while potentially lacking the necessary context and support to either meet these expectations or overcome such obstacles (Huynh, 2019). Since Huynh was a first-generation college student, he admits that he struggled in his beginning stages of college because he was not aware of all the resources he had available to him. As stated earlier the different stigmas Huynh faced as an Asian American did not allow him to feel comfortable asking for help. However, he found a mentor and she helped introduce him to many resources.

Another challenge Asian Americans and other minority first-generation students face is struggling with their racial identity and being a college student. While students attend college away from home it can be difficult to juggle all their different identities at once which causes them to pick the identity that is most suitable for the specific environment they are in. For minorities, this can be tricky because when they go home family may view them as becoming Americanized or "whitewashed" Huynh (2019). This identity crisis makes it hard for minorities to know which parts of their identity they want to keep and which parts to abandon. This just creates more stress while transitioning into college.

Huynh (2019) provides recommendations for colleges to follow to help first-generation Asian Americans. The list of recommendations can be applied to all first-generation college students as well. Many first-generation students do not know where their financial aid offices are located especially if they did not take a tour of the campus. Due to the fact that many first-generation student's parents never attended college their parents might not know the purpose and importance of financial aid officers therefore cannot offer any help. Huynh (2019) suggests it would be a good idea for financial aid and multicultural services to go to first year classes and introduce themselves/ talk about what their jobs are and where to find them on campus so first year college students and first-generation students can find them and use them as a resource.

Huynh (2019) believes institutions should help their students by normalizing faculty reaching out to the students rather than students seeking help.

Many students struggle with the need to ask for help and feel overwhelmed, not only can school cause mental health issues but issues with family members once first-generation students attend college can be a factor as well. Institutions and student affairs practitioners need to encourage students to use the resources available to them by creating a culture of interdependence, help-seeking, and mentorship as a way to help first-generation college students succeed (Stephens et al., 2012). One way to do this can be by validating students and listening to their experiences and the feelings they have about everything in their college experience.

It is a common fact that minorities are more likely to drop out of college than White students. Baker and Robnett (2012) investigate this topic by examining the process of integrating into college. As previously mentioned in Huynh's study many minorities have a hard time transitioning into college so the integration period can be very stressful and sometimes overwhelming. Baker and Robnett examined the precollege and college experience of first-year college students by collecting year-long data in the spring of 2004 through the fall of the following year (2012). Students were asked a series of demographic questions about their precollege experiences. The questions included: gender, family income, US birth, US birth of parents, and language background. Students were also asked about the type of high school attended, high school grade point average (GPA), and combined SAT score. For responses collected precollege, data suggested Latinos were significantly more likely than Asian Americans to have been born in the US and to have both parents born in the US; however, Latinos were less likely than Blacks and Whites to have been born in the US and to speak English as their first language. Whites had significantly higher high school GPA and SAT scores than Latinos; Asian Americans also had significantly higher SAT scores than Latinos (Baker & Robnett, 2012).

The results of Baker and Robnett's study suggest that, regardless of the differences in academic preparation for college, the experiences that are encountered once in college are important for the success of minority students. Social support from within the college environment appears to play a vital role in the retention of underrepresented minority college students. Social support from within the college environment appears to be important for the retention of minority students and may explain the difference in retention between Black and Latino students. Black students in this study were more likely than Latino students to have connections with others on campus (Baker & Robnett, 2012).

Transitioning To College

Another major topic of study is the difficulties faced by students as they transition to college. Clark (2015) conducted a study that focused on eight, second-semester freshman students. The students chosen were (18-19 years old), first-time college students. Clark's findings suggest that students' college transition experience includes an active process of strategizing (2015). Data revealed that students encountered challenges both inside and outside the college experience. Each challenge included its own set of influences, which also existed inside and/or outside the college environment. Students responded by devising strategies to address those challenges and accommodate the related influences (Clark, 2005). Specifically, Clark finds that the participants had a hard time with decision making and were unaware of sources outside of the classroom. Maintaining ongoing contact with students during the second semester could allow seminar leaders to be more effective in helping students recognize challenges, including ongoing challenges from the first semester or challenges that do not present themselves until the second semester (Clark, 2005).

Huynh (2019) and Baker and Robnett (2012) suggest that mentorship/ guidance at the college level benefits college students. From his personal experience, Huynh points to the importance of the mentorship he received as central to his ability to navigate the college experience and eventually graduate (2019). Baker & Robnett also argue that mentorship is likely to help retention and graduation rates for first-generation students (2012).

The Current Study

The research question is: What barriers impede first-generation college students' from graduating? It was hypothesized that the more support first-generation students had from people on campus the more likely they will be to feel comfortable on campus and do well academically. Additionally, they were asked about the different barriers they have faced prior to college, how they have gotten to college, and barriers they faced once arriving at the institution.

The participants were recruited from a predominantly white (72%) private liberal arts 4-year institution located in rural Wisconsin. At the time of the study approximately 21% of the student body was identified as first-generation. To participate in the current study participants needed to be (1) a first-generation college student (2) who is 18 years of age or older, and (3) have completed one full semester of college while currently still enrolled for the following semester. The current study was open to all majors as long as they met the three previously

stated requirements.

Methods

Design

The current study utilizes qualitative methods, specifically in-depth structured interviews of 15 first-generation college students. The objective of this study is to hear personal descriptions of first-generation college students transition and matriculation barriers into college. The interviews asked 34 questions that focused on life at home, the transition into college, social support at college, and financial barriers (see Appendix A).

Procedure

Participants were recruited through social media platforms such as Instagram, and Snapchat. Many of the participants responded to the post and volunteered to be a part of the study. Other participants were recruited through word of mouth. Participants were given informed consent forms to read and sign prior to the interview taking place. The informed consent form let them know they were not obligated to answer questions if they did not want to, and they were able to leave at any time during the interview. Before the interviews took place, participants were asked to state the definition of what it means to be a first-generation college student to ensure all participants had a similar understanding of the term and that their understanding was similar to the current studies definition of a first-generation college student. After finishing the interview. The participants were thanked for their time. All interviews were conducted in person with each lasting approximately twenty minutes. The interviews were audio recorded using a hand-held voice recorder and then transcribed and analyzed.

Coding

Thematic content analysis was used to analyze the interviews. There are 6 steps to follow when using this specific analysis concept: Learn the data, create coding categories, look for themes, review the themes, define the themes, and write a report (Braun & Clark, 2006). After following the 6 steps above the main themes that were found dealt with: race, having sibling, athletic participation, and distance from home. These themes contributed to barriers in five main areas: Upbringing and homelife, transitioning to college life, financial support systems, social supports and connections, and life on campus.

Results

Participants

The current study consisted of 15 first-generation students who were 80% (12) female and 20% (3) male. Participants had an age range from 18-25 years old ($M = 21$). The racial breakdown was 53% (8) White, 26% (4) Hispanic, 13% (2) African-American, and 6% (1) Native American. .06% (1) of participants were first-year college students, 13% (2) were second year students, 60% (9) of participants were third year students and 2% (3) were fourth year students. Student athletes accounted for 53% (8) of the participants, with nonathletes making up 47% (7) of participants.

The primary results of the study will be reported in the following order: upbringing and home life, transitioning to college, financial support systems, social support system.

Upbringing and Homelife

When participants were asked if their parents encouraged them to attend college 93% said yes. All participants who answered yes said their parents encouraged them to go to college so they would not struggle or have to live paycheck to paycheck like their parents. Participant 15 said "My parents encouraged me only because they didn't want me to have to work hard like them." Only 6% of participants said that their parents did not encourage them to attend college stating financial concerns as their parents' reason for not encouraging them. Participant 14 said "No, my mom wanted me to join the army because it'll help pay for college. For her it's all about the money."

Participants were then asked if they had mentors to help with the college selection and planning process. Forty percent of participants reported not having a mentor. Participant 16 said "No. I didn't because my school waited until senior year to be proactive and help us, but by senior year it's too late so I did most of it on my own." The other 60% of participants said they had a mentor with three participants reporting that they had counselors through the College Possible program. Participant 11 said "I guess I did, but they were through College Possible. I feel bad for the kids who didn't sign up because my school lowkey sucked with helping us. My school had a counselor but they were not the easiest to get in touch with."

Transitioning to College Life

When participants were asked how they felt about attending a college away from home the most common answers were "excited" or "happy." Even though respondents were universally excited

to be going to college, there was a difference in the degree of concern expressed about attending college between minority respondents and White respondents. A common answer among the minorities along with being excited was also "nervous," "scared," or "worried." Minorities stated they felt this way because they were scared of how they were going to be treated once they got to campus. Participant 9 responded to the question by saying "Specifically I was worried about it being at a predominantly white institution (PWI) and being a big black African American man. I was worried about racism at the time. I did not know what to expect or if I was going to be accepted." While minority students were concerned about how they would be treated or how they would fit in at a PWI, White students concerns centered around being away from home. For example, a white participant responded to the same question with "Just being homesick and not really being able to go home."

All participants who played on a sports team found that it made the transition to college easier because they had teammates to mingle with when they arrived instead of waiting to attend freshman orientation. Being an athlete made them feel like they were a part of campus life and helped them meet people. All athletes said that they believe if they did not play a sport, it would have been harder for them to make friends. One athlete even said they would have transferred if it were not participating in an intercollegiate sport. Participant 5 for example, answered by saying "I'm super thankful that I had friends already (coming to campus due to summer group chats with teammates). With my team I think it is tough to make friends outside of that. We already have one big thing in common and we spend so much time together." Participant 12 when asked about if they felt they belonged on campus said "I play basketball so I just hang out with my team. I'm not involved in a lot of other things, but I still feel like I belong."

Financial Support Systems

Participants were also asked "Do you feel comfortable asking your parents for academic or financial help while you are away at school?" The students who felt the most uncomfortable asking for help are students who had siblings. These are also the students who had the most financial difficulty and felt guilty for leaving home to go away to college. When participant 14 was asked this question, they responded with "Yeah but not financially. They do not have money to survive themselves and they can barely make it with my siblings still needing them. They are not just going to hand over money. I would never ask them for money. I will

never try to buy something I cannot afford. If I ever ask them for money that's a real low for me." Participant 10 said "Not really. Mostly if I have trouble financially, I do not tell them about it at all. We will be talking and they will be like 'what did you eat today' and I'd say a slice of pizza when really, I just straight up lied and ate a potato. So yeah, I am not going to ask them because I know my mom just started working at Walmart like 2 months ago. I know she barely had any income then the stimulus came and child support relief for my little brother and sister and I was like thank God they have that." For those who said they felt comfortable asking for assistance a common response was "I definitely feel comfortable asking my parents for help because I know if I need it they'll give it to me. I will never just ask to ask."

When asked about if they felt pressure to stop attending college and go home, 66% responded no and 33% responded they did feel that pressure. Of the 33% of participants who said they felt this pressure the pressure came in the form of financial and familial concerns. Participant 3 answered by saying "We live day by day and me being far away is a lot of expense. Sometimes I just want to go home and get a job and go to a school closer to home because it will be so much cheaper."

Year in school affected whether they understood financial aid and if they had a mentor. When asking students if they understood financial aid the 53% who said yes stated they did not understand it their freshman year, but they have a better understanding now. No one fully understands the free application for federal student aid (FAFSA) paperwork or process, but all participants understood it needed to be completed before the academic year in order to receive financial aid. Participant 7 said "No I do not understand any of those documents at all. I just sign my name where they [the paper] tell me to and hope for the best." Participant 8 responded by saying "No my mom does it." All participants who reported understanding the FAFSA documents have completed at least one full academic year.

Eighty-six percent of participants said they feel they can pay for all four years of college (with the help of loans). Everyone, with the exception of one participant, said they will be relying on student loans in order to afford all 4 years of school. The one participant who does not need student loans has an academic scholarship that covers all of their expenses. The remaining 13% said they will not be able to pay for all four years of college because they are trying their best to not have any debt and do not want to take out student loans. Participant 6 said "I am having a hard time paying for it now, so no." When asked what they do to be able to afford



college 66% of participants said they work during the summer and school year to pay for college, 22% reported only work during the summer. Only 13% of respondents reported not working at all.

Social Supports and Connections

When asked if they felt comfortable talking with their professors 66% reported they did and only 34% reported they did not. Participant 7 said “Yes, I feel like they are really approachable so it makes it easier for me to email them or stay after class.” Of the 33% who felt uncomfortable talking to their instructors, participant 12 said “Sometimes I don’t have questions but when I do, I just feel too weird approaching any of my teachers. All my education classes I’m comfortable, my math classes I felt are just crazy hard so I feel like to fully understand it I need a lot of help. I just go to other students and the internet.” All participants who did not feel comfortable said it wasn’t anything against their teachers they would prefer to send an email than approach them after class or during office hours because they never formed an actual relationship with their professors.

When asked if they had friends at the college that they felt comfortable talking to, 33% of participants said they did not have friends they felt comfortable talking to. The other 67% said they do have friends they feel comfortable talking to when they were asked. Seventy percent of the people who answered yes to this question were athletes. Participant 10 said “I used to my freshman year then they all left and did not come back. I have people I talk to, but I do not go full in depth.”

When participants were asked if they felt like a part of their campus only 33% said yes, 20% said no, 33% said they felt a mixture of both (being a part and not being a part of the school) and 13% of participants were undecided. Participant 12 who is an athlete said “I play basketball so I just hang out with my team. I’m not involved in a lot of other things but I still feel like I belong.” Participant 2 who is not an athlete said “I do within reason. It’s like I am not in the center like some people are. I’m like on the outskirts of it. I don’t want to be in that deep center. Not at all, I want to be on the sides.” Participant 6 who said they did not feel like they were a part of campus said “I was thinking about transferring last semester because I was working so much from freshman year, I didn’t really form a lot of connections so especially coming back this year it was kind of like woah I’m not working as much I don’t know what to do with my time. I feel like I kind of found my group now but it’s still really not set in stone.” Participant 10 who said they felt as if they were and were not a part of campus said “In a way yes because I feel like everyone knows

me and they let me be myself but I don’t have the friend group or deep people that I can have conversations with.” Participant 5 who was undecided said “I don’t know. I guess I feel like I am because I’m here working to get a degree and like that’s mainly what everyone comes to do. I guess like that’s the point of college.” All participants said they felt more connected when they received emails about on campus events and attended them. All off campus participants said they felt disconnected from everyone else due to them having jobs and not being able to attend most events. Participant 14 who lived off campus said “I did when I lived on campus. Living off campus I don’t.” When they were asked what would make them feel connected, they responded with “The emails make me feel connected for sure. I know I will not be able to attend anything due to the fact I work so many hours but just knowing what’s going on makes me feel good. I do not think any social supports will make a difference for me.”

Life on Campus

When participants were asked if their college experience matched their expectations 20% said yes, 60% said no, and 20% of the participants had no expectations. Participant 5 said their expectations matched what they are experiencing “Pretty much spending most of your day doing schoolwork. Because school is like your job when you are here then on the weekends going out and hanging out with friends.” Participant 2 whose experience is also matching what they expected said “It is because I am an older student if I was younger, I would probably be disappointed. If I would have come here when I was younger, I would not like it.” When asked why would it have been different if they were younger they replied by saying “I was definitely a partier back then and this is not a party school.” Participant 8 related by saying “Well my freshman year, I went to a bigger school so I have a different idea of what college should be like. Coming here because it is a smaller school it feels like it is a bigger high school.”

When asked if they ever thought about leaving the college 88% of participants said they have thought about leaving. The main reasons stated for considering leaving were financial and the school not having their intended major. Although students felt they would be able to pay for school with the help of student loans, many were not sure if they wanted to accumulate mounds of student loan debt. This is what caused them to think about leaving. The financial reasons varied considerably with participant 5 saying “Just that it’s like I don’t know what I am doing and it is like I could get a job that doesn’t need a degree. I could be getting paid instead of doing this because to be honest I don’t even know

if I’m going to use my degree when I graduate, and school is just so expensive.” However, participant 15 said “Yeah I was struggling academically and financially. There is no point of me paying so much to go to school and I’m barely passing.” The other major reason given for thinking about leaving the college is exemplified by participant 11 who wanted to transfer due to their major not being offered and who said “There is a point where I wanted to go to college by my family but the school was lying in a way. They said they had so many things but at the same time they don’t even have that. Then they were saying how you could easily transfer but you really have to go back a whole year.”

The last question participants were asked is “Are there things their school could have done to make it easier for them and what are they?” The question was open ended but 26% of participants agreed faculty could have had better communication with incoming students.

Participant 12 answered by saying “Being able to communicate with administration or meet with them easier. I think a lot of times if I email people from administration they take a while to get back to you. Having more open communication would be beneficial for students. They could definitely explain stuff better freshman year, and when I say stuff, I am really thinking about FAFSA.” Participant 15 also said “Just the communication between faculty people and I guess the business people or the dean of students residential life. There is a lot of miscommunication between everyone. I could try to reach someone and never get an answer or try.”

Discussion

The primary research question for the current study was: How does being a first-generation college student affect your transition into college? After analyzing all 15 participants’ answers it is apparent that race, participants academic year, and whether participants were student athletes had a huge impact on their transition and connections at college. Due to the review of literature, it was hypothesized that the more support first-generation students had from people on campus the more likely they will be to feel more comfortable on campus.

The results this study suggested that race affected first-generation students transition to college. Minorities were more likely to be worried about racism upon arrival, not feel comfortable asking their parents for help, feel pressure to stop attending, and more nervous to go to college away from home. White participants were more likely to be home sick and felt comfortable asking parents for help. Participants academic year affected how centered they felt on campus whether it be with peers, professors, or

faculty. The more years students spent at the institution the more likely they developed better relationships on campus. This also determined how well they understood financial aid documents. In addition, being an athlete had a huge effect on the student’s connection to the college. Athletes were more likely to have better relationships on campus and feel a part of campus life. Participation in a sport definitely helped with the social aspect of transitioning to college.

The results of the current study support findings from previous literature. In Lyons research they found first-generation college students are very likely to suffer from financial stress which affects students’ graduation rates (2004). Results also mentioned that first-generation students have a hard time understanding FAFSA. Although none of the participants in the current study dropped out of college many thought about leaving due to financial concerns.

Many also had a hard time understanding FAFSA documents especially during their freshman year. Although some participants may have faced financial hardship all participants in the study are students who decided they were definitely coming back to campus.

In Gibbons and Woodside’s (2014) research it is shown that students feel they have to attend college or go straight into the workforce. The results suggested that many students decided to go to college because they saw how not attending college affected their parents. The current study also shows that all participants felt it was “expected” of them to attend school or get a job. Participants whose parents encouraged them to go said their parents encouraged them to attend because they did not want the participants to “end up like them.”

Participants who were minorities in the current study said they were nervous to attend a PWI because they were not sure how they were going to be treated or if they would fit in. Huynh (2019) mentioned a stage in which minorities endure an identity crisis. Minority respondents in the current study do not mention identity crises but they do mention experiencing a culture shock upon arrival to college. All minorities in the study grew up in urban areas, they all expressed how attending a PWI in rural Wisconsin was a new experience. When minority students were asked if there was anything they had to adjust to upon arriving at college, many minority students responded that they had to get used to no longer being surrounded by people who look like them.

The results of Baker and Robnett’s study suggest that experiences once minorities get to college are more impactful than academic preparation (2012).



Both the Baker and, Robnett (2012) and Huynh's (2019) studies show that social support from colleges help minority students. In the current study social supports are beneficial for all first-generation students, not just minorities. Results show that respondents were more likely to feel comfortable talking to teachers and understand FAFSA if they had a mentor on campus.

The current study indicates that all first-generation students are benefitted by having financial support systems, and mentors to help build connections around campus. The current study also showcases how student athletes have an easier time transitioning to college. Although all first-generation students need mentors, minority first-generation students are more likely to need the most help with each barrier they face: social, financial, racial etc.

Participants were asked what social supports would make them feel like they are more involved on campus and all answers involved inclusivity, participants described parties or having more diversity. First-generation students would feel better if they were able to connect with other students in more neutral events held on campus rather than being confined to a group of students attending an outdoor orientation trip at the beginning of freshman year. Participants were also asked what their college could have done to make the transition to college easier and there were a few common answers that centered around communication. Respondents believe that it will be less pressure on them if faculty reached out to them during first semester of freshman year. This will allow students to know all their resources and feel more comfortable reaching out for help when they need it.

Limitations and Future Directions

The current study was held in the midst of a pandemic in which the college could not hold events. The lack of events may have impacted participants feelings, especially the one participant who is a first-year student. The pandemic also had an effect on the small sample size. Another limitation is that only first-generation students who decided to stay for another semester were included in the study. Therefore, it is possible that there may be additional barriers that caused others to leave the school that were not addressed by those who decided to stay. For this reason, more research should be conducted on those who decided to leave. For example, a true longitudinal study that tracks both those who decide to leave and those who decide to stay could be beneficial to better understanding barriers that face all first-generation students.

Conclusion

The current study has shown first-generation college students face social, racial, and financial barriers. Participants agreed the social transition could have been easier if there were more events on campus that brought everyone together. A few participants even mentioned having events with people who are in the same major to give students a chance to network and build connections within their area of study.

Participants believed that the racial transition will always be hard. Race is not a factor that only defines how you will be treated when you transition to college but anywhere you go. Participants felt it would help if they were surrounded by more people who looked like them, having a diversity club and advertising it to incoming freshmen can help minority students feel more comfortable on campus, especially minorities who are also first-generation students.

The financial barrier stems from high school. A few participants explained that their high schools held classes explaining what FAFSA is, and that helped them have a better understanding of the documents. Colleges should have these classes to teach freshman about how to fill out FAFSA documents, and why it is important. Participants felt their resources in the financial aid department at their college was not advertised enough and this is a contributing factor to why they struggled.

Communication between faculty and students is a major key in helping first-generation students feel comfortable on campus and also understanding the resources they are given while at school. Many participants were too shy to talk to their professors. The current study shows that being a student athlete makes the social transition much easier for first-generation college students. More events on campus, and better connections between faculty and students help with the social and racial transition to college. Lastly, the more educated students are on FAFSA whether it be from high school classes, a college class or, a member from financial aid office reaching out it is more likely they will be able to understand their FAFSA documents.

The current study has showcased many needs first-generation college students face upon arrival to campus. The final goal of this research is to help faculty and non-first-generation college students understand different barriers first-generation college students face and how we can all be of assistance to them as they continue to navigate through college.

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Appendix A

Interview Questions

Demographics

1. Age?
2. Ethnicity?
3. Where are you from?

Upbringing/home life

1. Describe your family situation
2. What does your parent/guardian do for a living?
3. What made you want to go to college?
4. Did your parent(s) / guardian(s) encourage you to go to college? Tell me more about that. Do you have any specific career goals?

Transition into college

1. Did you have HS counselors that helped with college selection or planning?
2. Did you have a mentor in HS that encourage you to go to college? Tell me about them.
3. What sorts of feelings did you have about attending college away from home?
4. Were you worried about anything in particular?
5. Did/Do your parents support your decision to go off to college?
6. Do you ever feel pressure to stop going to school and help out back home?
7. Do you feel comfortable asking your parents for help while you are at school? (could be financial assistance or a question about classes, etc.).

Support system:

1. Do you use services like tutoring, advising, counseling, diversity center, etc.? Why? Why not?

Financial

1. Do you understand the documents you received from financial aid?
2. Do you feel you will be able to pay for all 4 years of school?
3. What do you have to do to afford School? (work during summer, work during year, etc.)
4. What expenses concern you most while you are attending school?

Academic

1. Do you talk to your instructors outside of class? Why?/Why not?
2. What types of assignments do you work hardest to complete? Reading, writing, exams, etc.

Social

1. Do you have a mentor(s) here at Northland? Student, staff, faculty?
 - a. What do you do with them?
 - b. How have they helped you?
2. Do you have friends that you feel comfortable talking about stuff with?
3. Do you feel part of Northland?
4. What type of social supports would make you feel better about being a student here?

Life here at Northland

1. Did your idea of college match what you are experiencing now?
2. Have you ever thought about leaving Northland? Why?
3. What made you decide to stay?
4. Are there things you had to learn or things you had to adjust to get along here?
5. If you could change one thing about Northland what would it be?
6. Are there things that Northland could have done to make things easier for you? What are they?
- 7.

SOCIAL MEDIA AND DISINFORMATION: DIGITAL CRITICAL THINKING

Francis Hadley, University of Wisconsin-Superior
Dr. Daniel Lawrence, PhD, Mentor

Disinformation has come to public attention in the last decade, with the rise of social media and targeted, political advertisements. As computer technologies rapidly evolve, humans have struggled to develop methods to combat the effects of disinformation and have even struggled to understand how disinformation spreads. Despite this, very little conclusive data on how people interact with disinformation on social media in their daily lives exists. This study aims to look at how disinformation manifests itself on social media as perceived by those individual users. This study will examine some of the causes and effects of disinformation on today's world and begin to pose some solutions to fighting back against these technological actors.

The study explored digital literacy and disinformation across various generations using 30–45-minute qualitative interviews with participants across five different states. Respondents were asked about their social media use and digital critical thinking. Using inductive coding and analysis, the results show the impact of digital apathy across multiple generations as well as a lack of digital critical thinking when it comes to news stories.

The results suggest that digital apathy and a lack of digital critical thinking are fundamental elements in disinformation spread. Fearful of retaliation for going against the curated crowd, respondents would rather not waste their time or energy to correct false information. Digital sympathy and rhetorical thinking are crucial to fight back against rampant disinformation campaigns to protect the future generations of social media.

Literature Review

Classical Rhetoric

While public attention and scholars are only now beginning to scratch the surface of the disinformation phenomenon, ancient Greek philosophers understood the dangers and powers of persuasion. This literature review will cover key ideas from classical, contemporary, and digital rhetoric, and digital media theory, as these ideas can assist us with understanding the complex phenomenon of disinformation. To many, the term “rhetoric” brings images of long dead philosophers and graying legislatures launching verbal attacks against one another.

The term first meant an effective way of speaking and persuading. Scholars understand that the term “rhetorike” was first written by the Ancient Greeks of the 5th century and came into use in the democracies of Syracuse and Athens (Kennedy 1). In Plato’s dialogue Phaedrus, we see a critique of the Sophists and of making speeches that are not aligned with truth. It is in Phaedrus that we see a theory of rhetoric that demonstrates the significance of the alignment of speech and truth. Aristotle on the other hand, favored a more systematic approach to rhetoric, and laid down many of the terms and frameworks we still use today, such as the appeals of ethos, pathos, and logos. As we know, ethos, pathos, and logos are still widely used in college composition courses and in rhetorical analysis. These lessons from classical rhetoric can help us to analyze disinformation. With disinformation, as with speech, we can analyze a social media message for the character and trustworthiness of the speaker (Ethos), the logic of the argument (Logos), and the emotion evoked by the message (Pathos). These tools of classical rhetoric are still useful today in our contemporary understanding of speech, language, and media.

Technology Problems

As humanity advanced its level of knowledge and science, new devices, products, and skills followed suit. With each new wave of technology came a similar wave of fear and hesitation. Perhaps no time in human history has the power of speech been so evident as the 20th Century, which saw the rise of mass media technologies like radio and television. Powerful leaders took advantage of these tools and technologies to further their persuasion. By the 1940’s, people were beginning to see the power mass communications could have on the world, one of the biggest critics of these changing technologies being Martin Heidegger. He asked society to consider their relationship to technology and how that relationship may shape the future or define what it means to be human. Modern technology, according to Heidegger, is different because it challenges the forces of nature that humans previously were at the mercy of. Speaking on the transformative power of technology, Heidegger talks about the “energy” that is stored in the natural world. As new technology is developed, this energy is “unlocked” and “distributed” in ways not seen before (Heidegger 5). This distribution can have unforeseen consequences when we develop too rapidly.



This new wave of technological advances also brought about social change as well. Marshall McLuhan famously warned that “the medium is the message” (McLuhan 8). In other words, what mattered with these technological revolutions was not necessarily the content that people were consuming, but the medium through which it was being consumed. For example, the danger of television is not the violent shows a family watches-but the fact that a television now exists in the home and has changed our relationships with reality, with our families, and with society. In this sense, the television ‘invaded’ the world, and we haven’t been able to even fully grasp its influence on our lives as it has begun to fade into history. The idea that technology and advancement bears dangers to society is nothing new and it is no surprise the same echoes of these fears are being applied to the internet. Technology is more than a neutral facilitator, as discussed by Andrew Feenberg is his lecture on the philosophy of technology. Speaking of humanity and technology, “The goals of our society can no longer be specified in a knowledge of some sort” (Feenberg 5). The digital spaces created today are no longer simply libraries or archives-but living breathing spaces. And now, with the advancements in computer and internet technologies such as social media, smartphones, and targeted advertisements the exact place of technology in society remains a mystery, but it is a topic of discussion going into the future.

Technology and Rhetoric

As technologies advanced and continue to advance in the 20th and 21st Centuries, rhetoric as a field of study has been slow to keep up. 20th Century rhetoricians like Kenneth Burke demonstrated how all communication is symbolic and expanded the field of rhetoric beyond its rigid, classical bounds of oratory and speech. Scholars continued to push the field outward, with thinkers like Sonja Foss cementing a theory of visual rhetoric in the 1990s. Foss explains that the “study of visual imagery from a rhetorical perspective also has grown with the emerging recognition the visual images provide access to a range of human experience not always available” (Foss 143). A further study by Murray laid the groundwork for not only a visual theory of rhetoric, but all non-discursive rhetoric. This theoretical perspective on visual imagery is vitally important in the age of social media. With our feeds flooded with images and nondiscursive texts daily, it is important to know the power they hold over us. And yet, there is another set of forces that hold sway in the age of social media. One that is invisible and difficult to understand fully.

There are a variety of things that the

modern computer has brought into the world. One of those things is a large amount of rules and procedures that govern how people interact with the internet, or software such as video game and similar apps. Ian Bogost writes extensively on the persuasive power of such commands, many of which are invisible to the naked eye. Deemed “procedural rhetoric,” it is formally defined as “the practice of persuading through processes in general and computational processes in particular” (Bogost 3). These procedures are responsible for influencing millions of people simultaneously as they interact with and exist in digital spaces.

The effect of these procedures is starting to be seen in future generations. In one study, 97% of high school students failed to see a conflict of interest in a web page about climate change clearly marked as being written by a fossil fuel company (Breakstone). This work by the Stanford History Education Group inspired this study, by further documenting digital literacy in other age groups and exploring how disinformation functions in social media. The fundamental lack of critical thinking skills being applied to digital interactions such as these shows the power invisible procedures are having on the generations that grew up with them.

Disinformation and the Future

Bogost’s work on procedural rhetoric is so critically important because of the ubiquitous nature of algorithms in our daily lives. The same can also be said of social media platforms and the way information is spread today. Artificial Intelligence (AI) and algorithmic processes influence how we engage with the world on a daily basis. In a recent study, Kertysova talks about the double-edged nature of AI and disinformation. They speak on the rise of fact checking projects cropping up across the world, up to 188 projects over 50 countries (Kertysova 3). Given it’s impartial appearance, it would seem like AI is the key to countering disinformation, however. The problems arise when you consider the lack of human input in the censorship process. Purely AI systems can result in false positives, the over blocking of proper content, and keeps the dream of a fully automated AI fact checker distant on the horizon (Kertysova 5).

When it comes to the various problems disinformation can cause, the exact details are still hazy. According to a study done by McKay and Tenvoe, online disinformation campaigns have become the defining political communication of our time (McKay 1). Further, they pose that if left unchecked, these campaigns threaten any hope deliberative democracy has to survive. In the wake of the 2016 presidential election in the United States, it is clear

that one of the main fears is that such disinformation campaigns threaten the outcomes and legitimacy of elections. But it is more than that. These campaigns also look to weaken social institutions and trust in those who we should be looking to in times of crisis. McKay continues, describing a deliberative system, one that has “two general spaces: one where informal political discussion take place, and a core where deliberation is focused... such as legislatures” (McKay 2). Disinformation campaigns targeted to social media platforms take advantage of social media’s ability to take fringe information normally weeded out in the first sphere and launches it squarely into the second. They also highlight that the most troubling thing about disinformation campaigns is that they are participatory, meaning they spread “through – and with the help of – online crowds and other information providers” (McKay 5).

The study continues, talking about three specific areas of harm caused by disinformation: corrosive falsehoods, unjustified inclusion, and moral denigration. Corrosive falsehoods are misperceptions that can undermine those with “epistemic quality.” This is the quality given to those who work in the higher sphere of the deliberative system, those who have been empowered through their expertise. When disinformation spreads such misperceptions, it can cause those outside of the empowered sphere to question any findings without using facts or logic. A good example of this is the recent Anti-Vaxxer movement causing problems across the US (McKay 6). This can sometimes lead to “Unjustified inclusion” or actors without empowerment inserting themselves into democratic discussions. If left unchecked, pervasive inauthenticity can occur. This is where a majority of people fear normal discourse has broken down due to too many accounts being bots or foreign agents sent to change outcomes (McKay 7). Lastly there is moral denigration, where nefarious agents use “false claims, chauvinistic language and visual imagery to stoke moral revulsion towards particular individuals” (McKay 7). A deliberative system only operates when they can successfully promote mutual respect among citizens. When disinformation campaigns come into play, the breakdown of the entire system is immediate.

Disinformation is a problem that threatens all aspects of life in the age of social media. In a study, Rubin discussed the idea that disinformation could be classified as a epidemic or plague devastating the world. They touch briefly on the idea of Aristotle’s ethos as becoming dominant in today’s world. Disinformation relies heavily on appeals to emotions rather than grounding in any logic of fact-

based argument (Rubin 3). The problem of proliferation of dis/misinformation on the internet continues to explode due to social media sites. These sites remove news from it’s source and weakens the value of reputation in fact checking. It also allows users to stop checking sources entirely, simply taking anything that appears as a news story posted to Facebook as true. Rubin goes on to apply the disease triangle, a conceptual model from the 1960’s, to the disease of disinformation.

The original triangle had three components: A virulent pathogen, a susceptible host and a conducive environment. The pathogen is the easy one, as it is the campaigns themselves. The host is, quite simply, the overloaded masses with too much information coming at them too quickly with little way to sort fact from fiction. According to Rubin, “few news readers have the time and energy to fact-check every piece of information they come across” (Rubin 9). And lastly the environment takes the form of complacent platforms that willingly allow false information to be posted and spread across them. This is all due to a problem of turning clicks into revenue. “In a media economy based on user engagement, each hit on a web page translates directly into dollars” (Rubin 8).

There is quite a bit of quantitative data concerning disinformation. All of the studies conclude with the idea that more information is needed. None of this data alone seems to bring us closer to tackling the problem of how to remove large disinformation campaigns from digital spaces such as social media. The individualized nature of social media necessitates that a more qualitative approach reveal fundamental aspects of social media and disinformation in everyday life.

Methods

The methodology I used came from two main sources: First, I approach the problem of disinformation from an interdisciplinary perspective, using rhetorical analysis, the philosophy of technology, narrative, and creative non-fiction to address the complex problem of disinformation. I couple this overall approach with the analysis and review of responses from a qualitative ethnographic study to further the pool of knowledge on such a cumbersome and difficult topic.

Rhetoric is the art of persuasion founded in Ancient Greece regarding the effects of good and persuasive speech. Rhetorical analysis investigates how texts, media, speakers, etc. articulate messages to achieve particular goals. Modern rhetorical studies have expanded to include the analysis of visual, digital, and other non-discursive forms that influence us. I use contemporary rhetorical theories such



as Bogost’s procedural rhetoric to explore how disinformation manifests and interacts with the public.

The main reasoning behind my methods were due to disinformation’s intangible quality. Disinformation campaigns can take a variety of forms, and nearly everyone has come in contact with them on social media platforms. The tricky part is that everyone interacts with this information in different ways. This again makes quantitative data not only difficult to collect, but also lacking in the depth of analysis to begin to understand this disinformation. While knowing how these campaigns can spread and how fast they do so is helpful, that does not begin to break down the social reasoning behind why people share or interact with the stories. It is for these reasons that a smaller, qualitative data collection method was selected.

My research method was qualitative ethnographic interviews. As part of my formal research, I conducted seven personal interviews with participants, either in person or over a virtual software such as Zoom. Review by the University of Wisconsin—Superior IRB showed that the question being investigated would cause no more than minimal risk to the participants. In addition, all participants were provided an informed consent form to review and fill out before continuing with the process. All interviews were recorded with permission.

Participants were chosen across a wide range of age groups to help show how disinformation campaigns affect them differently. Participants were found through word of mouth and snowball sampling from prior participants. Once completed, the recordings were reviewed, and patterns began to emerge, forming the basis of the conclusions drawn in this paper.

Potential limitations ran into included where to find participants and the nature of the interview questions. It proved difficult to find and word questions that got at the heart of the research question without leading participants to a specific response. Future studies may wish to expand their sample size greatly and seek participants from a wide variety of backgrounds and geographic locations.

Results

The ethereal nature of disinformation in the digital world led this study to be set up for qualitative results. As such, the participants were each asked 10 questions regarding their social media use. Each interview brought about a different narrative and snapshot of a presumably typical digital user. Because of that, the results were quite varied across multiple areas of interest. Once all the data had been collected, it was first sorted using open coding. From these codes, patterns began to form and gather,

which is explored further in the discussion section.

Several themes emerged from the open coding of the interviews. For this study, participants were divided into three broad age categories: From ages 18-24 were considered Gen Z. Ages 25-39 were considered Millennials, and age 40 and older were Gen Xers. When asked about their age and what generation they identified with, one participant said they were part of Gen X, three identified as millennials, and one identified as Gen Z. One person identified themselves as “half millennial, because I am technologically compliant. But I do like the do your own thing kind of Gen X way.” (OP Interview). Generational identifiers were collected to learn more about the relationship between digital literacy and age group. There is a common misunderstanding that ‘young people’ are more digitally literate, but this is not always the case.

Participants were asked about the social media sites they used most frequently. There were a few common sites, such as Facebook, Twitter and Tiktok that came up across all interviews. Table 1 has the full breakdown all of the social media sites the participants said they used most often.

Social Media Site	Mentions in Interviews
Facebook	44
TikTok	21
Twitter	11
Instagram	8
Reddit	7
Snapchat	6
YouTube	4
Tumblr	3
MySpace	3
Discord	2
BuzzFeed	1

Table 1:
Breakdown of social media sites mentioned during interviews

Traditional News Source	Mentions in Interviews
BBC	11
Local News	8
NPR	4
New York Times	4
Wall Street Journal	3
Fox News	1

Table 2:
Breakdown of traditional news sources mentioned during interviews

Over the course of the interviews, participants all spoke about news sources that they trusted. 3 of the 7 mentioned their local news as a primary source they trusted. Two of them mentioned CNN or NPR while a others talked about Fox News in regard to trust. Table 2 has the full breakdown of all the news sources mentioned.

Five of the seven participants spoke about how social media had had an overall negative impact in their lives, while only three of them mentioned the positive impacts directly. One of the participants, an elder millennial named Nevada, talked about how dark the internet had become over the last decade:

There was a, there was one time I followed one of those (Reddit) threads. And as I scroll down, I started getting into, like, really, like, really dark stuff, like, things the average person really doesn’t need to take in, you know. And when I say that, I mean, I don’t think people were ever meant to have this amount of bad news thrown at them at once.

Most talked about a feeling of distrust towards posting because no matter what they would be attacked.

Everyone was able to identify one good aspect of social media, with the dominant idea being a sense of connection. All of those interviewed admitted to actively using social media for multiple hours and day. Four of the seven mentioned that it was nice to fill time when they were bored. When asked about deleting their online accounts, every participant said that it would be too difficult or would be bad if they did so. One person worried about the idea of a “phantom profile” lingering out in the digital world. All study participants were in some way aware of the algorithmic or procedural processes that influence the types of content that is delivered to their social media feeds.

Apathy was a strong theme across all of the interviews. Five of the participants discussed some form of disengagement when interacting with social media posts. For most, this took the form of simply avoiding the post causing them distress, while for one gen Xer, Oakley, they became more aware of posts that made them upset. “I had to just be aware that whenever something like that came up, like some of the creepy stuff you see on the internet just to be on the lookout for anything.” Others were concerned with their mental health due to their social media use. The idea that they were comparing themselves to what they were seeing on their feeds ran deep and caused negative emotions. Only Kennedy, a Gen Z participant that identified as the last of the millennials, was able to articulate the “rose colored” lens that social media is viewed through:

I think I can say this confidently, in that I

feel like social media, most of the time has more of a negative impact. Mostly because I think the things that were shown by both friends, family and outside resources, only show positives and only show the best side of someone or something. And so I think social media glosses over the negative aspects of life. You only see people putting their best foot forward, and it makes you feel bad, because of course, not everything is perfect all the time.

Discussion

Generational Differences

All study participants were not confident of their own generational identifier, yet seemed to consider it an important part of their digital identity. The lines blur quite a bit between these defined groups, however. Enough so that when asked, participants all struggled to even pronounce which generation they identify as. This blurring of lines leads to generational confusion and perceived isolation. How millennials are killing industries and Gen Zers have humor that does not make sense. Millennials reside in an interesting middle ground. They grew up in a world before the digital but were also there to pioneer it. They exist in both worlds, and bring with them a healthy amount of skepticism. They hold with them a sense of pride having been a part of shaping their digital spaces, through sites like Myspace or the original Facebook.

Social Media’s Impact

Social media and it’s design is something that is not going away anytime soon. A number of participants said that social media was here to stay, and getting rid of it permanently would prove to be difficult. Whether that was a fear of a profile still lingering out there, or simply losing the connection to loved ones, the idea of not having social media is too much for most people.

When talking about social media, most participants indicated some form of dependency or addictive behaviors. Multiple participants talked about using social media apps to “kill time” or something easy to do when they were bored. Many of them check social media sites multiple times a day and are active on these sites for multiple hours. Jaron Lanier discusses the idea of technology “lock-in” in his book *You Are Not a Gadget*. As technologies continue to build upon one another in a near linear path, once a technology or design has been around for a while, it becomes difficult to change them. This is because so many other designs rely on said design that it would be a logistical nightmare to retrofit



all of them (Lanier 7). A good example of this is in modern social media designs; an endless feed, and curated posts have become the standard for all new social sites. Social media as a concept has been locked-in to our everyday lives and lays the foundation of our interactions in the digital world, even if the individual site designs may differ. For some, however, the line between the digital and the real blurs a little too well.

The digital world is growing bigger every day, but that doesn't mean that our digital lives reflect our reality. It is too easy, as one participant points out, to forget that social media pages such as Facebook and Instagram are idealized versions of people. For the most part, the best pictures and words are chosen to represent us in the digital space. How simple it is, to forget there is a person with troubles and problems on the other side of the screen. The idea of comparison came up a few times in the discussions, a digital version of keeping up with the Joneses that has no perceivable end to it. One participant, a millennial named Kennedy, talking about outside validation:

When you post and feed off of a social media presence, that reflects in wanting outside validation, wanting people to see how happy you are, how attractive you are, how well you are doing

There are strong emotions tied to social media use, from the fear of a dissenting opinion to an unnerving distrust that something isn't quite right. Most of the people spoken to said that social media had had a negative impact in their lives in one way or another.

That doesn't mean that widespread social media use is a bad thing. All of the participants spoken to brought up a number of positive things social media has brought forth. The most common theme was staying connected to those that matter to them. Some met their significant others through social media, while others found comfort in the feeling of being connected to the wider world. Oakley Peters, a gen Xer, talked about the unique event of comforting a dear friend across the country. They talked about a family from years ago that had suffered the death of a loved one. Speaking on the positive event of sending them flowers, they said: "And, you know, it was like one of those things where had I not logged in, I wouldn't have seen that-I wouldn't been able to keep up with them." As social creatures, these social bonds form a foundational part of how to navigate our realities. During times of crisis, such as the COVID-19 pandemic that swept around the world, staying connected through social media was a lifeline many had to rely on. In today's world, some people's entire careers revolve around social media, creating jobs in the digital world, as was the case for some of the participants.

Digital Apathy

All across social media, strong emotional responses abound. Companies across the new digital world have distilled these emotions and seem to be trading them in for profit or political power. Whether it is fear of going against the perceived crowd, or becoming angry when they read a news headline, emotions drive almost everything that happens across social media today. This imbalance of pathos with little logical drive brings us back to the ancient days of Aristotle and Plato. The art of rhetoric is lost to the masses that only think with their heart. This is the same heart that disinformation seeks to control. Disinformation relies on a strong emotional response from people, which explains why it thrives on social media.

One of the more common responses seen was that of apathy towards anything posted on social media. Such digital apathy seems to stem from a few different places. First, there was an exhaustive feeling when participants were discussing social media use. There was simply too much content being generated for them to consume regularly. This causes tension when it runs into the need they had to stay connected with others or belong to a community. The fear of missing out led them to exhaust themselves trying to keep up. This content overload also led people to question, if only slightly, the impact their posts had on the digital world. Multiple participants said that they were not "interesting enough" to matter in social media spaces. When talking about why they stopped posting as much, Oakley said "I just fell out of it, because just nobody cares that I had a tuna sandwich or something... it was getting to the point of oversharing."

Another place that apathy popped up quite a bit was when faced with posted information that was incorrect. Everyone said, in one way or another, that it wasn't their place or worth the time or effort to try and correct someone who had posted something false or misleading. Kennedy Tatham, mentioned earlier, said "I don't feel like calling someone out for posting something's that's wrong changes how they actually feel about something. And so I just don't." Even if, and particularly, that person was a loved one or a close acquaintance. The very connections that people treasure in their social media use were causing them to hesitate in confronting someone spreading mis/disinformation. The fear of being "attacked" or "jumped on" by a perceived wall of opposing opinion caused people to find it not worth the effort to try and deal with the problem. Marlyn West, a self-identified "Elder Millennial," talked about a common event for them. Reading an article about a recent court sentence, the comment section ignites,

And the people in the comments, were all

like, this is an outrage, the justice system isn't serious, and everybody gets a slap on the wrist. And so I was like, commenting down there and like, you realize that if you lock this lady up, she's just gonna be sitting in a jail cell. But if you give her probation, she's gonna be like working a job and like earning money that's going to go back to pay the restitution... And then people were like, jumping all over me in the comments. And I'm like, okay, whatever. And I just kind of I just disengaged at that point, because I was like, these people are idiots and are not worth my time.

The fear of going against the crowd is a powerful deterrent for a lot of people in the digital world. Most participants spoke about how it wasn't worth it because they knew that they wouldn't change the mind of the original poster, so what was the point of trying to. They completely neglected to realize that in doing so, they were allowing something they knew was wrong to continue to persist on the internet, to be able to be seen by countless others as it spread.

The Power of Curation

Almost all of the participants mentioned algorithms in one way or another. This means that in general, people are aware that there are forces at play on the internet that influence them. Many mentioned the idea of curation, or a feed that is customized for just them. No one, however, seemed to grasp the power they held in their hands. Each acted as if they were under the thumb of these algorithms and simply had to accept what the computer thought they wanted to see. Most were aware of targeted advertising being directed at them when they clicked on a item or made a search and all were frightened or creeped out by this fact. They had completely lost the idea that if they want to change their page, they have that power. By being deliberate with their searches and digital consumption, they could create a space more to their liking.

The power of curation means that one could create a space they feel safe and comfortable in. To be able to find that connection and community so many are looking for. Being able to think about technology as a tool, instead of a looming mysterious giant is the core of the digital critical thinking needed in today's world. Without it, technology will continue to grow and evolve and leave humanity behind.

Digital Critical Thinking

As the digital world continues to become dominant, it is becoming harder and harder to keep track

of our own behavior as we are accessing it while tech companies seem to develop new ways everyday. Awareness of what we post on the internet is no longer enough. Our existence in these digital spaces is something we need to be aware of as well. As more and more of our activity on social media is being monitored, turned into data and monetized, being able to identify the warning signs of nefarious practices is paramount to success.

It was clear that people are aware of social media's design and function being just a little off. All participants were able to articulate that they knew social media was designed to be personalized, but no one was able to articulate how. Some talk about how they themselves were becoming a product, many mentioned algorithms and curated content for them. No one, however, was able to give specific examples of what those algorithms or designs looked like. This lack of digital literacy is worrying, as hundreds of thousands of people are interacting in a space they don't fully understand in a way that is highly influential to them.

Another problem unique to the current digital space is the differences in social cues. When all you see is word across the screen, it is easy to forget that another person is, supposedly, on the other end. This cuts both ways, as it is too easy for someone to hide behind their screen and either cause mischief or spread strong emotions. On the other side, you have people who are simply too afraid to stand against a crowd of digital phantoms that they perceive lurking just on the other side of the glass.

Procedural rhetoric up until now has been contained within the realm of video games, to describe the way designs and structure of electronics persuade and influence people. The data collected in this study begins to show that the designs and structures of social media sites is being harnessed by a variety of actors with the common purpose to influence people. Left unchecked, social digital illiteracy, or how we behave in digital spaces, could get worse as technology gets more sophisticated.

All the participants said that they were frustrated with loved ones who were perceived as not fact checking a news story before posting it or sharing it through social media. Those same participants also willingly admit that they themselves do not, or rarely, fact check a news story that they come across. Many indicated that reading a story outside of their "wheelhouse" or area of interest makes them less likely to do any sort of fact checking. If the news source in question is one that is trusted as reputable and the story sounds within the realm of possibility, participants were willing to accept it at face value.

All of this demonstrates a fundamental lack of digital critical thinking. People are interacting with



and being influenced by the procedures and designs of the internet every day. None of the participants, however, seemed to put more than a passing thought into how or why they are consuming this information in the digital world. Even knowing that social media's algorithms exists was not enough to spur participants into trying to figure them out. They would rather, it seems, wallow in their apathy filled with endless instant gratification.

In the digitizing of the world, fundamental skills have been left behind. Such digital critical thinking returns to the roots of classical rhetoric. People are not considering the basic questions proposed by classical rhetoricians. They instead consume messages as they are given to them without thought. This form of digital sophism has blinded society for too long. Rediscovering the core concepts of ethos, logos and pathos and applying them to the messages we encounter in the digital world is crucial to its survival. As the messages start to be analyzed, it will become easier for us to see the procedures and other rules in place, taking them out of the dark to be dealt with. Once this happens, solutions will become more obvious and clear. Things in the digital world are very similar, but not quite the same as the physical world. The relationships laid out in one may not transfer perfectly to the other, but it is a start. Forming a framework for the connections between the message, the sender and the method of sending will allow digital rhetoric to flourish. Perhaps procedures will be created that will prevent further spread of disinformation. Reclaiming basic skills such as these will begin to inoculate the viral spread of problems across these digital spaces.

Conclusion

The increased spread of disinformation in the modern world is alarming. There is a lack of data to help show where these dangerous campaigns are coming from. This study shows that digital apathy plays a large role in how disinformation spreads so quickly. It also revealed a concerning problem involving the lack of critical thinking that goes on in digital spaces. As more and more of the world is becoming digitized as technology is spreading, now is the time we need to start educating ourselves in the same critical thinking skills that exist in our physical reality. The digital world is just the next stage of evolution for the field of rhetoric. Now more than ever, the ways in which people influence each other is paramount to our success in this new frontier. The difficult part is operating in a world where not all of the influence can be seen or heard. What is clear is that without the transfer of these critical thinking skills into the digital world, the disinformation problem will only continue to worsen. By

once again learning to look at the messages being presented, we can begin to cure the problem of widespread disinformation.

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CIRCULAR ECONOMY AND SUSTAINABILITY: EVIDENCE FROM SMALL BUSINESSES OF MILWAUKEE

Alyssa M. Markley Konopa, University of Wisconsin-Superior
Dr. Sakib Mahmud, PhD, Mentor

Consumerism guided by linear economic principles that emphasize the extraction, use, and waste of material resources for financial capital gain has proved unsustainable as staggering resource exploitation and ecosystem degradation threatens a global sustainability crisis that cannot be reconciled in a linear society. This research proposes the paradigm shift to a nonlinear, circular economy (CE) as a solution for local communities around the globe to meet their global sustainable development goals (SDGs). The circular economic model represents a zero-waste, closed-loop system that builds environmental, economic, and social capital while significantly impacting global sustainability initiatives.

The integration of circular business models (CBM) into local small business operations is identified as a key leverage point in supporting the paradigm shift to a circular economy and achieving global sustainable development goals. Data indicated that the integration of circular management practices into local small business models can act as a catalyst for the paradigm shift to a circular society. This research investigated current applications of circular economic management practices within small business models in Milwaukee, Wisconsin and explored the challenges and barriers faced by local small businesses. Case studies were conducted to analyze sustainable management practices amongst small businesses in Milwaukee. Representatives of local small businesses and industry experts were interviewed and surveyed in order to collect qualitative data regarding the status of current sustainable management practices. The subsequent comparative analysis addressed the infrastructure barriers that create sustainability challenges in Milwaukee. The concluding research findings indicated the need for both community support and systemic reforms in the successful integration of circular economic principles.

Introduction

Without community support and systemic reforms, one can expect a lack of application of sustainable management practices within small business models of local communities. To test the hypothesis, this study applied a mixed-method approach of qualitative and quantitative analyses

based on case studies and online surveys of small business owners and industry experts in Milwaukee, Wisconsin. The mixed-method research approach was conducted for the primary purpose of (1) identifying current sustainable management practices and applications of circular economic principles within local small business models; and, (2) to develop a better understanding of the sustainability challenges and barriers that hinder the progression of widespread application of sustainable small business management practices in Milwaukee. The secondary purpose of this research is to investigate the ways in which local small business management was impacted by the COVID-19 pandemic, and how those impacts relate to the resiliency of circular business models. The research findings provided evidence indicating that Milwaukee small businesses can achieve triple-bottom line sustainability while contributing significantly to Sustainable Development Goals (SDGs) through the application of Circular Economic (CE) principles at key leverage points, such as the development of circular business models and sustainable local supply chains. However, findings also indicated that community support and systemic reform are both necessary for the widespread application of CE principles that encourage sustainable small business management practices in Milwaukee, Wisconsin.

Background

Consumerism in developed nations has led to material resource exploitation and natural ecosystem degradation worldwide. These unsustainable patterns of consumption are guided by linear economic principles that emphasize the extraction, utilization, and eventual waste of material resources for financial capital gain. This linear economic model has proven unsustainable as consequences threaten resource availability and supply chains across the globe. The circular economy represents the framework for a system that decouples economic activity from finite resource consumption to build environmental, economic, and social capital.

The fundamental difference between the linear economic model and the circular economic model is reflected by the ways in which "value" is perceived, created, and maintained. According to the Ellen MacArthur Foundation (2017), "the circular economy seeks to redefine growth, focusing on posi-

tive society-wide benefits,” by “looking beyond the current [linear] take-make-waste extractive industrial model.” In a CE, industry and development are driven by maximizing the lifecycle value of materials, products, and services, thereby creating incentive for ecological products and consumer goods, eco-design principles, waste recovery, recyclable packaging, dematerialization, and energy efficiency at every point in a product’s lifecycle. CE models are based on three principles: (1) design out waste and pollution; (2) keep products and materials in use; (3) regenerate natural systems (Ellen MacArthur Foundation, 2017). This CE model maximizes the potential for reuse and recycling of products and embedded materials while simultaneously reducing the consumption of natural resources, thereby closing resource material loops and eliminating waste streams.

CE principles applied at the micro, meso, and macro levels of small business operations, community initiatives, and systemic reforms can create a sustainable system of local businesses, consumer communities, and organizational structures. Implementing circular economic systems at these identified leverage points can support both local and global sustainability goals by reducing, and even reversing, the ecological impact of human activity.

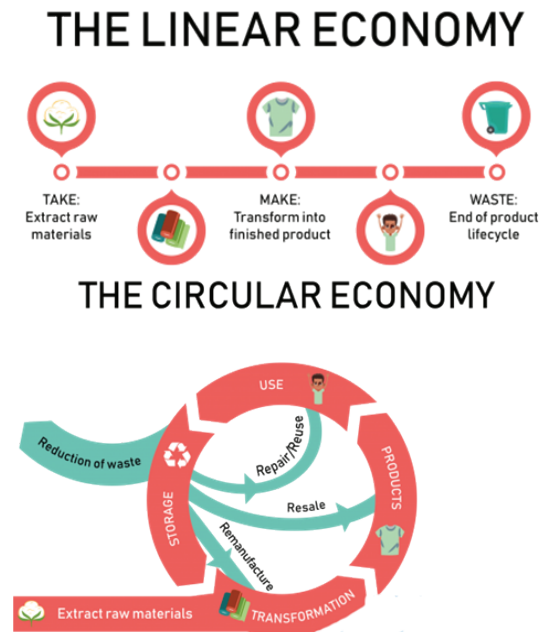


Figure 1
Linear Economy and Circular Economy
Note. Auriault, C. (2019). *The Linear Economy and The Circular Economy* [Image].

The integration of Circular Business Model

(CBM) into local business models represents one of the key leverage points in changing patterns of consumption and moving toward the circular paradigm shift. Sabina Scarpellini, et al. (2019) identified this key leverage point by concluding that there is significant environmental, social, and economic benefit in the regional by measuring the impact of local circular management practices. Schoeder, Anggraeni, and Weber (2019) support this claim while describing the application of CE at key leverage points as one of the most effective measures in achieving a significant number of the U.N. Sustainable Development Goals. Further research describes the global impact of local CE and CBM applications and “the [significant] extent to which (CE) practices are relevant for the implementation of the (SDGs)”



(Schroeder, et al., 2019).

Figure 2
Circular Economy Facilitating Sustainable Development Goals
Note. Patil, R., et al. (2019). *Circular Economy Facilitating U.N. Sustainable Development Goals* [Image].

Literature Review

This research is based on existing literature that analyzes the local application of sustainable management practices and circular economic principles amongst small businesses while identifying challenges, opportunities, and potential sustainability solutions. This review analyzes literature sources to determine how community support and systemic reforms can support the wider application of circular economic practices amongst business enterprises in Milwaukee.

Review of existing literature indicated that integration of circular economic principles into the business models of local enterprises has the potential to create society-wide benefits while positively impacting small businesses and stakeholders by supporting triple bottom line success. The Ellen MacArthur Foundation (2017) defines CE as an entirely sustainable system that builds economic, environmental, and social capital by eliminating waste streams, closing resource loops, and regenerating natural ecosystems. Further, the University

of Wisconsin Sustainable Management Program (2021) describes the ways in which CBM aligns with the triple bottom line sustainability framework, which expands business success metrics to include environmental health, social wellbeing, and an equitable economy (Miliotis, 2018). Integrating circular economic principles into sustainable management models involves decoupling business activity from finite resource consumption and transitioning to renewable energy sources (The Ellen MacArthur Foundation, 2017). As researcher Marcel C. Hollander (2017) reasoned, CBM included design and management practices that preserve the value of resources by increasing the lifespan of products and recycling materials indefinitely to eliminate waste streams. The University of Wisconsin Sustainable Management Program (2021) found that CBMs are proven to be more resilient and more effective in achieving triple bottom line success by supporting positive social, environmental, and financial performance. Circular economic theory can be applied in small business management to develop sustainable business models and supply chains that align with the triple bottom line framework and support the CE paradigm shift. According to McKinsey Quarterly’s analysis of Carnegie Mellon University’s Carbon Disclosure Project, more than 85% of environmental impact within the consumer sector is attributed to supply chains; supply chain management was 10-20 times more impactful than direct business operations. Menon, R., et al. (2021) identifies the main barriers to sustainable supply chain management: (1) lack of commitment from top management; (2) financial constraints; (3) organizational culture inhibitive; (4) “lack of new technology/materials and processes; (5) “lack of awareness of benefits; (6) lack of green purchasing; (7) lack of regulations; (8) lack of R&D; (9) lack of human expertise; (10) resistance to change; and (11) lack of performance metrics/evaluation standards.

Review of existing literature also finds that for most small businesses, legislation is the most important factor in implementing sustainable management practices (Schaper, 2002). Authorities at local levels can implement CE activities with more ease than their federal counterparts, and thus can encourage transition away from the global linear model through a bottom-up approach. A survey conducted by Revell et al. (2009) found that 60% of small business operators believed there should be more legislation to control the environmental and social impacts of businesses. By identifying leverage points at micro, meso, and macro levels, local authorities and initiatives can act as catalysts for the global transition away from linear economic models. The findings of the literature review indi-

cate that local applications of circular small business management require both community support and systemic reform.

Thesis statement

Based on the findings from the literature review, this study will examine the following thesis statement using small businesses of Milwaukee as the focus of the study.

Without community support and systemic reform, wider application of sustainable management practices that are built around circular economic principles would be lacking amongst small businesses in Milwaukee.”

Research Objectives

- Explore: current instances of sustainable small business management in Milwaukee
- Investigate: circular economic principles within local small business models
- Analyze: impact of COVID-19 related to local small business management
- Determine: local sustainability barriers
- Identify: leverage points for sustainable business development in Milwaukee
- Evaluate: opportunities for community support and systemic reform

Methods

To examine the thesis statement, this study applied mixed-method approach featuring both qualitative and quantitative analyses. Eight (8) interviews and an online survey involving small business owners and industry experts in Milwaukee were conducted to gather primary research data. Institutional Review Board (IRB) approval was granted to conduct the interviews and the online survey. Interview requests were submitted to twenty (20) local small business operators and five (5) industry experts via email or phone call using the purposive sampling method. Online survey requests were emailed to nearly one hundred (100) small business operators using the simple random sampling method. The interviews were conducted using Zoom, an online meeting platform, and the survey was conducted using Qualtrics, an online data collection platform. Interview subjects included six (6) operators of local small businesses and two (2) local industry experts. The six (6) case study subjects were chosen based on sustainability initiatives demonstrated by the small businesses; whereas, the industry experts were chosen based on their knowledge of sustainable management practices relative to the small business industry of Milwaukee. The interviews with local small business operators consisted of an average ten (10) questions presented over a dura-

tion of thirty (30) minutes; the interviews with local industry experts consisted of an average eight (8) questions presented over a duration of twenty (20) minutes. For the Qualtrics survey, subjects were chosen using random sampling of Milwaukee business owners registered with the U.S. Small Business Administration. The chosen subjects, then, received an email link to the Qualtrics survey featuring five (5) multiple choice questions and fifteen (15) short answer questions.

Limitations of the study

The results of this research were limited by the small number of interview and survey results, which may not adequately represent small businesses and/or industry experts in Milwaukee. Interview proposals were sent to twenty (20) small business operators and five (5) industry experts with a moderate response rate. However, the online Qualtrics survey, where the survey link was sent to nearly one hundred (100) small business owners in Milwaukee generated a low response rate of roughly 10%. Furthermore, responses from the surveys show varying levels of completion rates. Although 78% of the survey participants responded to all of the first five multiple choice questions, only 44.4% responded to the remaining short answer questions. Responses to interview and survey requests may have been low due to local small businesses grappling with the current worker shortage, and the reintegration of in-person shopping and dining due to shifting pandemic restrictions. Also, this experience indicates that online surveys with more multiple-choice questions than short answer questions might lead to higher response rates in the future. A post-pandemic world might allow more primary data collection through interviews and online surveys of local small business operators and community experts.

Results

Sustainable Business Operations. Analysis of case study interviews and surveys of small business operators in Milwaukee indicated sustainable business management practices based on eight focus categories: (1) supply chain, (2) energy & water, (3) pollution & emissions, (4) solid waste, (5) materials, (6) labor, (7) sustainability education, and (8) community engagement. Table 1 lists the categories of sustainable business management practices identified based on the research findings.

(1) Supply chain management and sustainability: Qualitative and quantitative analyses of Milwaukee small business case study interviews and online survey responses revealed sustainable supply chain management practices among small business owners. This is done by selectively engag-

ing with suppliers and companies. The selection process involves consideration of environmental impacts, localization, fair trade products, humane animal products, organic products, and green-seal certified products. In addition, local sustainable supply chain management efforts include a reduction in the number of factory shipments received and a shift from frequent air freight shipments to annual sea freight shipments. Small business owners in Milwaukee's restaurant industry demonstrate gardening, purchasing produce from local farms, and collecting food donations utilizing the local food systems.

(2) Energy efficiency & water sustainability: The analysis based on expert and case study interviews and the online Qualtrics survey indicated a variety of practices among Milwaukee small businesses that prefer to conserve energy and water resources. Water sustainability practices include practices such as reclamation methods to capture hot water generated through refrigeration systems for reuse in water heater tempering. The case studies also revealed energy conservation practices in the form of private solar energy projects. Two of the small businesses featured facilities total power by solar arrays. One facility reported solar energy generation of 56.32 kW; whereas, the other disclosed an annual carbon offset of 1178 tons by utilizing 493 rooftop solar panels. A separate case study interview revealed the implementation of a solar energy project capable of powering the entire small business facility with the ability to sell excess energy back to the power grid. Further noted examples of sustainable energy and water management among local Milwaukee small businesses include:

- Installation of 18-zone HVAC systems;
- eGauge tracking and analytics for energy management;
- Energy efficient doors on freezers and dairy cases;
- Night curtains on open coolers;
- Air curtains over building entryways;
- Electric vehicle charging stations; and,
- Sanctuary sink to toilet greywater systems that ensure water circulation.

(3) Pollution & emissions control: Findings also revealed various pollution and emissions control strategies adopted by Milwaukee small businesses. These include:

- Xeriscaping with native prairie grasses;
- Wetland conservation;
- Utilization of green spaces; and,
- Introduction of porous pavement for stormwater diversion and irrigation.

Furthermore, a primary case study of a small grocery store chain in Milwaukee reported annual reduc-

Focus Category	Sustainable Business Practices (Milwaukee)
(1) Supply chain	Low carbon-impact suppliers Local and regional purchasing Ethical products Local food systems Sustainable shipments
(2) Energy & water	Solar power Hydronic heating Water reclamation Energy efficient building fixtures Electric vehicle charging
(3) Pollution & emissions	Renewable energy credits Organic products Compressed natural gas vehicles Xeriscaping Stormwater runoff diversion
(4) Solid waste	Food waste diversion Plastic and cardboard recycling Plastic-free business models Recycling drop-off sites
(5) Materials	Repurposed building materials Reusable containers and dishes Packing material reduction and reuse Compostable materials Recycled marketing material
(6) Labor	Fair, competitive wages Benefits for part- and full-time employees Equal opportunity throughout structure Safe and healthy workplace Cooperation with unions Employee training programs
(7) Sustainability education	Solar energy education sites Public education of landfill diversion Internal and external education programs Sustainable community services
(8) Community engagement	Sponsorships, donations, and partnerships Community food security efforts Support for diversity and racial justice Development of cooperatives City-wide reusable food container system

Table 1

Findings: Sustainable Business Practices in Milwaukee

tions in greenhouse gas emissions through the use of refrigerated trucks that are fueled by compressed natural gas. The case study also revealed a significant annual carbon offset in the form of renewable energy credits for the grocery store chain, which decreased its emissions from 2,980 CO₂e₂ to less

than 430 CO₂e₂.

(4) Solid waste management: The interview and survey analysis of Milwaukee small business owners revealed solid waste management practices including solid waste reduction and landfill diversion. One small business demonstrated a circular

solid waste management model along with their recognition as a plastic-free business by the Plastic-Free MKE coalition. Noted recycling efforts among Milwaukee small businesses include:

- Baling soft plastic and shrink-wrap for recycling;
- Separating and recycling mixed plastics 1-7;
- Recycling natural corks, clear plastic films, and corrugated cardboard; and
- Providing recycling drop-off sites for community collection of household recyclables.

All the efforts listed above achieved a landfill diversion rate of 71% for one local grocer. The same local grocer also diverted over 170 tons of food waste from landfills by composting 100% of their food waste. Findings show that food waste diversion efforts of small businesses in Milwaukee include both internal composting programs and external composting services. One small business reported utilizing an external service that processes meat waste and another external service to process plant-based food waste. The meat waste is collected, reclaimed, and reintroduced into the consumer marketplace as tallow, protein, leather, and biofuels; whereas, the plant-based food waste is collected, processed into compost soil, and sold back to local residents and businesses. One case study of a Milwaukee grocery store chain reported an annual composting total of over 170 tons in 2020. Another case study of a local small business that provides external plant-based composting services to local restaurants has helped establish community partnership between a restaurant and its composting service program that led to the creation of the largest annual diversion of restaurant food waste in the entire nation. The impressive community partnership effort in Milwaukee received official recognition from the U.S. Environmental Protection Agency (US-EPA).

(5) *Repurposed building materials and sustainable food packaging*: The case study interviews revealed the sustainable use of material resources such as the use of repurposed building materials in the construction of new facilities and the use of reusable/recyclable food packaging. Other case studies of small businesses in Milwaukee found:

- Utilization of reusable food containers;
- Compostable food containers;
- Compostable produce bags;
- Washable dining dishes;
- Drop-off sites for glass jars;
- Recyclable and compostable packing materials; and,
- Recycled and locally printed marketing materials.

(6) *Employee management and sustainability*: The case study analysis of Milwaukee small

businesses found various sustainable business management practices associated with employee stakeholder management. These include:

- Commitment to provide opportunities for employees to learn new skills to improve their social and economic status (this is implemented by a local grocery chain which is part of the small business case study);
- Opportunities included leadership training programs;
- Professional and skill development programs; and,
- Apprenticeship programs.

(7) *Sustainability education*: a significant number of case study interviews reported sustainability education efforts amongst small businesses of Milwaukee. One small business is currently constructing a solar array which will power the entire facility and serve as a solar energy education site. Another small business, which offers a drop-off site for household recyclables, also uses these recycling centers to educate the public about landfill diversion. Further interviews found several small businesses offering internal and external sustainability education programs for their employees as well as members of their community. For example, the case study analysis identified a cafe offering sustainability education classes for its community members. The classes focus on healthy diets and food preparation, gardening and food cultivation, composting, canning, and other practices or skills to attain self-sufficiency. Survey findings also indicated small businesses in Milwaukee providing services and education to customers interested in composting, native planting, and sustainable home gardening.

(8) *Community engagement for sustainability*: primary analysis of both survey and interview results showed a strong desire for community engagement and mutually beneficial community partnerships among small businesses in Milwaukee. Results reveal a greater desire for participation in community coalitions, networking events, and sustainability initiatives. A noted example of current community engagement involves a cafe, which features a “pay-what-you-can” business model that supports community food security. This business model allows customers to pay what they can for any amount of food from a menu with a variety of options. Alternatively, customers can trade a half hour of work for a meal. This cafe was also found to employ youth interns, equip them with skills and training, and then, offer the option to hire them upon high school graduation. Findings also include:

- Circular food donations among community gardens, local farms, and small businesses;

- Community sponsorships;
- Fundraisers for youth lunch programs;
- Voucher programs enabling food donations to those in need;
- Sustainable agriculture partnerships; and,
- Youth outreach program partnerships.

Interviews with local co-ops showed discounted co-op membership fees for community members who receive government assistance. There are also co-op community funds to ensure sustainable development of local cooperatives. One co-op reported that it supports diversity and racial justice through public statements and recognizes black, indigenous, and people of color (BIPOC) suppliers and businesses through their website. Case study interviews also revealed how the city-county Task Force on Climate Change and Economic Equity is currently conducting research and reviewing proposals for the creation of a circular, community-wide reusable food container system in Milwaukee.

Barriers that impede sustainable business practices. Primary interview and survey responses indicated barriers that hinder the integration of business models that are characterized by sustainable supply chain management, service and distribution, and resource use amongst small business in Milwaukee. Qualitative data analysis indicated that the most prevalent barriers in implementing sustainable business practices among local small businesses include:

- Lack of information, misinformation, and/or, information asymmetry regarding the process;
- Lack of resources to support small businesses in terms of access to financial, economic, and operating capital;
- Low eco-literacy;
- Ineffective regulations;
- Poorly developed municipal infrastructures; and,
- Disruptions in sustainable supply chains.

For many small businesses in Milwaukee, low eco-literacy results in a lack of understanding of laws, environmental management, and best practice strategies. In addition, many local small businesses perceive sustainability efforts as requiring additional resources, in terms of time and staff, that are beyond their capacity. Analysis also indicated that small businesses do not face significant external pressure from customers, suppliers, or stakeholders to implement sustainable management practices. Results also showed that voluntary approaches to sustainable business management and environmental regulation are ineffective, especially in situations where challenges outweigh the benefits, or when it is the only strategy used.

Discussion

Circular small business management has the potential to promote both local and global environmental wellbeing, social capital, and economic success. The application of circular economy (CE) and circular business models (CBM) in Milwaukee is identified as a leverage point with the potential to conserve natural resources and restore ecosystem health on a global scale. Local small businesses can practice circular business management to facilitate community and planetary sustainability, as well as the sustainability of their own business enterprises. These twin goals could be achieved by (1) closing loops in industrial ecosystems, (2) replacing production with efficiency, and (3) reforming business operations through waste minimization. Opportunities to support the application of circular economic principles in Milwaukee small businesses include:

(1) *Circular business models*: Milwaukee small businesses can integrate circular product design, which generally follows one of two design structures: product life-extension (PLE) and design for recycling (DFR). PLE focuses on reusable products over disposable products, and guarantees an extended service lifecycle through product maintenance, repair, upgrades, remanufacturing, and retrofitting. DFR focuses on recycling and dematerializing products that have reached the end of their functional lifecycle, so that secondary materials can be reintegrated into manufacturing processes. Further, local small businesses can practice sustainable supply chain management by creating environmentally preferable purchasing policies to ensure positive social and environmental impacts while shifting business purchases to local and/or low eco-impact suppliers; Milwaukee small businesses can utilize a green purchasing resource called the Green Procurement Compilation (GPC) to compare the sustainability of potential supply chain management models.

(2) *Community support*: Community ecosystem partnerships with flexible and adaptive roles demonstrate increased resourcefulness and resilience. Resourcefulness is defined as “a community’s capacity to engage with their local resource base,” and is positively correlated with system resilience. (Ulug, et al., 2018). Circular community connections can be established to support regional resource exchange systems, training platforms, awareness campaigns, and certifications for sustainable products, practices, and employees. Regional resource exchange systems function to distribute resources amongst local businesses and organizations in order to mitigate costs and shrink waste streams. Community support can also be fostered by the development of a community network directory, which

could facilitate community connections through a network structure that directly connects local small business owners, organizations, and community members. Establishing circular community connections could also enable business mentor programs, which allow local businesses to share knowledge and support new sustainability initiatives within local businesses. Small businesses can also act as community mentors through partnerships with youth internship and adult outreach programs, which provide skills training and employment opportunities for community members. Interviews with local industry experts described current circular community connections, including the Wisconsin Sustainable Business Council and the Plastic-Free MKE coalition.

(3) *Systemic reform*: Interview and survey analysis indicated Milwaukee's need for action plans that support local circular economic systems, such as governance measures including indicators, standards, and planning; measures may also include governmental updates and increased enforcement of regulations and codes. Further, government agencies and NGOs could create organized markets; sectoral cooperation could through cross-cutting measures, like grants, incentives, and eco-innovation promotion. Interviews with small business operators and industry experts in Milwaukee revealed that a poorly developed recycling infrastructure and the complete lack of any municipal composting infrastructure are both major sustainability barriers that must be addressed by systemic reforms. Small businesses in Milwaukee also reported a need for policy reform that supports sustainable supply chain management. Regional government funding can be made available to local sustainability nonprofits and organizations that implement voluntary sustainable management; incentivizing local, sustainable supply chain management may offset hesitation caused by financial factors. Research conducted by Mendoza, et al. (2017) identifies circular supply chain management as a leverage point for the successful integration of CBM; the research found that the successful integration CBM included innovations within local supply chain management must be supported by systemic change.

The interview results with both small business operators and local industry experts indicated unanimous desire to redistribute tax dollars to support sustainability programs and equitable access to city resources. Leonidas Miliotis (2018) proposes a potential policy mix that can be adopted by local governments for the transition to CE; the proposal outlines three policy areas: (1) policies for reuse, repair and remanufacturing; (2) green public procurement and innovation procurement and (3) policies for improv-

ing secondary materials markets.

Barriers to Introduce Local Circular Economic Reforms

Study findings also revealed potential problems related the application of local circular economic reform as a means for achieving global sustainable development goals are the challenge of scale and the concept of "circular economy rebound." Scale presents a challenge if the application of local solutions, even in sum, proves to be an inadequate means for reaching global sustainable development goals. If CE projects remain isolated, they may not create a large enough ripple effect to facilitate a paradigm shift and the transition away from global linear models. Hence, it is necessary to confront these challenges in order to achieve global sustainability through local economic reforms. Solutions to this challenge of scale can be generated through national and international efforts to globalize the CE. Governments, organizations, individuals, and entities across all sectors can cooperate to create an international platform for sharing experiences, strategies, and data to facilitate the exchange of knowledge and develop missions, incentives, and practices that support CE application across the globe. Furthermore, there must also be cooperative efforts in establishing markets for the exchange of secondary materials to address the current unsustainable demand for resources. By coordinating international industrial policies and reforming global trade structures to connect and support local CE systems, the circular economy may be globalized as an adequate response to planetary sustainability issues.

Additionally, Trevor Zink and Roland Geyer (2017) introduce the concept of "circular economy rebound," which also presents a potential problem in the local application of CE principles as a solution for global sustainable development. Similar to the concept of energy efficiency rebound, circular economy rebound occurs when CE activities increase overall production, thereby offsetting the potential environmental or economic benefit of low-impact consumer products. This rebound effect is caused by things like disruption in supply and distribution chains, as well as mismanaged price effects. Furthermore, many potential strategies to avoid CE rebound are not feasible with for-profit business models. In fact, critics speculate that even encouraging CE opportunities among these private, for-profit firms is likely to cause CE rebound in itself. In addition to reformation of business models, the successful disassembly of consumer culture requires a social paradigm shift supported by the integrated ideas of sociological consumption studies, consumer and cultural psychology, as well as issues related to

labor, wealth distribution, and social equity. Changing consumer behaviors and culture can address societal overconsumption and mitigate consumer waste. Moreover, labor conditions, wealth distribution, and social equity must be addressed to analyze current material and energy economic throughput and enable societal transition to CE models. In sum, paradigm shifts regarding sociological and economic principles are critical in circular, sustainable development because it defines, with clarity, who must bear the cost of economic activities.

Future Directions: Using Municipal Infrastructure as the Key Leverage Point.

Primary case study analysis identifies the underdeveloped municipal recycling and composting programs as major local sustainability barriers. The development of sustainable municipal waste management infrastructure would divert waste from landfills and lower the environmental impact of human activities. There are significant connections between recycling, composting, landfill diversion, stormwater management, and freshwater safety. The development of municipal infrastructure that diverts material from waste streams represents a key leverage point for sustainable reform.

Future research can be applied to Wisconsin's underdeveloped recycling program, which is plagued by insufficient government monitoring, ineffective legislative rules, and low consumer recycling education. Significant flaws in Wisconsin's recycling infrastructure were uncovered in a nonpartisan Legislative Audit Bureau (2020). The Wisconsin State Journal's Chris Hubbuch (2020) summarizes the findings of the audit: the audit found that the DNR inappropriately spent over \$807,000 in funds that were appropriated for recycling administration. It was also revealed that the DNR failed to perform required reviews of local recycling programs; analysis of these review results would have served the development of municipal recycling infrastructure by revealing trends and identifying potential solutions. Additional findings noted that the DNR has not updated its recycling rules to reflect consumer habits in nearly 30 years. Further, the audit reported that the DNR has not been following the recycling rules, which require municipalities to collect specified amounts of certain recyclable materials per capita. Instead, recycling was being sorted without an itemized inventory for each municipality, and local governments were only reporting a lump sum of all recycling material collected. The audit also found disparities in the number of state recycling grants afforded to municipal government expenses, due partly to a statutory formula that has not been updated in over 20 years. The audit report suggests

that the statutory formula be modified and updated by the Legislature in order to reflect current populations and the current body of sustainability research. It will be necessary to conduct further comparative research for the development of a Wisconsin recycling infrastructure based on circular economic principles. Future researchers can investigate the recycling programs of neighboring states, like Michigan, which provides sizable grants to upgrade material recovery facilities for the efficient sorting of recyclables and the development of new markets for recycled materials.

Further research regarding the integration of municipal composting infrastructure can be conducted and applied in order to develop local composting programs. Primary research revealed the complete lack of any municipal composting system in Milwaukee; this lack of city-wide composting system represents tons of food waste entering local landfills where it cannot decompose properly. The development of composting infrastructure could divert a massive amount of annual food waste from landfills while also supporting local food cultivation, gardening, and soil health. Due to the lack of municipal composting infrastructure, small businesses that wish to implement a composting program must create an internal composting system or hire a third-party service to manage compost material. Third party compost management services seek to fulfill the community need for composting services by gathering food scraps and yard waste from residences and businesses, delivering it to a local processing site, and then selling the finished product back to community members. However, these businesses are not equipped to service the entirety of Milwaukee, making composting inaccessible to many local small businesses. Primary interviews also revealed that the only commercial compost processor in southeastern Wisconsin is privately owned, and has not accepted compostable food containers since 2019. This lack of infrastructure has led to countless pounds of compostable goods diverted to landfills instead of compost processors; one case study interview with a local sustainability manager reported increased levels of greenhouse gas emissions associated with the landfilling of compostable food containers when compared to the landfilling of their conventional counterparts. To fulfill the community needs for a compost processor that accepts compostable food containers, a local small business has fundraised in order to construct a new processing plant in the Milwaukee area. While this plan is a step in the right direction, it highlights the need for an organized, effective municipal composting infrastructure. The Urban Development Series Knowledge Papers, organized by World Bank

Group and Climate and Clean Air Coalition provides sustainable financing and policy models for the development of municipal composting infrastructure. An interview with a small business owner of a local composting service revealed that the development of municipal composting infrastructure is the responsibility of the DNR Sustainable Materials Management Subcommittee; however, according to the case study interview, there has been little progress in the development of sustainable waste management infrastructure because the recycling and composting industries are not represented in the DNR Sustainable Materials Management Subcommittee. This representation would require the membership to be expanded to professionals in the recycling and composting industries; subcommittee membership relies on member nomination and a majority vote, which has yet to favor professionals from the recycling and composting industries. It will be necessary to apply systemic reforms in this situation to ensure that nomination and membership voting works in a way that fairly represents all industries involved in sustainable waste management. Future researchers can use this information to propose systemic reformation strategies to create a circular economy for recyclable and compostable materials.

Lastly, further research regarding large-scale circular container systems will be necessary for the creation and implementation of infrastructure that can support Milwaukee's proposed community-wide reusable food service container system. A recent virtual meeting agenda of the city-county task force featured preliminary concept proposals and notes with reference to research on the topics of "community-wide reusable food service container system," "construction waste recycling," "food waste initiative," "event waste diversion," "lake friendly business campaign," "organic waste," and "litter abatement." (City-County Task Force on Climate and Economic Equity, 2021, Waste and Sustainable Consumption Work Group).

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ROSE COLORED GLASSES: AN EXPLORATION OF THE CAUSAL RELATIONSHIP BETWEEN SEXUAL NOSTALGIA AND SEXUAL SATISFACTION

Rachel J. L. Miller, University of Minnesota-Duluth
Dr. Ashley E. Thompson, PhD, Mentor

Sexual satisfaction contributes significantly to the quality of one's life and offers a variety of mental/physical health benefits. Consequently, researchers have conducted numerous studies examining ways to improve one's sexual satisfaction. Despite extensive literature, only one study has investigated how sexual nostalgia (defined as "the sentimental longing for or wistful reflection on past sexual memories with one's current sexual partner") impacts sexual satisfaction (Bjorback et al., 2021), whose results revealed that adults engaging in sexual nostalgia to a greater extent reported higher levels of sexual satisfaction than those nostalgizing to a lesser extent, suggesting that sexual nostalgia may serve as a useful technique for enhancing sexual satisfaction. That said, the causal link has yet to be examined. The current study adopted an experimental design to examine the causal relationship between sexual nostalgia and satisfaction. A total of 140 participants (89 men, 51 women) were randomly assigned to one of three conditions (sexual nostalgia, general nostalgia, or a control) and completed a battery of questionnaires (including the New Sexual Satisfaction Scale; Štulhofer et al., 2010). Preliminary results revealed that there was not a significant effect of the nostalgia condition on self-reported sexual satisfaction ($F[2,137] = 1.45, p = 0.24$), likely because of the short duration of the research design. In the future, researchers should examine the impact of sexual nostalgia using a longitudinal format by assessing satisfaction weeks or months later. Nevertheless, these findings have implications for clinicians working with couples experiencing low sexual desire and/or unmet sexual needs.

Introduction

Sexual nostalgia, the reflection of past, positive sexual experiences, is a form of sexual fantasy involving sexual memories (Muise et al., 2020). Sexual nostalgia is a neglected topic of research within the field of sexuality. Thus, research assessing the prevalence of sexual nostalgia and its impact on sexual relationships is important. Additionally, it is important to address the processes of sexual enhancement and its application towards the self and others and romantic relationships, as well as expand the limited knowledge in literature regarding outcomes of sexual nostalgia on sexual enhancement.

Sexual Satisfaction

In 1995, Lawrance and Byers defined sexual satisfaction as the following: "an affective response arising from one's subjective evaluation of the positive and negative dimensions associated with one's sexual relationship" (p.4). Research has revealed that benefits of sexual satisfaction include mental, physical, emotional, and overall health (Davison et al., 2009; Brody, 2010; Flynn et al., 2016; Mollaioli et al., 2021). Sexual satisfaction has also been linked to romantic relationship outcomes (Byers, 2005; Schwartz & Young, 2009). More specifically, research implies that individuals who are more sexually satisfied have higher rates of marriage success and greater relationship stability and satisfaction than individuals sexually satisfied to a lesser extent (Litzinger & Gordon, 2005; Yeh et al., 2006). Researchers have used various methods in regard to the enhancement of sexual satisfaction, which have included methods from areas such as novelty/variety (Morton & Gorzalka, 2014), communication/disclosure (Byers & Demmons, 1999; Brown & Weigel, 2018), mindfulness-based practices (Leavitt et al., 2019), and more. However, a notable area of research that has been neglected as a potential method of sexual enhancement is nostalgia; specifically, sexual nostalgia.

Nostalgia

Nostalgia is the wistful longing of past positive experiences (Batcho, 1995) and has been linked to reducing negative feelings, such as loneliness, boredom, and disconnectedness from others, as well as increasing existential meaning to one's life, social connectedness, and a sense of comfort both physiologically and psychologically (Batcho, 1995; Rosenberg, 1979; Zhou et al., 2008; Routledge et al., 2011; Wildschut et al., 2010). A study by Wildschut et al. (2010) was conducted to determine if nostalgia occurred in response to loneliness and also the role of attachment-avoidance on frequency of nostalgia, nostalgia as a method to counteract loneliness, and the effects of manipulated social connectedness on nostalgia via the moderating role of attachment-avoidance. Participants completed several scales and surveys, which led the investigators to discover that individuals low in attachment-avoidance focused on their social groups and bonds to counteract feelings of disconnectedness and distress compared to individuals higher in attachment-avoid-

ance (Birnbbaum, 2007; Wildschut et al., 2010).

Furthermore, individuals low in attachment avoidance were more likely to provide emotional support to others compared to individuals high in attachment-avoidance; these individuals, generally, did not rely on others for emotional support in times of distress or social disconnection.

Nostalgia Within Romantic Relationships

Continuing, researchers have recently applied the concept of nostalgia as a resource for romantic relationships. Again, research has shown various benefits of engaging in nostalgia while in romantic relationships such as increased relationship-promoting behaviors and enhanced relationship satisfaction (Abeyta et al., 2015; Mallory et al., 2018). A series of seven studies conducted by Abeyta et al. (2015) examined nostalgia as a function of social motivation and suggested that nostalgia mobilizes social goals while fostering the efforts individuals make to connect with others due to the inspiration of social goal pursuits. Participants were instructed to reflect on past nostalgic memories or general memories. Researchers then measured the attitudes towards relationship goals along with everyday aspirations via Ryan et al.'s (1996) Aspirations Index. Areas in the scale included the following: wealth, fame, image/appearance, personal growth, community involvement, and health. As a result, the researchers discovered that nostalgia enhanced relational aspirations suggest that nostalgia is a key promoter for social growth and goal aspirations towards relationship goals and overcoming obstacles.

An additional study conducted by Mallory et al. (2018) examined if reflecting on past experiences in a romantic relationship enhanced positive relationship satisfaction. Researchers discovered that relationship nostalgia affected satisfaction by leading towards "emotional homeostasis" (p. 561) instead of positive affect. Thus, relationship nostalgia was positively associated with relationship satisfaction in the moment but negatively short-term, and long term, the association disappears. Results revealed that relationship history can induce past, positive relational memories that create an enhanced sense of bonding as well as marriage quality, which is consistent across literature (Norton, 1983; Jacobson & Christensen, 1996; Gottman, 1999).

Although reflecting on relationship history may have short-term positive effects on relationship satisfaction, Mallory et al. (2018) argued that using this technique exclusively to create a sense of bonding could be deleterious due to the potential development of emotional homeostasis within the relationship.

Sexual Nostalgia

Limited research involves the use of sexual nostalgia as a means for sexual enhancement. This form of nostalgia likely has benefits for individuals in a romantic relationship as well as the self. Across four studies, Birnbbaum et al. (2019) sought to find if sexually fantasizing about one's partner, called "dyadic fantasies" (p. 461), or someone else, called "extradyadic fantasies, could impact a relationship. Researchers discovered a link that dyadic fantasies increased sexual desire and nonsexual, romantic behaviors between partners.

Although research has explored several methods of enhancing sexual satisfaction and relationship satisfaction via nostalgia, limited research involves the use of sexual nostalgia as a means for sexual enhancement. This form of nostalgia likely has benefits for individuals in a romantic relationship, particularly sexual satisfaction. Currently, only two studies by Muise et al. (2020) and Bjorback et al. (2021) have examined the relationship between sexual nostalgia and relational needs. Muise et al. (2020) examined the relationship between sexual fantasies, called sexual nostalgia, with a past romantic partner and relational needs via the moderating role of attachment avoidance. The researchers used an adaptation of Birnbbaum's (2007) Sexual Fantasy Checklist for measurement and assessment of common sexual fantasy themes, with two more items being added to examine fantasies regarding past partners. A scale from 1 (never) to 5 (very often) asked how much participants experienced each sexual fantasy type.

Muise et al. (2020) also adapted a general nostalgia scale from Wildschut et al. (2010) and added two items to assessing sexual nostalgia. Muise et al. (2020) discovered that individuals who were low in attachment avoidance experienced greater relational dissatisfaction and greater sexual nostalgia compared to individuals high in attachment avoidance who experienced the opposite effects. However, Muise et al. (2020) focused on sexual nostalgia in relation to extradyadic behaviors, a person's past partner, and the negative outcomes sexual nostalgia may have on one's primary partner. Additionally, the investigators did not manipulate sexual nostalgia to understand how it can be beneficial to sexual satisfaction and enhancement, specifically with one's current primary partner. This is problematic, seeing that positive outcomes of sexual nostalgia with one's primary partner could be used as a therapeutic technique for couples in distress or sexual homeostasis.

Consequently, only one study thus far has investigated how sexual nostalgia (defined as "the sentimental longing for or wistful reflection on past

sexual memories with one's current sexual partner") impacts sexual satisfaction (Bjorback et al., 2021). A total of 227 adults completed an online battery of questionnaires assessing satisfaction, romantic attachment, and sexual nostalgia. An exploratory factor analysis revealed that the Sexual Nostalgia Scale was composed of three subscales including a physical, an emotional, and a novelty subscale (accounting for 52.26% of the variance). Findings revealed that adults engaging in sexual nostalgia to a greater extent reported higher levels of sexual satisfaction than those nostalgizing to a lesser extent, suggesting that sexual nostalgia may serve as a useful technique for enhancing sexual satisfaction. That said, the causal link between sexual nostalgia serving as a useful technique for enhancing sexual satisfaction has yet to be examined.

The Current Study

The current study attempted to address the limitations of existing sexual nostalgia research. By adopting a between-subject design in which we examined the causal relationship between sexual nostalgia and sexual satisfaction. Due to previous research suggesting that adults engaging in sexual nostalgia to a greater extent would report higher levels of sexual satisfaction than those nostalgizing to a lesser extent (Bjorback et al., 2021) and the notion that sexual satisfaction contributes significantly to the quality of one's life while offering a variety of mental/physical health benefits, we hypothesized that after randomly assigning participants to one of three conditions (a condition in which they were asked to engage in sexual nostalgia, general nostalgia, or a control), participants in the sexual nostalgia condition would report the highest levels of sexual satisfaction followed by the general nostalgia condition and the control condition.

Method

Participants

A total of 140 participants (89 men, 51 women) who were 18 years of age or older ($M_{age} = 35.56$; $SD = 11.79$) and in a current relationship of at least 6 months were recruited for this online study via Amazon's Mechanical Turk (MTurk). The majority of the participants were white (75%), followed by Asian (17.86%), African American (6.43%), and American Indian or Alaska Native (1.43%). The average relationship length across all participants was 57.87 months (4.82 years) ($SD = 64.11$). 68.57% of the participants were married and 12.86% were dating. 19.29% of participants were in some form of monogamous relationship while 3.57% were in an open relationship, 2% were cohabitating, and

1.43% were polyamorous. Additionally, the majority of participants identified as heterosexual (75%) followed by bisexual (18.57%), gay (3.57%), lesbian (1.43%), queer (0.71%), and pansexual (0.71%). The ideal relationship style preferred by participants was a monogamous relationship (42.14%). However, over one-quarter of participants' ideal relationship style were consensually emotionally and sexually open (28.57%) followed by consensually sexually open (15%), consensually emotionally open (12.86%), nonconsensually sexual (12.14%) and nonconsensually emotional (3.57%). According to Field (2015), a minimum of 20 participants per experimental condition was needed to obtain significant statistical power when measuring hypothesized effects and to withstand assumptions in regards to parametric violation. This prerequisite was met as 47 participants were assigned to the sexual condition followed by 55 in the general condition and 38 in the control condition.

Measures and Materials

Experimental Manipulation. Each participant was randomly assigned to one of three conditions, sexual nostalgia, general nostalgia, or a control, and received the same opening information: "This study is designed to assess the effects of writing on interpersonal relationships. Writing often activates the right hemisphere of the brain (Zinger, 2000).

Research also indicates that activation of the right hemisphere of the brain can produce positive outcomes for one's relationships (Bat et al., 2019; Flag & Son, 2013). Thus, we want to see if performing a writing task has an effect on interpersonal relationships. It is our hope that the results of this study will inform our understanding of how to enhance interpersonal relationships. It is important to note that in this writing task (as well as in the surveys that follow), you will be asked potentially sensitive questions concerning different matters such as your romantic relationship and sexual intimacy." Then, each group read instructions tailored to the specific condition they were assigned to:

- **Sexual Nostalgia Condition:** In the space below, please write about a positive, past sexual memory involving your current romantic partner. Please describe in detail the specific scene, series of events, the figures, wishes, sensations, feelings, and thoughts that were experienced by you and your partner in the memory. At this point, we want to note that your responses will be completely confidential, so feel free to write anything you like. Please spend at least 2 minutes writing about this memory.
- **General Nostalgia Condition:** In the space below, please write about a positive, past

memory in your life that you miss in your current everyday life (e.g., school, family member, friend, pet, etc.). Please describe in detail the specific scene, series of events, the figures, wishes, sensations, feelings, and thoughts that were experienced by you in the memory. At this point, we want to note that your responses will be completely confidential, so feel free to write anything you like. Please spend at least 2 minutes writing about this memory.

- **Control Condition:** In the space below, please write about your surroundings at this moment. Please describe in detail what you see, hear, smell, feel, and any thoughts/feelings you experience in your current surroundings. At this point, we want to note that your responses will be completely confidential, so feel free to write anything you like. Please spend at least 2 minutes writing about your surroundings.

The New Sexual Satisfaction Scale (NSSS). Participants completed the internationally-established NSSS (Štulhofer et al., 2010), which is a 20-item questionnaire that assesses participants' sexual satisfaction via a 5-point Likert scale ranging from 1 (not at all satisfied), 2 (a little satisfied), 3 (moderately satisfied), 4 (very satisfied), to 5 (extremely satisfied). Participants were asked to report their sexual satisfaction with their primary partner(s) via two subscales: ego-focused and partner and sexual activity-centered, which asked questions such as the following: "The intensity of my sexual arousal", "My focus/concentration during sexual activity", "My partner's sexual availability", and "My partner's emotional opening up during sex". A high internal consistency of $\alpha = .94-.96$ was found for the full scale as well as both subscales ($\alpha = .91-.93$ and $\alpha = .90-.94$, respectively).

Demographics Questionnaire

Participants responded to a demographics questionnaire consisting of 32 questions, which included topics such as age, race, income, relationship status and length, sexual orientation, sexual frequency and experience, and sexual and romantic satisfaction in the participant's current romantic relationship(s) (See Appendix I).

Procedure

Upon approval from the Institutional Review Board (IRB), participants were recruited for this online study via a recruitment message on MTurk (See Appendix A). Eligible participants (at least 18 years of age and in a current relationship of at least 6 months) who were interested in participating were given an electronic consent form which

provided further information regarding the details of the study, including the study's potentially sensitive questions concerning different matters such as romantic relationship and sexual intimacy, as well as the study's deception that would occur via the following statement: "In order to incorporate a successful experiment, there are details within this study that are misinforming. However, we will explain fully at the end, so please do not skip the final page, the debriefing form." (See Appendix B).

This study adopted a between-subjects design in which all participants were randomly assigned to one of three conditions (sexual, general, or control; See Appendix C). After completing the experimental manipulation participants were asked to complete the NSSS and the demographic questionnaire. They were then thanked for their time and informed that if they inputted the correct completion code and did not miss any validity checks, they would receive a deposited \$2.00 compensation to their MTurk account for completing the study.

Results

Data Cleaning

Data was screened and cleaned using methods detailed by (Pallant, 2020). Out of 530 participants, 140 participants satisfied all data cleaning criteria. However, three participants were removed for missing more than 20% of their data with the rest being removed for the following reasons: under the age of 18 years, a relationship status of single, divorced or less than 6 months, missing validity checks, failing to properly fill out the experimental manipulation (e.g. copying and pasting the instructions into the text box, using a one-word answer, or writing about an event that was unrelated to what the manipulation asked), and taking the survey more than once. Using a cut-off score of ± 3.00 , one outlier was identified for the NSSS variable with a score of -3.12. This participant was not deleted due to the next closest score being -2.71 and keeping as many participants as possible in the study. This participant also had no missing data and adequately completed the experimental manipulation. As a result, the study ended with a final sample of 140 participants (89 men, 51 women) with a ($M_{age} = 35.56$; $SD = 11.79$)

After data cleaning and checking for outliers, tests of skewness were performed and indicated that scores on the TotalSex scale were not skewed (-1.63). To determine the skew, an overall mean score for all of the variables (TotalSex) was determined. In SPSS, the TotalSex score was inputted into variables under descriptives, and skewness was selected to calculate the skew. Given the output results in SPSS, the skewness statistic was then

divided by the skewness standard error. A critical value of ± 2.58 was adopted given the large sample size.

Descriptive Results

Results showed that 47 participants were in the sexual condition followed by 55 in the general condition, and 38 in the control condition. An overall mean NSSS score of 3.90 ($SD = 0.61$). These results indicated that people were “fairly satisfied in their relationship.” An analysis of a manipulation check was also conducted. The manipulation check, which stated, “At the beginning of the study you were asked to participate in a writing task, which of the following tasks did you complete?” resulted in 55 participants indicating that they received the sexual condition, 48 indicating that they received the general condition, and 37 indicating that they received the control condition.

Primary Analyses

To test the effectiveness of the manipulation, a between-subjects one-way ANOVA was conducted. Results indicated that there was not a significant effect of the nostalgia condition on self-reported sexual satisfaction ($F [2,137] = 1.45, p = 0.24$). While results indicated that the mean sexual condition score was slightly higher than the general condition, which scored slightly higher than the control condition, these scores were not significant. See Table 1 for descriptive statistics.

Discussion

Due to the limited research involving the use of sexual nostalgia as a means for sexual enhancement, the current study adopted an experimental design to examine the causal relationship between sexual nostalgia and satisfaction. The study used MTurk to recruit participants, who were then assigned to one of three experimental conditions (sexual nostalgia, general nostalgia, or a control) and reported on their sexual satisfaction. It was expected that participants randomly assigned to the sexual nostalgia condition would report the highest levels of sexual satisfaction followed by general nostalgia and the control condition.

Findings from this study were not consistent with previous literature, which suggested that sexual nostalgia may serve as a useful technique for enhancing sexual satisfaction. While scores in the sexual nostalgia condition were higher than any other category, they were not significant. Nevertheless, these findings have implications for clinicians working with couples experiencing low sexual desire and/or unmet sexual needs

Limitations and Future Direction

The following limitations should be kept in mind when interpreting this study’s results and expanding on the topic in the future. Findings revealed that there was not a significant effect of the nostalgia condition on self-reported sexual satisfaction, likely because of the short duration of the research design. In the future, researchers should examine the impact of sexual nostalgia using a longitudinal format by assessing satisfaction weeks later. Additionally, this study adopted a between-subjects design. Thus, participants’ attitudes pre- and post-manipulation were unassessed. Future research should adopt a repeated measures design to assess the changes, if any, in participants’ attitudes across time.

Conclusion and Implications

Sexual nostalgia is a neglected topic of research within the field of sexuality. Thus, research assessing the prevalence of sexual nostalgia and its impact on sexual relationships is important. Research suggests benefits regarding mental, physical, emotional, and overall health in terms of sexual satisfaction. While research has looked into various methods of increasing interpersonal satisfaction via nostalgia, a neglected and novel way that sexual satisfaction may be enhanced is via sexual nostalgia. The limited literature involving sexual nostalgia is problematic due to the potential for sexual nostalgia to be used as a technique and resource to enhance sexual satisfaction within a romantic relationship. Additionally, by utilizing sexual nostalgia with one’s current primary partner(s), practitioners, clinicians, educators, and the general public can learn and better understand the benefits of sexual nostalgia on romantic relationships, sexual satisfaction, and sexual enhancement.

Despite extensive literature, only one study has investigated how sexual nostalgia (defined as “the sentimental longing for or wistful reflection on past sexual memories with one’s current sexual partner”) impacts sexual satisfaction (Bjorback et al., 2021), whose results revealed that adults engaging in sexual nostalgia to a greater extent reported higher levels of sexual satisfaction than those nostalgizing to a lesser extent, suggesting that sexual nostalgia may serve as a useful technique for enhancing sexual satisfaction. That said, the causal link had yet to be examined prior to this study. The current study adopted an experimental design to examine the causal relationship between sexual nostalgia and satisfaction. Findings of this study suggested that there was not a significant effect of the type of nostalgia individuals participate in and self-reported sexual satisfaction. Nevertheless, the hope is that this study will lead to further research on the link between sexual nostalgia serving as a useful technique for enhancing

sexual satisfaction, as well as help clinicians working with couples experiencing low sexual desire and/or unmet sexual needs.

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Condition	N	Mean	Standard Deviation
Sexual	47	3.97	0.65
General	55	3.93	0.55
Control	38	3.76	0.62
Total	140	3.90	0.61

Table 1.
Descriptive Statistics for Each Condition

RENORMALIZATION GROUP METHOD ON REACTION-DIFFUSION PARTIAL DIFFERENTIAL EQUATIONS AND SOLUTIONS TO THE RESULTING COMPLEX GINZBURG-LANDAU EQUATION

Alex Neiman, Northland College
Dr. Andrew Jensen, PhD, Mentor

In order to find solutions to a set of reaction-diffusion PDEs, it will be shown that specific kinds of PDEs can immediately be reduced to a form of the complex Ginzburg-Landau equation (CGLE). Using the renormalization groups method, it is proven that given some reaction-diffusion equations, this is exactly the case. After some short matrix calculations, any reaction-diffusion equation of similar form can be reduced to an equation with known wave solutions. A wave solution for the specific set of PDEs in this paper is found, along with discussion on the stability of the solution.

Introduction

Perturbation theory is a branch of mathematics that allows for useful information to be obtained from perturbed relationships, or to create approximate solutions to problems that cannot be solved analytically. An example of a perturbation problem could look like $x^2 - x + \epsilon = 0$ where $0 < \epsilon \ll 1$. Typically, a solution would begin with solving the unperturbed problem $x^2 - x = 0$. Then the solution of the perturbed problem can follow by expanding x as $x = x_0 + \epsilon x_1 + \epsilon^2 x_2 + \dots$. For algebraic expressions, perturbation methods are typically unneeded as the expressions either have better methods of approximation or can be solved analytically.

Mathematics has moved far beyond simple algebraic expressions, especially for describing natural phenomenon. The most common systems for modeling complex behaviors are systems of partial differential equations (PDEs). There are endless forms that systems of PDEs could take, however, within these forms, the PDEs can be classified by their behavior. By classifying PDEs by their behavior, it allows for more meaningful results to be produced. Reaction-diffusion equations are one such type of classification and are often solved with perturbation methods. PDEs that display reaction-diffusion behavior often have points of stability that cause points of instability, along with points of instability that cause points of stability, which are overall called bifurcation points. Bifurcation points are essential in finding solutions of some PDEs.

Perturbation theory by itself is powerful, but can be enhanced by combining it with different methods. One method that utilizes the power of perturbation methods is the renormalization groups method

(RG). Despite the effectiveness of this method, there are some foundational topics that are yet to be researched, but there will be no attempt to address these foundational concepts in this paper, as the reason that renormalization groups are effective is not necessary for work in the field of reaction-diffusion systems.

The paper is organized as follows. In section II sources that describe the RG method and reaction-diffusion are summarized as background information. In section III a generalized solution to a set of reaction-diffusion PDEs is obtained using the RG method with envelopes, along with solutions to the general equation. Then, in part IV the results and application are summarized.

Background Information

RG methods were first applied to partial differential equations without a stochastic element in the paper *Intermediate Asymptotics and Renormalization Group Theory* by Goldenfeld et al. [5]. It was in this paper that the foundation for RG methods in reaction-diffusion equations began. Goldenfeld et al released another paper titled *Anomalous Dimensions and the Renormalization Group in a Nonlinear Diffusion Process* which greatly expanded the use of perturbation methods into not only the field of PDEs, but nonlinear PDEs with diffusion processes [6]. Shortly after Goldenfeld's papers were published, Teiji Kunihiro published a paper on the geometric meaning of RG methods and laid some foundational work on the method, giving it rigor that it had previously been lacking, specifically in the geometric meaning of the method [10]. In addition to giving the geometric meaning, Kunihiro produced a more repeatable method of solving problems with the RG method. Kunihiro also generalized the method to systems of PDEs, making it a very useful method for finding relative solutions to systems of PDEs, which will be done in this paper.

It was well known at the time that methods involving asymptotic analysis produced amplitude equations. In the paper titled *Renormalization Group Theory for Global Asymptotic Analysis* by Chen et al. proved that the amplitude equations that arise from other methods of asymptotic analysis, such as the method of multiple scales, are in fact the same result determined from renormalization groups [4]. Continuing their work on this Chen et

al. produced another paper titled *Renormalization group and singular perturbations: Multiple scales, boundary layers, and reductive perturbation theory* where they again showed that RG methods produce the same results as other asymptotic methods [3]. In addition to this, they showed that RG methods are much more general than other methods, as the method doesn't require any assumptions about the structure of the system, while in some cases even having superior accuracy to the other asymptotic methods. Additionally, they also used the method to describe spatial systems near bifurcation points [3].

The ability to pull useful information about a system near a bifurcation point cannot be overstated. However, the accuracy of solutions with this method quickly dwindles beyond the point being considered as the center. This means that anything outside of a very small neighborhood around a bifurcation point would no longer be representative of the system. In order to make progress on non-Markovian systems, systems which have short term memory and require more stable solutions, Torabi and Davidsen in their paper titled *Pattern formation in reaction-diffusion systems in the presence of non-Markovian diffusion* used reductive perturbation methods to analyze spatial systems with memory [7].

When mathematicians work in spatial systems it is often useful to express the system in the form of an integral and express related constants with RG equations. Alternatively, in systems with partial differential equations, using analytic methods in tandem with perturbation methods can also result in integrals with various constants being determined by RG equations, this alternative method is what Ei et al. did in their paper titled *Renormalization-Group Method for Reduction of Evolution Equations; Invariant Manifolds and Envelopes*. In this paper the time $t_0 = t$ is justified, resulting in a Markovian system. The idea of setting $t_0 = t$ is not a new concept, but the justification previously was that it produced useful results. Now that there is justification for that parameter, expanding the system outside of simple Markovian systems would be a much easier task. This is exactly what Torabi and Davidsen did in their paper. They began with this equation:

$$\frac{\partial P(x,t)}{\partial t} = \int_0^t dt K(t-t) D \frac{\partial^2 P(x,t)}{\partial x^2}$$

which is the generalized master equation for a diffusion equation [7]. This equation is time dependent, and the integral, which integrates over all time, makes it difficult to justify reducing this to a Markovian expression. So instead of doing that, Torabi and Davidsen manipulated the equation into a new form with "memory kernels" which looks like this:

$$\frac{\partial P(x,t)}{\partial t} = \int_0^t dt K(t-t) D \frac{\partial^2 P(x,t)}{\partial x^2}$$

which is an equation that has been previously derived called the Fokker-Planck equation. This equation can then be split into two separate equations, which can then be treated as a system of PDEs and solved using similar methods to find solutions near bifurcation points [7].

Derivation and Solution to the Complex Ginzburg-Landau Equation

[Note: Due to limitations with our publication software's ability to properly display complex mathematical characters, this section will consist of the originally submitted manuscript. pp 81-96]

The following set of reaction-diffusion PDEs, where Δ represents the laplacian, is where the method will begin:

$$\partial_t x = x - \beta x^2 - xy + D_x \Delta x \quad (1)$$

$$\partial_t y = -\alpha y + \beta x^2 + xy + D_y \Delta y \quad (2)$$

These equations by themselves are fine, but it is often useful to shift these, so, letting $(x_0, y_0) = \left(\frac{\alpha}{\alpha\beta+1}, \frac{1}{\alpha\beta+1}\right)$ and defining ζ, η by $x = x_0 + \zeta, y = y_0 + \eta$. The PDEs become:

$$\partial_t \zeta = -\frac{\alpha\beta\zeta}{\alpha\beta+1} - \frac{\alpha\eta}{\alpha\beta+1} - \beta\zeta^2 - \zeta\eta + D_x \Delta \zeta \quad (3)$$

$$\partial_t \eta = \frac{(2\alpha\beta+1)\zeta}{\alpha\beta+1} - \frac{\alpha^2\beta\eta}{\alpha\beta+1} + \beta\zeta^2 + \zeta\eta + D_y \Delta \eta \quad (4)$$

Now, given these equations, it is important to manipulate them into the following form:

$$\frac{\partial \mathbf{X}}{\partial t} = H(\mathbf{X}) + \mathbf{D} \Delta \mathbf{X} \quad (5)$$

which can be done easily by letting \mathbf{D} be a diagonalized matrix, with entries D_x and D_y .

Then, it can be simply said that

$$H(\mathbf{X}) = \begin{pmatrix} -\frac{\alpha\beta}{\alpha\beta+1}\zeta - \frac{\alpha}{\alpha\beta+1}\eta - \beta\zeta^2 - \zeta\eta \\ \frac{2\alpha\beta+1}{\alpha\beta+1}\zeta - \frac{\alpha^2\beta}{\alpha\beta+1}\eta + \beta\zeta^2 + \zeta\eta \end{pmatrix} \quad (6)$$

Again, the solution will be shifted by some amount, so, let \mathbf{X}_0 be a steady solution, then, substituting $\mathbf{X}_0 + \mathbf{u}$ into the equation results in $\frac{\partial \mathbf{u}}{\partial t} = H(\mathbf{u}) + \mathbf{D} \Delta \mathbf{u}$. Since X_0 is a steady solution, all of the terms related to it will become 0, leaving only the shifted variable's terms. Then, to approximate the functions, $H(\mathbf{u})$ is expanded with a Taylor series, and coefficients L , M , and N are produced. This results in the equation:

$$\frac{\partial \mathbf{u}}{\partial t} = \hat{L}\mathbf{u} + M\mathbf{u}\mathbf{u} + N\mathbf{u}\mathbf{u}\mathbf{u} \quad (7)$$

where $\hat{L} = L + D\Delta$. Now \mathbf{u} , \hat{L} , M , and N will be expanded using perturbation where $\varepsilon = \sqrt{|\mu|}$ and $\chi = \text{sgn}(\mu)$.

$$\mathbf{u} = \varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots \quad (8)$$

$$\hat{L} = \hat{L}_0 + \mu\hat{L}_1 + \dots \quad (9)$$

$$M = M_0 + \mu M_1 + \dots \quad (10)$$

$$N = N_0 + \mu N_1 + \dots \quad (11)$$

Plugging equations 8,9, 10, and 11 into equation 7, results in the following:

$$\begin{aligned} \frac{\partial}{\partial t}(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots) = \\ (\hat{L}_0 + \mu\hat{L}_1 + \dots)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots) + \\ (M_0 + \mu M_1 + \dots)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots) + \\ (N_0 + \mu N_1 + \dots)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \dots) \end{aligned}$$

Because these are infinite expressions, the correction added by each term diminishes as the number of terms increase. This means that expanding out to ε^3 will produce a model with little loss in accuracy, meaning that every term of ε^4 and greater can be treated as zero, and thus vanish from the resulting equation. Simplifying in the manner reduces the expression to:

$$\begin{aligned} \frac{\partial}{\partial t}(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \varepsilon^3\mathbf{u}_3) = (\hat{L}_0 + \mu\hat{L}_1)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2 + \varepsilon^3\mathbf{u}_3) + \\ (M_0)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2)(\varepsilon\mathbf{u}_1 + \varepsilon^2\mathbf{u}_2) + \\ (N_0)(\varepsilon\mathbf{u}_1)(\varepsilon\mathbf{u}_1)(\varepsilon\mathbf{u}_1) \end{aligned}$$

On the left-hand side, there will be products with increasing values of ε^n (where n is a positive integer). On the right-hand side, this will also be true, so, for all terms of the same ε^n on the right-hand side, they must be equal to that term on the left-hand side. Performing this expansion, and then setting all terms with the same ε equal to each other produces the following:

$$\frac{\partial\mathbf{u}_1}{\partial t} = \hat{L}_0\mathbf{u}_1$$

$$\frac{\partial\mathbf{u}_2}{\partial t} = \hat{L}_0\mathbf{u}_2 + M_0\mathbf{u}_1\mathbf{u}_1$$

$$\frac{\partial\mathbf{u}_3}{\partial t} = \hat{L}_0\mathbf{u}_3 + \chi\hat{L}_1\mathbf{u}_1 + 2M_0\mathbf{u}_1\mathbf{u}_2 + N_0\mathbf{u}_1\mathbf{u}_1\mathbf{u}_1$$

In perturbation theory, it is customary to produce a solution hierarchy. That is to say, the previous equations should be manipulated so that they have a common form, and, that the solution of each increasing term depends on the previous term. So, the solution hierarchy is:

$$\left(\frac{\partial}{\partial t} - \hat{L}_0\right)\mathbf{u}_1 = 0 \quad (12)$$

$$\left(\frac{\partial}{\partial t} - \hat{L}_0\right)\mathbf{u}_2 = M_0\mathbf{u}_1\mathbf{u}_1 \quad (13)$$

$$\left(\frac{\partial}{\partial t} - \hat{L}_0\right)\mathbf{u}_3 = \chi\hat{L}_1\mathbf{u}_1 + 2M_0\mathbf{u}_1\mathbf{u}_2 + N_0\mathbf{u}_1\mathbf{u}_1\mathbf{u}_1 \quad (14)$$

The solution to equation (12) is required for equation (13), and this is true of (13) for (14). In addition, the difficulty of finding each solution increases. Apart from diminishing accuracy, this is another reason to limit the number of terms in the perturbation expansion. In order to find the solution to \mathbf{u}_1 , this equation can be treated as an ordinary differential equation (ODE) and then solved with direct integration, as shown below:

$$\left(\frac{\partial}{\partial t} - \hat{L}_0\right)\mathbf{u}_1 = 0$$

$$\frac{\partial\mathbf{u}_1}{\partial t} = \hat{L}_0\mathbf{u}_1$$

$$\int \frac{\partial\mathbf{u}_1}{\mathbf{u}_1} = \int \hat{L}_0\partial t$$

$$\mathbf{u}_1 = W e^{\hat{L}_0 t}$$

Then, using the property that $e^{At} = U e^{\lambda t}$

$$\mathbf{u}_1 = W U e^{\lambda t}$$

It is likely that λ is complex, so it will be assumed that λ has the form $\lambda = i\omega_0$, which results in a final answer of

$$\mathbf{u}_1 = WUe^{i\omega_0 t} + W\bar{U}e^{-i\omega_0 t} \quad (15)$$

where \bar{U} is the complex conjugate of U .

Now that u_1 has a solution, u_2 can be derived. However, u_2 cannot be solved via direct integration, so a different method must be used. First, multiplying out $M_0\mathbf{u}_1\mathbf{u}_1$ results in the expression

$$M_0(UUW^2e^{2i\omega_0 t} + \bar{U}\bar{U}W^2e^{-2i\omega_0 t} + 2W^2U\bar{U}) \quad (16)$$

Then, the left-hand side can be easily seen to be

$$\frac{\partial \mathbf{u}_2}{\partial t} - \hat{L}_0 \mathbf{u}_2 \quad (17)$$

In order to solve this, it is easiest to guess the form of the solution, so, the form of \mathbf{u}_2 will be assumed to be

$$\mathbf{u}_2 = A_1e^{ibt} + A_2e^{-ibt} + c \quad (18)$$

Now, using the method of judicious guessing, the partial derivative must also be derived. This is so that both the assumed solution and its derivative can be substituted into equation (17).

$$\frac{\partial \mathbf{u}_2}{\partial t} = A_1ibe^{ibt} - A_2ibe^{-ibt} \quad (19)$$

Now, equations (18) and (19) can be plugged into (17). Since equation (16) is the right-hand side, these expressions can be set equal to each other, producing:

$$A_1ibe^{ibt} - A_2ibe^{-ibt} - \hat{L}_0(A_1e^{ibt} + A_2e^{-ibt} + c) = M_0(UUW^2e^{2i\omega_0 t} + \bar{U}\bar{U}W^2e^{-2i\omega_0 t} + 2W^2U\bar{U}) \quad (20)$$

Each part of the solution can be treated individually

$$A_1e^{ibt}[-(\hat{L}_0 - ib)] = M_0UUW^2e^{2i\omega_0 t} \quad (21)$$

$$A_2e^{-ibt}[-(\hat{L}_0 + ib)] = M_0\bar{U}\bar{U}W^2e^{2i\omega_0 t} \quad (22)$$

$$\hat{L}_0c = -2M_0U\bar{U}W^2 \quad (23)$$

Equation (23) can be solved directly to produce

$$c = -2\hat{L}_0^{-1}M_0U\bar{U}W^2 \quad (24)$$

Equations (21) and (22) are solved in the same, so only (21) will be demonstrated:

$$A_1e^{ibt} = -(\hat{L}_0 - ib)^{-1}M_0UUW^2e^{2i\omega_0 t} \quad (25)$$

From this expression, it is easy to see that $A_1 = -(\hat{L}_0 - ib)^{-1}M_0UUW^2$ and $b = 2\omega_0$. For readability, V_+ and V_0 are defined such that $V_+ = -(\hat{L}_0 - 2i\omega_0)^{-1}M_0UU$ and $V_0 = -2\hat{L}_0^{-1}M_0U\bar{U}$ [10]. Thus, overall the solution of \mathbf{u}_2 is

$$\mathbf{u}_2 = V_+W^2e^{2i\omega_0 t} + c.c. + V_0|W|^2 \quad (26)$$

where c.c. is the complex conjugate.

The solution of \mathbf{u}_3 begins much the same way as u_2 . Recall the solution hierarchy for \mathbf{u}_3 :

$$\left(\frac{\partial}{\partial t} - \hat{L}_0\right)\mathbf{u}_3 = \chi L_1\mathbf{u}_1 + 2M_0\mathbf{u}_1\mathbf{u}_2 + N_0\mathbf{u}_1\mathbf{u}_1$$

It is useful to do each term separately, as these calculations can be quite messy, so the equation will be further broken down into the following:

$$\chi L_1\mathbf{u}_1 \quad (27)$$

$$2M_0\mathbf{u}_1\mathbf{u}_2 \quad (28)$$

$$N_0\mathbf{u}_1\mathbf{u}_1 \quad (29)$$

Equation (27) is trivial, so the following shows equation (28)

$$\mathbf{u}_1 \mathbf{u}_2 = (WUe^{i\omega_0 t} + W\bar{U}e^{-i\omega_0 t})(V_+ W^2 e^{2i\omega_0 t} + V_- W^2 e^{-2i\omega_0 t} + V_0 |W|^2)$$

This expression can simply be multiplied through, however, all terms of $e^{ni\omega_0 t}$ where $|n| > 1$ will be labeled as higher harmonic terms (H.H.) and be kept separate. The RG method focuses on reducing equations that are too difficult (or impossible) to solve analytically, so there is no reason to include higher order terms. Higher order terms often make the equation just as, or in some cases even more difficult, to find solutions to. These terms add little to the accuracy of the final model, so at some point they will vanish from the equation.

Thus, with this in mind, equation (28) simplifies to

$$2M_0 V_+ W \bar{U} e^{i\omega_0 t} + 2M_0 V_- W U e^{-i\omega_0 t} + H.H. \quad (30)$$

Expression (29) is handled in the same way, and results in

$$3N_0 |W|^2 W U \bar{U} e^{i\omega_0 t} + 3N_0 |W|^2 W \bar{U} U e^{-i\omega_0 t} + H.H. \quad (31)$$

Thus, the original equation for u_3 can be simplified to the following:

$$\left(\frac{\partial}{\partial t} - \hat{L}_0\right) \mathbf{u}_3 = [\chi L_1 W U + (2M_0 \bar{U} V_+ + 3N_0 U \bar{U}) |W|^2 W] e^{i\omega_0 t} + c.c. + H.H. \quad (32)$$

To simplify even more, let $A = \chi L_1 W U + (2M_0 \bar{U} V_+ + 3N_0 U \bar{U}) |W|^2 W$ so that

$$\left(\frac{\partial}{\partial t} - \hat{L}_0\right) \mathbf{u}_3 = A e^{i\omega_0 t} + c.c. + H.H. \quad (33)$$

In order to get the most general form, let

$$A = \sum_{\alpha} A_{\alpha} U_{\alpha}$$

This means that A can be expanded to create a more general solution. Just as in the case of ODEs, these solutions will be multiplied by the variable so that they're unique, however, since u_3 is a PDE, each solution will be multiplied by a factor of both t and x . To prevent secular terms, constants δ and δ' are introduced so that when $t = t_0$ and $x = x_0$ the secular terms of the first solution vanish.

$$\mathbf{u}_3 = [A_1 c_1 (t - t_0 + \delta) - \frac{c_2}{2} \mathbf{D}^{-1} (x^2 - x_0^2 + \delta') \mathbf{U} + \sum_{\alpha \neq 1} \frac{A_{\alpha}}{i\omega_0 - \lambda_0^{\alpha}} \mathbf{U}_{\alpha}] e^{i\omega_0 t} + c.c. + H.H. \quad (34)$$

The values of the introduced constants c_1 and c_2 are constrained by the condition that $c_1 + c_2 = 1$. With this result, \mathbf{u}_1 , \mathbf{u}_2 , and \mathbf{u}_3 have solutions. Since u is expressed as a perturbed value, adding together all the solutions creates an accurate approximation of the original equations. However, because this is an approximation, only terms of $e^{i\omega_0 t}$ are included, as larger terms are hard to work with and do not greatly affect the accuracy of the model. Thus, the solution of \mathbf{u}_2 is a higher harmonic and will vanish in the final result.

So, this means the approximation of \mathbf{u} is

$$\mathbf{u} = \{\varepsilon W U + \varepsilon^3 [A_1 c_1 (t - t_0 + \delta) - \frac{c_2}{2} \mathbf{D}^{-1} (x^2 - x_0^2 + \delta') \mathbf{U} + \sum_{\alpha \neq 1} \frac{A_{\alpha}}{i\omega_0 - \lambda_0^{\alpha}} \mathbf{U}_{\alpha}]\} e^{i\omega_0 t} + c.c. + H.H. \quad (35)$$

The renormalization group method takes advantages of (or rather, is defined by) the property that:

$$\left. \frac{\partial \mathbf{u}}{\partial t_0} \right|_{t_0=t} = 0 \quad (36)$$

$$\left. \frac{\partial \mathbf{u}}{\partial x_0} \right|_{x_0=x} = 0 \quad (37)$$

These results follow directly from the fundamental theorem of envelopes.

In order to use equations (36) and (37) it is important to mention that the complex conjugate and the higher harmonics are additional solutions to the system, meaning that they can be excluded from the application of the partial derivatives without any loss to the generality. Additionally, A_α will be treated as independent from x and t . Thus, after applying the partial derivatives we achieve the following:

$$\frac{\partial W}{\partial t} = \varepsilon^2 c_1 A_1 + O(\varepsilon^3) \quad (38)$$

$$\mathbf{D} \frac{\partial W}{\partial x} = -\varepsilon^2 x c_2 A_1 + O(\varepsilon^3) \quad (39)$$

Taking the partial derivative of (39) again yields a nearly symmetrical equation to (38)

$$\mathbf{D} \frac{\partial^2 W}{\partial x^2} = -\varepsilon^2 c_2 A_1 + O(\varepsilon^3) \quad (40)$$

The symmetry between equations (39) and (41) suggests taking advantage of the fact that $c_1 + c_2 = 1$. By subtracting the equations, the following takes place:

$$\frac{\partial W}{\partial t} - \mathbf{D} \frac{\partial^2 W}{\partial x^2} = \varepsilon^2 c_1 A_1 + O(\varepsilon^3) - (-\varepsilon^2 c_2 A_1 + O(\varepsilon^3))$$

$$\frac{\partial W}{\partial t} - \mathbf{D} \frac{\partial^2 W}{\partial x^2} = \varepsilon^2 c_1 A_1 + O(\varepsilon^3) + \varepsilon^2 c_2 A_1 - O(\varepsilon^3)$$

$$\frac{\partial W}{\partial t} - \mathbf{D} \frac{\partial^2 W}{\partial x^2} = \varepsilon^2 A_1 (c_1 + c_2) + [O(\varepsilon^3) - O(\varepsilon^3)]$$

which finally simplifies to:

$$\frac{\partial W}{\partial t} - \mathbf{D} \frac{\partial^2 W}{\partial x^2} = \varepsilon^2 A_1 \quad (41)$$

where

$$A_1 = \chi \mathbf{U}^* L_1 W U + (2\mathbf{U}^* M_0 \bar{\mathbf{U}} V_+ + 3\mathbf{U}^* N_0 U \bar{\mathbf{U}}) |W|^2 W \quad (42)$$

and \mathbf{U}^* is the complex conjugate of \mathbf{U} .

Now that a generalized equation has been derived, all that's needed is to find all constants and perform some matrix operations. After they are derived, it is simply a matter of substituting and simplifying. L_0 , while only in the V_+ term, is still important because \mathbf{U} is defined as the eigenvector of L_0 . This means that \mathbf{U} , $\bar{\mathbf{U}}$, and \mathbf{U}^* all depend on L_0 . Thus, the complete list of needed matrices is L_0 , L_1 , \mathbf{U} , $\bar{\mathbf{U}}$, \mathbf{U}^* , and N_0 . M_0 also needs to be fine, but is dependent upon the vectors to the right of it, so it will be treated differently.

M_0 is a confusing constant to calculate, as it is not calculated by itself. Instead, it is calculated using the two matrices next to it as its components. Thus, it is calculated using:

$$(\mathbf{M}_0 \mathbf{A} \mathbf{B}) = \left(\begin{array}{c} \left. \frac{1}{2} \frac{\partial^2 H_1}{\partial \zeta^2} \right|_{\zeta_0} A_1^2 + \frac{1}{2} \left(\left. \frac{\partial^2 H_1}{\partial \zeta \partial \eta} \right|_{\zeta_0} A_1 B_2 + \left. \frac{\partial^2 H_1}{\partial \eta \partial \zeta} \right|_{\zeta_0} A_2 B_1 \right) + \left. \frac{1}{2} \frac{\partial^2 H_1}{\partial \eta^2} \right|_{\zeta_0} B_2^2 \\ \left. \frac{1}{2} \frac{\partial^2 H_2}{\partial \zeta^2} \right|_{\zeta_0} A_1^2 + \frac{1}{2} \left(\left. \frac{\partial^2 H_2}{\partial \zeta \partial \eta} \right|_{\zeta_0} A_1 B_2 + \left. \frac{\partial^2 H_2}{\partial \eta \partial \zeta} \right|_{\zeta_0} A_2 B_1 \right) + \left. \frac{1}{2} \frac{\partial^2 H_2}{\partial \eta^2} \right|_{\zeta_0} B_2^2 \end{array} \right) \quad (43)$$

It is important to note that \mathbf{A} and \mathbf{B} are 2x1 matrices. A_1 (not to be confused with the A_1 term in u) is the first component of \mathbf{A} and A_2 is the second component. The same is true for \mathbf{B} . So, to calculate the whole matrix, $(\mathbf{M}_0 \mathbf{A} \mathbf{B})$, the matrices immediately to the right of M_0 are crucial for its construction. N_0 is constructed in a similar way, however, it involves taking third order partials. Since the equation being used only has terms that go up to the second order, it is easily seen that the whole N_0 term is zero, and as such is disregarded in further calculations. Taking this into consideration produces a simplified A_1 equation where:

$$A_1 = \chi \mathbf{U}^* L_1 W U + 2\mathbf{U}^* M_0 \bar{\mathbf{U}} V_+ |W|^2 W \quad (44)$$

In order to calculate L_0 and L_1 , the coefficients of the linear terms of equations (3) and (4) are extracted so that they create a 2x2 matrix L such that

$$L = \begin{pmatrix} \frac{-\alpha\beta}{\alpha\beta+1} & \frac{-\alpha}{\alpha\beta+1} \\ \frac{2\alpha\beta+1}{\alpha\beta+1} & \frac{-\alpha^2\beta}{\alpha\beta+1} \end{pmatrix} \quad (45)$$

The expression $\frac{1}{\alpha\beta+1}$ can be expanded using a geometric series:

$$L = \begin{pmatrix} -\alpha\beta(1 - \alpha\beta + \dots) & -\alpha(1 - \alpha\beta + \dots) \\ (2\alpha\beta + 1)(1 - \alpha\beta + \dots) & -\alpha^2\beta(1 - \alpha\beta + \dots) \end{pmatrix} \quad (46)$$

Recalling that $L = L_0 + \mu L_1 + \dots$, L_0 can be thought of as L when $\beta = 0$. This results in

$$L_0 = \begin{pmatrix} 0 & -\alpha \\ 1 & 0 \end{pmatrix} \quad (47)$$

L_1 can be found with a similar approach. Instead of all β terms being set to zero, in this case, all β terms except β^1 will be defined as zero, including β^0 . This is equivalent to taking the coefficients of all β^1 terms of L . This produces the matrix

$$L_1 = \begin{pmatrix} -\alpha & -\alpha^2 \\ \alpha & -\alpha^2 \end{pmatrix} \quad (48)$$

Now, U can be calculated fairly quickly. First, find the eigenvalues of L_0 using the standard method, which turns out to simply be $\lambda = i\sqrt{\alpha}$. This also means that $\omega_0 = \sqrt{\alpha}$. U can then be found by solving the following system of equations for a and b :

$$L_0 \begin{pmatrix} a \\ b \end{pmatrix} = i\sqrt{\alpha} \begin{pmatrix} a \\ b \end{pmatrix} \quad (49)$$

It is easily seen, using basic properties of matrices and algebra, that $a = i\sqrt{\alpha}$ and $b = 1$. One thing to note is that the eigenvector is not unique. It can be scaled up or down and still be a solution; for reasons that will soon be justified, the eigenvector will be scaled by half, resulting in a final matrix:

$$U = \frac{1}{2} \begin{pmatrix} i\sqrt{\alpha} \\ 1 \end{pmatrix} \quad (50)$$

Now this is used to find U^* and \bar{U} . Beginning with U^* , it is found by using the property that $U^*U = 1$. Choosing to scale U by $\frac{1}{2}$ allows us to choose a much more simple U^* since it

is not unique. If U had not been rescaled, U^* would be more complicated and not work well with the system. Thus, U^* is

$$U^* = \frac{1}{i\sqrt{\alpha}} \begin{pmatrix} 1 & i\sqrt{\alpha} \end{pmatrix} \quad (51)$$

Then, since \bar{U} is the complex conjugate of U , \bar{U} is shown to simply be

$$\bar{U} = \frac{1}{2} \begin{pmatrix} -i\sqrt{\alpha} & 1 \end{pmatrix} \quad (52)$$

With the exception of the M_0 terms, all of the constants have been found, and that results in the following equation:

$$A_1 = \chi \frac{1}{2i\sqrt{\alpha}} \begin{pmatrix} 1 & i\sqrt{\alpha} \end{pmatrix} \begin{pmatrix} -\alpha & \alpha^2 \\ \alpha & -\alpha^2 \end{pmatrix} \begin{pmatrix} i\sqrt{\alpha} \\ 1 \end{pmatrix} W + \frac{2}{i\sqrt{\alpha}} \begin{pmatrix} 1 & i\sqrt{\alpha} \end{pmatrix} (M_0 \bar{U} V_+) |W|^2 W \quad (53)$$

Equation (53) has two terms; the first of which is very easy to calculate, the second of which is much more tedious. The first one can be solved the following way:

$$\chi \frac{1}{2i\sqrt{\alpha}} \begin{pmatrix} 1 & i\sqrt{\alpha} \end{pmatrix} \begin{pmatrix} -i\alpha\sqrt{\alpha} + \alpha^2 \\ +i\alpha\sqrt{\alpha} - \alpha^2 \end{pmatrix} \chi \frac{1}{2i\sqrt{\alpha}} \begin{pmatrix} -i\alpha^2\sqrt{\alpha} - i\alpha\sqrt{\alpha} \end{pmatrix}$$

which can be factored and simplified to the following:

$$-\chi \frac{\alpha}{2} (\alpha + 1) \quad (54)$$

In order to simplify the second term, V_+ must be calculated separately. Recall:

$$V_+ = -(\hat{L}_0 - 2i\omega_0)^{-1} M_0 U U$$

The inverse matrix must be dealt with, and the first thing that needs to be done is to add $-2i\omega_0$ to the L_0 matrix. This can be done by multiplying $-2i\omega_0$ by the identity matrix like so:

$$\begin{pmatrix} 0 & -\alpha \\ 1 & 0 \end{pmatrix} - 2i\sqrt{\alpha} \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

The scalar can then be multiplied through, and the matrices can be added component wise, which results in the matrix:

$$\begin{pmatrix} -2i\sqrt{\alpha} & -\alpha \\ 1 & -2i\sqrt{\alpha} \end{pmatrix}$$

This matrix will be defined as S_0 . The inversion of S_0 is the matrix that makes the following expression true:

$$S_0 S_0^{-1} = 1$$

One way to approach this is to insert variables into S_0^{-1} and solve it as a system of equations, which looks like the following:

$$\begin{pmatrix} -2i\sqrt{\alpha} & -\alpha \\ 1 & -2i\sqrt{\alpha} \end{pmatrix} \begin{pmatrix} a & b \\ c & d \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

This produces the following system of equations:

$$-2ia\sqrt{\alpha} - \alpha c = 1 \quad (55)$$

$$a -wic\sqrt{\alpha} = 0 \quad (56)$$

$$-2ib\sqrt{\alpha} - \alpha d = 0 \quad (57)$$

$$b -wid\sqrt{\alpha} = 1 \quad (58)$$

These are very easily solved to find that:

$$a = \frac{2i\sqrt{\alpha}}{3\alpha} \quad (59)$$

$$b = -\frac{1}{3} \quad (60)$$

$$c = \frac{1}{3\alpha} \quad (61)$$

$$d = \frac{2i\sqrt{\alpha}}{3\alpha} \quad (62)$$

Equations (60), (61), (62), and (63) can be inserted into S_0^{-1} to get that:

$$S_0^{-1} = \begin{pmatrix} \frac{2i\sqrt{\alpha}}{3\alpha} & -\frac{1}{3} \\ \frac{1}{3\alpha} & \frac{2i\sqrt{\alpha}}{3\alpha} \end{pmatrix} \quad (63)$$

Finally, the negative can be distributed to all the components of S_0 to produce the matrix:

$$\begin{pmatrix} -\frac{2i\sqrt{\alpha}}{3\alpha} & \frac{1}{3} \\ -\frac{1}{3\alpha} & -\frac{2i\sqrt{\alpha}}{3\alpha} \end{pmatrix} \quad (64)$$

Now, $(M_0 \mathbf{U} \mathbf{U})$ still needs to be calculated. Using equation (43) with $A = \mathbf{U}$ and $B = \mathbf{U}$ will result in the following:

$$\begin{pmatrix} \frac{-i\sqrt{\alpha}}{4} \\ \frac{i\sqrt{\alpha}}{4} \end{pmatrix} \quad (65)$$

Therefore, combining (64) and (65):

$$v_+ = \begin{pmatrix} -\frac{2i\sqrt{\alpha}}{3\alpha} & \frac{1}{3} \\ -\frac{1}{3\alpha} & -\frac{2i\sqrt{\alpha}}{3\alpha} \end{pmatrix} \begin{pmatrix} \frac{-i\sqrt{\alpha}}{4} \\ \frac{i\sqrt{\alpha}}{4} \end{pmatrix} \quad (66)$$

which ultimately simplifies to

$$V_+ = \begin{pmatrix} \frac{i\alpha\sqrt{\alpha}-2\alpha}{12\alpha} \\ \frac{i\sqrt{\alpha}+2\alpha}{12\alpha} \end{pmatrix} \quad (67)$$

With this, it is now possible to calculate $M_0 \bar{\mathbf{U}} V_+$. Using the same formula, except with $A = \bar{\mathbf{U}}$ and $B = V_+$, the following is produced:

$$(M_0 \bar{\mathbf{U}} V_+) = \begin{pmatrix} \frac{1}{48} + \frac{i\sqrt{\alpha}}{48} \\ -\frac{1}{48} - \frac{i\sqrt{\alpha}}{48} \end{pmatrix} \quad (68)$$

Plugging this into the overall expression, produces this:

$$\frac{1}{24i\sqrt{\alpha}} \begin{pmatrix} 1 & i\sqrt{\alpha} \\ 1 & -i\sqrt{\alpha} \end{pmatrix} \begin{pmatrix} 1 + i\sqrt{\alpha} \\ 1 - i\sqrt{\alpha} \end{pmatrix} \quad (69)$$

This expression can be simplified to

$$-i \frac{(\alpha + 1)}{24\sqrt{\alpha}} \quad (70)$$

Combining (54) and (71) results in this final equation:

$$\frac{\partial W}{\partial t} - \mathbf{D} \frac{\partial^2 W}{\partial x^2} = \varepsilon^2 \left[-\chi \frac{\alpha}{2} (\alpha + 1) W - i \frac{(\alpha + 1)}{24\sqrt{\alpha}} |W|^2 W \right] \quad (71)$$

Equation (72) is in the form of the complex Ginzburg-Landau equation, which is an equation that has well-understood wave solutions. In order to find these solutions, equation (72) must be slightly reorganized. The desired form is:

$$\frac{\partial W}{\partial t} = (1 - ic_1 |W|^2) W + (1 + ic_2) \frac{\partial^2 W}{\partial x^2} \quad (72)$$

This new form is not a drastic change, but it does introduce new constants, namely c_1 and c_2 which are not to be confused with the c_1 and c_2 from equation (34). After adding $\mathbf{D} \frac{\partial^2 W}{\partial x^2}$ to the other side, the other terms can be factored such that the new constants must satisfy the following conditions:

$$\mathbf{D} = 1 + ic_1 \quad (73)$$

$$1 - ic_2 |W|^2 = -\varepsilon^2 \chi \frac{\alpha}{2} (\alpha + 1) - i \varepsilon^2 \frac{(\alpha + 1)}{24\sqrt{\alpha}} |W|^2 \quad (74)$$

Equation (74) is in a form that is solvable with standard algebra, whereas equation (75) has potential problems. If traditional algebra were used to solve for C_2 , then C_2 would contain $|W|^{-2}$ which is not desirable since W is the solution. To avoid this, it must then be assumed that

$$1 = -\varepsilon^2 \chi \frac{\alpha}{2} (\alpha + 1) \quad (75)$$

$$c_2 = \varepsilon^2 \frac{(\alpha + 1)}{24\sqrt{\alpha}} \quad (76)$$

Using this assumption, c_1 and C_2 are shown to be

$$c_1 = -i(D - 1) \quad (77)$$

$$c_2 = \varepsilon^2 \frac{(\alpha + 1)}{24\sqrt{\alpha}} \quad (78)$$

The CGLE has known wave solutions of the form:

$$W_Q = R_Q e^{i(Qx - \omega_Q t)} \quad (79)$$

where

$$R_Q = \sqrt{1 - Q^2} \quad (80)$$

$$\omega_Q = c_1 Q^2 - (1 - Q^2) c_2 \quad (81)$$

$$|Q| < 1 \quad (82)$$

With these parameters, the wave solution takes the form:

$$W_Q(x, t) = R_Q e^{i[Qx - (-(D-1)Q^2 - (1-Q^2)\frac{\varepsilon^2(\alpha+1)}{24\sqrt{\alpha}})t]} \quad (83)$$

Thus, the behavior of the solutions to the equations presented at the beginning of this section can be studied by studying equation (84). Since the CGLE is known to have bifurcation, it is useful to know when the solutions transition from stability to instability. There are several ways of finding these conditions, but one known condition is that if

$$Q^2 < \frac{1 + c_1 c_2}{2c_2^2 + c_1 c_2 + 3} \quad (84)$$

holds, then the solution is long-wave stable. Thus, whenever this condition is not met, the solution is unstable.

Plugging equations (78) and (79) into equation (85) will allow for investigation into the stability of the specific equations used so far. These substitutions produce

$$Q^2 < \frac{1 + \varepsilon^2 (-i[\mathbf{D} + i]) (\frac{\alpha+1}{24\sqrt{\alpha}})}{\varepsilon^4 (\frac{(\alpha+1)^2}{576\alpha}) + \varepsilon^2 (-i[\mathbf{D} + i]) (\frac{\alpha+1}{24\sqrt{\alpha}}) + 3} \quad (85)$$

There are a few problems with this expression, namely that there is a matrix D , and also complex numbers. This is a problem because complex numbers are not ordered, thus it is not possible to compare sizes. There is one obvious way to deal with this problem, and one way that requires some arbitrary decisions. Beginning with the intuitive nature, ε represents a small number between 0 and 1. Thus, for a sufficiently small ε , the equation can be reduced to

$$Q^2 < \frac{1}{3} \quad (86)$$

which is known as the Eckhaus condition. Alternative, if ε is not small enough that such a condition is met, then other assumptions will have to be made.

For the sake of demonstrating how the stability of the system might change, naive and arbitrary assumptions about the system are made. Since ε is not small, $\varepsilon = 1$ is not an absurd assumption. This is completely arbitrary, as any small real value could have been chosen instead. Next, in order to deal with both the matrix and the complex numbers it will be assumed that $D = 1$. Since D is a diagonalized matrix whose values are constant, D rescales but does not affect the nature of the solution, thus this assumption may change the scale but will not affect the overall behavior. Plugging these values into equation (86) and performing simple algebra results in the simplified equation

$$Q^2 < \frac{288\alpha}{(\alpha + 1)^2 + 864\alpha} \quad (87)$$

Using the fact that Q is some arbitrary real number, and that $|Q| < 1$, it is perfectly reasonable to pick Q such that $Q = 0.9$.

Then, the solution is stable so long as $-0.0019 < \alpha < -0.0012$. Since α is a constant, it can easily be picked such that the solution is stable. However, in nature, these values are not picked out of convenience. Instead, Q and α will vary as conditions around them change. This means that the stability of the solution will also change as the conditions change. While only one example was done here, it is easy to see how with the stability condition, the solution will often fluctuate between stable and unstable.

Conclusion

The renormalization group method is an incredibly useful tool in the process of reducing PDEs to more manageable forms. If given a system of PDEs that matches the general form of this paper, that system can be immediately reduced to the form of a CGLE. Additionally, the derivation of this fact is not nearly as difficult as other methods. The ability to use the method without as much specialization makes it much more viable for wide spread use and possibly the ability to handle a greater variety of equations.

As shown with the specific set of PDEs, it's easy to apply the reduction to even complicated sets of PDEs. Doing an example that is non-linear in nature is important to the demonstration of the method, as calculating some of the unique matrices is not intuitive. Moreover, previous literature has used confusing notation, and this paper attempts to improve both the clarity of the notation, along with provide clear example of application.

One final point: it is incredibly convenient that reaction-diffusion equations can be reduced to the CGLE. Since the CGLE has been well studied along with its known solutions, it is no longer difficult to find wave solutions to PDEs that originally were not solvable with known analytic methods. This means that many PDEs that were previously only studyable with standard numerical analysis can have more meaningful information inferred through the known wave equations of the CGLE.

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